Chapter 7: MONITORING FRAMEWORK

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7. MONITORING FRAMEWORK

Monitoring serves to assess, verify as appropriate, and adapt as necessary to achieve Sustainable Forest Management (SFM), *i.e.,* the sustainable flow of ecosystem goods and services for the present and future. Through monitoring, we can determine how effective forest management activities are in producing results or meeting stated targets of the approved FMP. The end use of monitoring results is to continuously improve forest management direction using Adaptive Management.

After the FMP has been implemented for a minimum of five years, monitoring could contribute to refinement in both strategic and operational planning. Operational practices could also be refined, depending on the monitoring outcomes compared to the targets.

The Forest Management Licence #3 (FML #3) monitoring framework is divided into three main sections:

1. **Existing Monitoring** (*e.g.* pre-harvest surveys and silviculture surveys);
2. **Five-year Report Monitoring** on the approved Forest Management Plan goals and targets (*e.g.* balancing cover types); and,
3. **Future Monitoring** (*e.g.* joint projects such as moose).

Existing monitoring efforts in FML #3 continue by the FML #3 Licencee and Quota Holders. These monitoring efforts include bird monitoring, bird surveys, Pre-Harvest Surveys, silviculture surveys, harvest inspections, water crossing inspections, cutover imagery, and many different research projects.

Five years after FMP (Forest Management Plan) approval by the Province of Manitoba, an FML #3 Five-year FMP Report will be created, per the provincial 20-Year plan guidelines (Manitoba Conservation 2007). The Five-year FMP Report will provide a check to see if forest management operations and strategies being implemented are moving towards the stated FMP targets.

Future monitoring projects will be done within an Adaptive Management framework (Manitoba Conservation 2007). Ecosystems and all their interlinked ecosystem components are complex and numerous. Therefore, future monitoring will be actively pursued in partnerships with the province of Manitoba, Indigenous communities, conservation organizations, stakeholders, and educational institutions.

7.1 MONITORING CONTEXT

The framework and concepts for monitoring in FML #3 include:

1. An Adaptive Management framework will be used for monitoring;
2. Monitoring of Forest Management Plan (FMP) directions and targets will start once the FMP is approved in writing;
3. Coarse-Filter Biodiversity includes Natural Range of Variability and Indicator Bird Species;
4. Fine-Filter Biodiversity includes moose;
5. Indigenous involvement in monitoring is desirable;
6. Significant concerns brought forward during FMP development have been placed into Chapter 7 Monitoring (*e.g.* Forest Management Unit (FMU) 11 forest regeneration may be different than FMU 13 forest regeneration);
7. Citizen Science is encouraged;
8. Cost-sharing of monitoring efforts with The Province of Manitoba, conservation agencies, or academic agencies;
9. Research and monitoring grants can be sought from the Sustainable Forestry Initiative certification body, federal government, and the provincial government.
10. Mutually-beneficial partnerships are strongly encouraged; *e.g.* larger efforts such as Light Detection and Ranging (LiDAR) may only happen through a multi-agency partnership.

Science-led efforts will provide better monitoring and better conservation plans. Real-world data will be used instead of expert opinion. Active forest management activities can be a conservation tool, especially configuration of harvest that benefits wildlife habitat.

The nature of potential future monitoring projects involves both the Forest Management Licence holder and The Province of Manitoba. There are three kinds of monitoring projects regarding which agency leads the monitoring:

1. The Forest Management Licence holder only (*e.g.* tracking Natural Range of Variability, moose habitat in the FML #3 Five-year Report);
2. Joint projects which have monitoring efforts (monetary or in-kind) by both agencies (*e.g.* elk habitat and use; moose habitat use); and,
3. Projects peripheral to meeting FMP requirements, led by The Province of Manitoba but the Forest Management Licence holder may from time to time make in-kind contributions.

Joint monitoring projects are not limited to just two partners. A greater number of partners brings more expertise, ideas, experience, in-kind contributions, and sometimes financial contributions. Larger partnerships have a greater chance of obtaining grants, especially with the Sustainable Forestry Initiative forest certification body.

7.1.1 Adaptive Management

Adaptive Management (AM), also known as Adaptive Resource Management (ARM), is a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring[1].

[1]https://en.wikipedia.org/wiki/Adaptive_management [accessed Sept. 24, 2019]

Essentially, Adaptive Management is "learning by doing", rather than "learning then doing" (Lancia *et al*. 1996; Nudds 1998; and Nudds 2018). A key to different types of adaptive management is presented in Table 7.1.

Table 7.1 Key to types of Adaptive Management (Nudds and Baker 2019).

1. Deliberate attempt to evaluate policy
    - **A.** Yes.....Adaptive management; go to **2**
    - **B.** No.....Reactive management.

2. Two or more alternate policies evaluated
    - **A.** Yes.....Active adaptive management (AAM); go to **3**
    - **B.** No.....Passive adaptive management (PAM); go to **6**

3. Evaluation is prospectively planned
    - **A.** Yes.....Manipulative AAM; go to **4**
    - **B.** No.....Mensurative AAM; go to **5**

4. Evaluation uses spatial/temporal controls
    - **A.** Yes.....AAM by treatments with controls
    - **B.** No.....AAM by treatments and model selection

5. Evaluation is retrospectively assembled
    - **A.** Yes .....AAM by treatments with controls

6. Evaluation is prospectively planned
    - **A.** Yes.....Manipulative PAM; go to **7**
    - **B**. No.....Mensurative PAM; go to **8**

7. Evaluation uses spatial/temporal controls
    - **A.** Yes.....PAM by treatment with controls
    - **B.** No.....PAM by treatment and model selection

8. Evaluation is retrospectively assembled
    - **A.** Yes .....PAM by treatment with controls

Karl Popper (1959) famously stated that policy is a hypothesis that needs to be revised in light of experience. Adaptive Management is a process of policy/hypothesis testing at the scale of whole ecosystems (Walters, 1997). In forestry, Adaptive Management is a means of attaining longer-term goals sooner, through shorter-term testing of policies/hypotheses accomplished by monitoring the outcomes of management practices on forest ecosystems (Lyons *et al.* 2010).

There are two critical elements in adaptive management – the first is the need to use modeling to predict the outcomes of management decisions. The second element is the requirement that learning become an integral and linked part of the planning and management cycle and not a separate process (Rempel *et al*. 2004). We could evaluate a policy by harvesting forest in a way that improves moose habitat and could improve the moose population in absence of other factors.

For example, adaptive management can be utilized to evaluate whether a harvest pattern intended to improve moose habitat does improve moose habitat. Observing whether the moose population improves, in turn, informs – through a process known as 'strong inference' – on the merits of alternate hypotheses about the effects of other factors on moose (*e.g.,* hunting, disease, ticks, *etc*.).

Some of the differentiating characteristics of Adaptive Management are:

- acknowledgement of uncertainty about what policy or practice is "best" for the management issue;
- thoughtful selection of the policies or practices to be applied (the assessment and design stages of the cycle);
- careful implementation of a plan of action designed to reveal the critical knowledge that is currently lacking;
- monitoring of key response indicators;
- analysis of the management outcomes in consideration of the original objectives; and,
- incorporation of the results into future decisions.

7.1.2 Predictive Modeling and Testing Assumptions

Another key element of an adaptive management approach to forest management is the use of predictive modeling to assist with the design of monitoring and research projects. Through scenario planning, we predict possible future forest conditions. This is based on a combination of different strategies that were designed to achieve different management objectives. These future landscapes are assessed for a suite of desired features, in terms of location and attributes, based on the expected outcomes of the management strategies. The monitoring program is designed to assess the outcomes in terms of data and new knowledge that can be used to assess the effectiveness of strategies, key assumptions, and uncertainties.

A Sustainable Forest Management (SFM) framework should involve several key elements (after Rempel *et al.* 2004):

1) establishing a clear set of values and goals;
2) planning actions that are most likely to meet those goals;
3) implementing appropriate management activities;
4) monitoring the outcomes of management to check on predictions (*e.g.* 5-year report);
5) evaluating monitoring outcomes and adjusting management if goals were not met; and
6) revisiting goals based on new knowledge gained about the system.

The elements of the SFM Framework are linked together using of a suite of indicators arranged within a hierarchical structure. A suite of indicators has been developed within the FMP to assess and evaluate the ability of the management scenarios tested to achieve the desired future forest condition in terms of ecological, social and economic values.

There are several criteria to consider when selecting indicators (Hannon and Macallum, 2004) including:

- effectiveness
- ability to measure during a specified time period
- relate to the issue
- responsive to management actions
- cost efficient

Indicator selection should be based on linking the indicators to important processes, structures and compositions in the forest that may be altered by forest management activities (Rempel *et al*. 2004).

7.1.2.1 Prescriptive Indicators

Compliance or management control indicators are used in scenario planning to describe the desired Future Forest Condition (*e.g*. a range of harvest patch sizes). Prescriptive indicators are chosen to represent structural, functional, or compositional forest elements that are likely to be different after harvesting, relative to after natural disturbances (*e.g*. different amounts of snags and coarse woody debris, patch size distribution, connectivity, and old seral stages).

7.1.2.2 Evaluative Indicators

Evaluative (passive) indicators are used to test whether the future forest condition achieves the desired values and management objectives (*e.g*. species richness), provide new knowledge, and promotes continued learning that feeds into the adaptive management process.

> *"Good evaluative indicators should be sufficiently abundant and widespread within specific habitats to monitor, be in the core of their range, and exhibit low temporal and spatial variability to enable ease of census"* (Dufrene & Legendre 1997 in Rempel *et al.* 2004).

Furthermore, evaluative indicators are closely related to the original objectives, but represent essentially unproven hypotheses that must be continually tested. For example, if we implement Variable Retention harvesting, we will have more cavity-nesting birds. We have hypothesized a 'cause and effect' linkage. The prescriptive indicator allows the plan to be compared directly to the outcome. The evaluative indicators allow the effectiveness of the prescription itself to be assessed (Rempel *et al.* 2004).

Future research and monitoring projects may be developed in collaboration with other provincial and national level partnerships. Additional input to research priorities or monitoring requirements can be obtained from consultation with stakeholders, public advisory committees, other resource managers, and the Province.

7.2 EXISTING MONITORING

The current and existing monitoring of actual activities for roads, crossings, harvest areas, volumes, and all renewal efforts will be continued. Forest operations will be monitored to ensure compliance with operational prescriptions. Monitoring will also identify the effect of forest management activities on forest cover and forest values.

The following monitoring programs are included in the existing monitoring section:

- Bird Species at Risk Surveys
- Pre-Harvest Surveys
- Growth and Yield studies
- Harvest Inspections
- Cutover Imagery
- Forest Renewal Assessments
- Stream Crossing Inspections
- Road Decommissioning
- Forest Certification (SFI Audits)
- Invasive Insects

The remainder of this section describes:

1. an overview of each active monitoring program;
2. Standards for data collection, forms or details as appropriate; and,
3. If the Provincial Government has a similar program (*e.g.* insect surveys), there is a description of how the monitoring program will be coordinated with similar programs.

7.2.1 Bird Species at Risk Surveys

Bird species at risk surveys are performed in proposed summer cutblocks listening for birds classified as species at risk. Surveys are done to avoid summer harvest in blocks that contain bird species at risk.

Proposed cutblocks that would have harvesting activity during the bird breeding season are screened for species at risk birds. Field staff digitally record bird calls in these proposed summer harvest blocks. The digital recordings are sent to bird experts who identify the bird calls. These data are put into a data base of summer bird observations. If any proposed summer cutblocks contain bird species at risk, harvest is deferred until after the bird breeding season is over.

The dates that bird species at risk sampling can occur is weather-dependent, but typically sampled between June 1st and June 21st of each year. Bird point samples are planned on a transect within the proposed summer harvest blocks. Transects are a minimum distance of 50 m from the block edge. The point samples along the transect are a minimum 250 m apart to avoid recording the same birds twice. Field staff arrive on site at 5 am with sensitive recording equipment. A 12-minute recording of the birds is taken at each point sample. Field sampling ceases at 9 am. Excessive wind or rain compromises the bird recordings, since the wind and raindrop noise mask any bird songs.

7.2.2 Growth and Yield studies

The growth portion of 'growth and yield' requires repeated measures data or dendrochronological destructive sampling. Permanent sample plots are the most common form of repeated measures data. Yield typically refers to a single measurement of the quantity of wood, measured from a temporary plot. Timber cruising or Pre-Harvest Survey (PHS) is the most common form of yield measurement. PHS measures many ecosystem components in addition to the wood (*e.g.* wildlife, soil, vegetation *etc.*).

7.2.2.1 Permanent Sample Plots

Permanent Sample Plots (PSPs) have been established and remeasured in different forest cover types. Mature, fire-origin stands were the earliest and largest PSP dataset. These plots were mostly established in aspen (H) and aspen-mixedwood (N) stands. Harvested and regenerated aspen PSPs exist in a mixedwood experiment, a grazing trial, and in regenerating aspen cutovers.

Mature Fire-Origin Plots

The Environment Act Licence 2191E required LP to establish Permanent Sample Plots (PSPs). PSPs were established in fire-origin hardwood and hardwood mixedwood stands. Some post-harvest regeneration PSPs were established in regenerating hardwood stands from 2011 to 2016. PSP remeasurements provide growth data by comparing the original PSP measurement metrics to current PSP measurements. Remeasurements provide valuable growth data that temporary sample plots cannot.

Standards for PSP data collection are outlined in the PSP manual (Appendix I). PSP data has previously been sent to the Province of Manitoba's Forest Inventory and Analysis section of Forestry and Peatlands Branch.

Young Harvested Aspen Stands

LP established a mixedwood (aspen and white spruce) density experiment in 1998 and continues to remeasurement the plots. The 20th year full remeasurement was completed in the fall of 2018. These measurements included pure spruce plots, various spruce-aspen and aspen-spruce mixedwood plots, and some pure aspen under various densities. The next scheduled remeasurement is fall 2021, when the experimental site will be 23 years old.

The Garland Grazing Trial was a combination of harvesting and controlled cattle grazing. Fenced enclosures with no grazing provided regeneration control plots. This trial was established in the spring of 2000. These permanent plots have been remeasured every five years, including the 20th year remeasurement in early summer 2020.

A third group of harvested and regenerated young aspen consists of plots re-established in hardwood cutovers in the spring of 2014. These plots, once remeasured, will assist in quantifying growth rates of regenerated aspen cutovers.

7.2.2.2 Pre-Harvest Surveys

Pre-Harvest Surveys (PHS) are a site-specific ecosystem assessment of mature forest, which is a proposed harvest area. PHS survey points are on a 150 m systematic grid with a random start. Pre-harvest surveys collect site-specific information which contributes to harvest prescriptions, silvicultural prescriptions, ecosystem classification, volume assessments, and benchmarking the pre-harvest forest condition. Pre-Harvest Surveys are conducted on all blocks allocated for harvest and provide information for the planner to determine the appropriate season of harvest and renewal prescription. Exceptional features such as unmapped streams or wildlife features are also field mapped.

Standards for data collection are outlined in the Pre-Harvest Survey manual (Appendix II). The PHS manual for the Mountain Forest Section meets or exceeds the standards described in provincial PHS guideline.

Bubble cards are scanned with a card reader, making the PHS data digital. These data are used to create PHS reports by cutblock. These PHS reports are used in mitigation with the local Integrated Regional Management Team. PHS reports data also appears on the Cutblock Prescriptions which form a significant part of the Operating Plans.

7.2.3 Harvest Inspections

Harvest inspections are performed on all harvest blocks to ensure the planned prescription is met, and that the Standard Operations Guidelines are being followed. Both LP operations staff and provincial Conservation Officers complete inspections on harvest blocks. Harvest inspections are performed to ensure work permit conditions are met during and following harvest operations. The inspection frequency is usually related to the speed at which operations are proceeding, meaning that if harvest activities are moving at a fast rate then the inspection frequency may be increased.

The province of Manitoba also performs harvest inspections to provide an additional check to ensure that proper forest management practices are being performed. A minimum of one final inspection from the Province of Manitoba was completed on each block to ensure that all harvest operations and road closures have been completed before final clearance is given to the Work Permit Holder.

The 'Harvesting and Roads Monitoring/Inspection form' is shown in Appendix III. Once completed, these forms are scanned. The paper and digital versions are filed by Forest Management Unit and by block number.

Copies of the Province of Manitoba cutblock inspections are also filed by Forest Management Unit and by block number. Both paper and digital versions exist for provincial inspections.

7.2.4 Cutover Imagery

In FML #3, airborne imagery or sometimes satellite imagery is obtained for all cutovers annually, for both LP and Quota Holder cutovers. The boundaries of the cutovers are delineated, digitized, and then mapped. All photos and imagery are archived, since the cutover records are important historically. Many other users, such as silviculture, planners, and researchers utilize the cutover information.

The imagery standard is a minimum resolution of 1 m pixels on the ground. The leaf-on summer imagery is collected with two separate cameras in the aircraft. A normal colour camera is used to capture imagery, as well as a near-infra red colour camera.

Once the imagery is received, the cutover boundaries are delineated by the field staff that harvested the block. These boundaries are reviewed and combined into a cutblock shape file for each year's harvest.

Copies of the cutover shape files are submitted to the provincial government. Typically, this occurs in conjunction with submission of the FML #3 Two-Year Report (formally Annual Reports).

7.2.5 Forest Renewal Assessments

Forest renewal assessments are required on all LP and Quota Holder harvest blocks. The primary reforestation goal is to regenerate all harvested stands to meet or exceed provincial forest renewal standards and acquire a 'Certificate of Reforestation' from the province of Manitoba. Forest renewal assessments are the mode of measurement to determine the silviculture success metrics (*i.e.* percent stocking, stems per ha, and second-growth tree heights).

The silviculture survey data collected provides numerous benefits, such as:

- reporting on the status of harvested areas;
- analysis of site-specific treatment responses;
- establishment of relationships; and
- development of trends.

Softwood 'S' and mixedwood 'M' harvest sites are monitored via forest renewal assessments 10 years after harvest. The Mountain Forest Section Renewal Company surveys Quota Holder softwood and softwood-mixedwood renewed stands.

The standards for softwood forest renewal assessment data collection standards are outlined in the provincial forest renewal assessment manual (Manitoba Sustainable Development 2019). Digital survey data and maps are submitted to the Province of Manitoba annually in the 'ledger format' that facilitates provincial data consistency and ease of data import.

Hardwood 'H' and hardwood mixedwoods 'N' sites are surveyed for both LP and Quota Holder hardwood cutovers. Hardwood surveys are completed at ages three to five years after harvest.

The standards for forest renewal assessment data collection standards are outlined in the provincial forest renewal assessment manual (Manitoba Sustainable Development 2019). A survey package is annually submitted to the province of Manitoba that includes:

- summary table of each year's renewal assessments
- summary table of cutblock-level silviculture data;
- survey database (Microsoft Access);
- summary for each block;
- internal check cruise results;
- scans of completed field maps;
- maps of plot centers with colour orthophotography background; and
- GIS shape files.

The above-mentioned digital submission is in the 'ledger format' that facilitates provincial data consistency and ease of data import.

7.2.6 Stream Crossing Inspections

Road building and installation of stream crossings, such as culverts and bridges, are well-recognized as one of the forest management activities with the greatest potential to have adverse effects on aquatic systems. To avoid and minimize the potential for deleterious effects to aquatic systems, a tracking system and monitoring protocol was developed to monitor stream crossing installations, use and decommissioning. This system is consistently applied across FML #3 for all water crossings. The primary objective of this program is to ensure that effects from the construction and removal of water crossings will not impair water quality, fish or fish habitat within permanent or seasonal streams.

For all active water crossings (bridges and culverts), inspections and checklists are completed twice a year. The spring inspections are conducted between April 1st and June 1st, while the fall inspection is conducted between the dates of September 1st and November 1st before freeze-up occurs. These inspections ensure water crossing and erosion and sediment control techniques applied during the installation phase of the crossing are stable enough to withstand spring runoff and peak flow events.

For all deactivated water crossings such as bridges and culverts, inspections and checklists are completed twice a year, until vegetation has stabilized the exposed soil for two growing seasons. Digital photos are taken at the time of the inspection along with the completion of the Water Crossing Checklist form (Appendix IV).

7.2.7 Road Decommissioning

The length of existing and new roads constructed by both Quota Holders and LP in FML #3 is tracked in the FML #3 Two-Year Reports. Monitoring of roads has recently been expanded from existing and new road construction to include road decommissioning, which began in the 2017-2018 operating year (Appendix V). The standards for road decommissioning data collection use either aerial imagery or ground-based GPS data collection.

7.2.8 Forest Certification SFI Audits

Forest certification is not about collecting data, but instead requires evidence proving compliance with the certification standard. The Sustainable Forestry Initiative (SFI) Forest Certification Program https://www.sfiprogram.org/sfistandards/ is one of the world's most widely applied standards. SFI is also one of several voluntary systems that offers a means for companies and governments to demonstrate their commitment to responsible forest management. The SFI Program contains a comprehensive set of principles, objectives, and performance measures that were developed by foresters, conservationists and scientists. It combines the growing and harvesting of trees with the protection of wildlife, plants, soil, and water quality. An independent multi-stakeholder Sustainable Forestry Board governs the SFI Program and is the sole body responsible for the content of the SFI Standard and the Audit Procedures and Qualifications.

Adherence to the SFI certification standards is assured through the application of a series of operating guidelines and work instructions, supported by operator training and audits. These audits involve a review of documentation as well as field inspections, to provide evidence for the core indicators in the SFI forest certification program. SFI audit summaries for both LP and Spruce Products Ltd. are available on the web and in Appendix VI.

7.2.9 Invasive Insects

There is a potential for these invasive insects to become more prominent and be a problem in the future:

- Emerald Ash Borer – risk is greater to urban areas since there are no ash dominant stands within FML #3
- Mountain Pine Beetle – has the potential cross over to jack pine and red pine
- Gypsy Moth – a defoliator with a strong preference for hardwoods, but can also affect softwoods

Note that the Province of Manitoba monitors for these invasive species and will notify the Forest Management Licence holder if any invasive insect outbreaks occur near or within FML #3. If necessary, the Province of Manitoba will implement a management plan and communicate with the FML holder on potential mitigation strategies, such as salvage harvests.

7.3 FIVE-YEAR REPORT FMP MONITORING

This section outlines 20-year Forest Management Plan (FMP) monitoring elements that would be included in future five-year reports and two-year reports for FML #3 (Table 7.2). A five-year forest report summarizes five years of forestry actual activity and compares it to planned objectives in the Forest Management Plan, five years after FMP approval. The five-year forest report contains tables and text to describe forestry activities. The forest reports would discuss how the management objectives, targets, and strategies are being achieved during each five-year term. Reporting on results provides a way to measure progress on targets of FMP planned strategies.

Table 7.2. Two-year and five-year reports over the lifespan of the approved 20-year Forest Management Plan.

FMP Year	Planning	2-yr Reports
	submission of final revised FMP **Terms of Reference** (signed: July 29th, 2019) Submission of **new FMP** (Dec. 19th, 2019) **FMP approval** by provincial government – *expected date Dec. 2021*	2-year reports of actual roads, crossings, harvest, and renewal
1 2	1st year of approved FMP	2-year Report
3 4		2-year Report
5 6	5-yr Report (FMP Years 1- 5) – *due at the end of year 6*	2-year Report
7 8		2-year Report
9 10		2-year Report
11 12	5-yr Report (FMP Years 6 - 10) – *due at the end of year 11*	2-year Report
13 14		2-year Report
15 16	5-yr Report (FMP Years 11 - 15) – *due at the end of year 16*	2-year Report
17 18		2-year Report
19 20	5-yr Report (FMP Years 16 - 20) – *due at the end of year 21*	2-year Report

7.3.1 Land Base 5-Year Update

The spatial land base for FML #3 was a foundational piece of the 20-year Forest Management Plan (FMP). The 2020 land base was utilized by many different aspects of the plan, including:

- Natural Range of Variation – seral stages
- Bird modeling
- Moose modeling
- Marten winter cover modeling
- Cover type stability
- Carbon stocks, both upland and wetland
- Wood flows

Without updating the land base, none of the above-listed FMP aspects can be updated either. Therefore, the land base update is very significant. Five years after FMP approval, the spatial land base would be updated to allow five-year reporting of the above-listed FMP components. These components are also detailed in the following sections.

Data required would be all disturbances (*i.e.* fire, insect, disease, windthrow, and harvesting), as well as any administration boundary changes. The FML holder would supply all harvest disturbance boundaries and information. The Province of Manitoba would need to provide the fire, insect, disease, and windthrow spatial data. The Province of Manitoba would also provide spatial data on any administration boundary changes. All three of these updates would be required to accurately update the land base. The FML holder would retain a consultant to spatially incorporate these changes. The resulting updated land base would then be used for many different purposes, including updating aspects of the FML #3 Five-Year Report.

7.3.2 Natural Range of Variability

Natural Range of Variability (NRV) refers to the spectrum of ecosystem states and processes encountered over a long time period, typically dominated by wildfire disturbance. Two important metrics of NRV include seral stages and patch sizes.

0NRV Seral Stages
Seral stages are groups of forest ages. In general, the NRV seral stages have grouped seral stages for all species groups by 40-year age classes:

- **Young** Seral Stage (0 – 40 years old);
- **Immature** Seral Stage (40 – 80 years old, except immature hardwoods which are 40 – 60 years old);
- **Mature** Seral Stage (80 – 120 years old, except mature hardwoods which are 60 – 120 years old); and
- **Old** Seral Stage (120 years and older).

Natural Range of Variability (NRV) analysis for the Duck Mountain area (Andison 2019) has estimated the natural proportions of young, immature, mature, and old seral stages (Figure 7.1). The Forest Management Plan has an objective to move the mature and old seral stages closer to the natural proportions. Therefore, these seral stages would be monitored in the future.

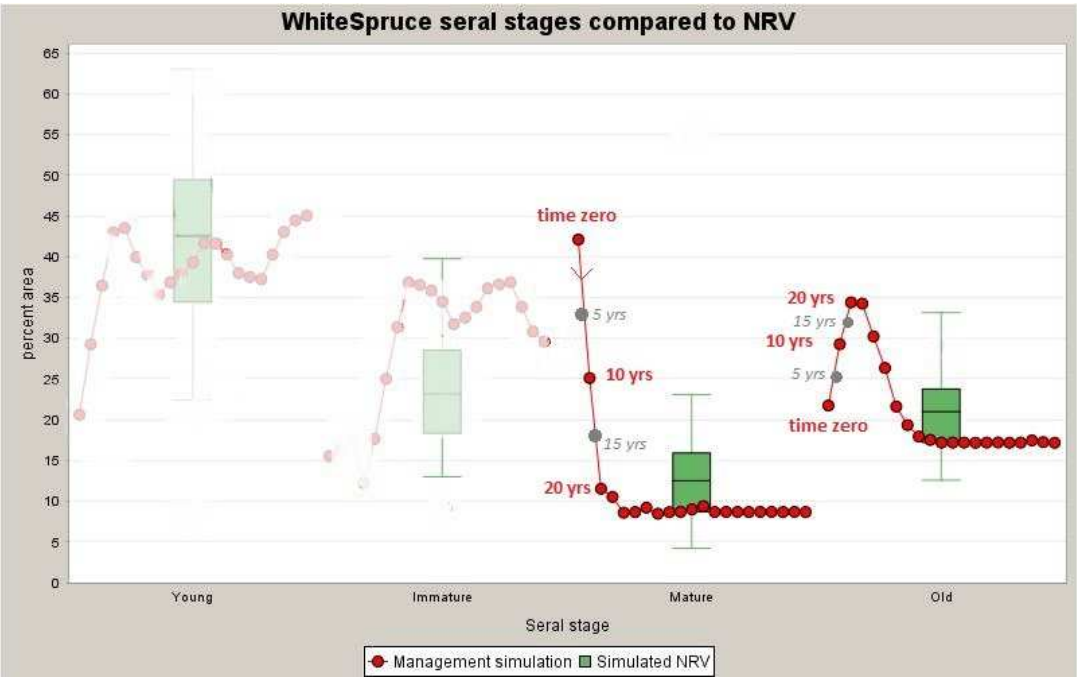

Figure 7.1 Example of tracking mature seral stage and old seral stage white spruce across FML #3.

Strategic planning in the Forest Management Plan was done in 10-year increments. Therefore, 10 and 20-year reviews of land base seral stage actuals would be compared to planned seral stage proportions. However, it may be possible and desirable to interpolate 5-year increments of seral stages between the time zero (starting condition in the year 2020) and 10-years. This potential 5-year review of seral stage targets would necessitate updating the entire land base at five years in addition to a 10-year land base update. Note that all stand-replacing disturbances (harvesting, fires, insects, disease, and blow down) would need to be incorporated into the land base update. Also note that the Province of Manitoba is responsible to provide information on the natural disturbances, which includes fires, insects, disease, and blow down.

Natural Range of Variation (NRV) seral stage trends for mature and old seral stages are proposed to be compared (Table 7.3) in the first 5-year report, post-FMP approval. This will show if forest management activities are moving the forest towards the natural seral stage range target. Mature seral stages and old seral stages will be compared by species group (*i.e.* white spruce, black spruce, jack pine, deciduous, and mixedwood).

Table 7.3 Proposed comparison of planned and actual seral stage targets.

Species Group	**Seral Stage**	**2020 Start Condition** (%)*	**5 Year Actual** (%)	**10 Year Planned** (%)	**10 Year Actual** (%)
White Spruce	Mature	42%		26%	
	Old	21%		30%	
Black Spruce	Mature	31%		23%	
	Old	33%		41%	
Jack Pine	Mature	43%		34%	
	Old	17%		20%	
Mixedwood	Mature	59%		44%	
	Old	11%		22%	
Hardwood	Mature	48%		41%	
	Old	2%		10%	

*percent (%) of landbase by species group

NRV Patch Sizes

Fire has historically been the primary form of forest disturbance in the boreal forest. There have been very few fires in FML #3 in the recent past. Therefore, harvesting disturbance can emulate the natural fires, assuming the patch sizes of harvesting approximates natural fire patch sizes.

Public input showed some acceptance of incorporating larger disturbances into the landscape to better emulate fire patterns, but very large harvest blocks would have adverse effects on aesthetics and perhaps other values. A broader range of harvest block sizes (Table 7.4) is modestly proposed. This represents another coarse-filter strategy for biodiversity conservation.

Natural Range of Variation was modeled in 10-year planning periods. Five-year (post-FMP approval) patch size results can be generated from a summary of actual cutblock sizes. Maintaining a functional landscape pattern of forest cover and habitat types is achieved by scheduling the harvest of blocks to emulate natural disturbance patterns, such as patch size distribution.

Table 7.4 Proposed comparison of planned and actual harvest patch size distribution.

Patch Size (ha)	Proposed Patch Sizes (%)	5 Year Actual Patch Sizes (%)	10 Year Actual Patch Sizes (%)	15 Year Actual Patch Sizes (%)	20 Year Actual Patch Sizes (%)
0 to 5	0%				
5 to 50	10%				
50 to 250	10%				
250 to 500	25%				
500 to 1,000	50%				
1,000 plus	5%				

7.3.3 Bird Species at Risk

There were enough bird data (469 observations) to model probability of habitat occupancy for the bird species at risk Canada Warbler (CAWA). The model shows an increase in CAWA habitat under the Moose Emphasis forest management scenario (Figure 7.2).

If enough new Canada Warblers are observed, then the new data could be pooled with the existing 469 observations. The pooled data could be re-analyzed and examined for different trends to confirm or modify the original modeled Canada Warbler habitat future projections.

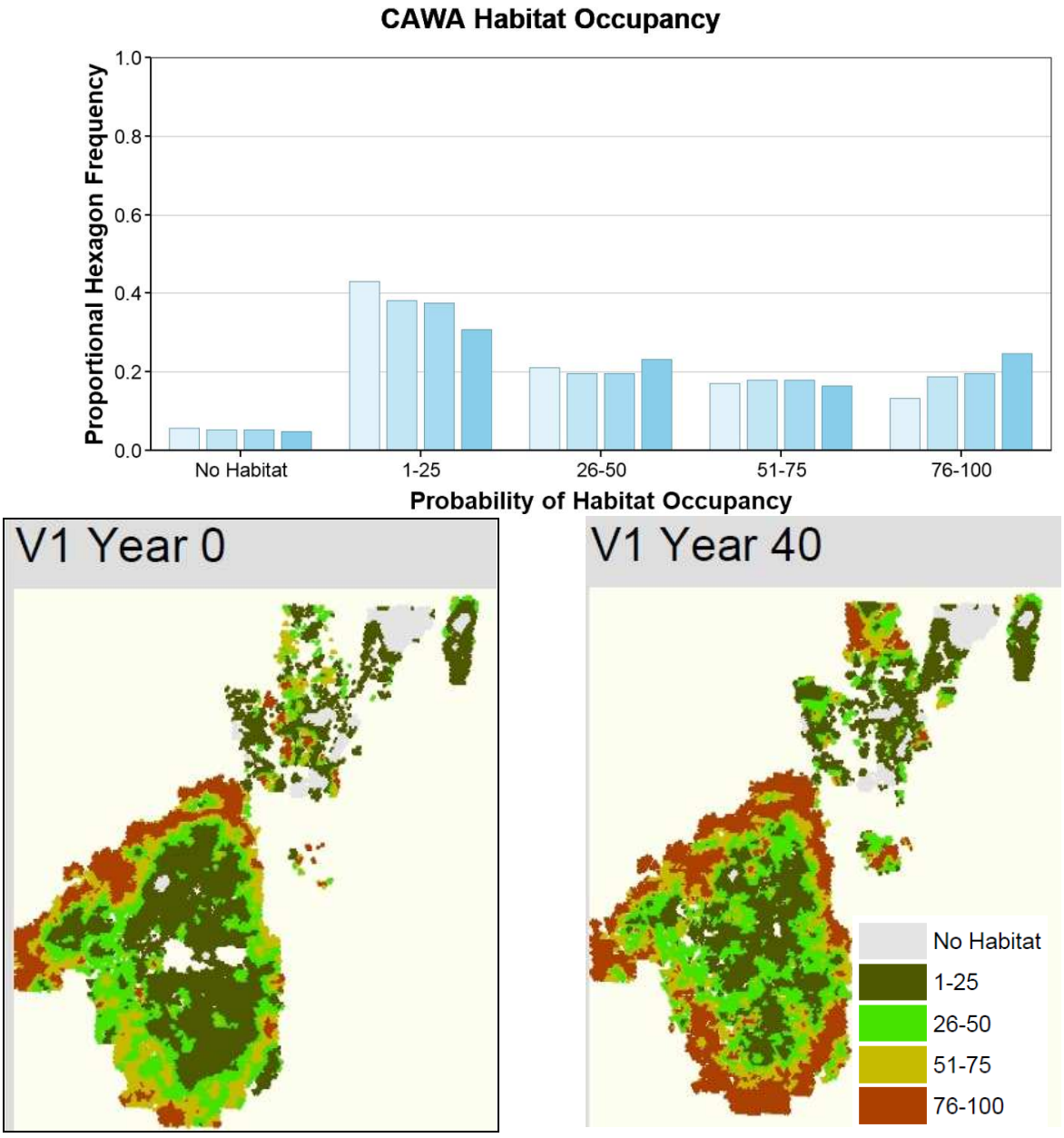

Figure 7.2 Canada Warbler projected habitat from time zero (left) to year 40 (right).

There is currently insufficient data to model the bird species at risk Golden Winged Warbler (GWWA). The GWWA only has 21 observations to date, which is far too little data to build a model. A habitat model could be built in the future if there are significantly more observations.

The Olive Sided Flycatcher (OSFL) does not have enough data to model OSFL probability of habitat occupancy. OSFL has only 45 observations to date. A habitat model could be built in the future if there are significantly more OSFL observations.

7.3.4 Indicator Bird Species

The Spatial Landscape Assessment Model (SLAM) output demonstrates the potential different habitat niches in the forest, represented by indicator bird species (Table 7.5). Indicator bird habitat occupancy projections can be confirmed or modified in the future if additional data become available.

Table 7.5. Linkages between indicator bird species, and FMP strata.

Common Bird Name	Habitat Preference			Forest Management Plan Strata
	Age	Canopy	Forest Type	
American Redstart	Either	Open	Either	All HWD and MWD units only
Black-capped Chickadee	Either	Open	Either	All strata
Brown-headed Cowbird	Either	Open	Deciduous	All strata
Blue-headed Vireo	Old	Closed	Either	All strata (except HDW1 & HWD3)
Boreal Chickadee	Old	Closed	Either	All strata (except HDW1 & HWD3)
Brown Creeper	Old	Closed	Either	All strata
Common Yellowthroat	Young	N/A	Wetland	SWD4 only
Chestnut-sided Warbler	Either	Open	Deciduous	All HWD and MWD units only
Golden-crowned Kinglet	Old	Closed	Coniferous	All Strata (except HDW1 & HWD3)
Hermit Thrush	Old	Open	Either	All Strata (except HDW1 & HWD3)
Ovenbird	Old	Closed	Either	All Strata
Red-eyed Vireo	Old	Open	Deciduous	All Strata
Swainson's Thrush	Old	Open	Coniferous	All Strata (except SDW2 & SWD4)
Veery	Old	Closed	Deciduous	All HWD and MWD units only
Winter Wren	Either	Closed	Coniferous	All Strata (except HDW1 & HWD3)
Yellow-bellied Sapsucker	Old	Open	Either	All HWD and MWD units only
Yellow Warbler	Young	Open	Deciduous	All HWD and MWD units only

7.3.5 Cover Type Stability

The cover types (S-softwood, M-softwood mixedwood, N-hardwood mixedwood, and H-hardwood) are stable across the landscape (Figure 7.3). Cover type stability is important, since some wildlife species rely on specific cover types as part of their life requirements. Therefore, maintaining the landscape-level cover type balance is an important part of coarse-filter biodiversity.

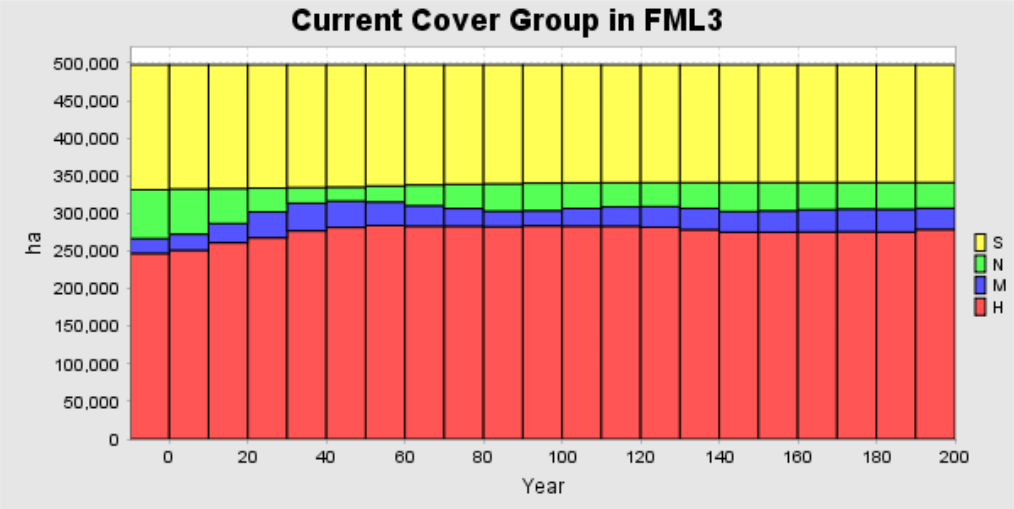

Figure 7.3 Cover type estimates from time zero to 200 years in the future across FML #3.

It is proposed to compare the 2020 existing (start condition) cover type distribution (Table 7.6) to five-year actual cover type distribution by percentage and area.

Table 7.6 Proposed cover type tracking in the five-year report.

Cover Group	2020 Start Condition (% and area of FML #3)	5 Year Actual Cover Groups (%)	10 Year Actual Cover Groups (%)	15 Year Actual Cover Groups (%)	20 Year Actual Cover Groups (%)
S - softwoods	33.4% 166,262 ha				
M – softwood mixedwoods	4.0% 19,677 ha				
N – hardwood mixedwoods	13.0% 64,842 ha				
H - hardwoods	49.6% 246,927 ha				
totals	**100% 497,708 ha**				

Potentially, we could explore maintaining cover types across environmental gradients. Cover type would be sub-divided by the ecological strata used all modeling of this Forest Management Plan (Table 7.7), in addition to cover type. Note that the 13 ecological strata (SWD1, SWD2, … HWD3) are fully compatible with the four cover types (*i.e.* S, M, N, H). Also note that the ecological strata are based on 24 ecosites, classified by Arnup *et al.* 2006 for the Duck Mountain Provincial Forest.

Table 7.7 Potential sub-division of cover types by ecological strata.

Cover Group	Ecological Strata	Ecosites
S - softwood 166,262 ha (33.4%)	**SWD1** – dry sandy	13, 24
	SWD2 – average moisture on clay	36
	SWD3 – wet sand or wet clay	43, 53
	SWD4 – organic soils	61
	SWD5 – organic soils, bogs and fens	62, 63, 64
M – softwood mixedwood 19,677 ha (4.0%)	**MWD1_M** – dry sandy	None sampled
	MWD2_M – average moisture on clay	34, 35
	MWD3_M – wet sand or wet clay	42
N – hardwood mixedwood 64,842 ha (13.0%)	**MWD1_N** – dry sandy	12, 23
	MWD2_N – average moisture on clay	31, 33
	MWD3_N – wet sand or wet clay	52
H - hardwood 246,927 ha (49.6%)	**HWD1** – dry sandy	11, 21, 22
	HWD2 – average moisture on clay	32
	HWD3 – wet sand or wet clay	41, 44, 51

7.3.6 Winter Moose

In the moose emphasis scenario described in chapter 5 of the Forest Management Plan (FMP), winter moose habitat is modeled over time (Figure 7.4).

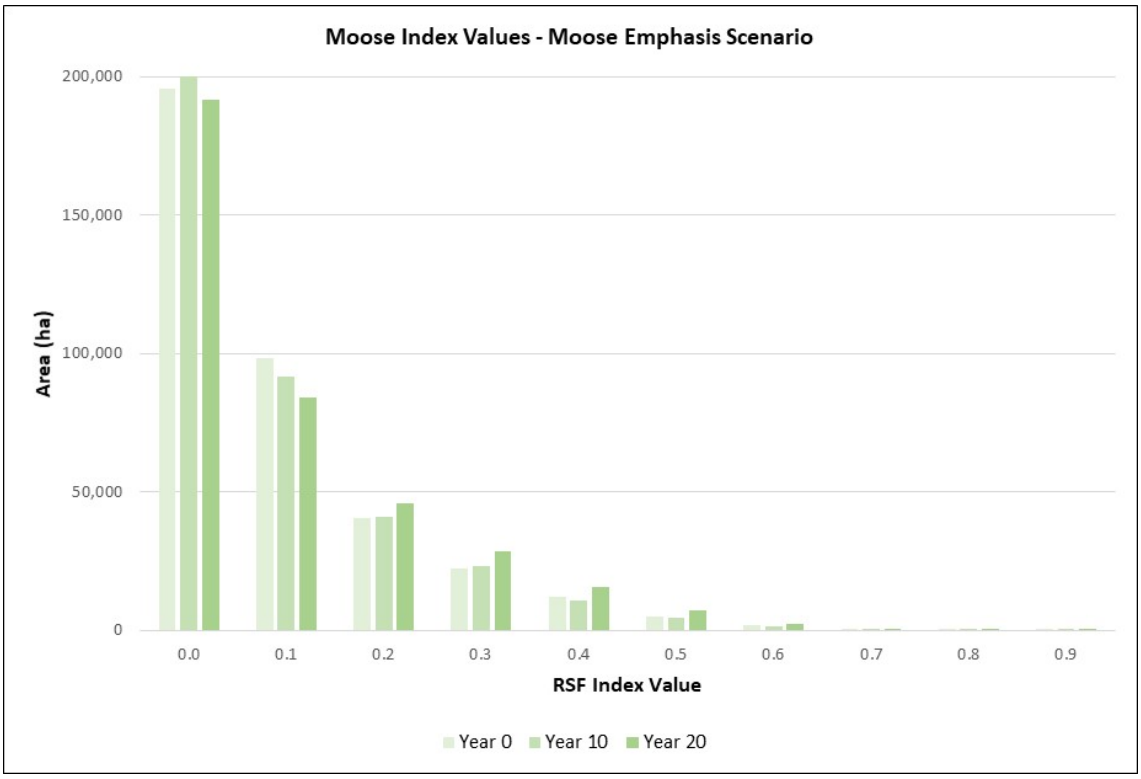

Figure 7.4. Winter moose habitat modeled estimates over the life of the 20-Year Forest Management Plan.

These winter moose habitat estimates are based on the spatial mixture of stand age, distance to water, and distance to roads. Note that young stands provide moose forage, while older stands provide moose cover. Moose habitat is classified on a scale of 0.0 to 1.0, with 1.0 being the best winter moose habitat (Table 7.8).

Table 7.8 Modeled winter moose habitat units from 2020 (time zero) to 20 years in the future.

	Winter moose habitat quality (0.0 to 1.0)											
Year	**0.0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**Total Habitat Units across FML #3**
Year 0	195,501	98,292	40,413	22,525	12,347	4,952	1,781	568	178	79	0	**15,852**
*Yr 5**	*199,154*	*94,989*	*40,809*	*22,835*	*11,686*	*4,836*	*1,682*	*454*	*135*	*53*	*0*	
Year 10	202,808	91,686	41,206	23,146	11,025	4,720	1,583	341	92	28	0	**15,001**
*Yr 15**	*197,253*	*87,819*	*43,656*	*25,972*	*13,330*	*6,064*	*1,981*	*423*	*107*	*32*	*0.5*	
Year 20	191,698	83,951	46,106	28,798	15,635	7,409	2,378	504	121	35	1.0	**20,506**

**years 5 and 15 are interpolated values between the 10-year modeling periods.*

In the 5-year FMP reports, winter moose habitat unit estimates could be compared to actual habitat units. An updated landbase would be necessary to update the winter moose habitat units.

7.3.7 Marten Winter Cover

Marten winter cover habitat estimates were based on modeling projections, from the opinion-based HSI model provided by the Province of Manitoba. A baseline of marten winter cover was estimated for the year 2020, which is the beginning of the Forest Management Plan (FMP). Future estimates, based on changes to the forest cover, were also estimated.

The 2020 marten habitat projections can be re-estimated post-FMP approval (Table 7.9) by using an updated land base that accounts for disturbances, growth, and succession. This land base would be updated to include actual changes in forest stands. For example, all forest stand ages can be increased by five years. Actual harvested areas age would be reset to zero, or the year the block was harvested.

Table 7.9 Marten Winter Cover Habitat Units across the landscape

Year	Planned MOOSE EMPHASIS scenario *(habitat units)*	5-Year Actual	10-Year Actual	15-Year Actual	20-Year Actual
0 *(baseline in 2020)*	50,667				
5*	45,842				
10	41,016				
*15**	*38,659*				
20	36,302				

**years 5 and 15 are interpolated values between the 10-year modeling periods.*

Marten winter cover habitat unit values are heavily benefitted by dense conifer stands. Natural stand aging and break-up changes these dense conifer stands (crown closure class 3 with a Suitability Index of 1.0) to older open stands (crown closure class 2 with a Suitability Index of 0.5). Reducing the Suitability Index of variable 3 by 50% (1.0 down to 0.5) has a significant landscape-level effect on future marten winter cover.

Mature seral stage conifer is highly beneficial to marten winter cover. However, undisturbed mature seral stage stands age and become old seral stage conifer stands with significantly less value to marten. Old seral stage stands are less dense and have a lower marten winter cover value.

The solution to maintaining mature seral stage conifer stands is follow the Natural Range of Variability targets and provide a steady supply of young and immature conifer stands over time, which will transition into mature conifer stands.

7.3.8 Limit disturbances within watersheds

Both the Baseline and Moose Emphasis Forest Management Scenarios ensure that never more than 30% of a watershed is planned to be in a harvested state. The values in Table 7.10 are planned projections based on the disturbance criteria of less than 5 years for hardwood types and 10 years for softwood types. This disturbance calculation applies only to disturbances within FMU 13 (Duck Mountain Provincial Forest) based on the total productive area of the entire watershed.

Table 7.10 Watershed limits (%) over time.

Watershed	Baseline 2020	Planned 5 yrs	Actual 5 yrs	Planned 20 yrs	Actual 20 yrs
ASSINIBOINE	0.31	0.09		0.08	
CENTRAL VALLEY	1.48	0.84		1.13	
CRANE	0.0	0.0		0	
FISH MINK CREEK	0.69	0.18		0.26	
FORK RIVER	0.51	0.16		0.46	
GARLAND RIVER	1.94	1.81		1.29	
HAMELIN DRAIN	0.0	0.0		0	
KETTLE HILLS	0.0	0.0		0	
LOWER ROARING	0.52	0.37		1.03	
LOWER SHELL	0.33	0.19		0.38	
LOWER SWAN	0.01	0.17		0.04	
LOWER TURTLE	0.0	0.0		0	
LOWER VALLEY SILVER CREEK	0.76	0.6		0.35	
LOWER WOODY	0.0	0.0		0	
PELICAN LAKE EAST	0.0	0.0		0	
PINE RIVER	2.14	1.87		0.95	
SCLATER DUCK	0.86	1.16		0.7	
UPPER ROARING	1.15	2.33		2.06	
UPPER SHELL	2.94	3.34		2.66	
UPPER SWAN	0.42	0.16		0.48	
UPPER TURTLE	0.0	0.0		0	
UPPER VALLEY	4.37	3.89		2.53	
UPPER WOODY	0.0	0.0		0	

7.3.9 Carbon Stocks

It is desirable to maintain sequestered carbon in the existing soil profile or in wetlands to reduce greenhouse gas carbon emissions. Atmospheric carbon is fixed into upland and wetland carbon during photosynthesis. Carbon is stored in peat, tree stems, branches, bark (non-stem biomass) and in significant amounts in root structures (soil biomass). When stands are harvested the carbon from the stem of the trees may be converted and locked in durable forest products for an average of 100 years.

Carbon stocks are maintained by maintaining levels of mature forest, but not converting to all overmature forest. The primary control on mature forest is the rate of harvest and the subsequent renewal of the forest. Harvesting removes carbon in the form of stem biomass and transforms carbon into building products. Non-stem biomass is either burned as hog fuel or decomposes on the forest floor. Soil biomass is reduced gradually after harvest, due to decomposition. All biomass categories are replenished as stands mature and decline as trees senesce. Intensive silvicultural treatments that promote better stand establishment increase the amount of carbon in trees as they grow. Silviculture can also improve stocking levels, although there is an upper limit due to site productivity.

Upland carbon stocks in FML #3 are projected to be stable over time. Specifically, carbon removals due to harvesting of softwood sawlogs and hardwood for both siding and firewood are balanced by the natural increases in carbon (Figure 7.5) in FML #3.

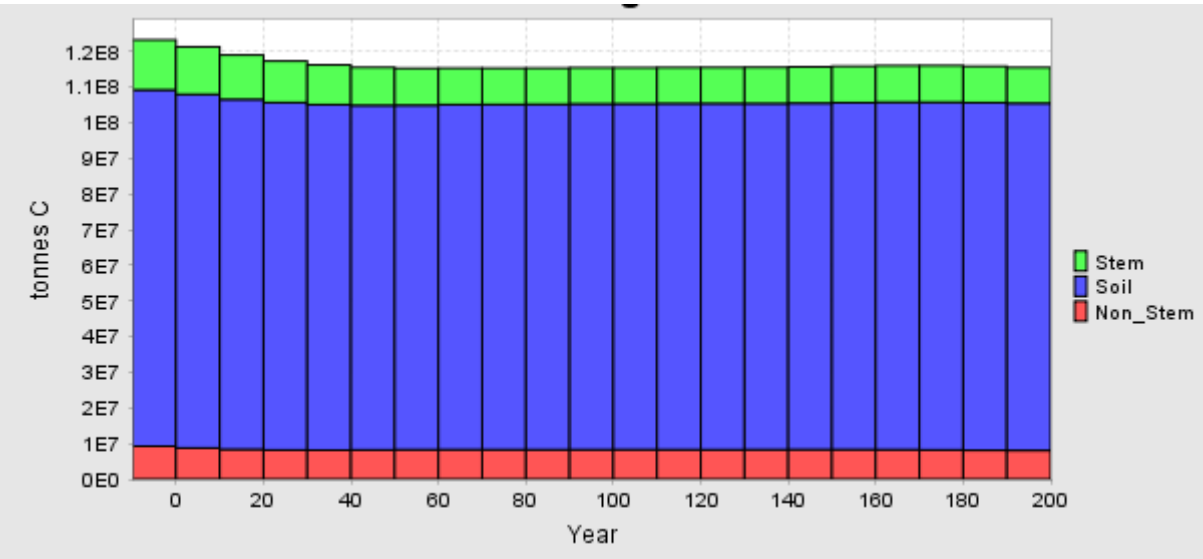

Figure 7.5 Upland carbon estimates over time are estimated to be stable.

The carbon estimates can be compared to actual carbon amounts in each FMP report. A sample of what this would look like is shown in Table 7.11.

Table 7.11 Upland carbon estimates from 2020 (time zero) to 20 years in the future.

Upland Carbon Type	0 (baseline year 2020)	baseline year 2020 (%)	Upland Carbon estimate at 10 yrs	Upland Carbon actual at 10 yrs	Upland Carbon estimate at 20 yrs	Upland Carbon actual at 20 yrs
Non-Stem Carbon*	9,242,584	7.5%	8,748,503		8,374,192	
Soil Carbon	100,034,944	81.1%	99,277,544		98,220,512	
Stem Carbon	14,022,850	11.4%	13,333,104		12,457,816	
Totals	**123,300,378**	**100.0%**	**121,359,151**		**119,052,520**	

**non-stem carbon includes tree roots, stumps, tops, and branches.*

Note that wetland carbon estimates are static, which prevents being able to calculate change in wetland carbon over time. Estimates of how wetland types change organic peat depths over time is needed to be able to calculate changes in wetland carbon.

7.3.10 Regenerating Cover Types

LP will use silviculture survey data to provide an approximation of post-harvest transitions at year five for hardwood and year 10 for softwood. Data from 1996 harvest blocks to present will be used.

Stands proposed for harvest receive a Pre-Harvest Survey before harvest. After harvest (time 0 years) a hardwood survey is performed by age 3 to 5 years. The example below (Figure 7.6) shows a Pre-Harvest Survey measurement of 20% softwood pre-harvest, and 20% at age five years, as measured from the silviculture survey.

Post-harvest transitions from age 5 or 10 years to 100 years old across all strata are needed.

This significant stand dynamics gap can be filled using a growth model. Two growth models are currently available:

1. Mixedwood Growth Model (MGM 2018) https://mgm.ualberta.ca/ which includes climate-sensitive survival functions; or
2. Province of Manitoba's in-progress version of GYPSY (Growth and Yield Projection System).

A growth model can estimates stand parameters using the silviculture survey data as the starting condition. The growth model then projects stand parameters out to rotation (60 to 100 years in the future). These growth estimates, based on local data, are exceptionally valuable.

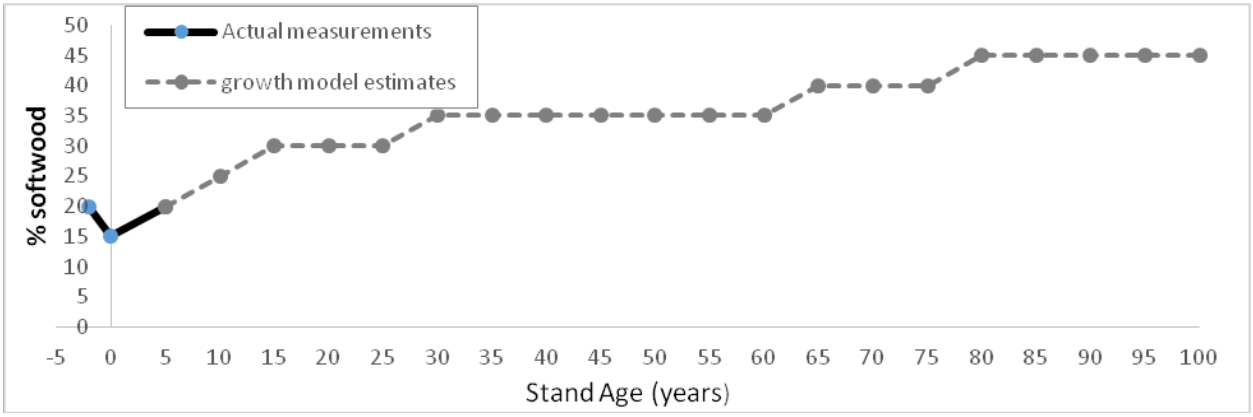

Figure 7.6 Actual measurements pre-harvest and 5 years post-harvest (solid line), then growth model estimates are needed (dashed line).

7.3.11 Regeneration Differences between FMU 11 and FMU 13

Regeneration or treatment and response differences between Forest Management Unit (FMU) 13 (Duck Mountain Provincial Forest) and FMU 11 (Swan-Pelican Provincial Forest) will be monitored. The mutually agreed upon treatment and responses were previously calculated from FML #3 (*i.e.* FMUs 13, 11, and 10), silviculture surveys. The format in the tables below (Table 7.12) will be used to compare FMU 13 and FMU 11 silviculture survey results in the Five-year reports (*i.e.* years 5, 10, 15, and 20 years post-FMP approval).

Table 7.12 Regeneration treatment and response tables for FML #3 (planted and leave-for-natural).

PLANTED: Based on data collected from blocks at harvest year of 1996 and above from FML #3					
	Post-harvest **S**	Post-harvest **M**	Post-harvest **N**	Post-harvest **H**	Area (ha)
pre-harvest **S**	62%	29%	8%	1%	2,436
pre- harvest **M**	31%	44%	21%	4%	3,095
pre- harvest **N**	24%	48%	23%	5%	8,020
pre- harvest **H**	8%	40%	33%	19%	5,013

Leave-For-Natural regeneration results						
	Post-harvest **S**	Post-harvest **M**	Post-harvest **N**	Post-harvest **H**	Area (ha)	Comments
pre-harvest **S**	51%	34%	10%	5%	663	all historical survey data collected from FMU 13 (survey years: 1986 to 1995)
pre-harvest **M**	28%	56%	8%	8%	967	all historical survey data collected from FMU 13 (survey years: 1986 to 1995)
pre-harvest **N**	1%	6%	19%	74%	2,003	data collected from blocks at harvest year of 1996 and above from FML #3
pre-harvest **H**	1%	2%	6%	91%	14,148	data collected from blocks at harvest year of 1996 and above from FML #3

7.3.12 Yield Curves in FMU 11

The five-year average volumes of all harvested blocks in Forest Management Unit 11 will be compared to the FMU 11 yield curves (*i.e.* volume per hectare over stand age). Delineated cutover imagery will be used to determine actual area. Scale information by block will be used to determine actual volume. Actual volume per hectare in FMU 11 will be determined from actual volume and actual area.

All blocks harvested in FMU 11, five years after approval of the Forest Management Plan, will be compared as planned volume per hectare compared to actual volume per hectare. This comparison will be reported in the Forest Management Plan 5-year report.

Note that stand volume is not the driver of the FML #3 sustainability modeling in the Forest Management Plan. Volume is simply an output with a maximum sustainable volume not to be exceeded. Drivers of the FML #3 sustainable modeling are moose habitat, watersheds, Natural Range of Variability seral stages, *etc*. In contrast, volume is the driver in the Province of Manitoba sustainable volume calculations.

7.4 FUTURE MONITORING

Future monitoring projects need to be addressed in an Adaptive Management framework, as described in previous section 7.1.1. Monitoring would be accomplished in cooperative, cost-shared effort with the provincial government, conservation groups, or academic agencies. In addition, research grants can be jointly applied for from the Sustainable Forestry Initiative certification body, federal, or provincial governments. Indigenous involvement in monitoring is desirable.

Monitoring as a system helps structure our thinking about how the pieces might fit together to form a unified planning and monitoring system. Lack of a systems approach to monitoring such as 'just go collect data' typically ends up with an unimplemented and shelved monitoring report.

The future monitoring projects chosen to explore and pursue (ranked in order of importance) are:

1. Seasonal moose and elk habitat models
2. Climate Change Vulnerability and Adaptation
3. Bird Species at Risk habitat
4. Forest Growth Model Implementation

7.4.1 Seasonal Moose and Elk Habitat Models

Both the FML #3 holder and the Province of Manitoba have been exploring and pursuing collaborative options for modeling both moose and elk habitat. Habitat modeling would only be built with wildlife data, not expert opinion. Ideally, the wildlife data would be stratified by season, such as winter versus summer.

Resource Selection Probability Function (RSPF) models have been proposed (Appendix I) to be applied to all relevant moose and elk survey data. RSPF models are used in spatial ecology to assess which habitat characteristics are important to a species of animal.

Scale is important in wildlife habitat analyses. Therefore, a multi-scale analysis of the moose and elk data will be completed at three scales simultaneously:

1. Local scale (50 ha);
2. Meso scale (500 ha); and
3. Landscape scale (5000 ha).

Quantifying and assessing current moose and elk habitat (by season) will be beneficial in configuring operational and landscape-level harvest to benefit moose and elk, while not exceeding other ecosystem targets (*e.g.* watershed limits, fire emulation (NRV) targets, sustainable harvest levels, *etc*.).

7.4.2 Climate Change Vulnerability and Adaptation

The health and sustainability of Canada's boreal forests are vulnerable, to varying degrees, to climate change. Climate-related impacts that lead to vulnerabilities within Sustainable Forest Management, include:

- Increased frequency and intensity of extreme weather events,
- Increased frequency and severity of insect/disease outbreaks, along with the introduction of non-indigenous organisms,
- Forest growth/productivity/mortality changes (either positive or negative),
- Regeneration success challenges,
- Land and access conditions are changing (length of winter road season decreasing due to extreme temperature fluctuations, earlier spring thaws); road structures (including bridges and culverts); length of season when ground and water bodies are frozen – decreasing due to increase winter temperature fluctuations, late fall freeze up and earlier spring thaw)
- Changes in seasonality and precipitation events,
- Increased periods of drought (could lead to increased risk of fire).

With these vulnerabilities, SFM objectives may become more challenging to achieve. It is important to identify these vulnerabilities within the LP SFM system and develop tools and strategies that will help manage these changes. Using existing and developing additional tools in LP's SFM system to develop adaptation options, mainstream, and monitor at both a strategic and operational level to account for climate change through technology, government policy and collaboration among academia, government and other stakeholders, is a priority for LP.

LP is participating in a collaborative climate change vulnerability and adaptation project funded by Natural Resources Canada which is facilitated by the Saskatchewan Research Council and the University of British Columbia. Four industrial partners include Spruce Products Ltd., LP Swan River, Weyerhaeuser Saskatchewan (Hudson Bay, SK) and Edgewood (Carrot River, SK).

The objectives of the project are:

- To assess and manage Sustainable Forest Management vulnerabilities
- To mainstream adaptation options into LP planning and operations

This project is focused on assessing the climate-related impacts and vulnerabilities on sustainable forest management on the LP FMP area. The project applies the conceptual framework developed by the Canadian Council of Forest Ministers (CCFM) and involves:

- describing the current climate and forest condition on the LP FMP area;
- developing scenarios of future climate and forest conditions;
- assessing the vulnerability of SFM to current and future climate;
- developing and refining options for adaptation;
- mainstreaming and monitoring climate change and adaption at both strategic and operational scales.

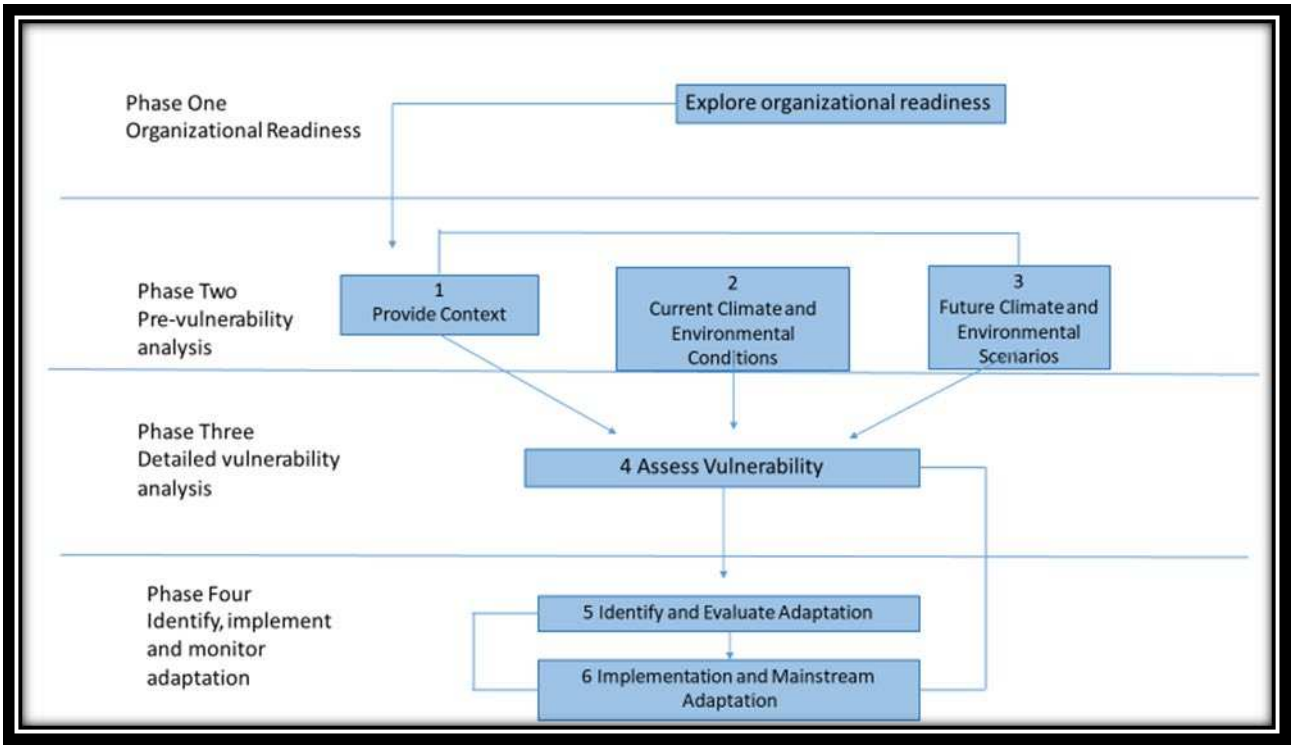

Figure 7.7 The four stages and six components of adaptation to climate change for Sustainable Forest Management (adapted from Edwards et al., 2015).

Phases one, two, and three are completed. Phase four is not yet completed and will happen after FMP submission. Possible monitoring and adaptations may include:

- Operation days lost (Mistik Management Ltd. case study) and local adaptations to reduce operational days lost; pre-approved and pre-permitted contingency winter stockpiles and,
- Weyerhaeuser Saskatchewan example of more bridges and less culverts to increase reliability and security of priority wood haul areas
- Adaption to assist mitigation – Explore and pursue increased haul weights on lower class roads, reducing fuel consumption and reducing $C0_2$ emissions.

The results of Phases one, two, and three demonstrate that LP's Sustainable Forest Management system is vulnerable to climate change and extreme weather events now and into the future, to varying degrees. It is also expected that vulnerabilities will change and may increase going forward. Moving into Phase four of the assessment process, LP will develop and identify potential adaption options to address vulnerabilities and establish a plan for implementation and mainstreaming of adaptation and monitoring for strategic and operational scales on FML #3 to ensure best practices and sustainability.

7.4.3 Bird Species at Risk

Bird species at risk could be monitored using a variety of techniques. Current bird monitoring options include:

- Continue to survey proposed summer hardwood cutblocks as part of the regular bird species at risk monitoring (mature hardwood ecosystems only)
- additional bird survey field work in targeted habitat (*e.g.* softwoods, young hardwood, bogs, and fens) where species at risk birds are more likely to be observed. Multiple years of field data could be analyzed, linking birds to habitat.
- wait for the Federal government to deliver habitat information in the future
- scan relevant bird habitat literature as it becomes available
- maintain our connection with BAM (Boreal Avian Modeling) at the University of Alberta https://borealbirds.ualberta.ca/

It is also important to maintain awareness of new bird monitoring equipment and techniques. Future improvements to the existing bird monitoring equipment and techniques would be evaluated and implemented if feasible. For example, automated bird sound recording stations have been established by the Canadian Wildlife Service in the Mountain Forest Section to record winter owls.

7.4.4 Forest Growth Model Implementation

Maintaining the cover type (hardwood, mixedwoods, and softwood) balance at the landscape-level is important to maintaining both coarse-filter biodiversity and the natural range of variability.

From stand ages five years (hardwood) to 10 years (softwood) forest renewal assessment data is collected. These data give a single point of a stand's species trajectory. After years 5 to 10 we assume future regenerating cover types of harvest blocks out to ages 50 to 150 years old. We could explore and pursue the use of a growth model to use data to interpolate:

- species composition and cover type;
- mortality (live trees, snags, coarse woody debris);
- tree heights by species;
- stand densities;
- diameters;
- volume; and,
- crown heights and crown widths.

We can begin by utilizing MGM (Mixedwood Growth Model). MGM 2018 https://mgm.ualberta.ca/ has been completed, tested, and now includes climate-sensitive survival functions. Previous versions of the MGM model have been available since the 1990's, attesting to the validity and longevity of the MGM model.

The Province of Manitoba has been developing a version of Alberta's GYPSY (2009) growth model https://www.alberta.ca/growth-and-yield-projection-system.aspx.

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7.6 APPENDICES

APPENDIX 1: Permanent Sample Plot Procedures Manual

APPENDIX 2: Pre-Harvest Survey Manual

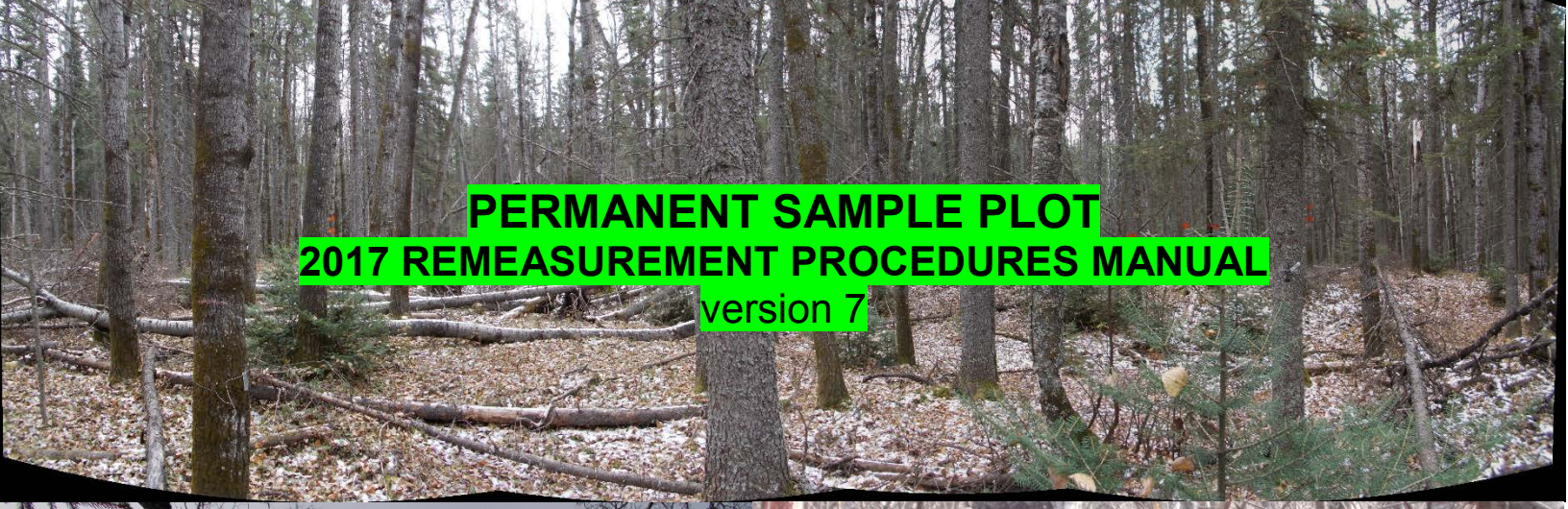
APPENDIX 3: Harvesting and Roads Monitoring/Inspection form

APPENDIX 4: Water Crossing Checklist form

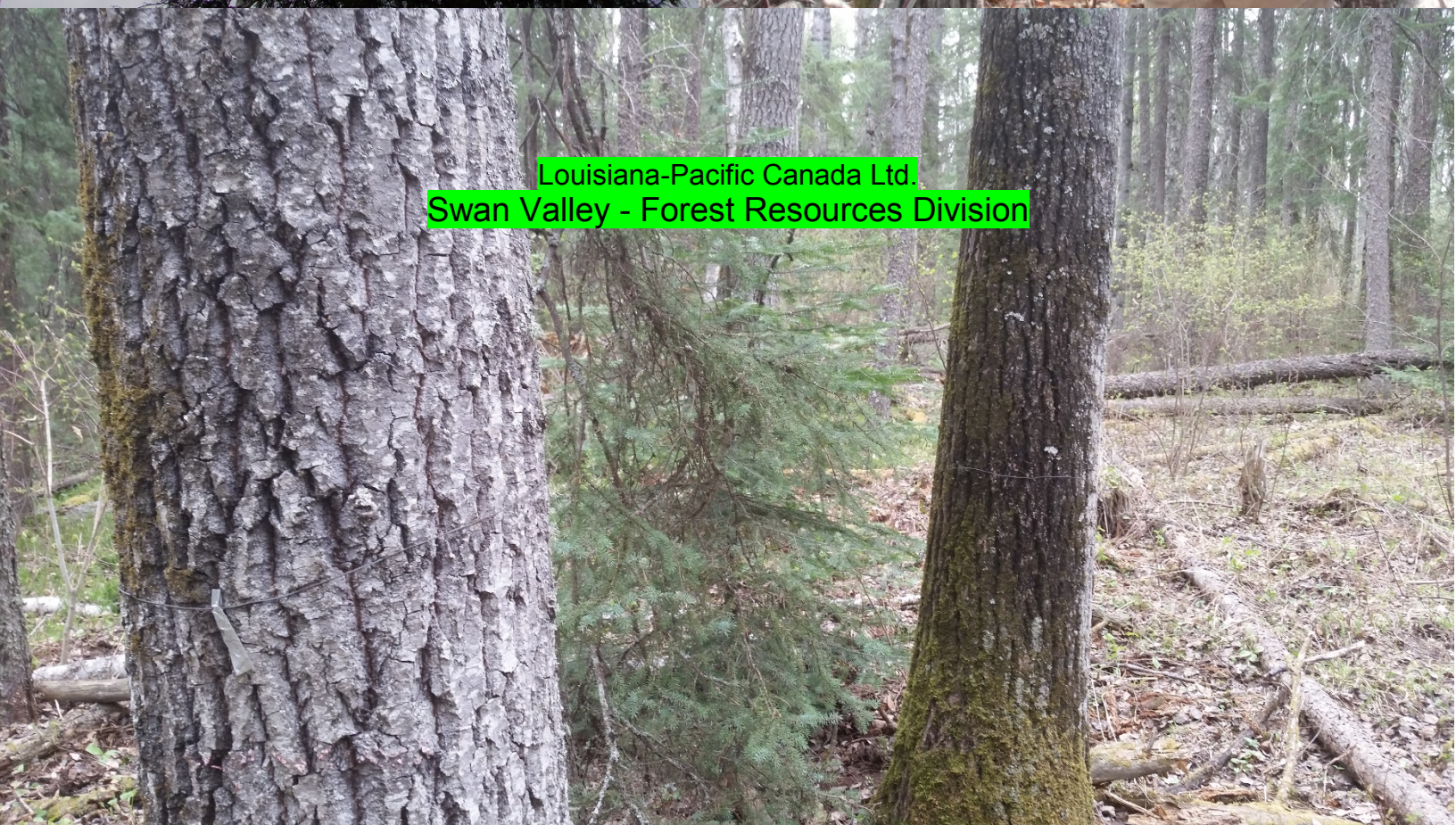
APPENDIX 5: Road decommissioning table

APPENDIX 6: SFI Certification audit summary

APPENDIX 7: Development of Seasonal Moose and Elk Habitat RSPF Models



PERMANENT SAMPLE PLOT
2017 REMEASUREMENT PROCEDURES MANUAL
version 7



Louisiana-Pacific Canada Ltd.
Swan Valley - Forest Resources Division

ACKNOWLEDGEMENTS

LP established a PSP network between the years 1994 and 2000. The original version of the ecological Monitoring Permanent Sample Plot Field Procedures Manual was developed using a series of Permanent Sample Plot (PSP) protocols from across Canada. Louisiana-Pacific Canada Ltd. (LP) Swan Valley Forest Resources Division would like to acknowledge the following authors:

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LP would also like to give special thanks to Swan Valley Forest Resources Division staff for the development and implementation of this ecological monitoring program. LP would also like to thank the PSP seasonal staff who have worked on the program throughout the years and who have contributed so many suggestions to the improvement and clarification of the protocol.

Remeasurement procedures have been revised as follows:

Version 5 PSP manual was revised in 2004 by LP staff and by Dr. Norm Kenkel from the University of Manitoba.

Version 6 of the PSP manual was revised in 2010, changing from 100% height measurement to 50% sub-sampling of heights.

Version 7 PSP manual (2017) measures all snags to assist with carbon calculations of dead trees.

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1.0 INTRODUCTION

Louisiana-Pacific Canada Ltd. (LP) is responsible for sustainably managing the forest resources in Forest Management License Area # 3 in west-central Manitoba. In order to manage forest resources effectively, there is a need to acquire a better understanding of stand dynamics, (*i.e.* how trees grow and stands change over time, ecosystem structure and functional relationships). This can be accomplished through the establishment of long-term ecological plots that collect standard growth and yield mensurational data along with a variety of other parameters. The growth of a stand can be measured by taking measurements of the same trees at periodic intervals.

1.1 PSP Objectives

The main objectives in the establishment of a network of ecological monitoring permanent sample plots are to quantify:

1) **Sustainability** – growth and drain. PSPs are the actual measurement of growth. Drain is the volume of wood harvested and the volume of wood lost to fires, insects, and disease.

2) **stand dynamics** – succession (changes in amounts of tree species), regeneration, in-growth, and mortality;

3) **growth curves -** provide a database that can be used to develop growth curves (i.e. actual measured growth over time, not assumed growth);

4) **monitoring -** provide data for long term ecosystem monitoring and strengthening the development of forest ecosystem classification and forest resource inventory (FRI) relationship linkages;

5) **site productivity** - describe soil characteristics and collect samples for nutrient analysis and site productivity determination; and

6) **wildlife** - collect data on wildlife habitat values to develop relationships between stand level descriptions and inherent structural attributes such as coarse woody debris, vertical structure, and snags present.

1.2 PSP Establishment History

In 1994, LP initiated its Ecological Monitoring Permanent Sample Plot Program by establishing 150 permanent sample plots (Figure 1.1) within the Mountain Forest Section of Manitoba (Duck Mountains and Porcupine Hills Provincial Forests). The data collected on these 150 PSPs were tree data only (*i.e.* no vegetation or soils), since most of the plots were established in the winter under a contract with Don Reimer.

In 1997, LP began upgrading the original 150 PSPs to include ecological information, including vegetation, soils, down woody debris, cavity assessment in snags, and stem mapping trees. LP also established 279 new PSPs (tree and ecological data) during the period of 1997 to 2000 (Figure 1.1). These plots were established in hardwood and mixedwood cover types.

2000 – experimental regen: eight PSPs were established in the Garland Grazing Trial to quantify aspen growth with grazing and no grazing treatments.

2006 – experimental regen: 18 PSPs Season of Harvest Study in two cutblocks (SLC-114 and SLC-124).

2013 and 2014 – seven PSPs were established in regenerating hardwood cutovers, typically within two years of the mature PSP being harvested (PSPs 5, 20, 34, 110, 112, 142, and 186).

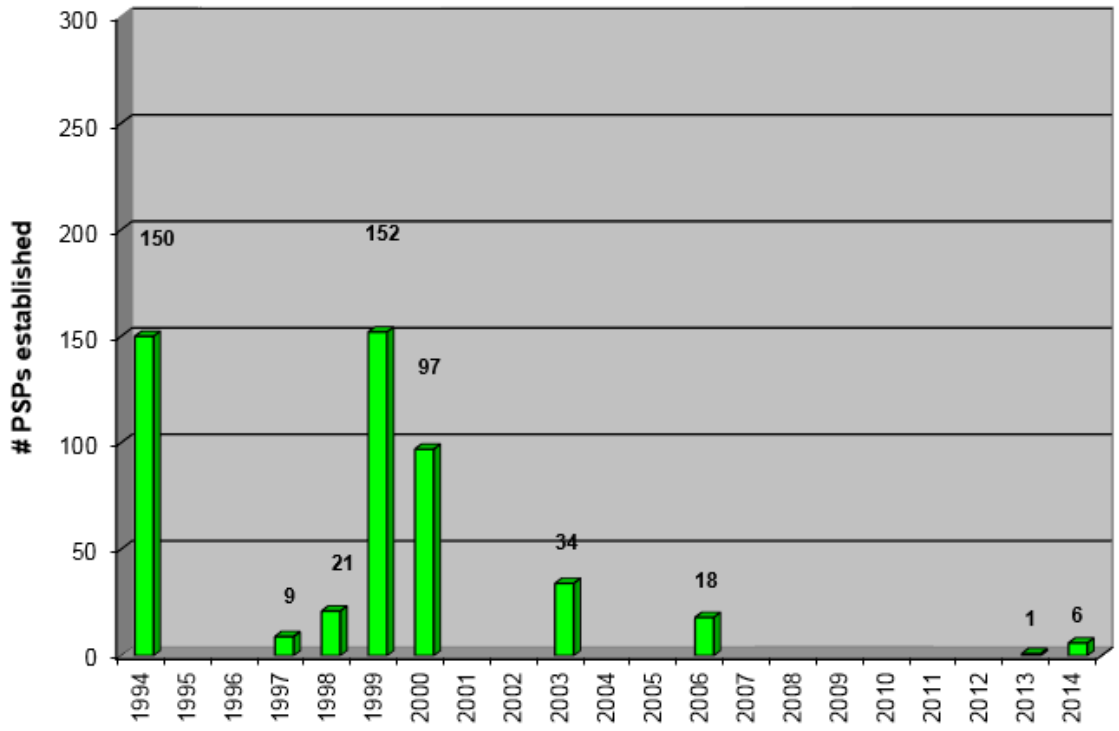


Figure 1.1 LP PSP establishment history.

1.3 PSP Remeasurement History

As of 2017, 32% of the PSP network have had two or more measures. 65% of the PSP network (280 PSPs) have never been remeasured (Table 1.1). 3% of the plots have been lost to blowdown, beavers, and other disturbances.

Table 1.1 Measurement history 1994 to 2017.

# of PSP measures	# PSPs	%
4	8	2%
3	31	7%
2	99	23%
PSPs with only 1 measurement (establishment) do not have change data	280	65%
lost to blowdown, beavers etc.	11	3%
	429	**100%**

In 1999 and 2000, a subset (26 PSPs) of the first 150 PSPs established between 1994 to 1997 were remeasured (Figure 1.2). Comparison of the original plot data to the remeasured plot data showed that the 3 to 5 years growth interval was too small. J.S. Thrower and Associates (2000) suggested to LP that they wait for a 10 year growth interval before starting PSP remeasurements.

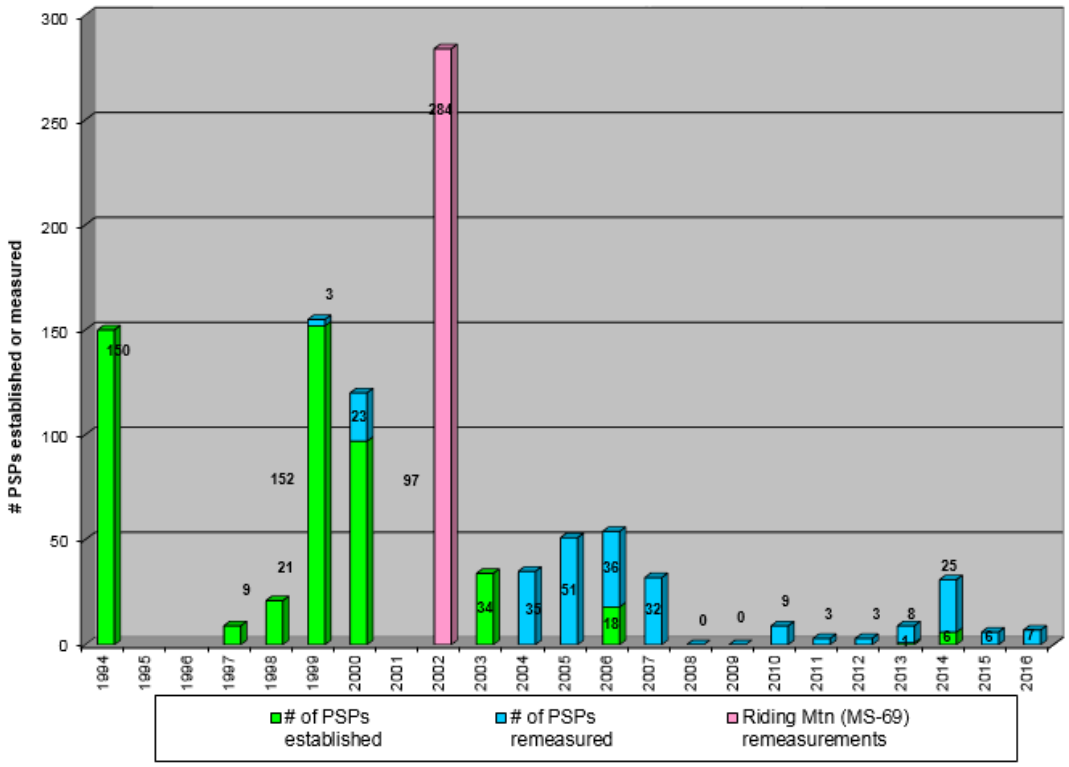


Figure 1.2 LP PSP remeasurement history.

In 2001, LP and the Canadian Forest Service (CFS) in Edmonton discovered 17 paper boxes of PSP tally sheets from the Riding Mountain Forest Experimental Station. Approximately 1,400 PSPs were established by the Federal government from 1947-1949, and remeasured two to four times between 1947 and 1966. LP then contracted the CFS to digitally enter all these data.
In 2002, LP staff remeasured 284 of approximately 1,400 PSPs in Riding Mountain National Park. The 2002 measurement yielded a remeasurement growth period of 55 years.

From 2004 to 2007, LP remeasured 10% of the PSP network on an annual basis, or a 10-year cycle. Approximately 42 PSPs were targeted for remeasurement each year, from the network of 429 PSPs. Unfortunately, we have had no PSP seasonal staff since 2008.

Today, PSP remeasurement effort is only targeted at plots that are in a proposed harvest block. Zero to three PSPs per year get measured from the network of 429 PSPs (0.0 to 0.7% remeasurement effort; or a 140 to 200 year cycle). Typically, a cluster of three PSPs will have the harvest block redesigned to buffer out one PSP, while the remaining two PSPs get harvested. These PSPs get remeasurement before harvest, and decommissioned by removing plot posts and tree tags and wires.

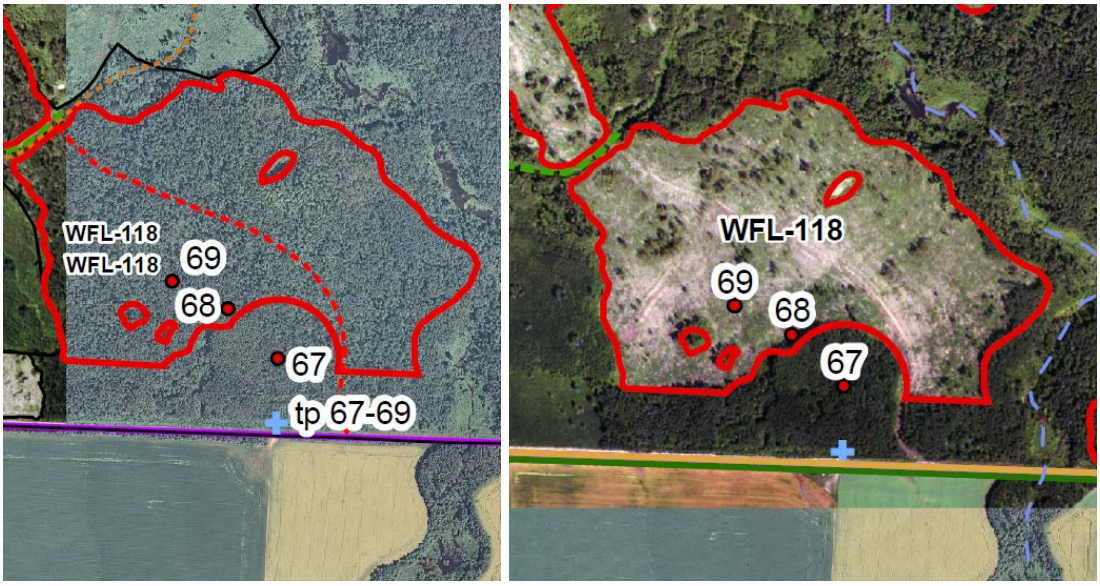


Figure 1.2 PSPs within a proposed cutblock have one PSP buffered out the block (PSP 67) while the other two PSPs get harvested.

2.0 PSP SCOUTING MAINTENANCE, AND UPGRADING

Since its inception, LP's PSP program has undergone improvements to its' protocol in an effort to make it clearer and more complete. The following procedures apply to the scouting, maintenance, and upgrading of existing PSPs.

2.1 Location Description

PSPs are in clusters of three PSPs, with a single tie point (Figure 2.1). Each PSP is 500 m^2 in size.

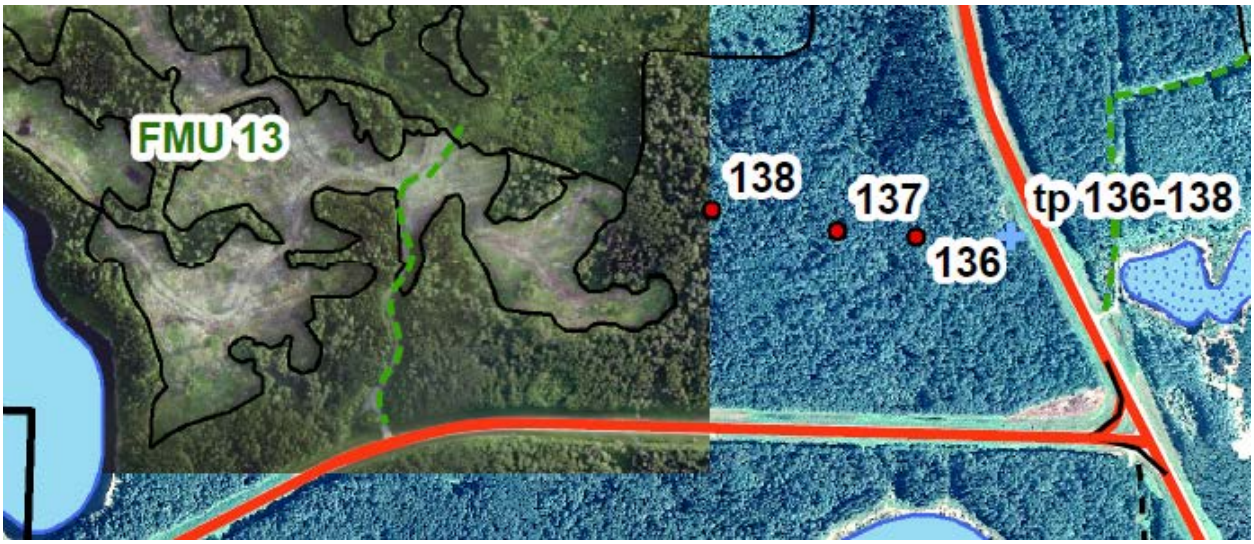


Figure 2.1 Tiepoint (blue) and cluster of three PSPs (red dots) off highway # 83.

2.2 Tie Points

There is one tie point for each cluster of three PSPs. Tie points link the PSPs to a permanent land feature, which assists in relocation of the PSPs.

2.3 GPS Information

GPS coordinates exist for all PSP centre posts and PSP tie points (Appendix 4). UTM (Universal Transverse Mercator) coordinate system is used. All PSPs are with UTM Zone 14 North.

2.4 PSP Scouting

-benefits of one person scouting PSPs makes for more efficient use of the three-person crew
-checklist, plot sheet (here or in appendix?)
-replace written on tags with better and more durable stamped tags

2.5 Tree Plot Corner Posts

Determine if all four corner posts and the centre post are present (Figure 2.2). The posts are 10 mm rebar painted orange and are tagged. Repaint and retag each post, if necessary. If the post is loose, pound it in until post is tight (you must wear safety glasses when pounding metal!). If the post is missing, replace the post and tag it. Corner posts should be located 15.81 m from plot centre and have the following azimuths:

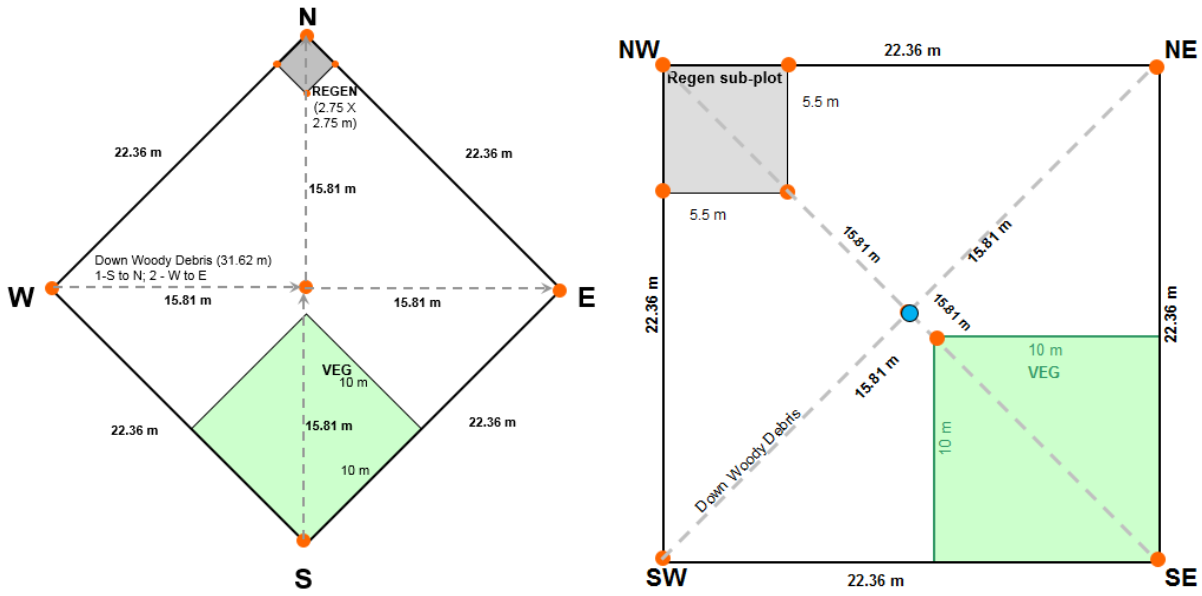


Figure 2.2 Corner posts on diamond plots (left) and corner posts on square plots (right).

Table 2.1 Corner post azimuths from plot center.

Post Corners	Diamond PSPs *(azimuth from plot center)*		Post Corners	Square PSPs *(azimuth from plot center)*
S	15.81 m at **180º**		SE	15.81 m at **135º**
W	15.81 m at **270º**		NE	15.81 m at **45º**
N	15.81 m at **360º**		NW	15.81 m at **315º**
E	15.81 m at **90º**		SW	15.81 m at **225º**

2.6 Regeneration Sub-Plot Posts

Determine if all regeneration sub-plot posts are present. The posts are 10 mm rebar painted orange and are tagged. Repaint each post and retag the post(s), if necessary. If posts are missing, they must be re-established.

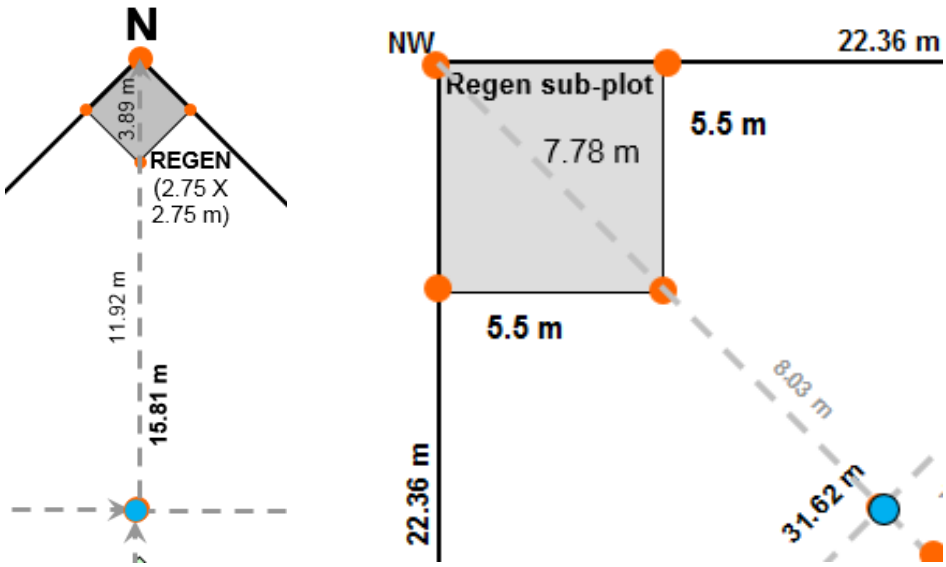


Figure 2.3 Regeneration sub-plot dimensions showing post locations for diamond (left) and square (right) plots.

2.7 Tree Tagging

Tags are important to maintain each tree's unique identity.

2.7.1 Nails

If the plot's trees were tagged using nails rather than wires, remove the nails and re-tag the tree with wire. To re-tag the trees, do the following:

1. Using a claw hammer, remove the nail from the tree.
2. Using pruning paint, fill in the nail hole.
3. Rewire the tree tag onto the tree. If the tree tag is missing, use the tree stem-mapping information to determine the tree number and write out a new tag for the tree.

2.7.2 Ingrowth

Ingrowth trees were too small to be tagged (8.9 cm dbh or smaller) at the last measurement, but now are big enough (9.0 cm dbh or larger) and must be tagged.

Use the next available number after the last tree in the plot to number the ingrowth trees. For example, a PSP has 55 trees (#1 to #55), and there is one ingrowth tree. The new ingrowth tree would become tree #56.

For each tree in the plot, indicate on the tree tally sheet whether it is the original tree (code = 1) or an ingrowth tree (code=2).

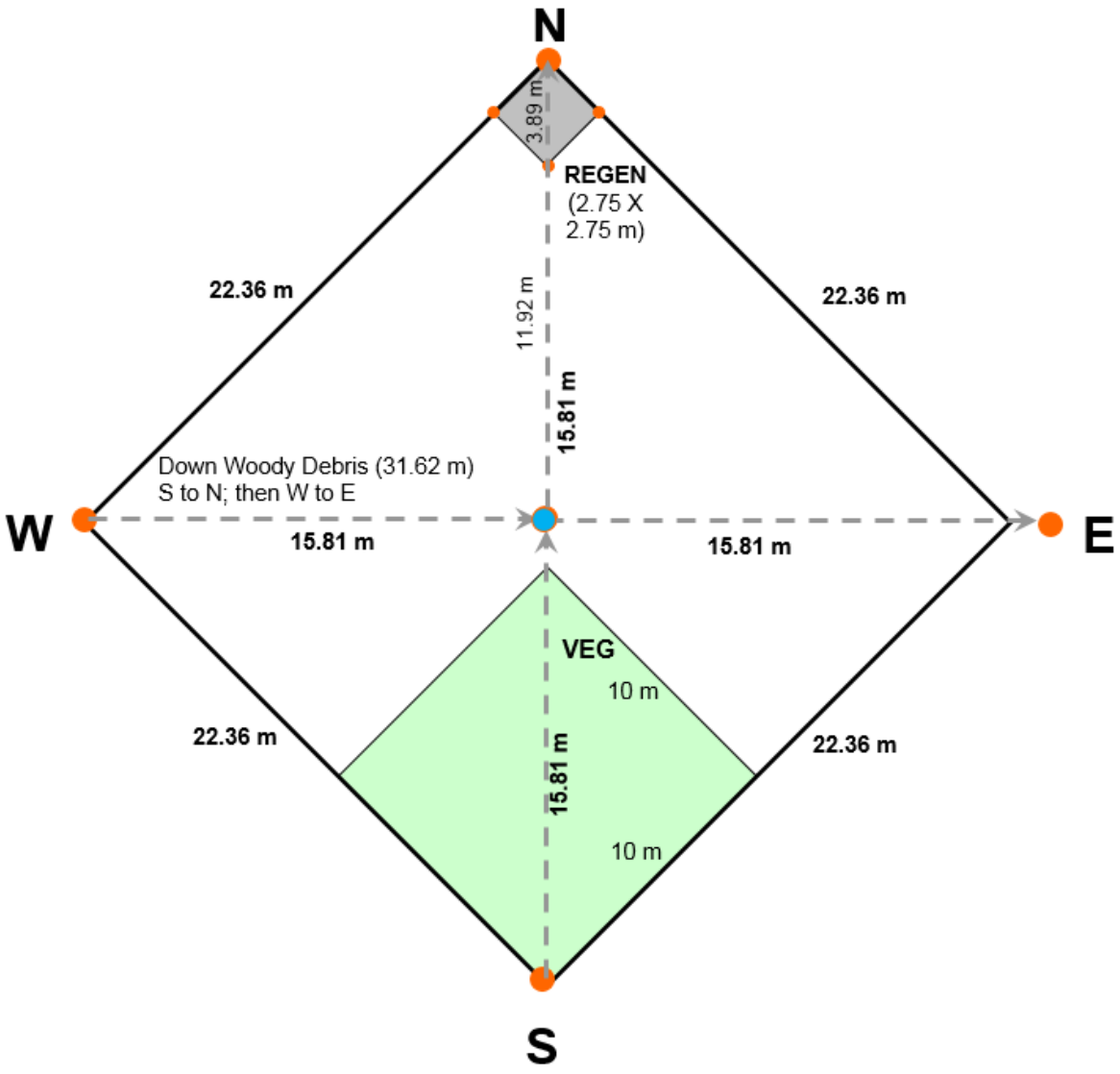


Figure 2.4 **PSP dimensions for the tree plot, vegetation sub-plot and down woody debris transect (diamond plot shape).**

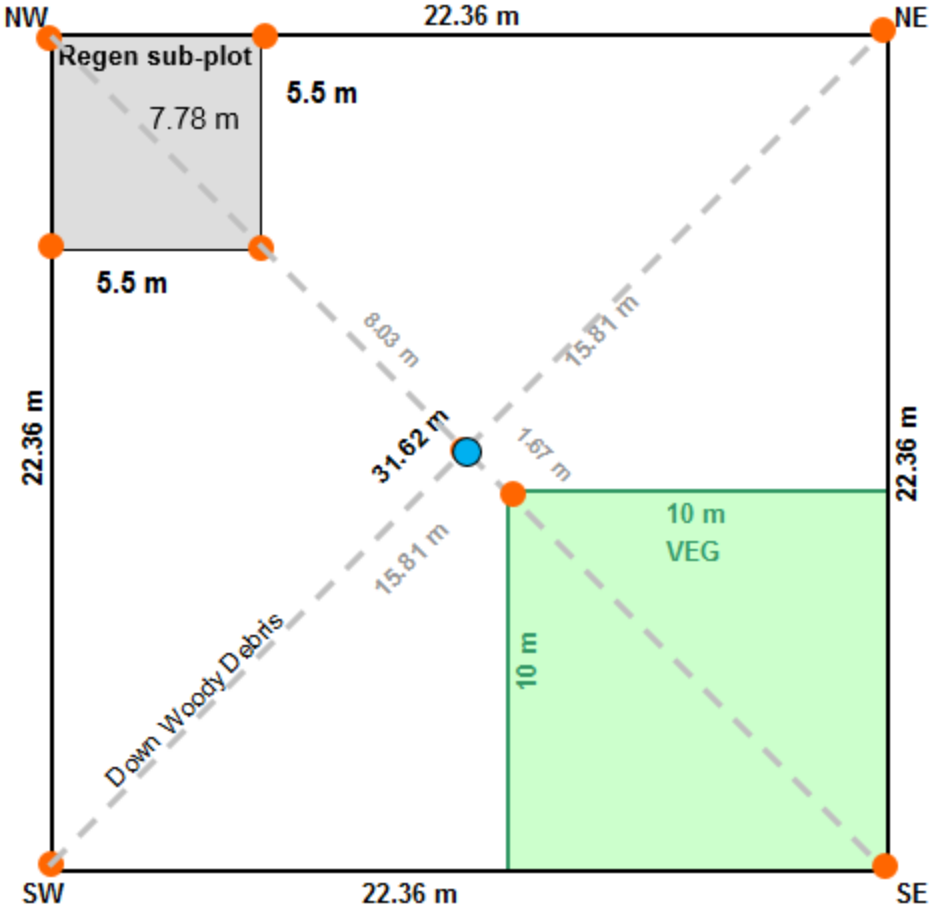


Figure 2.5 PSP dimensions for the tree plot, vegetation sub-plot and down woody debris transect (square plot shape).

Table 2.2 PSP Plot & Sub-Plot Dimensions

Tree & Sapling Plot			Regeneration Sub-Plot (North corner)			Vegetation Sub-Plot (South corner)		
Area (m^2)	Side (m)	Diagonal (m)	Area (m^2)	Side (m)	Diagonal (m)	Area (m^2)	Side (m)	Diagonal (m)
500	22.36	31.62	7.56	2.75	3.89	100	10.0	14.14

2.8 Plot Boundary Trees

Painting the boundaries of the plot helps to ensure that all trees within the plot are tagged and measured, and aids in the relocation of the plot. The plot boundary trees are outside, but adjacent to the plot, and must be re-painted orange. Safety glasses must be worn while painting!

Paint **two** orange rings (as high as you can reach) around the circumference of each tree beside each plot corner post just outside the plot boundary.

Paint a single orange ring (as high as you can reach) around the circumference of each tree just outside the plot boundary

Care must be taken with borderline trees. A tree is considered “in” if more than half of the stem, at breast height, falls inside the plot, and will have a wire and a tag. If possible, avoid painting dead trees, wind-blown trees, and trees with thick, low-hanging branches.

2.9 Plot Photographs

Using a digital camera mounted on a tripod, take 8 to 12 photographs of the PSP from plot center. Take the first photo with either a N (north) or NW (north west) plot corner. Shoot the remaining photos clockwise from the plot corner, in order to photograph the entire plot.

Download all digital PSP pictures and file them on the network in the directory:

L:\images\PSP\2017

and name the files as PSP# and the direction the photo was taken:

PSP161NW.jpg,
PSP161N.jpg,
PSP161NE.jpg,
PSP161E.jpg
PSP161SE.jpg
PSP161S.jpg
PSP161SW.jpg
PSP161W.jpg

Also from plot centre, shoot a canopy picture straight up. This helps visually describe the forest canopy.

In addition, a 360 degree panoramic photo can created by digitally stiching a series (8 to 12 photos per PSP) of photos. Mounting the camera on a tripod makes better panoramic photos.

Top: panorama stitched from photos taken by hand (no tripod)
Bottom: panorama stitched from photos taken with a camera mounted on a tripod

3.0 PSP REMEASUREMENTS

This chapter outlines the protocol used to collect data within the established permanent sample plot. All remeasurement tally sheets are in Appendix 3.

A soils assessment has already been completed for one plot in each cluster of three PSPs during plot establishment, from 1997 to 2000. Therefore, no additional soils information is required at this time.

Tree age data has previously been collected for the PSPs and is not necessary to collect age data a second time.

3.1 Vegetation Sub-Plot Measurement

The vegetation sub-plot is located in the south (S) corner of the PSP. The sub-plot should be measured prior to other work to prevent the trampling of vegetation during other work. The dimensions of the square vegetation plot are 10 m x 10 m or 100 m^2.

Percent cover of woody and herbaceous plants is estimated by floristic layer. A tree species such as black spruce could occur in layers 1, 2, 3, 4 and 5. In this example, a percent cover for black spruce would be estimated for each floristic layer.

Table 3.1 Floristic layer descriptions for vegetation data collection.

Layer	Description - Height Class
1	Dominant trees – emergent or supercanopy trees
2	Codominant trees – trees in the main canopy layer
3	Understory layer (trees and shrubs), >3 to 10 m in height
4	Tall shrubs – >0.5 to 3.0 m in height
5	Low shrubs – up to 0.5 m in height
6	All non-woody species: herbs, ferns, fern allies, grasses and sedges
7	All mosses, liverworts, and lichens

Percent cover of woody and herbaceous plants is estimated using a modified Braun-Blanquet cover-abundance scale (Mueller-Dombois and Ellenberg 1973):

Scale Value	Percent Cover
r	one plant, less than 1 % cover
+	several plants, less than 1 % cover
1	1 to 5%
2	6 to 25%
3	26 to 50%
4	51 to 75%
5	76 to 100%

Vegetation is considered to be inside of a sub-plot only if it is rooted in (*i.e.* the point of germination) the sub-plot. Do not measure vegetation which extends over the sub-plot but is not rooted in the sub-plot. Include percent cover measurements of any trees, saplings, or seedlings in addition to shrubs, forbs, herbs, mosses and lichens.
Mosses and lichens should be measured when they are located on the ground, on rocks, or on downed woody debris inside the sub-plot. Do not measure mosses and lichens located on standing trees (arboreal lichens).
All plants must be identified. If a plant cannot be identified in the field it is recorded as an UKNOWN #__ (unknowns are numbered sequentially) and its cover class estimated. A sample of the unknown plant species must be taken from outside the shrub/herb plot, and placed in a plastic bag with a label indicating the UNKNOWN #, site description and its associated plant species.

Plant species that cannot be identified but are believed to be rare or endangered are **NOT** to be sampled from the site. Use the digital camera provided to photograph the plant and use the photo to help identify the species back at the office. If a plant species is identified as a rare or endangered species, notify the District Forester, District Biologist or Area Planners immediately to ensure that the Conservation Data Centre forms are completed and additional information required is provided.

3.2 Downed Woody Debris

Using a 50 m fiberglass measuring tape, establish a downed woody debris (DWD) transect from the S plot post to the N plot post, bearing through plot centre of the PSP. The second DWD transect runs from the W plot post to the E plot post.

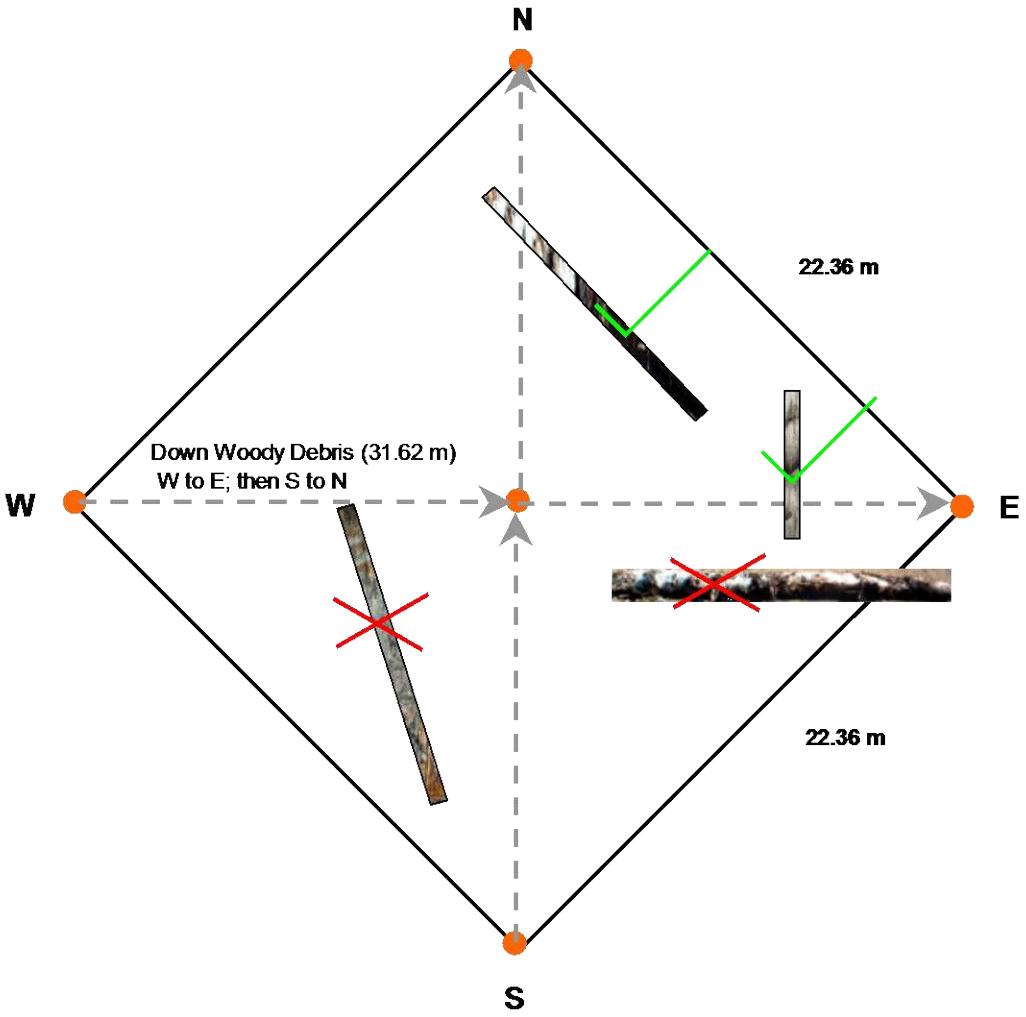


Figure 3.1 Downed woody debris (DWD) transect showing logs to tally (green check mark) and which logs are no tally (red X).

Add a square plot diagram for downed woody

Along each transect measure the distance of DWD that is greater than 7.5 cm in diameter from where the DWD first intersects the transect line to where it no longer intersects the transect line. Down woody debris (DWD) species codes are the same as live trees, except for:

UN – unknown;
HW – hardwood (individual species cannot be determined);
SW – softwood (individual species cannot be determined);
AL - alder species;
MA – Mountain Ash; and
99 – no tally (transect completed, but no DWD)

Identify DWD as either a stump (<1.3m in height) or log and assess the decomposition class (1-5) and species (or species group) of each DWD.

Measure the diameter of the DWD perpendicular to the stem (at the center point of intersection with the transect line for logs, or at the base of a stump just above the root swell). Indicate whether the diameter was measured with the DBH tape measure around the circumference of the log (C), or linearly (L) with a standard tape measure held over the log perpendicular to it (for logs which are too decomposed to obtain a diameter with the DBH tape measure). All information and any additional comments are to be recorded on the tally sheet. Once all measurements are complete, trace the transect line at the point of intersection on the piece of DWD using orange spray paint to indicate the location of the transect for future re-sampling.

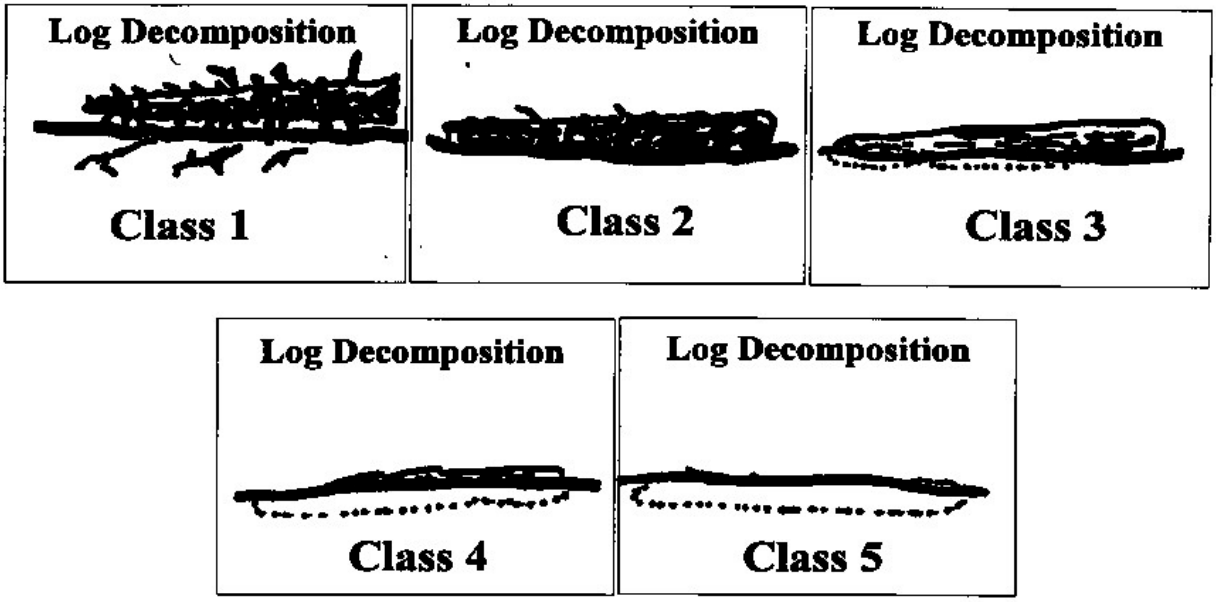


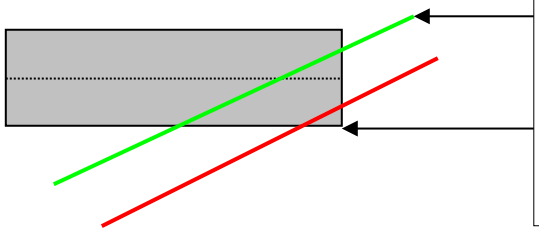
Figure 3.2 Decomposition Class of Downed Woody Debris (Hayden *et al*, 1995)

Table 3.2 Decay class characteristics.

Log Character	Log Decay Class				
	1	2	3	4	5
Bark	Intact	Intact	Trace (<10%)	Absent	Absent
Twigs < 3 cm	Present	Absent	Absent	Absent	Absent
Texture	Intact	Intact to Partially Soft	Hard Large Pieces	Small Soft Blocky Pieces	Soft and Powdery
Shape	Round	Round	Round	Round to Oval	Oval
Wood Colour	Original Colour	Original Colour	Original Colour to Faded	Light Brown to Faded Brown or Yellowish	Faded to Light Yellow or Grey
Log Elevation	Log Elevated on Support Points	Log Elevated on Support Points but Sags Slightly	Log is Sagging Near Ground	All of Log is on Ground	All of Log is on Ground

Information is to be collected on all downed woody debris that intersects the transect and has a minimum diameter of 7.5 cm using the following tally rules:

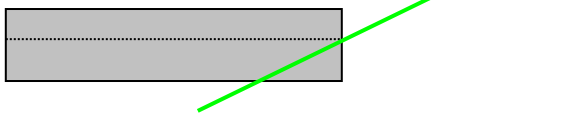
- tally only those pieces intersected above the duff layer,
- if the transect line crosses the end of the piece, tally the piece only if the central axis of the piece is crossed,



transect crosses the end of piece and the central axis of piece - **tally**

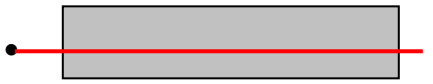
transect crosses the end of piece but not the central axis of piece - **no tally**

- if the transect line passes exactly through the end of a piece and the central axis of the piece, tally every second piece,



transect passes exactly through central axis of piece at end of piece - **tally every second log**

- ignore any piece whose central axis coincides with the transect line (is lined up with the transect line),



transect coincides with the central axis of the piece - **no tally**

- if the transect line crosses a curved piece more than once, tally each crossing.

3.3 Regeneration Measurements

Regeneration (regen) is classified as any tree species stem 0.10 m in height or taller with a maximum DBH of 1.0 cm. Regen is counted by species and height class and recorded on the regeneration tally sheet using a standard dot tally within the regen subplot.

The five height classes for regen classification are as follows:

Class **1**: 0.10 m - 0.30 m

Class **2**: 0.31 m - 0.60 m

Class **3**: 0.61 m - 0.90 m

Class **4**: 0.91 m - 1.20 m

Class **5**: 1.21 m +

Do <u>not</u> straighten leaning regen when measuring its height. To assist in determining which height class a regen stem is in, a Dbh/ Height Class Stick is used and is marked at intervals of 0.10 m, 0.30 m, 0.60 m, 0.90 m, and 1.20 m.

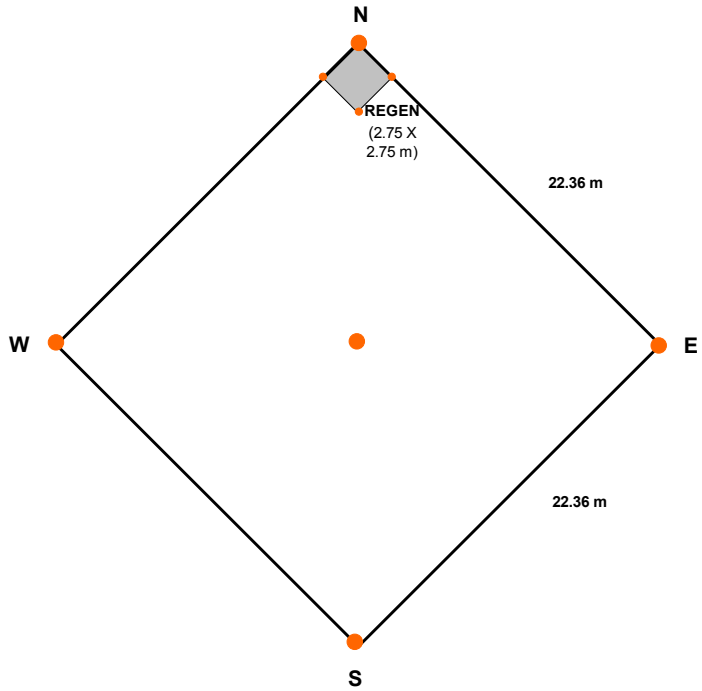


Figure 3.3 Regeneration sub-plot within PSP (grey shaded area).add square diagram

3.4 Tree Plot Measures

3.4.1 Tree Numbering

All standing trees (live and dead) ≥ 9.1 cm DBH (diameter at breast height) within the tree plot are tagged, measured, and tallied. Trees are to be numbered and tagged sequentially according to their bearing relative to plot centre. Start at a bearing of 1^{o} and rotate clockwise around the plot to 360^{o} numbering the trees sequentially from 001 to 999 as they are encountered. Numbers should be written vertically down the aluminum tags.

To attach the number tags to the trees a 17 gauge galvanized wire is used. The wire must be cut to a length large enough to allow for the formation of a 40 cm large loop of extra wire to be present once the wire has been attached to the tree. The tag should be wired to the tree so that the tag faces plot centre. The extra loop should be on the right side of the tree (when facing the tree from plot centre) and the twisted ends of the wire should be on the left side of the tree and tucked in against the tree to prevent injury. Please note: always wear protective eye-wear when wiring the trees and be very cautious to prevent injury to yourself or another crew member.

In summary, tally stems that are:

1) standing alive (living branches or buds);
2) standing dead (of a height > 1.3 m); or
3) any woody plant species with a diameter at breast height ≥ 9.1 cm.

3.4.2 Tree Species

Use the following species codes for these common tree species:

Table 3.3 Tree Species Code

Common Name	Scientific Name	Species Code
Fir Balsam fir	Abies A. balsamea	 BF
Birch White Birch	Betula B. papyrifera	 WB
Larch Tamarack	Larix L. laricina	 TL
Pine Jack pine	Pinus P. banksiana	 JP
Poplar Aspen (White Poplar) Balsam poplar (Black Poplar)	Populus P. tremuloides P. balsamifera	 TA BA
Spruce Black spruce	Picea P. mariana	 BS

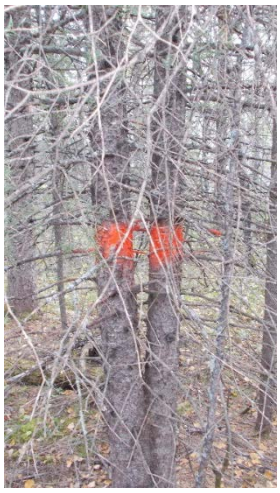
White spruce	P. glauca	WS
Oak Bur oak	Quercus Q. macrocarpa	 BO
Elm White elm	Ulmus U. americana	 WE
Maple Manitoba maple	Acer A. negundo	 MM
Ash Black ash Green ash	Fraxinus F. nigra F. pennsylvanica	 AS GA

3.4.3 DBH Measurement

Diameter at breast height (DBH) is to be measured at a height of 1.30 m from the point of germination. Use the existing painted dbh line if the paint is still visible. Consistency in diameter measurements is very important.

If there is no visible paint, measure exactly 1.30 m (DBH stick or tape) up the stem and measure DBH, then spray paint a new line.

If the previous DBH measurement was recorded at a height of 1.3 m +/- 5 cm or more, then record the height at which the previous DBH was recorded (on the PSP Plot Re-measurement Summary Sheet). Previous DBH measurements were recorded either:
(i) at a height indicated by the pink line on the tree; or
(ii) directly above the nail hole which previously held the tree's number tag.



Trees forked <u>below</u> 1.3 m are treated as two separate stems and are tagged and tallied as two separate trees with different tree numbers. Once the DBH measurement has been recorded, paint a line on the tree where DBH has been measured.

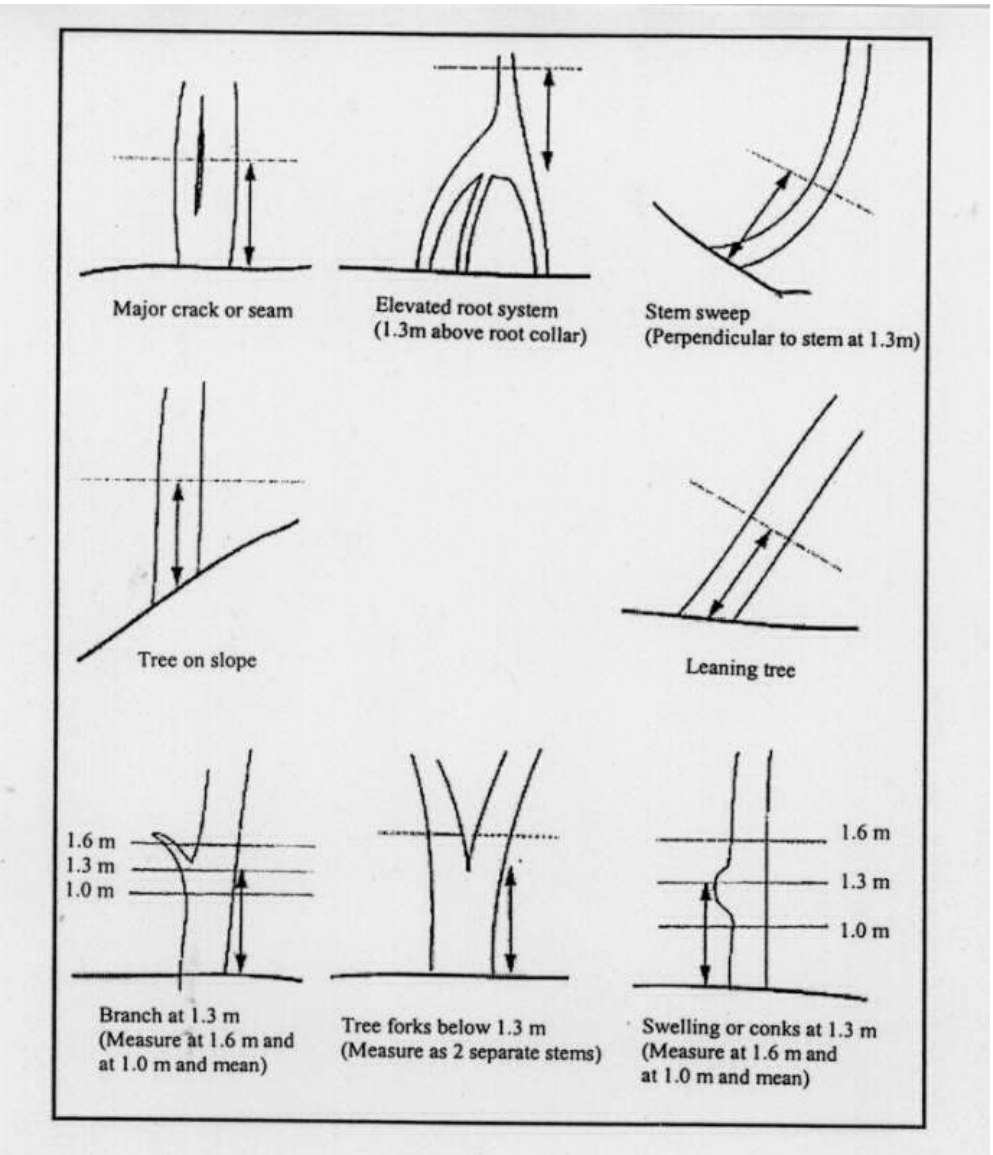


Figure 3.4 Determining Point of Germination and Breast Height (Canadian Forest Service, 1994)

3.4.4 Condition Codes

For each tree, record condition code(s) as appropriate. If the tree has no defects, insect or disease problems, then give the tree a code 000 – healthy tree.

Table 3.4 Tree Condition Codes

CODE #	CODE DESCRIPTION
000	Healthy
001	Standing Dead with Top Intact
002	Standing Dead & Broken
003	Dead & Down
004	Dead Top / Dieback
005	Dieback with New Leader
006	Broken Top (broken in the crown)
007	Broken Stem
008	Missing
009	Cut Down
010	Forked
011	Multiple Leader
012	Leaning
013	Poor Form
014	Pronounced Crook
015	Sweep
016	Spiral Grain
017	Frost Crack
018	Windshake
019	Sucker from Old Stump
020	Cavities Present
021	Multiple Stems-
022	Foliage Insects
023	Foliage Disease
024	Stem Insects
025	Stem Disease
026	Conks
027	Open Scar
028	Closed Scar
029	Rubbing by a Fallen Tree
030	Burls and Galls
031	Limby
032	Suppression - (leader or lateral)
033	Nutrient Deficiency (Chlorotic)
034	Witches' Broom
035	Lateral Dieback
036	Calculated DBH
037	Tree was missed on previous measurement (should have been tagged)
038	Flooding
039	Fire Damage

CODE #	CODE DESCRIPTION
040	Sunscald
041	Frost
042	Hail
043	Windthrow
044	Erosion
045	Ice/Snow Accumulation
046	Climate
049	General Animal Damage (Unknown Origin)
050	Browse (Unknown Origin)
051	Porcupine Browse
052	Squirrel Cone (Branch) Clipping
053	Beaver Damage
054	Bear Scarring
055	Ungulate Debarking
056	Woodpecker Feeding
057	Yellow-Bellied Sapsucker Feeding
058	Bird's Nest (Indicate size & location in Comments section)
062	Mechanical Damage (Unknown cause)
063	Man (Describe damage in Comments section)
064	Herbicide
065	Poor Planting
066	J-Root
067	Mouldy Planting Stock
071	Snow mould
072	Needle casts of pine
073	Needle rusts
074	Cone Disease
075	Yellow Witch's Broom (rust fungus)
076	Dwarf mistletoe
080	Stem canker
030	Burls and galls (tumors)
081	Stem Rusts - General
082	Stalactiform blister rust
083	Comandra blister rust (also occurs on branches)
084	Sweet fern blister rust
085	Western gall rust (also occurs on branches)
086	Scleraderris canker
087	Butt Rot
091	Root Rot - General
092	Armillaria root rot
093	Root Rot Tomentosus
097	Leaf spot
098	Leaf/Shoot Blight
099	Shepherd's Crook
100	Leaf rust
101	Powdery mildew
102	Dutch elm disease

CODE #	CODE DESCRIPTION
105	Diplodia gall and rough-bark
106	Hypoxylon Canker
107	Fire blight
108	Black Knot
109	Nectria and Cytospora (on stem or branches)
117	Seed and cone insects
118	Jack Pine budworm
119	Spruce budworm
120	Other larvae
121	Pine needle scale
122	Pine tube moth
123	Insect Galls on conifer
124	Spruce and pine needle miners
125	Adelgid galls
126	Shoot and bud insects
127	Aphids
128	Spittle bugs
129	Pitch Moth
130	Scale Insects
131	Terminal Weevil
132	Defoliation Insects
133	White Pine Weevil
137	Beetles (bark/wood)
138	Stem/Wood Borers
139	Carpenter Ants
140	Root Collar Weevil
127	Aphids
145	Defoliator Larvae
146	Forest Tent Caterpillar
147	Mite Galls
148	Leaf Miners
149	Leaf Rollers
150	Leaf and Bud Insect Galls
151	Scale Insects
152	Twig/Shoot/Branch Borers
153	Large Aspen Tortrix
138	Stem/Wood Borers
157	Root and Basal Stem Borers
158	Elm Bark Beetle
159	Bronze Birch Borer
160	Poplar Borer
200	Data Changed by Office

3.4.5 Height Measurements

NEW as of 2010 - The heights of trees will now be systematically sub-sampled at each PSP. A 50% sampling rate has been chosen. Measure the heights of the **first 20 trees,** whether live or dead). The tally sheets have been designed to have 20 trees per page to facilitate sub-sampling of tree heights.

Tree #'s 1 – 20	Measure all heights. Live or dead
Tree #'s 21 - 40	Don't measure heights
Tree #'s 41 - 60	Measure all heights. Live or dead
Tree #'s 61 - 80	Don't measure heights
Tree #'s 81 - 100	Measure all heights. Live or dead
Tree #'s 101 - 120	Don't measure heights…

The unmeasured heights will be estimated using dbh's and the height/dbh relationship from each plot by measurement year, stratified by tree species. If unmeasured trees are within the sampled diameter range, then the PSP-specific height-diameter regression will be used (i.e. interpellation). If the unmeasured trees are outside the sampled diameter range, extrapolation will be avoided, and the global height-diameter regression (by species) for all PSPs (based on the entire PSP data set – Appendix 6) will be used.

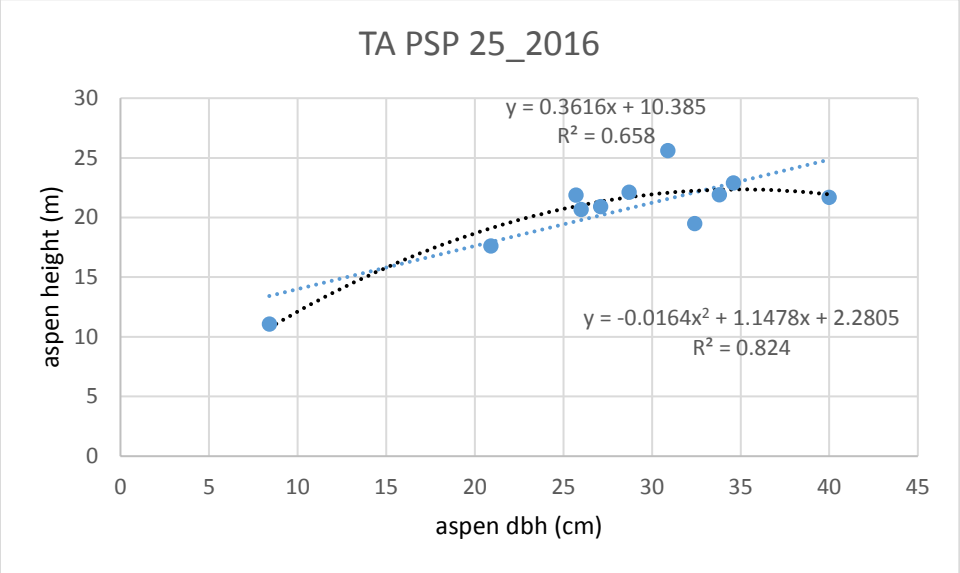


Figure 3.5 Height-diameter relationship for sub-sampled aspen heights.

NEW for 2017 measure the height of dead trees (snags), not just the live trees, subject to the 50% sub-sampling of heights described above. Heights of dead trees will assist with volume and carbon estimates of snags. Only one height is required for dead trees.


(left) Code 001 – standing dead –top intact - measure the height to the tip of the snag;
(right) Code 002 – standing dead – broken top – measure the height to the broken top.

Tree heights can be measured with one of these instruments:

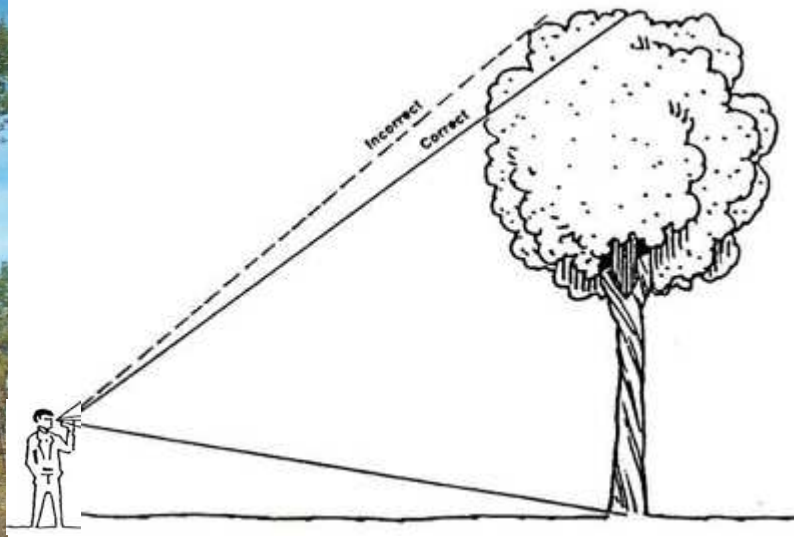
1) **Vertex**, which uses ultrasound to measure horizontal distance accurately despite dense vegetation. Note that you must calibrate the instrument for air temperature.

2) **Laser** which uses laser pulses to measure horizontal distance accurately, but cannot penetrate dense vegetation. Note that you must use a reflective target with the laser to obtain an accurate horizontal distance.

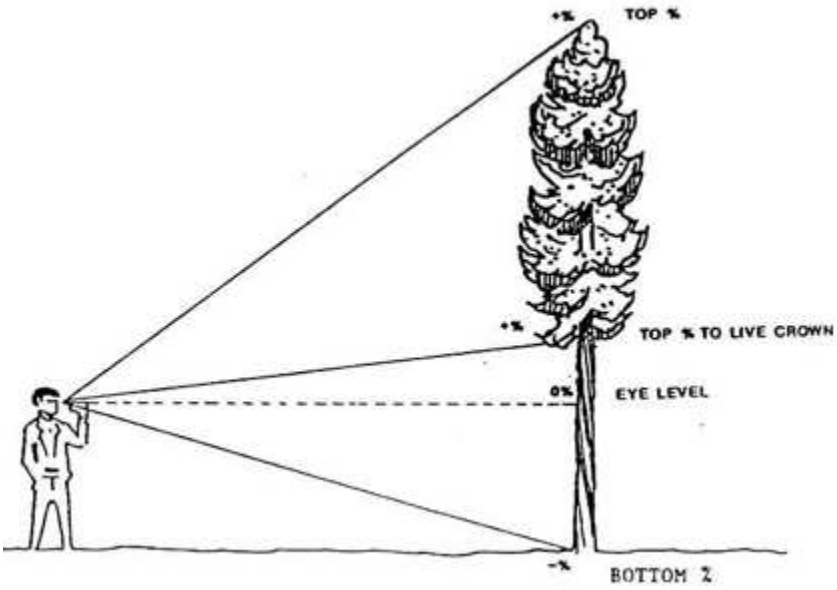
3) **% scale Suunto** clinometer (not 15/20 scale, since 0.25 m increments are too coarse for PSP height remeasurement). Note that you must write down % reading of the base, % reading of the tree top, and the horizontal distance. The tree's height would be calculated in the office, based on the three measurements.

Hardwood Heights

Hardwoods have rounded crowns, making height measurements difficult. Take two (2) height measurements for each tree in the PSP, and record both heights on the tally sheet. If the two heights differ more than 0.25 m, retake the heights.



Softwood Heights – usually have a pointed tip on the crown, facilitating accurate height measurements. Therefore, one height measurement per softwood tree is sufficient, if you have a clear sight picture of the softwood's crown.



Leaning trees

Regardless of which method of measurement is used to determine a tree's height, it is very important that a tree be inspected prior to height measurement to determine if it is leaning, even slightly, in any direction. If a tree is leaning, the height measurement must be taken from a location wherein the line of sight to the tree is perpendicular to the direction of the lean. This will allow a more accurate height measurement to be taken. When measuring tree height it is very important not to blindly trust that the laser or clinometer has given you an accurate height measurement. Take a good look at the tree and assess whether or not the height measurement makes sense. Make sure that you haven't accidentally measured the top of the tree behind yours or that the laser hasn't based its height calculation on an incorrect horizontal distance reading, etc. If you aren't sure about the height measurement, find a better location to measure the tree height from and try again.

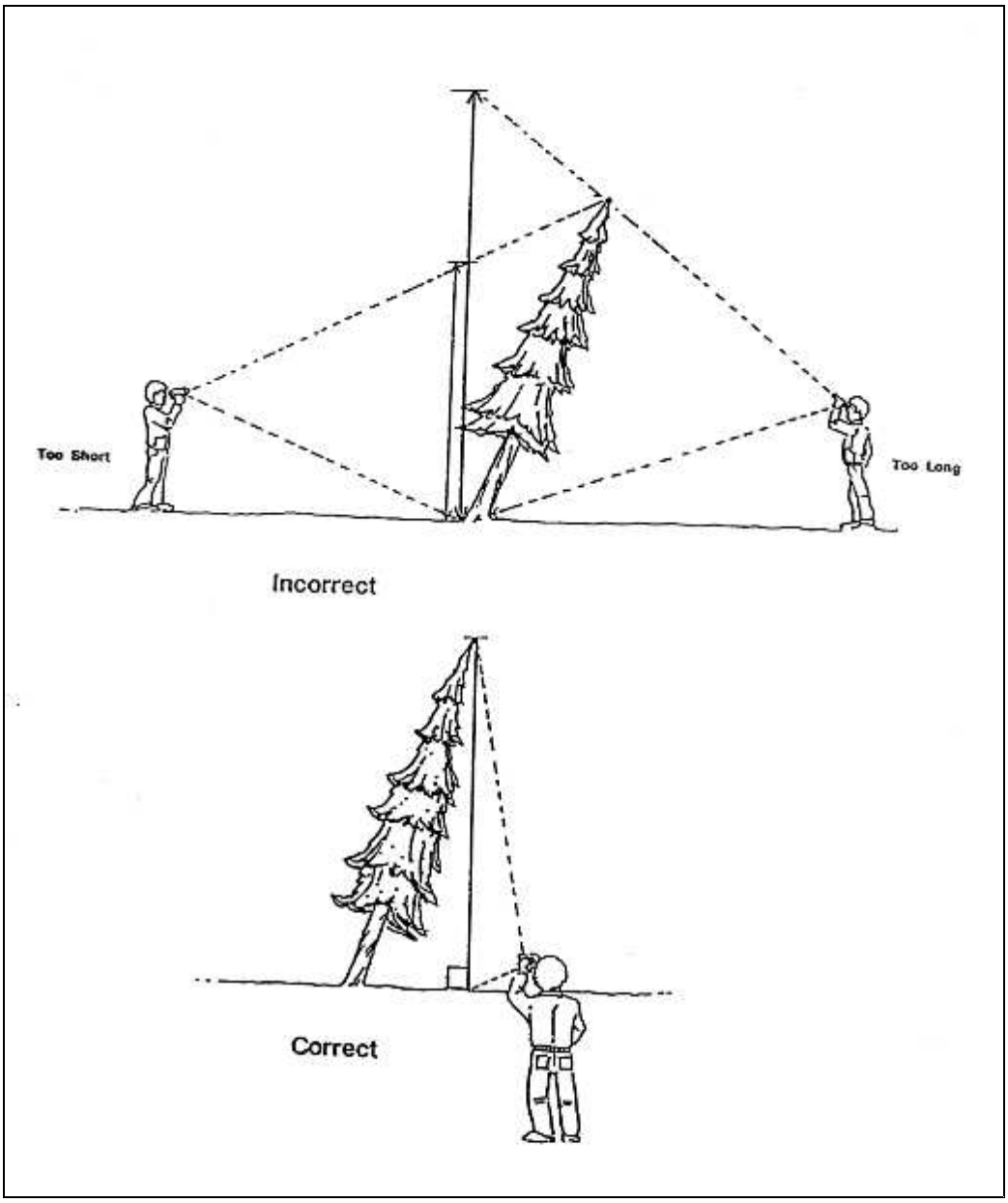


Figure 3.6 Height measurement of leaning trees (Alberta Land and Forest Service, 1997).

3.4.6 Height To Live Crown

The height from the ground to the base of the live crown (Figure 4.4) is measured on all living trees. The base of the live crown is the point that separates the continuously branched portion of the tree from the part that has sporadic or no branching. Live crowns on deciduous species start at the leaves, not at the branches. Live crowns on coniferous species start at the tip of the live branch, not at the base of the branch. The height to live crown is quite variable depending on stand maturity and density with young, open stands having low live crowns and mature, stocked stands having higher live crowns.

Height to live crown should not be measured after fall leaf-off has occurred.

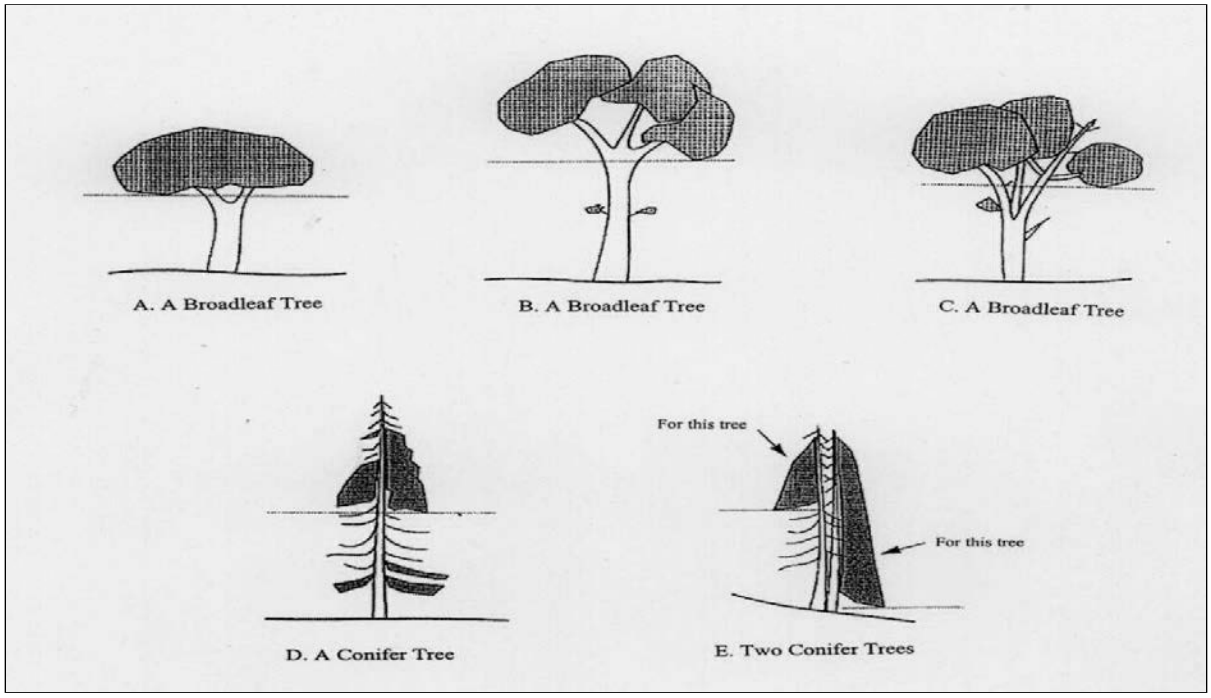


Figure 3.7 Height to Live Crown – Crown Base (Canadian Forest Service, 1994).

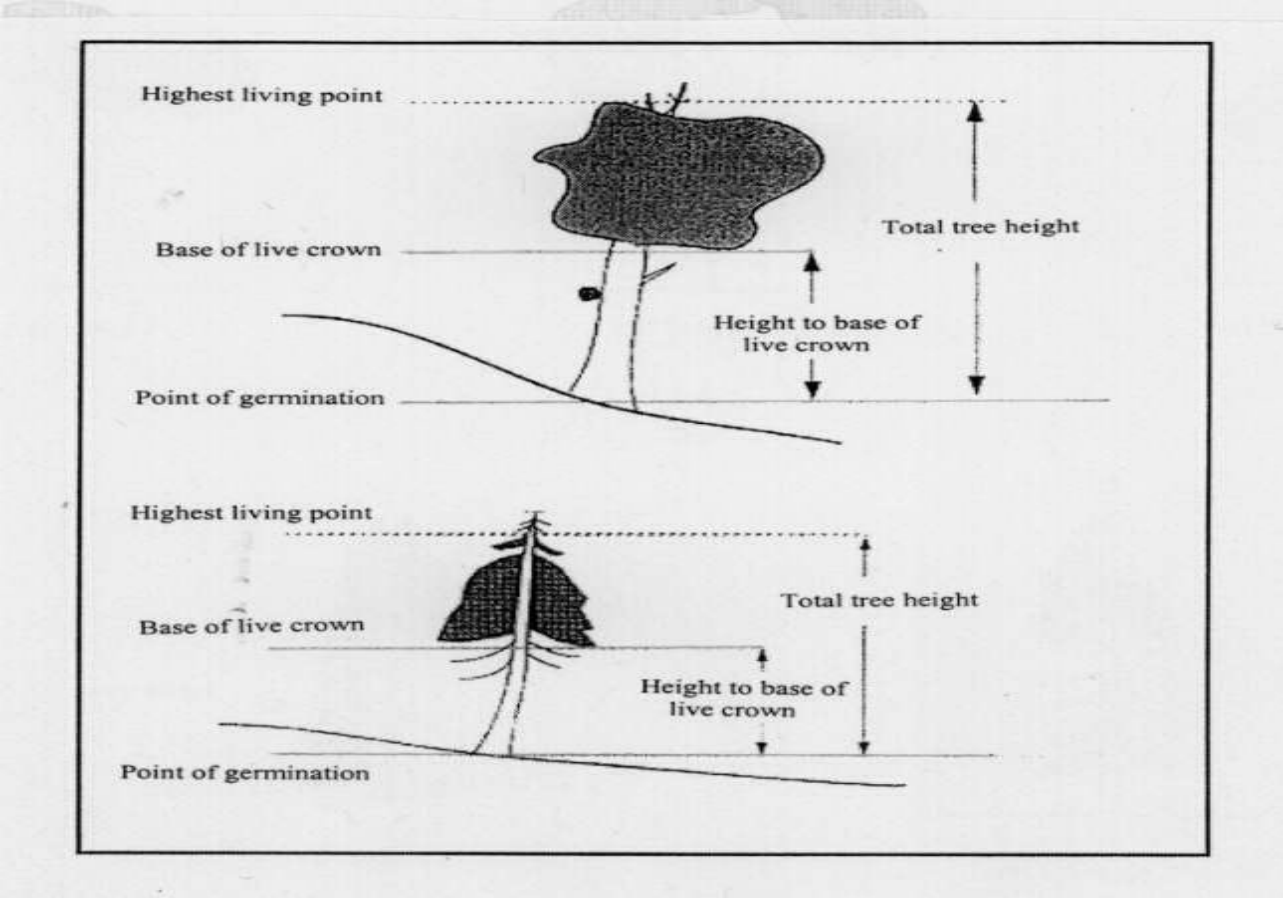


Figure 3.8 Summary of Tree Height and Height to Live Crown

3.5 Sapling Measurements

A sapling is a living stem with a DBH ≥ 1.1 cm and < 9.1 cm. Sapling data is collected on the entire 500 m^2 plot. Saplings are counted by dbh classes (1.1 to 3.0 cm; 3.1 to 6.0 cm and 6.1 to 9.0 cm), instead of measured individually. An average height by dbh class is measured for each species.

Saplings are not tagged or numbered. Count the saplings systematically by following transect sweeps in strips, starting in the northwest corner of the plot.

3.6 Tree Cavities

Dead standing trees (snags) must have a wildlife habitat values assessment done during tree measurements. Each numbered dead tree must be examined for nesting, feeding and escape cavities that may be used by birds or small mammals.

When a cavity is discovered the following information must be recorded:

1) Tree Number — The number on the tree's tag.

2) Type of Cavity: **N** - nesting
F - feeding
E – escape

3) Location of Cavity: **S** - stump
B - bole
C - crown

4) Excavated or Natural: **E** - excavated
N - natural
B - both

5) Cavity Size: **S** - small (2.5 -7.0 cm)
M - medium (7.1 -15 cm)
L - large (> 15.1 cm)

6) Other Evidence of Wildlife: List any animals seen (*e.g.* small mammals), heard, tracks or droppings, nesting or bedding sites, dens etc.

In addition to cavity information, the decomposition class of all snags (standing dead or dead and broken trees) is to be recorded on the Wildlife Habitat Assessment data sheet, regardless of whether or not cavities are present.

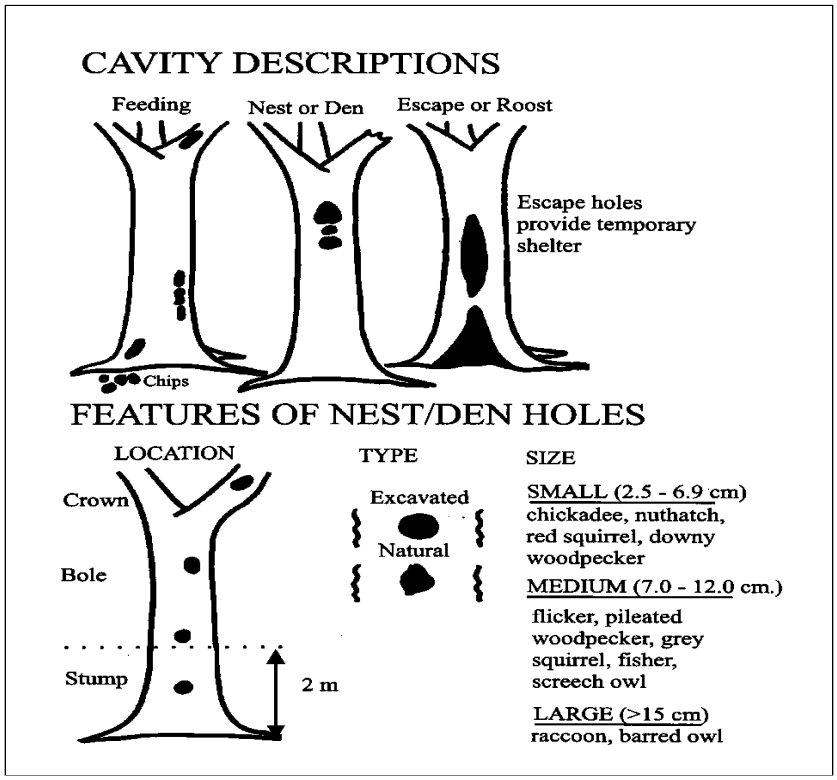


Figure 3.9 Cavity Descriptions (Hayden *et al*. 1995)

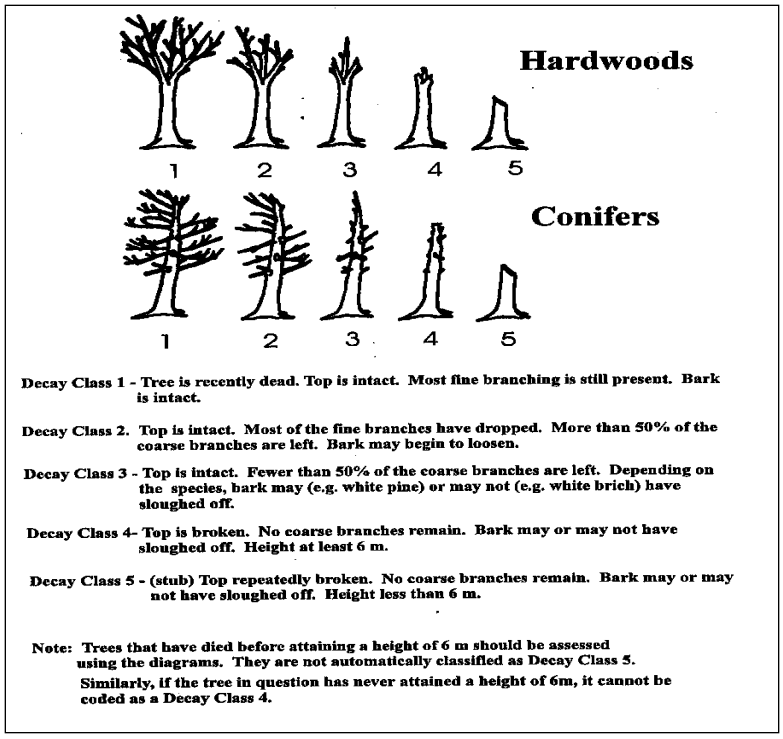


Figure 3.10 Snag Decomposition Classes

3.7 Stem Mapping Ingrowth

Only the ingrowth needs to be stem mapped, since the plot was stem mapped during the PSP establishment phase (1997 to 2000). Therefore, you must have the last tree number for each PSP, in order to assign a tree number to the ingrowth.

Stem mapping is used to identify the position of each tree with respect to other surrounding trees and can be used in distance dependent growth models and is used in plot re-measurement to locate trees. Before working on tree measurement, clearly identify the boundaries of the vegetation plot to prevent trampling. Station the laser at plot center and rotate clockwise around the plot recording the following for each ingrowth tree:

- distance (to nearest 0.01 m) from plot center to the center of the tree at breast height (1.3 m). Distances can be measured with the laser or with a tape;
- azimuth (1 - 360°) to the center of the tree at breast height (be sure to sight with the compass using only 1 eye to ensure accurate, consistent readings);

- species code; and
- condition codes.

The same person should use the laser on a PSP to stem map the entire plot to ensure consistency.

4.0 PSP ESTABLISHMENT

If new Permanent Sample Plots are to be established, the procedures to do so are in this chapter.

4.1 Re-establishing Harvested PSPs

Add info here – square PSP with 5.5 X 5.5 m regen sub plot

4.2 Establishing New PSPs

Add info here – square PSP with 5.5 X 5.5 m regen sub plot

5.0 PROCEDURAL CHANGES

This section documents all changes from the original version one PSP manual from 1998. Improvements to the PSP procedures began in the 2004 field season. Changes were timely, since the PSP network was complete, and remeasurements were beginning in 2004. Another procedural change was made for the 2010 field season, where tree heights were sub-sampled 50% instead of measuring 100% of tree heights.

5.1 Tree Plot

No change. The tree plot remains 500 m^2 in size. Changing the tree plot size is not recommended.

5.2 Sapling Sub-Plot

Originally, a 30.25 m^2 sapling plot was measured in the northwest corner of the PSP. Previous year's measurements in the Riding Mountain National Park (project MS-69) and subsequent analysis by Dr. Norm Kenkel from the University of Manitoba showed the great value of measuring sapling data over the entire plot, instead of a sub-plot.

Therefore, we are counting saplings (trees whose dbh is less than the 9.1 cm tagging limit) over the entire PSP (500 m^2). Dr. Norm Kenkel has advised us that we should count the sapling, not tag them. We are also counting saplings by three dbh classes (*i.e.* 1.0 to 3.0 cm, 3.1 to 6.0 cm, and 6.1 to 9.0 cm).

5.3 Regeneration Sub-Plot

No change. Regeneration (trees <1.0 cm dbh) are measured in a 7.56 m^2 subplot in the northwest corner of the PSP.

5.4 Shrub and Understorey Vegetation Sub-Plots

Originally, the shrub sub-plots were 4 – 1 X 1 m plots (2 m X 2 m nested hierarchically). Each 1m^2 shrub plot was measured separately. Originally, the vegetation sub-plot was a single 1 X 1 m plot in the southeast corner.

5.4.1 Plot Size

The shrub sub-plot and understorey vegetation sub-plot has been expanded in size to 100m^2. Plot size is critical with regards to a minimum sample area required to accurately describe plant communities. Larger plots will capture plant species that are missed by smaller plots. Furthermore, larger plots will have lower variability than small plots. However, there is an upper limit of 'diminishing returns' where the gain in larger plots is insignificant. Wright *et al.* 1995 quantified minimal area curves for the Duck Mountain Provincial Park near Madge Lake. Minimum area for vegetation plots is 64 m^2 (Figure 4.1).

The only concerns regarding expanding the plot size is backwards compatibility and validity of comparing shrub data from 1m^2 plots to 100 m^2. Therefore, the original shrub sub-plots and vegetation sub-plots will be measured in addition to the new 100 m^2 sub-plot.

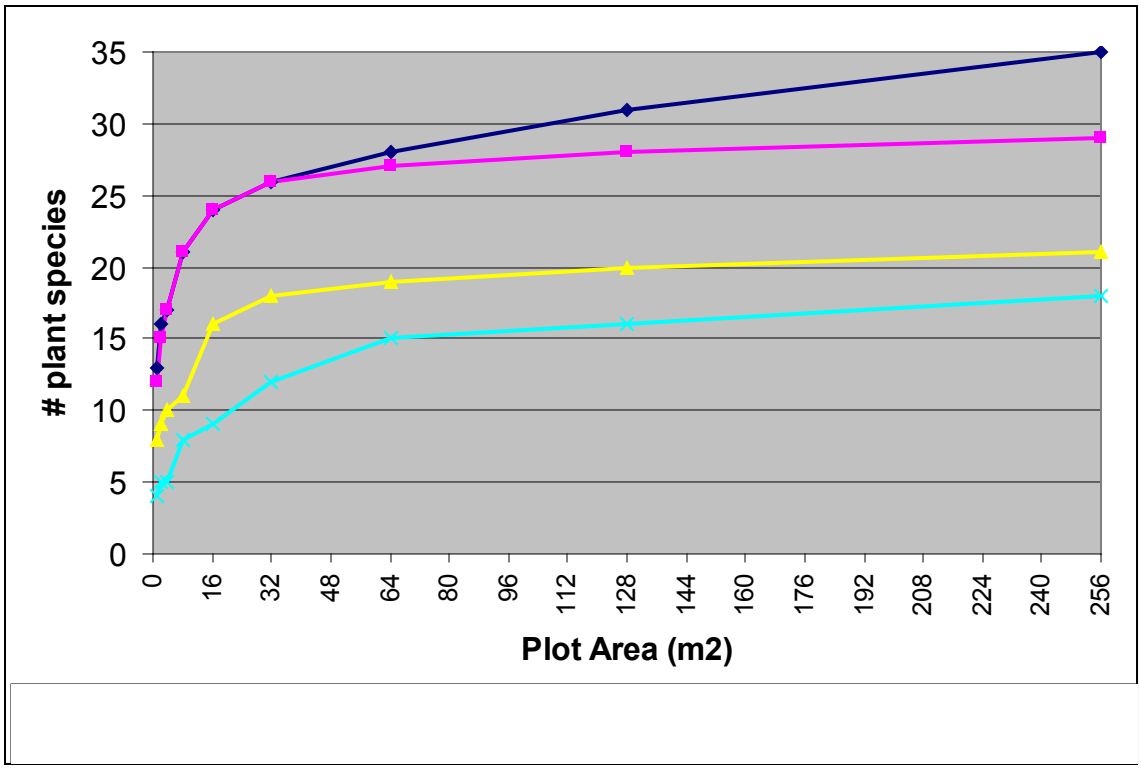


Figure 4.1 Minimal area curve by forest type in the Duck Mountain Provincial Park (Wright *et al.* 1995).

5.4.2 Plot Measurement Procedures

The original measurement procedure was to estimate the shrub or understorey vegetation species to the nearest percentage (*i.e.* beaked hazel 78%).

For the 2004 field season we will estimating percent cover of woody and herbaceous plants using a modified Braun-Blanquet cover-abundance scale (Mueller-Dombois and Ellenberg 1973):

Scale Value	Percent Cover
r	one plant, less than 1 % cover
+	several plants, less than 1 % cover
6	1 to 5%
7	5 to 25%

8 26 to 50%

9 51 to 75%

10 76 to 100%

The use of the Braun-Blanquet scale has been proven to reduce labour and inter-observer error when compared to estimating plant cover to 1%. Note that the Riding Mountain PSPs had used Braun-Blanquet scale back in 1947.

Previously, plant percent covers were not stratified by height. It is valuable to separate plants heights or 'lifeform layers ' into the following categories:

1 – tree layer

2 – sub-canopy layer

3 – understory layer

4 – tall shrub layer

5– short shrub layer

6 – herbaceous layer

7 – moss and lichen layer

For example, knowing that there is 10% black spruce in a vegetation sub-plot is good to know, but are the black spruce trees 10 m understory, 3 m understory or mere seedlings? Adding the percent species by lifeform layer gives the data better resolution and useability, especially for successional trends.

5.5 Down Woody Debris Transects

No change. The two diagonal transects remain at 31.62 m in length each.

5.6 Crown Class

Crown class (*i.e.* dominant, co-dominant, intermediate or suppressed) was previously estimated for each tree, based on the tree's height compared to other trees in the plot. However, since very accurate heights for each tree are taken with lasers, it makes more sense to use the tree heights to determine crown class, rather than visually estimate crown class and height. Therefore, crown closure will no longer be estimated in the field.

5.7 Tree Heights

Sampling 100% of all tree heights was taking more time than any other aspect of PSP remeasurement. Subsampling tree heights is a common and accepted methodology, combined with using a height-diameter curve to accurately estimate the remaining tree heights.

However, there are many different subsampling methodologies, including:

- random sampling;
- systematic sampling;
- stratified sampling across the diameter distribution; and
- sampling the first trees in each plot (*e.g.* measure first 20 trees only).

We chose the systematic sampling for simplicity and ease of use in the field. Furthermore, it was found that when applying systematic sampling to previously measured PSPs, that systematic sampling provided a representative sample across the diameter range, which is crucial when using a height-diameter curve.

In addition, there are many different sampling percentages, ranging from 10% to 75% in the literature. We wanted a simple, robust method that was operationally efficient, yet still accurate. We analyzed previously measured PSP where 100% of the heights were measured. For low, medium and high density PSPs, we analyzed 50%, 33%, and 25% sampling percentages. The 50% subsampling was found to be the most accurate at predicting tree heights. Carlson *et al*. 2009 also found that 50% systematic sampling

combined with a height-dbh regression will reduce height measurement effort without compromising accuracy.

Snag Heights – added in March 2017. Previous the heights of dead trees were not taken.

Hardwood heights – two heights per tree; previously stated if heights were more than 0.25 m apart (e.g. ht1=20.0 m and ht2=20.5 m, then you would need to take more heights until the heights were no more than 0.25 m apart. This height variation threshold has not really been adhered to in the past, and a more reasonable threshold (0.5 m? 1.0 m? 1.5 m? 2.0 m?) is being considered (changed in March 2017).

Softwood heights one height per tree (changed in March 2017).

6.0 DATA QUALITY CONTROL

It is extremely important that the data collected in permanent sample plots be accurate, consistent, and legible. To help ensure this, there are several rules to follow when collecting data during the establishment or re-measurement of a permanent sample plot:

1. The establishment or re-measurement of a PSP **must follow** the procedures described in this manual. If technicians are not clear on how to perform certain procedures, ask field supervisor or project leader for assistance.

2. Prior to leaving the PSP site, technicians must check over data forms to ensure that all data has been collected. **Data that cannot be collected must be noted as N/A** in the space provided - **do not** leave it blank, **do not** strike a line through the space provided and **do not** place a zero in the allotted space.

3. All information collected on the data forms must be **legible**. Any abbreviations used must be defined in the comment sections of the PSP data forms.

4. Additional information can be included in the comment sections such as unique site characteristics, other wildlife observations (endangered or rare species sightings and/or any problems that were encountered during PSP establishment or re-measurement

5. The “Field Check” section of a data quality control form is to be filled out and signed by the technician while in the field, after the completion of each PSP.

6. Information that needs to be filled out back at the office must be completed in addition to completing the “Office Check” section of the data quality control form, prior to the establishment or re-measurement of a new PSP cluster.

7. Once a PSP cluster has been completed and the “Field Check” and “Office Check” portions of the Data Quality Control Forms have been filled out for each of the 3 plots in the cluster, put the completed data in Trevor’s mailbox.

A sample of the LP PSP Data Quality Control Form is provided.

7.0 REFERENCES

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APPENDICES

Appendix 1: Rare Threatened and Endangered Plant Species List

Manitoba Conservation
Wildlife and Ecosystem
Protection Branch

Conservation
Data Centre

http://web2.gov.mb.ca/conservation/cdc/species/

As of April 10th, 2007 there are six rare, threatened, or endangered (RTE) vascular plant species in Manitoba (*i.e.* MBESA status = endangered or threatened). Currently there are no non-vascular plants of conservation concern in Manitoba.

Species	Global Rank	[1]SARA Status	Provincial Rank	[2]MBESA Status	[3]COSEWIC Status
SMALL WHITE LADY'S-SLIPPER *Cypripedium candidum*	G4	Endangered	S1	ENDA	ENDA
WESTERN PRAIRIE FRINGED ORCHID *Platanthera praeclara*	G2	Endangered	S1	ENDA	ENDA
GREAT PLAINS LADIES'-TRESSES *Spiranthes magnicamporum*	G4	not listed	S1?	ENDA	Not Listed
WESTERN SPIDERWORT Tradescantia occidentalis	G5	Threatened	S1	THRE	THRE
WESTERN SILVERY ASTER alternate common names: Silky Aster *Aster sericeus*	G5	not listed	S2	THRE	VULN
*WESTERN SILVERY ASTER Aster sericeus var sericeus	G5T5	not listed	S2	THRE	VULN

*no pictures available
[1]SARA: Species at Risk Act (Federal)
[2]MBESA: Manitoba Endangered Species Act (Provincial)
[3]COSEWIC: Committee on the Status of Endangered Wildlife in Canada

Pictures and descriptions for three of the six plants are on the following pages.

Plant species that cannot be identified in the field but are believed to be rare, threatened or endangered are NOT to be sampled from the site. If you suspect that an RTE species has been discovered fill out the Manitoba Conservation Data Centre RTE species form and submit it to the LP District Biologist or District Forester and they will confirm and send documentation to Manitoba Conservation Winnipeg Branch Office.

MBCDC Species of Conservation Concern

The term "species of conservation concern" includes species that are rare, disjunct, or at risk throughout their range or in Manitoba and in need of further research. The term also encompasses species that are listed under the Manitoba Endangered Species Act (MBESA), or that have a special designation by the Committee On the Status of Endangered Wildlife In Canada (COSEWIC).

Conservation Data Centre Ranks (Global and Provincial)

Species are evaluated and ranked by the Conservation Data Centre on the basis of their range-wide (global - G) status, and their province-wide (subnational - S) status according to a standardized procedure used by all Conservation Data Centres and Natural Heritage Programs. These ranks are used to determine protection and data collection priorities, and are revised as new information becomes available.

For each level of distribution—global and provincial—species are assigned a numeric rank ranging from 1 (very rare) to 5 (demonstrably secure). This reflects the species' relative endangerment and is based primarily on the number of occurrences of that species globally or within the province. However, other information, such as date of collection, degree of habitat threat, geographic distribution patterns and population size and trends, is considered when assigning a rank. The number of occurrences listed below are suggestions, not absolute criteria.

For example, the Green Frog (*Rana clamitans*) is ranked G5, S2. That is, globally the species is abundant and secure, while in Manitoba it is rare and may be vulnerable to extirpation.

Rank	Definition
1	Very rare throughout its range or in the province (5 or fewer occurrences, or very few remaining individuals). May be especially vulnerable to extirpation.
2	Rare throughout its range or in the province (6 to 20 occurrences). May be vulnerable to extirpation.
3	Uncommon throughout its range or in the province (21 to 100 occurrences).
4	Widespread, abundant, and apparently secure throughout its range or in the province, with many occurrences, but the element is of long-term concern (> 100 occurrences).
5	Demonstrably widespread, abundant, and secure throughout its range or in the province, and essentially irradicable under present conditions.
U	Possibly in peril, but status uncertain; more information needed.
H	Historically known; may be rediscovered.
X	Believed to be extinct; historical records only, continue search.

Other Heritage Codes

Code	Definition
G#G# S#S#	Numeric range rank: A range between two of the numeric ranks. Denotes range of uncertainty about the exact rarity of the species.

Subrank

Code	Definition
T	Rank for subspecific taxon (subspecies, variety, or population); appended to the global rank for the full species, e.g. G4T3.

Qualifiers

Code	Definition
B	Breeding status of a migratory species. Example: S1B,SZN - breeding occurrences for the species are ranked S1 (critically imperilled) in the province, nonbreeding occurrences are not ranked in the province.
N	Non-breeding status of a migratory species. Example: S1B,SZN - breeding occurrences for the species are ranked S1 (critically imperilled) in the province, nonbreeding occurrences are not ranked in the province.
Q	Taxonomic questions or problems involved, more information needed; appended to the global rank.
T	Rank for subspecific taxon (subspecies, variety, or population); appended to the global rank for the full species.
#	A modifier to SX or SH; the species has been reintroduced but the population is not yet established.
?	Inexact or uncertain; for numeric ranks, denotes inexactness.

SMALL WHITE LADY'S-SLIPPER
Cypripedium candidum (ORCHIDACEAE)
GENERAL DESCRIPTION

CYPRIPEDIUM CANDIDUM, is a herbaceous perennial, with pubescent stems to 40 cm tall produced from rhizomes (underground stems). Leaves 3-5, usually dark green, oval to lance-shaped, 8-16 x 1.5-4 cm, sheathing the stem. Flowers solitary (rarely two), small, subtended by green leaf-like floral bracts. Dorsal sepals oval to elliptical, greenish yellow, suffused with brown and with brown veins. Lateral sepals fused to form a single sepal located below the lip of the flower and similar in colour to the dorsal petal. Petals narrow, lance-shaped, undulate or slightly twisted, similar in colour to the sepals. The lip (or slipper) white, egg-shaped, often with faint purple veins or spots, with a rounded opening. Staminode ovate, yellow, spotted with purple. Fruit a capsule, to 3 cm long, containing very small seeds.

LIFE HISTORY

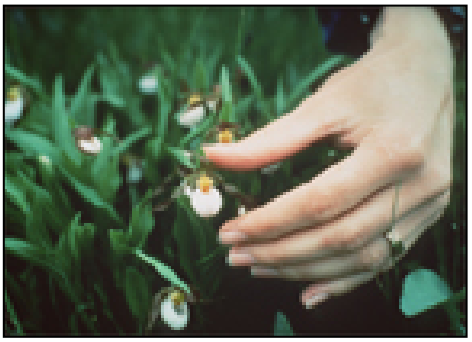
Leaves appear in late April-early May. Flowering commences from mid May to mid June. Capsules are produced by mid to late July.

HABITAT

Mesic blacksoil prairie, wet blacksoil prairie, glacial till hill prairie, sedge meadow, calcareous fen, glade. Calcareous soils.

C. CANDIDUM is found on mesic to wet calcareous soils in prairies or prairie openings in the wooded grassland. Sites are often south-facing. It requires high light intensities and is negatively impacted by fire suppression which permits the invasion of woody species.


© Gary Allen



WESTERN PRAIRIE FRINGED ORCHID

Platanthera praeclara (ORCHIDACEAE)

GENERAL DESCRIPTION

"An herbaceous perennial orchid arising from a fleshy tuber. Leaves are thickened and smooth, lance-shaped to slightly rounded, sheathing the stem and up to 5 cm wide and 26 cm long but progressively smaller toward the inflorescence. Inflorescences are large and showy with up to 20 or more flowers arranged on a spike reaching up to 75 cm in height. Flowers are creamy white and hooded; with the lower of three petals larger, three lobed and fringed, 0.75 to 1.5 inches in length and with a nectar spur 3.8 to 5 cm in length (and noticeably longer than the ovary). Fruit capsules are elongated-oval and about 2.5 cm in length; they remain green until the end of the growing season and persist on the stem in dried condition, developing vertical cracks from which seeds are dispersed." (Bowles, M.L. and A. Duxbury. 1986. Report on the status of Platanthera praeclara... U.S.F.W.S. 60181-1447-84)

LIFE HISTORY

Stems first appear in late May, the peak flowering period varies from late June to late July (K. Johnson, pers. comm.).

HABITAT

Western portions of the North American tallgrass prairie. Most commonly on moist, calcareous or subsaline prairies and sedge meadows (many flooded for a period of 1-2 weeks during the year). Platanthera praeclara is found predominantly in moist, calcareous or sub-saline prairies and sedge meadows. In Manitoba it is located in areas of relatively undisturbed parkland with numerous prairie patches. The prairie components are of wet to mesic tall grass prairie, fire- and grazing-adapted communities which are dominated by graminoid species. The forested areas are dominated by Quercus and Populus species. Soils are dark grey chernozemic or luvisolic, with imperfect drainage and are strongly to extremely calcareous. This species requires full sun and will therefore decline with the invasion of woody species. It will colonize disturbed sites, but persists only if the site reverts to prairie. Roughly half of the Manitoba occurrences are in roadside ditches.

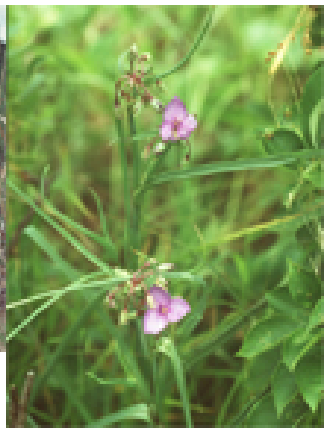
WESTERN SPIDERWORT
Tradescantia occidentalis (COMMELINACEAE)
GENERAL DESCRIPTION

Perennial, subsucculent herbaceous plant. Roots both fleshy and succulent. Stems to 60 cm in height. Leaves, green with a whitish bloom, alternate, linear-lanceolate, entire, 6-50 cm in length and 0.2-2.0 cm broad, with sheathing bases. Inflorescence umbellate, subtended by elongate bracts similar to the foliage leaves. Bracts to 60 cm long. Flower stalks, 1-2 cm long, and glandular hairy. Sepals 3, 6-12 mm long, glandular hairy, with purplish margins. Petals 3, blue to rose, broadly ovate, and 7-15 mm long. One flower in each cluster opens each day, and lasts for only a few hours. Stamens six. Fruit a capsule with three locules (sections), each locule producing 3-6 oblong seeds, 2-4 mm long, yellow to dark brown in colour.

> Perennial, subsucculent herb, with alternate linear-lanceolate leaves with basal sheaths. Inflorescence an umbellate cluster, subtended by two elongate bracts. Flowers perfect, regular, with three glandular-hairy sepals, and three blue to rose coloured petals. Stamens 6. Fruit a capsule with three locules, each locule containing 1 or more seeds. Associated with sandhill habitats.

LIFE HISTORY
Shoots appear in early May. Flower buds appear in early June. Flowers open from mid-June to mid-July but may continue to mid-August. Capsules release seed about three weeks after flowering. Seed release occurs from late July until late September (Goulet and Kenkel 1997).

HABITAT
Tradescantia occidentalis is restricted to dry dune or sand hill communities within the mixed grass prairie. Preferring partially stabilized sand, it will also colonize active dune blow outs, and is found almost exclusively on the upper slopes and crests of dunes. In Manitoba, it is found at two sites, the Lauder Sand Hills and the Routledge Sand Hills. These locations have sand or sand/silt substrates, are level to hummocky, experience imperfect drainage, and receive 400-800mm of precipitation annually. Areas with low litter accumulation and sparse vegetation appear to be best suited for Spiderwort.

WESTERN SILVERY ASTER
Aster sericeus (ASTERACEA)
GENERAL DESCRIPTION

Native erect perennial forb 8"-24" in height.

Easy to identify because of its soft silvery leaves and habitat. It is really and unmistakable plant. *A. sericeus* has quite large flowers for the overall size of the plant.

An uncommon species of sandy prairies and associated forest edge. Growth form is low and branching, reaching only to 40 cm in height. The leaves are covered in dense silvery-white hairs. The delicate looking flowers are mauve in colour.

The Western Silvery Aster occurs in central North America from Manitoba to Texas. In Canada, it is at the northern limit of its distribution and a total of about 6,500 stems occur at two major sites and a number of smaller ones in Ontario and southeastern Manitoba.

LIFE HISTORY

HABITAT

Prairie, Sand Barrens, and Savanna (partially forested sites)

FLOWERING DATES: Aug. – Oct.

GREAT PLAINS LADIES'-TRESSES
Spiranthes magnicamporum

GENERAL DESCRIPTION

The specific epithet magnicamporum is the Latin meaning "of the large plain," referring to the prairie habitat that this species is found in.

Plant pubescent above the leaves, 12-38 cm tall (including inflorescence), arising from a cluster of large, fleshy roots, appearing tuberous. Leaves 2-3, basal, oblanceolate to linear-lanceolate, 10-14 cm long and 0.8-1 cm wide, fugacious (withering at flowering), grading into reduced sheathing bracts below the inflorescence, the bracts typically overlapping. Inflorescence a downy, spicate raceme of 20-40 creamy-white to yellowish, fragrant flowers, 12-38 cm tall, dense and multi-ranked, each flower subtended by an elongate, ovate-lanceolate bract. Sepals linear-lanceolate, 6-11 mm long and about 2 mm wide, the lateral sepals with margins inrolled, and typically spreading slightly and ascending with the tips often recurved and nearly meeting above the flower, dorsal sepal connivent with petals to form a hood over the column, sepals creamy-white to yellowish-colored. Petals linear-lanceolate to linear, 7-10 mm long and 1-2 mm wide, closely appressed to the dorsal sepal, tips of dorsal sepal and petals reflexed slightly, colored as sepals. Labellum ovate to obovate and strongly arcuate-recurved, 6.5-11 mm long and 4-6 mm wide, creamy-white to yellowish-colored with the central portion typically thickened and yellowish, the central portion never constricted, the base of the labellum with two small, incurved, pubescent calli.

LIFE HISTORY

HABITAT

Typically found on dry bluff or hill prairies over limestone or dolomite.

FLOWERING DATES: September 5-October 7

Manitoba Conservation Data Centre
Box 24, 200 Saulteaux Crescent
Manitoba, Canada R3J 3W3
(204) 945-7743 fax (204) 945-3077

INSTRUCTIONS - PLEASE READ CAREFULLY:

1. Important: this form is to be COMPLETED BY THE PERSON WHO MADE THE OBSERVATION and is for reporting FIRST-HAND ON-SITE FIELD OBSERVATIONS; do NOT use this form to report second or third hand data from a letter, report, or conversation. Send us a copy of the letter, report, memo, etc. and we will process it in another manner.
2. Complete one form per species per site. Use a pen or dark pencil.
3. Very Important: attach a copy of the NTS topographic map indicating the location/boundary of the species. (see p.2).

SPECIES (scientific) NAME:
_____
COMMON NAME:
_____
OBSERVATION DATA:
LAST observed: month: _____ day: _____ yr.:_____
FIRST observed: month: _____ day: _____ yr.:_____
Name of observer(s):
_____
Telephone: ( ) _____
Fax: ( ) _____
Address:
_____
_____
_____
Prov: _____
Others knowledgeable about this occurrence (name, address, phone):
_____
_____
_____
_____
_____
_____
LOCATION INFORMATION:
ELEVATION (if known): _____ft./m (circle one)
SURVEY SITE NAME (local or place name for site) :
_____

TOPOGRAPHIC MAP NAME:

_____

TOPOGRAPHIC MAP NUMBER:

_____

MUNICIPALITY/LGD(S):

_____

TOWNSHIP(S):

_____

DIRECTIONS TO THE OCCURRENCE: Describe in detail the PRECISE LOCATION of the species occurrence. Refer to nearby topographic landmarks and street names. Include distances and mileage whenever possible. Be clear and concise.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

BIOLOGY: Total number of animals (adults, juveniles, nests, etc.) or plants (flowering, fruits, stems, etc.) observed:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Photograph taken? Y N (circle one)
Specimen taken? Y N (circle one)
Collection #/ repository : _____
Identification problems? Y N (circle one)
Explain :

_____
____

Quality of this occurrence : Excellent Good Fair Poor (circle one)
Explain:

_____
_____

SURVEY SITE INFORMATION:
Habitat/site description: (plant communities / dominants / associated species / other rare species / substrates / soils / aspect / slope):

_____
_____

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
Overall quality of the site: Excellent Good Fair Poor (circle one)
Explain:
_____
_____
_____
_____
MANAGEMENT and PROTECTION:
Landowner(s) or manager(s) if known. Include name / address /phone:
_____
_____
_____
_____
Current Land Use:
_____
_____
_____
_____
Visible disturbance and possible threats :
_____
_____
_____
_____
Conservation / management needs:
_____
_____
_____
_____
Data security needed? Y N (circle one)
Explain :
_____
_____
_____
_____
***TOPOGRAPHIC MAP:** (VERY IMPORTANT) - ATTACH (staple) a PHOTOCOPY of the appropriate portion of the TOPOGRAPHIC MAP for area and indicate the precise location of each species occurrence.

See the directions below :

- If the size of the occurrence is very small, simply draw a DOT on the map indicating the location of the occurrence.
- If the occurrence is large enough, draw a boundary (using a solid line) around the known extent of the occurrence.

HABITAT MAP: On an attached piece of paper please provide a detailed SKETCH of the habitat showing fine details not shown on the topographic map. Indicate the ROUTE taken, STREETS, LANDMARKS, DISTURBANCE, SCALE, and NORTH.

IMPORTANT - PLEASE FILL OUT THE FOLLOWING:

FORM FILLED OUT BY:

Date: _____ Name:

_____

Affiliation:

_____

___

Address:

_____

____

Prov.:

_____

_____

Postal Code:

_____

_

SUBMITTED BY: (if different from above) :

_____

Appendix 2: PSP Equipment and Supplies

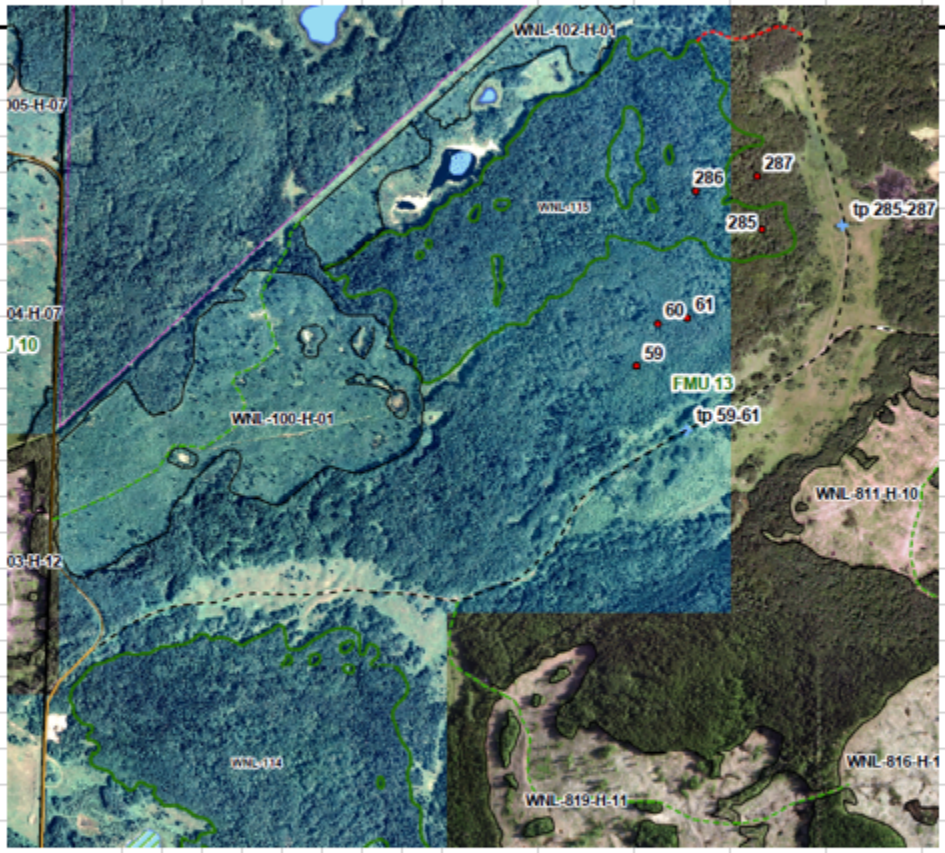
EQUIPMENT	SUPPLIES
50 m Tape (1)	Aluminum Tree Tags
Bear Spray (3)	Anti-fog Spray
Calipers (1)	Batteries - laser & GPS unit
Camera - disposable (1)	Corner Posts (36 x 3’ rebar per cluster)
Clinometer (1)	Data Quality Control Sheet
Clipboard (2)	Data Sheets
Codes Sheet (2 sets)	aged tree sheets
Compass (3)	cover sheets
Cruise Vest (3)	downed woody debris sheets
Dbh & Height Class Stick (2)	herb/shrub sheets
Dbh Tape (2)	regen/sapling sheets
Douglas Protractor (1)	soil sheets
Ecological Monitoring PSP Field Manual (3)	tree sheets
Additions/Alterations to PSP Field Manual (1)	wildlife sheets
Equipment Bag (2)	waterproof data sheets
Explanation Booklet for Tree Condition Codes (1)	Duct Tape
FEC Book (3)	Flagging Tape (pink candystripe)
Field Guide - plants (3)	Flagging Tape (biodegradeable)
Field Guide - soils (1)	Grease Pencils
Field Notebook (1)	HCl Acid
File Carrier (1)	Hip Chain String
First Aid Kit - personal (3)	Marker (thick black permanent)
Folding Pruning Saw (1)	Marker (thin black permanent)
Forest Insects and Diseases Field Sheets (3 sets)	Masking Tape
Forest Insects and Diseases Book (1)	Paint Sticks (pink)
GPS Unit (1)	Paper Plates (office)
Hammer (1)	Pencils
Hand Lens (1)	Spray Paint (orange)
Hard Hat with Face Protector and Liner (3)	Straws for Tree Age Cores
HCl Dispenser (1)	Unknown Plant Sample Tags
High Visibility Vests (3)	Wire for Tree Tagging
Hip Chain (1)	Ziploc Bags (large)
Increment Borer (1)	Ziploc Bags (small)
Lighter (1)	
Jack Knife (1)	
Laser with Tripod (1)	
Munsell Colour Chart (1)	

EQUIPMENT	SUPPLIES
Pencil Sharpener (1)	
Photo Case (1)	
Regen Plot Cord and Holder (1)	
Safety Glasses (3)	
Scale Ruler (3)	
Scissors (1)	
Soil Cores (4)	
Soil Core Mallet (1)	
Soil Sieve for Coarse Fragments (1)	
Spade - large size (1) - small size (1)	
Tape Measure (1)	
Tarp (1)	
Tent Pegs (8)	
Trowel (1)	
Tupperware Container (1)	
Veg. Measuring Sticks (2)	
Veg. Plot Ropes (6)	
Wire Cutters (2)	

Appendix 3: PSP Data Sheets

1 - PSP REMEASUREMENT HEADER

FMU	10, 11, 12, 13, 14	crew 1		PSP#	285
Operating Area	W N L	crew 2		page	1 of 1
UTM_Zone	14	crew 3		Measurement #	2
UTM_Easting	,	GPS taken		Year	2017
UTM_Northing	, ,			Month	
PSP Access	walk (km)_____ quad (km)_____			Day	
					revised: April 12th, 2007



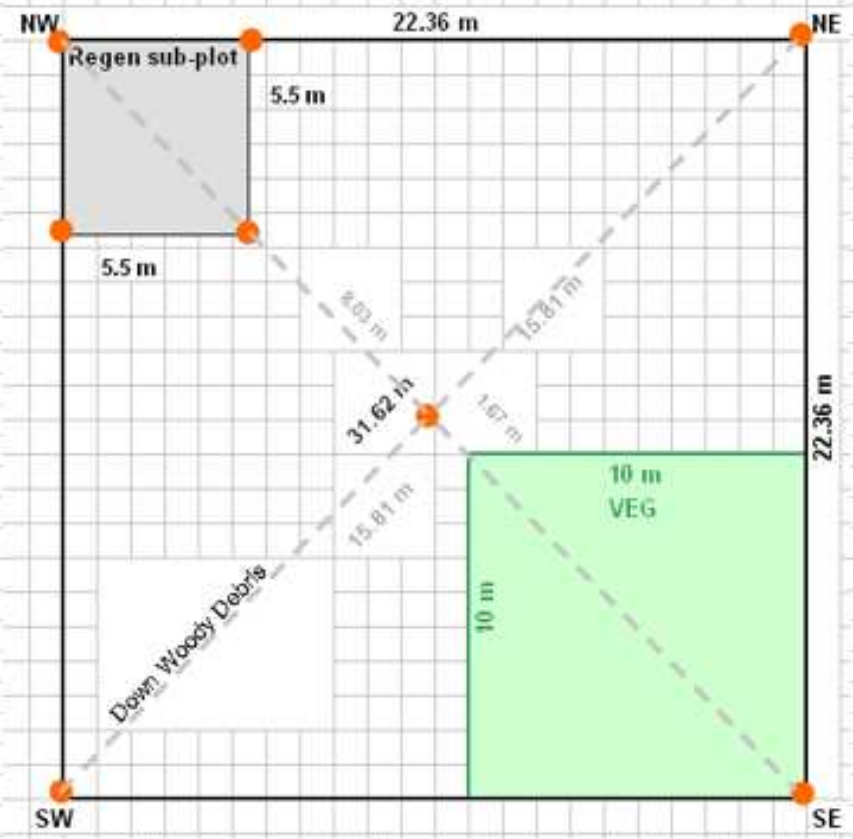
Location Instructions:

PSP Number	UTM_Easting	UTM_Northing
285	**345,478**	**5,711,806**
286	345,270	5,711,928
287	345,463	5,711,975

2 - PSP MAINTENANCE

revised Sept. 1st, 2011

PSP#	285
Year	2017



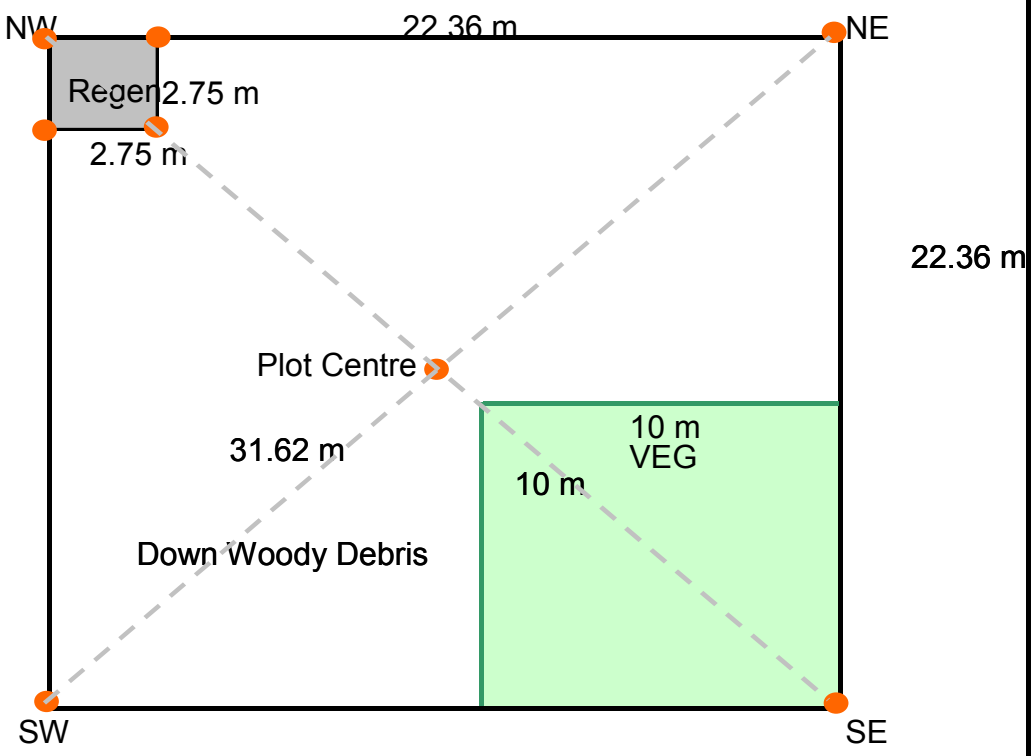
	improvements to location description?
	Tie point remarked if necessary?
	GPS tiepoint?
	GPS plot centre?
	Tree plot corner post present?
	Boundary trees painted orange?
	Regen sub-plot posts present?
	Tree tags all present?
	4 photos taken (plot centre towards S, W, N & E)?

2 - PSP MAINTENANCE

revised April 12th, 2007

PSP# _____

Year 2007



	improvements to location description?
	Tie point remarked if necessary?
	GPS tiepoint?
	GPS plot centre?
	Tree plot corner post present?
	Boundary trees painted orange?
	Regen sub-plot posts present?
	Tree tags all present?
	4 photos taken (plot centre towards S, W, N & E)?

3 - PSP VEGETATION SUB-PLOT

plot size	100 m2	Year	2017	crew 1		PSP#	285
		Month		crew 2		page	of
		Day		crew 3		Measurement #	2

(all vegetation: tree, understorey, shrub, herb, moss & lichen - % cover classes) *revised: April 12th, 2007*

Species (7 letters short-form)	Layer (1-7)	Braun-Blanquet cover	Species (7 letters short-form)	Layer (1-7)	Braun-Blanquet cover

	Percent Cover
r	one plant, < 1% cover
+	several plants, < 1% cover
1	1 to 5%
2	5 to 25%
3	26 to 50%
4	51 to 75%
5	76 to 100%

Lage	Description - Height Class
1	Dominant trees – emergent or supercanopy trees
2	Codominant trees – trees in the main canopy layer
3	Understory layer (trees and shrubs), >3 to 10 m in height
4	Tall shrubs – >0.5 to 3.0 m in height
5	Low shrubs – up to 0.5 m in height
6	non-woody spp: herbs, ferns, fern allies, grasses and sedges
7	All mosses, liverworts, and lichens

4 - PSP DOWNED WOODY DEBRIS TRANSECT

length (m)	31.62 m	crew1		PSP#	285
Year	2017	crew2		page	of
Month		crew3		Measurement #	2
Day		*(down woody material) > 7.5 cm)*		*revised Nov. 6th, 2012*	

Line# 1 S to N OR SE to NW

Distance First (0.01 m)	Distance Last (0.01 m)	Dead Tree Spp (TA, BA...)	Diameter (cm)	Measurement Type (Circ or Linear)	Decomposition Class (1-5)	Stump or Log (S / L)

Line # 2 W to E OR SW TO NE

Distance First (0.01 m)	Distance Last (0.01 m)	Dead Tree Spp (TA, BA...)	Diameter (cm)	Measurement Type (Circ or Linear)	Decomposition Class (1-5)	Stump or Log (S / L)

Downed Woody Debris: Any stump <1.3m in height, or a tree bole or large branch that is no longer free standing or leaning and is supported only by the ground, a rock, its own branches or another log.

Method: Run two transects on a SE/NW and SW/NE bearing through plot centre to form diagonal lines.

Assess downed woody debris decomposition along these two lines only.

For each stump or log that intersects the transect (diameter 7.5 or greater at the point of intersection with the transect) assess and record species, diameter, and mortality

5 - PSP REGENERATION SUB-PLOT

size	7.56 m2 or 30.25 m	crew1		PSP#	285
Year	2017	crew2		page	of
Month		crew3		Measurement #	2
Day					

(Live Trees 10 cm+ tall AND dbh 0 to 1.0 cm) *revised: Nov. 4th, 2015*

	HT Class 1 0.1 to 0.3 m	HT Class 2 0.31 to 0.6 m	HT Class 3 0.61 to 0.9 m	HT Class 4 0.91 to 1.2 m	HT Class 5 1.21 m+
Species	**count**	count	**count**	count	**count**
TA					
BA					
WB					
WS					
BS					
JP					
BF					
TL					

6 - PSP SAPLING TALLY

plot size	500 m2	crew 1		PSP#	285
		crew 2		page	of
		crew 3		Measurement #	2
				Year	2017
				Month	
				Day	

(Live Trees 1.1 to 9.0 cm dbh) *revised: June 1st, 2016*

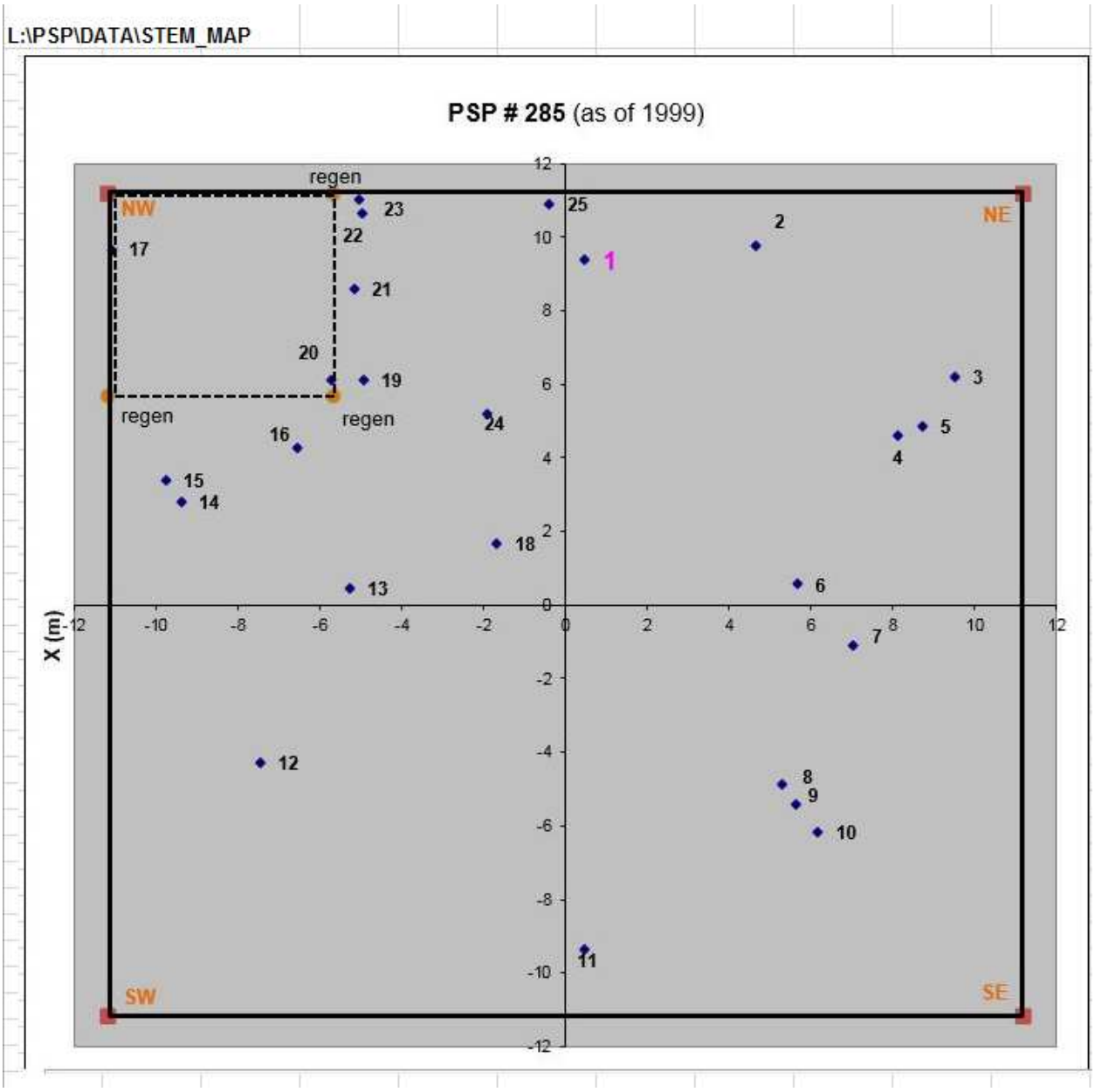
	3			6			9		
	1.1 – 3.0 cm DBH			3.1 – 6.0 cm DBH			6.1 – 9.0 cm DBH		
Species	count	Avg Ht (m)		count	Avg Ht (m)		count	Avg Ht (m)	
TA			.			.			.
BA			.			.			.
WB			.			.			.
			.			.			.
WS			.			.			.
BS			.			.			.
JP			.			.			.
BF			.			.			.
TL			.			.			.
			.			.			.

Comments:

7 - PSP TREE TALLY

plot size	500 m2	crew1		PSP#	285
tagging limit	9.1 cm +	crew2		page	1 of
Year	2017	crew3		Measurement #	2
Month				ONLY 25 trees - do all heights	
Day		(Live and Dead Trees 9.1cm or greater DBH)		revised: Apr. 12th, 2017	

Tree #	Spp	DBH (0.1 cm)	live or dead	Condition Codes			Height 1 (0.1 m)	Height 2 (0.1 m)	Height to Live Crown (0.1 m)			Original (1) Ingrowth (2)	Snag Decomp Class (1-5)	Down Woody Decomp (1-5)
1	WS	31.0	live	22	0	0	18.5				.	1		
2	TA	31.7	live	30	10	106	17.3				.	1		
3	BA	10.1	live	0	0	0	10.8				.	1		
4	WS	34.3	live	22	131	0	16.4				.	1		
5	WS	11.9	live	22	0	0	7.3				.	1		
6	WS	17.2	live	22	0	0	9.1				.	1		
7	WS	43.7	live	0	0	0	19.4				.	1		
8	TA	17.8	live	2	7	0	5.1				.	1		
9	WS	14.1	live	14	0	0	12.0				.	1		
10	WS	32.0	live	0	0	0	14.4				.	1		
11	TA	28.9	live	26	106	12	15.7				.	1		
12	TA	31.0	live	26	14	0	18.7				.	1		
13	TA	12.2	live	12	0	0	9.2				.	1		


L:\PSP\DATA\STEM_MAP
PSP # 285 (as of 1999)
regen
NW
NE
SW
SE
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regen
17
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21
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19
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24
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6
7
12
8
9
10
11
X (m)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12

SP Numbe	eas_No_Tr	Meas Yr	Tree No	Spp	Dbh (cm)	ive or Dea	eight 1 (m	eight 2 (m	tal Tree He	Crown Cl	ond Code	ond Code	ond Code	SNAG DE	COMP CLASS 1 TO 5
285	1	1999	1	WS	31.0	live	18.54		18.54	1	22	0	0		
285	1	1999	2	TA	31.7	live	17.34		17.34	1	30	10	106		
285	1	1999	3	BA	10.1	live	10.79		10.79	4	0	0	0		
285	1	1999	4	WS	34.3	live	16.43		16.43	2	22	131	0		
285	1	1999	5	WS	11.9	live	7.25		7.25	4	22	0	0		
285	1	1999	6	WS	17.2	live	9.06		9.06	3	22	0	0		
285	1	1999	7	WS	43.7	live	19.38		19.38	1	0	0	0		
285	1	1999	8	TA	17.8	live	5.06		5.06		2	7	0		
285	1	1999	9	WS	14.1	live	12.00		12.00	3	14	0	0		
285	1	1999	10	WS	32.0	live	14.37		14.37	1	0	0	0		
285	1	1999	11	TA	28.9	live	15.73		15.73	1	26	106	12		
285	1	1999	12	TA	31.0	live	18.74		18.74	1	26	14	0		
285	1	1999	13	TA	12.2	live	9.24		9.24	3	12	0	0		
285	1	1999	14	TA	31.9	live	20.94		20.94	1	26	14	0		
285	1	1999	15	TA	28.3	live	17.40		17.40	1	26	28	0		
285	1	1999	16	WS	25.9	live	13.71		13.71	2	22	0	0		
285	1	1999	17	WS	24.0	live	12.65		12.65	2	22	50	0		
285	1	1999	18	BA	16.2	dead	10.70		10.70	3	14	25	0		
285	1	1999	19	WS	35.5	live	19.46		19.46	1	22	0	0		
285	1	1999	20	TA	12.0	live	17.16		17.16	4	14	26	0		
285	1	1999	21	WS	19.3	live	13.23		13.23	3	14	22	0		
285	1	1999	22	WS	12.3	live	6.98		6.98	4	50	22	14		
285	1	1999	23	WS	9.9	live	6.98		6.98	4	22	30	0		
285	1	1999	24	WS	14.0	live	8.99		8.99	3	14	30	0		
285	1	1999	25	WS	15.4	live	11.24		11.24		1	50	0		

8 - TREE CAVITIES

plot size	500 m2	crew1		PSP#	285
		crew2		page	of
		crew3		Measurement #	2
				Year	2017
				Month	
				Day	

(trees with cavities) *revised:April 12th, 2007*

Tree #	Cavity Description	Location of Cavity	Cavity Type	Cavity Size	# cavities
	N - nesting	S - stump	E-excavated	S - small (2.5 - 7 cm)	
	F - feeding	B - bole	N-natural	M - med (7.1 to 15 cm)	
	E - escape	C - crown	B-both	L - large (>15 cm)	

Appendix 4: GPS Coordinates

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
1	1	fire-origin	1994	0	2012 BLOW DOWN	500	diamond
2	1	fire-origin	1994	0	2012 BLOW DOWN	500	diamond
3	1	fire-origin	1994	0	2012 BLOW DOWN	500	diamond
4	2	fire-origin	1994	0	WJL-034-H-09	500	diamond
5	2	REGEN	1994	1	WJL-034-H-09; re-established July 2014	500	diamond
6	2	fire-origin	1994	1	buffered out of WJL-034-H-09	500	diamond
7	3	fire-origin	1994	1		500	diamond
8	3	fire-origin	1994	1		500	diamond
9	3	fire-origin	1994	1		500	diamond
10	4	fire-origin	1994	1		500	diamond
11	4	fire-origin	1994	1		500	diamond
12	4	fire-origin	1994	1		500	diamond
13	5	fire-origin	1994	1		500	diamond
14	5	fire-origin	1994	1		500	diamond
15	5	fire-origin	1994	1		500	diamond
16	6	fire-origin	1994	1		500	diamond
17	6	fire-origin	1994	1		500	diamond
18	6	fire-origin	1994	1		500	diamond
19	7	fire-origin	1994	0	WEF-001 2012 BLOW DOWN	500	diamond
20	7	REGEN	1994	1	WEF-001 2012 BLOW DOWN, Cut, Re-established 2014	500	diamond
21	7	fire-origin	1994	0	WEF-001 2012 BLOW DOWN	500	diamond
22	8	fire-origin	1994	1		500	diamond
23	8	fire-origin	1994	0	final measure & decommissioned	500	diamond
24	8	fire-origin	1994	0	MISSING-can't find	500	diamond
25	9	fire-origin	1994	1		500	diamond
26	9	fire-origin	1994	1		500	diamond
27	10	fire-origin	1994	1		500	diamond
28	10	fire-origin	1994	1		500	diamond
29	10	fire-origin	1994	1		500	diamond

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
30	11	fire-origin	1994	1		500	diamond
31	11	fire-origin	1994	1		500	diamond
32	11	fire-origin	1994	1		500	diamond
33	12	fire-origin	1994	1	PSP SAVED	500	diamond
34	12	REGEN	1994	1	PSP re-established Nov 2013 after WNL-022 harv	500	diamond
35	12	fire-origin	1994	0	WNL-022 cut fall 2012 and summer 2013	500	diamond
36	13	fire-origin	1994	1		500	diamond
37	13	fire-origin	1994	1		500	diamond
38	13	fire-origin	1994	1		500	diamond
39	14	fire-origin	1994	1		500	diamond
40	14	fire-origin	1994	1		500	diamond
41	14	fire-origin	1994	1		500	diamond
42	15	fire-origin	1994	1	PSP SAVED	500	diamond
43	15	fire-origin	1994	0	harvested in 2014 VLR-852	500	diamond
44	15	fire-origin	1994	0	harvested in 2014 VLR-852	500	diamond
45	16	fire-origin	1994	1		500	diamond
46	16	fire-origin	1994	1		500	diamond
47	16	fire-origin	1994	1		500	diamond
48	17	fire-origin	1994	1		500	diamond
49	17	fire-origin	1994	1		500	diamond
50	18	fire-origin	1994	1		500	diamond
51	18	fire-origin	1994	1		500	diamond
52	18	fire-origin	1994	1		500	diamond
53	19	fire-origin	1994	0	CWE-001 2012 BLOW DOWN	500	diamond
54	19	fire-origin	1994	0	CWE-001 2012 BLOW DOWN	500	diamond
55	19	fire-origin	1994	0	CWE-001 2012 BLOW DOWN	500	diamond
56	20	fire-origin	1994	0	2012 BLOW DOWN	500	diamond
57	20	fire-origin	1994	0	2012 BLOW DOWN	500	diamond
58	20	fire-origin	1994	0	2012 BLOW DOWN	500	diamond
59	21	fire-origin	1994	1		500	diamond
60	21	fire-origin	1994	1		500	diamond

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
61	21	fire-origin	1994	1		500	diamond
62	22	fire-origin	1994	1		500	diamond
63	22	fire-origin	1994	1		500	diamond
64	22	fire-origin	1994	1		500	diamond
65	23	fire-origin	1994	1		500	diamond
66	23	fire-origin	1994	1		500	diamond
67	24	fire-origin	1994	1		500	diamond
68	24	fire-origin	1994	0	final measure & decommissioned	500	diamond
69	24	fire-origin	1994	0	final measure & decommissioned	500	diamond
70	25	fire-origin	1994	1		500	diamond
71	25	fire-origin	1994	1		500	diamond
72	25	fire-origin	1994	1		500	diamond
73	26	fire-origin	1994	0	harvested by Valley River FNs	500	diamond
74	26	fire-origin	1994	0	harvested by Valley River FNs	500	diamond
75	26	fire-origin	1994	0	harvested by Valley River FNs	500	diamond
76	27	fire-origin	1994	1		500	diamond
77	27	fire-origin	1994	1		500	diamond
78	27	fire-origin	1994	1		500	diamond
79	28	fire-origin	1994	0	final measure & decommissioned	500	diamond
80	28	fire-origin	1994	0	final measure & decommissioned	500	diamond
81	28	fire-origin	1994	1		500	diamond
82	29	fire-origin	1994	0	Treaty Land Entitlement in 2004	500	diamond
83	29	fire-origin	1994	0	Treaty Land Entitlement in 2004	500	diamond
84	29	fire-origin	1994	0	Treaty Land Entitlement in 2004	500	diamond
85	30	fire-origin	1994	0	Treaty Land Entitlement in 2004	500	diamond
86	30	fire-origin	1994	0	Treaty Land Entitlement in 2004	500	diamond

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
87	30	fire-origin	1994	0	Treaty Land Entitlement in 2004	500	diamond
88	31	fire-origin	1994	0	Treaty Land Entitlement in 2004	500	diamond
89	31	fire-origin	1994	0	Treaty Land Entitlement in 2004	500	diamond
90	31	fire-origin	1994	0	Treaty Land Entitlement in 2004	500	diamond
91	32	fire-origin	1994	1		500	diamond
92	32	fire-origin	1994	1		500	diamond
93	32	fire-origin	1994	1		500	diamond
94	33	fire-origin	1994	1		500	diamond
95	33	fire-origin	1994	1		500	diamond
96	33	fire-origin	1994	1		500	diamond
97	34	fire-origin	1994	1		500	diamond
98	34	fire-origin	1994	1		500	diamond
99	34	fire-origin	1994	1		500	diamond
100	35	fire-origin	1994	1		500	diamond
101	35	fire-origin	1994	1		500	diamond
102	35	fire-origin	1994	1		500	diamond
103	36	fire-origin	1994	0	MISSING - wires & posts gone	500	diamond
104	36	fire-origin	1994	0	in CWC-118 decom 2014	500	diamond
105	36	fire-origin	1994	0	in CWC-118 decom 2014	500	diamond
106	37	fire-origin	1994	1		500	diamond
107	37	fire-origin	1994	1		500	diamond
108	37	fire-origin	1994	1		500	diamond
109	38	fire-origin	1994	1		500	diamond
110	38	REGEN	1994	1	HSC-031 cut in Mar2012; re-est 2014	500	diamond
111	38	fire-origin	1994	0	HSC-031 cut in Mar2012	500	diamond
112	39	REGEN	1994	1	RCK-102 cut June 2013; re-est 2014	500	diamond
113	39	fire-origin	1994	1	PSP protected by 50 m buffer	500	diamond
114	39	fire-origin	1994	0	RCK-102 cut June 2013	500	diamond
115	40	fire-origin	1994	0	in RCK-105 decom 2014	500	diamond
116	40	fire-origin	1994	0	in RCK-105 decom 2014	500	diamond

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
117	40	fire-origin	1994	1		500	diamond
118	41	fire-origin	1994	0	cut in SRR-301 in 2016-2017 op yr	500	diamond
119	41	fire-origin	1994	0	cut in SRR-301 in 2016-2017 op yr	500	diamond
120	41	fire-origin	1994	1	PSP protected	500	diamond
121	42	fire-origin	1994	1		500	diamond
122	42	fire-origin	1994	1		500	diamond
123	42	fire-origin	1994	0	beavers???	500	diamond
124	43	fire-origin	1994	1		500	diamond
125	43	fire-origin	1994	1		500	diamond
126	43	fire-origin	1994	1		500	diamond
127	44	fire-origin	1994	1		500	diamond
128	44	fire-origin	1994	1		500	diamond
129	44	fire-origin	1994	1		500	diamond
130	45	fire-origin	1994	0	Treaty Land Entitlement	500	diamond
131	45	fire-origin	1994	0	Treaty Land Entitlement	500	diamond
132	45	fire-origin	1994	0	Treaty Land Entitlement	500	diamond
133	46	fire-origin	1994	0	cut TEL-905-H-09	500	diamond
134	46	fire-origin	1994	1		500	diamond
135	46	fire-origin	1994	1		500	diamond
136	47	fire-origin	1994	1		500	diamond
137	47	fire-origin	1994	1		500	diamond
138	47	fire-origin	1994	1		500	diamond
139	48	fire-origin	1994	1		500	diamond
140	48	fire-origin	1994	1		500	diamond
141	48	fire-origin	1994	1		500	diamond
142	49	REGEN	1994	1	Cut BSR-113 in 2013, Re-establised Oct 21 2014	500	diamond
143	49	fire-origin	1994	1		500	diamond
144	49	fire-origin	1994	1		500	diamond
145	50	fire-origin	1994	1		500	diamond
146	50	fire-origin	1994	1		500	diamond
147	50	fire-origin	1994	1		500	diamond
148	51	fire-origin	1994	1		500	diamond
149	51	fire-origin	1994	1		500	diamond
150	51	fire-origin	1994	1		500	diamond

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
151	52	fire-origin	1999	1	plot# changed to 601 (prev logging)	500	square
152	52	fire-origin	1999	1	plot# changed to 602 (prev logging)	500	square
153	52	fire-origin	1999	1	plot# changed to 603 (prev logging)	500	square
154	53	fire-origin	1997	1		500	square
155	53	fire-origin	1997	1		500	square
156	53	fire-origin	1997	1		500	square
157	54	fire-origin	1999	1		500	square
158	54	fire-origin	1999	1		500	square
159	54	fire-origin	1999	1		500	square
160	55	fire-origin	1998	0	to be cut SGL-806; plot decomissioned Oct 2013	500	square
161	55	fire-origin	1998	1	SAVED	500	square
162	55	fire-origin	1998	0	PSP162 99% windthrown in 2013	500	square
163	56	fire-origin	1998	1		500	square
164	56	fire-origin	1998	1		500	square
165	56	fire-origin	1998	1		500	square
166	57	fire-origin	1998	1		500	square
167	57	fire-origin	1998	1		500	square
168	57	fire-origin	1998	1		500	square
169	58	fire-origin	1998	1		500	square
170	58	fire-origin	1998	1		500	square
171	58	fire-origin	1998	1		500	square
172	59	fire-origin	1998	0	blowndown - 3 trees standing	500	square
173	59	fire-origin	1998	0	blowndown	500	square
174	59	fire-origin	1998	0	blowndown	500	square
175	60	fire-origin	1998	1		500	square
176	60	fire-origin	1998	1		500	square
177	60	fire-origin	1998	1		500	square
178	61	fire-origin	1998	1		500	square
179	61	fire-origin	1998	1		500	square
180	61	fire-origin	1998	1		500	square
181	62	fire-origin	1999	1		500	square
182	62	fire-origin	1999	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
183	62	fire-origin	1999	1		500	square
184	63	fire-origin	1999	0	SRL-100-H-11	500	square
185	63	fire-origin	1999	1	buffered & saved from harvest	500	square
186	63	REGEN	1999	1	SRL-100-H-11, Re-established Oct 23, 2014	500	square
187	64	fire-origin	1999	1		500	square
188	64	fire-origin	1999	1		500	square
189	65	fire-origin	1999	1		500	square
190	65	fire-origin	1999	1		500	square
191	65	fire-origin	1999	1		500	square
192	66	fire-origin	1999	1		500	square
193	66	fire-origin	1999	1		500	square
194	66	fire-origin	1999	1		500	square
195	67	fire-origin	1999	1		500	square
196	67	fire-origin	1999	1		500	square
197	67	fire-origin	1999	1		500	square
198	68	fire-origin	1999	1		500	square
199	68	fire-origin	1999	1		500	square
200	68	fire-origin	1999	1		500	square
201	69	fire-origin	1999	1		500	square
202	69	fire-origin	1999	1		500	square
203	69	fire-origin	1999	1		500	square
204	70	fire-origin	1999	1	0.3 km walk in	500	square
205	70	fire-origin	1999	1	0.3 km walk in	500	square
206	70	fire-origin	1999	1	0.3 km walk in	500	square
207	71	fire-origin	1999	1		500	square
208	71	fire-origin	1999	1		500	square
209	71	fire-origin	1999	1		500	square
210	72	fire-origin	1999	1		500	square
211	72	fire-origin	1999	1		500	square
212	72	fire-origin	1999	1		500	square
213	73	fire-origin	1999	1		500	square
214	73	fire-origin	1999	1		500	square
215	73	fire-origin	1999	1		500	square
216	74	fire-origin	1999	1		500	square
217	74	fire-origin	1999	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
218	74	fire-origin	1999	1		500	square
219	75	fire-origin	1999	1		500	square
220	75	fire-origin	1999	1		500	square
221	75	fire-origin	1999	1		500	square
222	76	fire-origin	1999	1		500	square
223	76	fire-origin	1999	1		500	square
224	76	fire-origin	1999	1		500	square
225	77	fire-origin	1999	1		500	square
226	77	fire-origin	1999	1		500	square
227	77	fire-origin	1999	1		500	square
228	78	fire-origin	1999	1		500	square
229	78	fire-origin	1999	1		500	square
230	78	fire-origin	1999	1		500	square
231	79	fire-origin	1999	1		500	square
232	79	fire-origin	1999	1		500	square
233	79	fire-origin	1999	1		500	square
234	80	fire-origin	1999	0	SGL-822 cut in 2016	500	square
235	80	fire-origin	1999	1		500	square
236	80	fire-origin	1999	0	SGL-822 cut in 2016	500	square
237	81	fire-origin	1999	1		500	square
238	81	fire-origin	1999	1		500	square
239	81	fire-origin	1999	1		500	square
240	82	fire-origin	1999	1		500	square
241	82	fire-origin	1999	1		500	square
242	82	fire-origin	1999	1		500	square
243	83	fire-origin	1999	1		500	square
244	83	fire-origin	1999	1		500	square
245	83	fire-origin	1999	1		500	square
246	84	fire-origin	1999	1		500	square
247	84	fire-origin	1999	1		500	square
248	84	fire-origin	1999	1		500	square
249	85	fire-origin	1999	1		500	square
250	85	fire-origin	1999	1		500	square
251	85	fire-origin	1999	1		500	square
252	86	fire-origin	1999	1		500	square
253	86	fire-origin	1999	1		500	square
254	86	fire-origin	1999	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
255	87	fire-origin	1999	1		500	square
256	87	fire-origin	1999	1		500	square
257	87	fire-origin	1999	1		500	square
258	88	fire-origin	1999	1		500	square
259	88	fire-origin	1999	1		500	square
260	88	fire-origin	1999	1		500	square
261	89	fire-origin	1999	1		500	square
262	89	fire-origin	1999	1		500	square
263	89	fire-origin	1999	1		500	square
264	90	fire-origin	1999	1		500	square
265	90	fire-origin	1999	1		500	square
266	90	fire-origin	1999	1		500	square
267	91	fire-origin	1999	1		500	square
268	91	fire-origin	1999	1		500	square
269	91	fire-origin	1999	1		500	square
270	92	fire-origin	1999	1		500	square
271	92	fire-origin	1999	1		500	square
272	92	fire-origin	1999	1		500	square
273	93	fire-origin	1999	1		500	square
274	93	fire-origin	1999	1		500	square
275	93	fire-origin	1999	1		500	square
276	94	fire-origin	1999	0	CWE-005 2012 BLOW DOWN	500	square
277	94	fire-origin	1999	0	CWE-005 2012 BLOW DOWN	500	square
278	94	fire-origin	1999	0	CWE-005 2012 BLOW DOWN	500	square
279	95	fire-origin	1999	1		500	square
280	95	fire-origin	1999	1		500	square
281	95	fire-origin	1999	1		500	square
282	96	fire-origin	1999	1		500	square
283	96	fire-origin	1999	1		500	square
284	96	fire-origin	1999	1		500	square
285	97	fire-origin	1999	1		500	square
286	97	fire-origin	1999	1		500	square
287	97	fire-origin	1999	1		500	square
288	98	fire-origin	1999	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
289	98	fire-origin	1999	1		500	square
290	98	fire-origin	1999	1		500	square
291	99	fire-origin	1999	1		500	square
292	99	fire-origin	1999	1		500	square
293	99	fire-origin	1999	1		500	square
294	100	fire-origin	1999	1		500	square
295	100	fire-origin	1999	1		500	square
296	100	fire-origin	1999	1		500	square
297	101	fire-origin	1999	1		500	square
298	101	fire-origin	1999	1		500	square
299	101	fire-origin	1999	1		500	square
300	102	fire-origin	1999	1		500	square
301	102	fire-origin	1999	1		500	square
302	102	fire-origin	1999	1		500	square
303	103	fire-origin	1999	1		500	square
304	103	fire-origin	1999	1		500	square
305	103	fire-origin	1999	1		500	square
306	104	fire-origin	1999	1		500	square
307	104	fire-origin	1999	1		500	square
308	104	fire-origin	1999	1		500	square
309	105	fire-origin	1999	1		500	square
310	105	fire-origin	1999	1		500	square
311	105	fire-origin	1999	1		500	square
312	106	fire-origin	1999	1		500	square
313	106	fire-origin	1999	1		500	square
314	106	fire-origin	1999	1		500	square
315	107	fire-origin	1999	1		500	square
316	107	fire-origin	1999	1		500	square
317	107	fire-origin	1999	1		500	square
318	108	fire-origin	1999	1		500	square
319	108	fire-origin	1999	1		500	square
320	108	fire-origin	1999	1		500	square
321	109	fire-origin	1999	1		500	square
322	109	fire-origin	1999	1		500	square
323	109	fire-origin	1999	1		500	square
324	110	fire-origin	1999	1		500	square
325	110	fire-origin	1999	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
326	110	fire-origin	1999	1		500	square
327	111	PLANTATION	2000	1		500	square
328	111	PLANTATION	2000	1		500	square
329	111	PLANTATION	2000	1		500	square
330	112	EXPERIMENTAL - REGEN	2000	1		500	square
331	112	EXPERIMENTAL - REGEN	2000	0	beaver flooded in 2015	500	square
332	112	EXPERIMENTAL - REGEN	2000	1		500	square
333	112	EXPERIMENTAL - REGEN	2000	0	beaver flooded in 2015	500	square
334	112	EXPERIMENTAL - REGEN	2000	1		500	square
335	112	EXPERIMENTAL - REGEN	2000	1		500	square
336	112	EXPERIMENTAL - REGEN	2000	1		500	square
337	112	EXPERIMENTAL - REGEN	2000	1		500	square
338	112	fire-origin	2000	1		500	square
339	113	fire-origin	2000	1		500	square
340	113	fire-origin	2000	1		500	square
341	113	fire-origin	2000	1		500	square
342	17	fire-origin	2000	1		500	square
343	114	fire-origin	2000	1		500	square
344	114	fire-origin	2000	1		500	square
345	114	fire-origin	2000	1		500	square
346	115	fire-origin	2000	1		500	square
347	115	fire-origin	2000	1		500	square
348	115	fire-origin	2000	1		500	square
349	116	fire-origin	2000	1		500	square
350	116	fire-origin	2000	1		500	square
351	116	fire-origin	2000	1		500	square
352	117	fire-origin	2000	1		500	square
353	117	fire-origin	2000	1		500	square
354	117	fire-origin	2000	1		500	square
355	118	fire-origin	2000	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
356	118	fire-origin	2000	1		500	square
357	118	fire-origin	2000	1		500	square
358	119	fire-origin	2000	1		500	square
359	119	fire-origin	2000	1		500	square
360	119	fire-origin	2000	1		500	square
361	120	fire-origin	2000	1		500	square
362	120	fire-origin	2000	1		500	square
363	120	fire-origin	2000	1		500	square
364	121	fire-origin	2000	1		500	square
365	121	fire-origin	2000	1		500	square
366	121	fire-origin	2000	1		500	square
367	122	fire-origin	2000	1		500	square
368	122	fire-origin	2000	1		500	square
369	122	fire-origin	2000	1		500	square
370	123	fire-origin	2000	1		500	square
371	123	fire-origin	2000	1		500	square
372	123	fire-origin	2000	1		500	square
373	124	fire-origin	2000	1		500	square
374	124	fire-origin	2000	1		500	square
375	124	fire-origin	2000	1		500	square
376	125	fire-origin	2000	1		500	square
377	125	fire-origin	2000	1		500	square
378	125	fire-origin	2000	1		500	square
379	126	fire-origin	2000	1		500	square
380	126	fire-origin	2000	1		500	square
381	126	fire-origin	2000	1		500	square
382	127	fire-origin	2000	1		500	square
383	127	fire-origin	2000	1		500	square
384	127	fire-origin	2000	1		500	square
385	128	fire-origin	2000	1		500	square
386	128	fire-origin	2000	1		500	square
387	128	fire-origin	2000	1		500	square
388	129	fire-origin	2000	1		500	square
389	129	fire-origin	2000	1		500	square
390	129	fire-origin	2000	1		500	square
391	130	fire-origin	2000	1		500	square
392	130	fire-origin	2000	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
393	130	fire-origin	2000	1		500	square
394	131	fire-origin	2000	1		500	square
395	131	fire-origin	2000	1		500	square
396	131	fire-origin	2000	1		500	square
397	132	fire-origin	2000	1		500	square
398	132	fire-origin	2000	1		500	square
399	132	fire-origin	2000	1		500	square
400	133	fire-origin	2000	1		500	square
401	133	fire-origin	2000	1		500	square
402	133	fire-origin	2000	1		500	square
403	134	fire-origin	2000	1		500	square
404	134	fire-origin	2000	1		500	square
405	134	fire-origin	2000	1		500	square
406	135	fire-origin	2000	1		500	square
407	135	fire-origin	2000	1		500	square
408	135	fire-origin	2000	1		500	square
409	136	fire-origin	2000	1		500	square
410	136	fire-origin	2000	1		500	square
411	136	fire-origin	2000	1		500	square
412	137	fire-origin	2000	1		500	square
413	137	fire-origin	2000	1		500	square
414	137	fire-origin	2000	1		500	square
415	138	fire-origin	2000	1		500	square
416	138	fire-origin	2000	1		500	square
417	138	fire-origin	2000	1		500	square
418	139	fire-origin	2000	1		500	square
419	139	fire-origin	2000	1		500	square
420	139	fire-origin	2000	1		500	square
421	140	fire-origin	2000	1		500	square
422	140	fire-origin	2000	1		500	square
423	140	fire-origin	2000	1		500	square
500	141	fire-origin YOUNG	2003	1		500	square
501	141	fire-origin YOUNG	2003	1		500	square
502	141	fire-origin YOUNG	2003	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
503	141	fire-origin YOUNG	2003	1		500	square
504	141	fire-origin YOUNG	2003	1		500	square
505	141	fire-origin YOUNG	2003	1		500	square
506	141	fire-origin YOUNG	2003	1		500	square
507	141	fire-origin YOUNG	2003	1		500	square
508	141	fire-origin YOUNG	2003	1		500	square
509	141	fire-origin YOUNG	2003	1		500	square
510	141	fire-origin YOUNG	2003	1		500	square
511	141	fire-origin YOUNG	2003	1		500	square
512	141	fire-origin YOUNG	2003	1		500	square
513	141	fire-origin YOUNG	2003	1		500	square
514	141	fire-origin YOUNG	2003	1		500	square
515	141	fire-origin YOUNG	2003	1		500	square
516	141	fire-origin YOUNG	2003	1		500	square
517	141	fire-origin YOUNG	2003	1		500	square
518	141	fire-origin YOUNG	2003	1		500	square
519	141	fire-origin YOUNG	2003	1		500	square
520	141	fire-origin YOUNG	2003	1		500	square
521	141	fire-origin YOUNG	2003	1		500	square
522	141	fire-origin YOUNG	2003	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
523	141	fire-origin YOUNG	2003	1		500	square
524	141	fire-origin YOUNG	2003	1		500	square
525	141	fire-origin YOUNG	2003	1		500	square
526	141	fire-origin YOUNG	2003	1		500	square
527	141	fire-origin YOUNG	2003	1		500	square
528	141	fire-origin YOUNG	2003	1		500	square
529	141	fire-origin YOUNG	2003	1		500	square
530	141	fire-origin YOUNG	2003	1		500	square
531	141	fire-origin YOUNG	2003	1		500	square
532	141	fire-origin YOUNG	2003	1		500	square
533	141	fire-origin YOUNG	2003	1		500	square
534		EXPERIMENTAL - REGEN	2006	1		500	square
535		EXPERIMENTAL - REGEN	2006	1		500	square
536		EXPERIMENTAL - REGEN	2006	1		500	square
537		EXPERIMENTAL - REGEN	2006	1		500	square
538		EXPERIMENTAL - REGEN	2006	1		500	square
539		EXPERIMENTAL - REGEN	2006	1		500	square
540		EXPERIMENTAL - REGEN	2006	1		500	square
541		EXPERIMENTAL - REGEN	2006	1		500	square
542		EXPERIMENTAL - REGEN	2006	1		500	square

PSP Number	PSP Cluster	PSP Type	Est_Year	PSP_Status	Status_Comments	Plot_Size	Plot Shape
543		EXPERIMENTAL - REGEN	2006	1		500	square
544		EXPERIMENTAL - REGEN	2006	1		500	square
545		EXPERIMENTAL - REGEN	2006	1		500	square
546		EXPERIMENTAL - REGEN	2006	1		500	square
547		EXPERIMENTAL - REGEN	2006	1		500	square
548		EXPERIMENTAL - REGEN	2006	1		500	square
549		EXPERIMENTAL - REGEN	2006	1		500	square
550		EXPERIMENTAL - REGEN	2006	1		500	square
551		EXPERIMENTAL - REGEN	2006	1		500	square
601		fire-origin	1997	1	originally plot# 151	500	square
602		fire-origin	1997	1	originally plot# 152	500	square
603		fire-origin	1997	1	originally plot# 153	500	square
604		fire-origin	1997	1		500	square
605		fire-origin	1997	1		500	square
606		fire-origin	1997	1		500	square

Appendix 5: Vegetation list by life form.

Reference Number	Short Form	Genus	species	Common Name
TREES				
1	Abiebal	Abies	balsamea	Balsam fir
2	Acerneg	Acer	negundo	Manitoba maple
3	Betupap	Betula	papyrifera	White birch
4	Fraxpen	Fraxinus	pennsylvanica	Green ash
5	Larilar	Larix	laricina	Larch
6	Picegla	Picea	glauca	White spruce
7	Picemar	Picea	mariana	Black spruce
8	Pinuban	Pinus	banksiana	Jack pine
9	Popubal	Populus	balsamifera	Balsam poplar
10	Poputre	Populus	tremuloides	Trembling aspen
11	Quermac	Quercus	macrocarpa	Bur oak
12	Ulmuame	Ulmus	americana	White elm
SHRUBS				
13	Acerspi	Acer	spicatum	Mountain maple
14	Alnuvir	Alnus	viridus ssp. Crispa	Green alder
15	Alnuinc	Alnus	incana ssp. Rugosa	Speckled alder
16	Amelaln	Amelanchier	alnifolia	Saskatoon berry
17	Amelhum	Amelanchier	humilis	Juneberry
18	Amelspp	Amelanchier	spp.	Serviceberry
19	Andrgla	Andromeda	glaucophylla	Bog rosemary
20	Betugla	Betula	glandulifera	Swamp birch
21	Betupum	Betula	pumila	Dwarf birch
22	Chamcal	Chamaedaphne	calyculata	Leatherleaf
23	Cornsto	Cornus	stolonifera	Red osier dogwood
24	Corycor	Corylus	cornuta	Beaked hazel
25	Dierlon	Diervilla	lonicera	Bush honeysuckle
26	Junicom	Juniperus	communis	Common juniper
27	Kalmang	Kalmia	angustifolia	Sheep laurel
28	Kalmpol	Kalmia	polifolia	Pale laurel
29	Ledugro	Ledum	groenlandicum	Labrador-tea
30	Lonican	Lonicera	canadensis	Canada honeysuckle
31	Lonidio	Lonicera	dioica var. glaucescens	Twining honeysuckle
32	Loniinv	Lonicera	involucrata	Four-lined honeysuckle
33	Loniobl	Lonicera	oblongifolia	Swamp fly honeysuckle

Reference Number	Short Form	Genus	species	Common Name
34	Lonivil	Lonicera	villosa	Northern fly honeysuckle
35	Myrigal	Myrica	gale	Sweetgale
36	Potefru	Potentilla	fruticosa	Shrubby cinquefoil
37	Prunpen	Prunus	pennsylvanica	Pin cherry
38	Prunvir	Prunus	virginiana	Choke cherry
39	Rhamaln	Rhamnus	alnifolia	Alder-leaved buckthorn
40	Ribeame	Ribes	americana	Wild black currant
41	Ribegla	Ribes	glandulosum	Skunk currant
42	Ribehud	Ribes	hudsonianus	Northern black currant
43	Ribelac	Ribes	lacustre	Bristly black currant
44	Ribeoxy	Ribes	oxyacanthoides	Northern gooseberry
45	Ribetri	Ribes	triste	Swamp red currant
46	Rosaaci	Rosa	acicularis	Bristly wild rose
47	Rosawoo	Rosa	woodsii	Common wild rose
48	Rubuaca	Rubus	acaulis	Dwarf raspberry
49	Rubustr	Rubus	strigosus var. idaeus	wild red raspberry
50	Salibeb	Salix	bebbiana	Bebb's (diamond) willow
51	Salican	Salix	candida	Hoary willow
52	Salidis	Salix	discolor	Pussy willow
53	Saliexi	Salix	exigua	Sandbar willow
54	Salilas	Salix	lasiandra	Western shining willow
55	Salimac	Salix	maccalliana	Velvet-fruited willow
56	Salimyr	Salix	myricoides	Low blueberry willow
57	Saliped	Salix	pedicellaris	Bog willow
58	Salipet	Salix	petiolaris	Basket willow
59	Salipla	Salix	planifolia	Flat-leaved willow
60	Salispp	Salix	spp	Willow spp.
61	Sambpub	Sambucus	pubens	Red-berried elder
62	Shepcan	Shepherdia	canadensis	Soapberry
63	Sorbdec	Sorbus	decora	Eastern (showy) mountain ash
64	Sorbsco	Sorbus	scopulina	Western mountain ash
65	Spiralb	Spiraea	alba	Narrow-leaved meadowsweet
66	Sympalb	Symphoricarpus	albus	Common snowberry
67	Sympocc	Symphoricarpus	occidentalis	Western snowberry
68	Vaccang	Vaccinium	angustifolium	Early low blueberry

Reference Number	Short Form	Genus	species	Common Name
69	Vacccae	Vaccinium	caespitosum	Dwarf bilberry
70	Vaccmyr	Vaccinium	myrtilloides	Velvet-leaved blueberry
71	Vibuedu	Viburnum	edule	Squashberry
72	Vibuopu	Viburnum	opulifolius	Highbush cranberry
SEMI-SHRUB				
73	Arctuva	Arctyostaphylos	uva-ursi	Bearberry
74	Corncan	Cornus	canadensis	Bunchberry
75	Empeneg	Empetrum	negrum	Crowberry
76	Gaulhis	Gaultheria	hispidula	Creeping snowberry
77	Gaulpro	Gaultheria	procumbens	Wintergreen
78	Oxycmic	Oxycoccus	microcarpus	Small cranberry
79	Rubupub	Rubus	pubescens	Dwarf raspberry
80	Vaccvit	Vaccinium	vitis-idaea	Bog cranberry
HERBS				
81	Achimil	Achillea	millefolium	Yarrow
82	Actapac	Actaea	pachypoda	White baneberry
83	Actarub	Actaea	rubra	Red baneberry
84	Agrosca	Agrostis	scabra	Ticklegrass
85	Agrospp	Agrostis	spp.	Grass
86	Agrotra	Agropyron	trachycaulum	Slender wheat-grass
87	Agrotra	Agropyron	trachycaulum var. unilaterale	Awned wheat-grass
88	Anemcan	Anemone	canadensis	Canada anemone
89	Anemmul	Anemone	multifida	Cut-leaved anemone
90	Anemqui	Anemone	quinquefolia	Wood anemone
91	Anemrip	Anemone	riparia	Tall anemone
92	Anemspp	Anemone	spp	Anemone spp.
93	Antemic	Antennaria	microphylla	Small-leaved pussytoes
94	Apocand	Apocynum	androesifolium	Spreading dogbane
95	Aquibre	Aquilegia	brevistyla	Blue columbine
96	Arabdiv	Arabis	divaricarpa	Purple rock cress
97	Aralnud	Aralia	nudicaulis	Sarsaparilla
98	Arenlat	Arenaria	lateriflora	Blunt-leaved sandwort
99	Asarcan	Asarum	canadensis	Wild ginger
100	Astebor	Aster	borealis	Marsh aster
101	Astecil	Aster	ciliolatus	Ciliolate aster

Reference Number	Short Form	Genus	species	Common Name
102	Astecon	Aster	conspicuus	Showy aster
103	Astelae	Aster	laevis	Smooth aster
104	Astelan	Aster	lanceolatus	Panicled aster
105	Astenem	Aster	nemoralis	Bog aster
106	Astepun	Aster	puniceus	Purple-stemmed aster
107	Astespp	Aster	spp.	Aster species
108	Astralp	Astralagus	alpinus	Alpine milk-vetch
109	Astrcan	Astralagus	canadensis	Canadian milk-vetch
110	Athyfil	Athyrium	filix-femina	Lady fern
111	Botrvir	Botrichyum	virginiana	Rattlesnake fern
112	Bromcil	Bromus	ciliatus	Fringed brome grass
113	Calacan	Calamagrostis	canadensis	Purple reed grass, bluejoint
114	Calaine	Calamagrostis	inexpansa	Northern reed-grass
115	Caltpal	Caltha	palustris	Marsh marigold
116	Campapa	Campanula	aparinoides	Marsh bellflower
117	Camprot	Campanula	rotundifolia	Common harebell, bluebells
118	Careaqu	Carex	aquatilis	Water sedge
119	Carebru	Carex	brunnescens	Brownish sedge
120	Carecap	Carex	capillaris	Hair-like sedge
121	Carecho	Carex	chordorrhiza	Prostrate sedge
122	Carecon	Carex	concinna	Beautiful sedge
123	Caredef	Carex	deflexa	Bent sedge
124	Caredew	Carex	deweyana	Dewey's sedge
125	Caredia	Carex	diandra	Two-stamened sedge
126	Caredis	Carex	disperma	Two-seeded sedge
127	Caregyn	Carex	gynocrates	Northern bog sedge
128	Careint	Carex	interior	Inland sedge
129	Carelas	Carex	lasiocarpa	Hairy-fruited sedge
130	Carelep	Carex	leptalea	Bristle-stalked sedge
131	Carelim	Carex	limosa	Mud sedge
132	Careoli	Carex	oligosperma	Few-seeded sedge
133	Carepau	Carex	paupercula	Poor sedge
134	Careped	Carex	pedunculata	Peduncled sedge
135	Caresar	Carex	sartwellii	Sartwell's sedge
136	Careten	Carex	tenuiflora	Thin-flowered sedge
137	Caretri	Carex	trisperma	Three-seeded sedge
138	Careutr	Carex	utriculata	Beaked sedge

Reference Number	Short Form	Genus	species	Common Name
139	Carevag	Carex	vaginata	Sheathed (virgin) sedge
140	Carevir	Carex	viridula	Green sedge
141	Carespp	Carex	spp.	Sedge spp.
142	Chimumb	Chimaphila	umbellata	Prince's pine
143	Cicumac	Cicuta	maculata	Water hemlock
144	Cinnlat	Cinna	latifolia	Drooping wood-reed
145	Circalp	Circaea	alpina	Smaller enchanter's nightshade
146	Cirsarv	Cirsium	arvense	Canada thistle
147	Cirsmut	Cirsium	muticum	Swamp thistle
148	Cirsspp	Cirsium	spp.	Thistle spp.
149	Copttri	Coptis	trifolia	Goldthread
150	Coramac	Corallorhiza	maculata	Spotted coral-root
151	Corastr	Corallorhiza	striata	Striped coral-root
152	Coratri	Corallorhiza	trifida	Pale coral-root
153	Cyprcal	Cypripedium	calceolus	Yellow ladies slipper
154	Desccae	Deschampia	caespitosa	Tufted hairgrass
155	Disptra	Disporum	trachycarpum	Fairybells
156	Dracpar	Dracocephalum	parviflorum	American dragonhead
157	Drosrot	Drosera	rotundifolia	Round-leaved sundew
158	Dryoaus	Dryopteris	austriaca	Spinulose shield fern
159	Elymcan	Elymus	canadensis	Canada wild rye
160	Elyminn	Elymus	innova	Hairy wild rye
161	Epilang	Epilobium	angustifolium	Fireweed
162	Epilgla	Epilobium	glandulosum	Purple-leaved willow-herb
163	Epilpal	Epilobium	palustre	Swamp willow-herb
164	Equiarv	Equisetum	arvense	Field horsetail
165	Equiflu	Equisetum	fluviatile	Swamp horsetail
166	Equihye	Equisetum	hyemalis	Common scouring-rush
167	Equipal	Equisetum	palustre	Marsh horsetail
168	Equipra	Equisetum	pratense	Meadow horsetail
169	Equisci	Equisetum	scirpoides	Dwarf scouring rush
170	Equisyl	Equisetum	sylvaticum	Woodland horsetail
171	Erigacr	Erigeron	acris	Northern daisy fleabane
172	Erigphi	Erigeron	philadephicus	Philadelphia fleabane
173	Eriovag	Eriophorum	vaginatum ssp. Vaginatum	Sheathed cotton-grass
174	Eriovir	Eriophorum	viridi-carinatum	Thin-leaved cotton-grass

Reference Number	Short Form	Genus	species	Common Name
175	Eupapur	Eupatorium	purpureum var. maculatum	spotted Joe-pye-weed
176	Fragves	Fragaria	vesca	Woodland strawberry
177	Fragvir	Fragaria	virginiana	Wild strawberry
178	Galibor	Galium	boreale	Northern bedstraw
179	Galilab	Galium	labradoricum	Labrador bedstraw
180	Galitri	Galium	trifidum	Small bedstraw
181	Galitri	Galium	trifolium	Fragrant bedstraw
182	Geocliv	Geocaulon	lividum	Northern comandra
183	Geummac	Geum	macrophyllum	Large-leaved avens
184	Geumriv	Geum	rivale	Purple avens
185	Glycstr	Glyceria	striata	Fowl manna grass
186	Goodpub	Goodyera	pubens	Rattlesnake plantain
187	Goodrep	Goodyera	repens	Dwarf rattlesnake plantain
188	Grasspp	Grass	spp.	Grass
189	Gymndry	Gymnocarpium	dryopteris	Oak fern
190	Habehyp	Habenaria	hyperborea	Northern green bog orchid
191	Habeobt	Habenaria	obtusata	Blunt-leaved bog-orchid
192	Habeorb	Habenaria	orbiculata	Round-leaved bog orchid
193	Haledef	Halenia	deflexa	Spurred gentian
194	Hedyalp	Hedysarum	alpinum	Alpine sweet-vetch
195	Heralan	Heracleum	lanatum	Cow-parsnip
196	Hierodo	Hierochloe	odorata	Common sweet-grass
197	Hierumb	Hieracium	umbellatum	Narrow-leaved hawkweed
198	Hypevir	Hypericum	virginicum	Marsh St-John's wort
199	Impacap	Impatiens	capensis	Spotted jewel-weed
200	Juncbal	Juncus	balticus	Wire rush
201	Lacttat	Lactuca	tatarica	Common blue lettuce
202	Lathoch	Lathyrus	ochreolucus	Creamy pea-vine
203	Lathpal	Lathyrus	palustris	Marsh pea-vine
204	Lathven	Lathyrus	venosum	Purple pea-vine
205	Liliphi	Lilium	philadelphicum	Wood lily
206	Linnbor	Linnaea	borealis	Twinflower
207	Lipaloe	Liparis	loeselii	Twayblade
208	Listbor	Listera	borealis	Northern twayblade
209	Listcor	Listera	cordata	Heart-leaved twayblade

Reference Number	Short Form	Genus	species	Common Name
210	Lobekal	Lobelia	kalmii	Kalm's lobelia
211	Luzupar	Luzula	parviflora	Small-flowered wood rush
212	Lycoann	Lycopodium	annotinum	Interrupted club-moss
213	Lycocla	Lycopodium	clavatum	Wolf's claw club-moss
214	Lycocom	Lycopodium	complanatum	Ground cedar
215	Lycoluc	Lycopodium	lucidulum	Shining club-moss
216	Lycoobs	Lycopodium	obscurum	Ground pine club-moss
217	Lycouni	Lycopus	uniflorus	Bugleweed
218	Lysicil	Lysimachia	ciliata	Fringed loosestrife
219	Lysithy	Lysimachia	thyrsiflora	Tufted loosestrife
220	Maiacan	Maianthemum	canadense	Wild lily-of-the-valley
221	Maiatri	Maianthemum	trifolia	Three-leaved FALSE Solomon's seal
222	Malamon	Malaxis	monophylla	White adder's-mouth
223	Malvneg	Malva	neglecta	Cheeses
224	Mattstr	Matteucia	struthiopteris	Royal fern
225	Melalin	Melampyrum	lineare	Cow-wheat
226	Melioff	Melilotus	officinalis	Yellow sweet-clover
227	Mentarv	Mentha	arvensis	Wild mint
228	Menytri	Menyanthes	trifolia	Buckbean
229	Mertpan	Mertensia	paniculata	Bluebells/northern bluebells
230	Mitenud	Mitella	nuda	Naked mitrewort
231	Moneuni	Monesis	uniflora	One-flowered wintergreen
232	Monouni	Monotropa	uniflora	Indian pipe
233	Muhlglo	Muhlenbergia	glomerata	Bog muhly
234	Oryzasp	Oryzopsis	asperifolia	Rough-leaved rice grass
235	Oryzpun	Oryzopsis	pungens	Northern rice-grass
236	Osmodep	Osmorhiza	depauperata	Spreading sweet-cicely
237	Osmolon	Osmorhiza	longistyla	Smooth sweet-cicely
238	Oxytspl	Oxytropis	splendens	Showy locoweed
239	Parnpal	Parnassia	palustris	Northern grass-of-Parnassus
240	Petafri	Petasites	frigidus	Arctic coltsfoot
241	Petafri	Petasites	frigidus ssp. Palmatus	Palmate-leaved coltsfoot
242	Petasag	Petasites	sagitatus	Arrow-leaved coltsfoot
243	Phalaru	Phalaris	arundinacea	Reed canary-grass
244	Poapal	Poa	palustre	Fowl bluegrass

Reference Number	Short Form	Genus	species	Common Name
245	Poapra	Poa	pratensis	Kentucky bluegrass
246	Polycil	Polygonum	cilinode	Bindweed
247	Polyviv	Polygonum	viviparium	Alpine bistort
248	Poteans	Potentilla	anserina	Silverweed
249	Potegra	Potentilla	gracilis	Graceful cinquefoil
250	Potepal	Potentilla	palustris	Marsh cinquefoil
251	Prenalb	Prenanthes	alba	White lettuce
252	Pteraqu	Pteridium	aquilinum	Bracken fern
253	Pyroasa	Pyrola	asarifolia	Common pink (kidney-leaved) wintergreen
254	Pyromin	Pyrola	minor	Lesser pyrola
255	Pyrosec	Pyrola	secunda (cf. chlorantha)	One-sided wintergreen
256	Pyrospp	Pyrola	spp	Pyrola spp.
257	Pyrouli	Pyrola	uliginosa	Bog wintergreen
258	Pyrovir	Pyrola	virens	Green wintergreen
259	Ranuabo	Ranunculus	abortivus	Small-flowered buttercup
260	Ranucym	Ranunculus	cymbalaria	Shore buttercup
261	Ranulap	Ranunculus	lapponicus	Swamp buttercup
262	Rubucha	Rubus	chamaemorus	Cloudberry
263	Rumeocc	Rumex	occidentalis	Western dock
264	Sagirig	Sagittaria	rigida	Stiff arrowhead
265	Sanimar	Sanicula	marilandica	Snakeroot
266	Schipur	Schizachne	purpurescens	Purple oat-grass
267	Scircae	Scirpus	caespitosus	Tufted bulrush
268	Scutgal	Scutellaria	galericulata	March skullcap
269	Seneere	Senecio	eremophilus	Cut-leaved ragwort
270	Senepau	Senecio	pauperculus	Balsam groundsel
271	Smilrac	Smilacina	racemosa	FALSE Solomon's-seal
272	Smilste	Smilacina	stellaris	Star-flowered FALSE Solomon's-seal
273	Smilspp	Smilax	spp	Cat-brier
274	Solican	Solidago	canadensis	Canada goldenrod
275	Soligra	Solidago	graminifolia	Flat-topped goldenrod
276	Solirug	Solidago	rugosa	Rough-stemmed goldenrod
277	Solispa	Solidago	spathulata	Spike-like goldenrod
278	Stelcal	Stellaria	calycantha	Fleshy stitchwort
279	Stellon	Stellaria	longipes	Long-stalked stitchwort
280	Streamp	Streptopus	amplexifolius	Twisted-stalk

Reference Number	Short Form	Genus	species	Common Name
281	Taraoff	Taraxacum	officinale	Dandelion
282	Thaldas	Thalyctrum	dasycarpum	Tall meadow-rue
283	Thalven	Thalyctrum	venulosum	Veiny meadow-rue
284	Triebor	Trientalis	borealis	Starflower
285	Trifhyb	Trifolium	hybridum	Alsike clover
286	Trifpra	Trifolium	pratense	Red clover
287	Trigmar	Triglochin	maritima	Seaside arrow-grass
288	Trilcer	Trillium	cernuum	Nodding trillium
289	Urtidio	Urtica	dioica	Stinging nettle
290	Viciame	Vicia	americana	Purple vetch
291	Violadu	Viola	adunca	Early blue violet
292	Violcan	Viola	canadensis	Canada violet
293	Violnep	Viola	nephrophylla	Bog violet
294	Violren	Viola	renifolia	Kidney-leaved violet
295	Violspe	Viola	species	Violet spp.
MOSSES & LIVERWORTS				
296	Amblser	Amblystegium	serpens	Moss spp.
297	Amblvar	Amblystegium	varium	Moss spp.
298	Anasmin	Anastrophyllum	minutum	liverwort
299	Aulopal	Aulocomium	palustre	Ribbed bog moss
300	Bracref	Bracythecium	reflexum	Moss spp.
301	Bracspp	Bracythecium	spp	Moss spp.
302	Bracvel	Bracythecium	velutinum	Moss spp.
303	Callgig	Calliergon	giganteum	Giant water moss
304	Callric	Calliergon	richardsonii	Richardson's water moss
305	Callspp	Calliergon	spp	Calliergon spp.
306	Callstr	Calliergon	stramineum	Straw-colored water moss
307	Campste	Campyllium	stellatum	Yellow star moss
308	Cerapur	Ceratodon	purpureus	Purple horn-toothed moss
309	Climden	Climacium	dendroides	Common tree moss
310	Conocon	Conocephalum	conicum	Snake liverwort
311	Cratfil	Cratoneuron	filicinum	Fern moss
312	Dicrdru	Dicranum	drummondii	Moss spp.
313	Dicrfla	Dicranum	flagellare	Whip fork moss
314	Dicrfus	Dicranum	fuscescens	Curly heron's-bill moss
315	Dicrmon	Dicranum	montanum	Lawn moss

Reference Number	Short Form	Genus	species	Common Name
316	Dicrpol	Dicranum	polysetum	Wavy-leaved moss
317	Dicrsco	Dicranum	scoparium	Broom moss
318	Dicrspp	Dicranum	spp	Dicranum spp.
319	Dicrund	Dicranum	undulatum	Wavy bog Dicranum
320	Distcap	Distichium	capillaceum	Erect-fruited iris moss
321	Drepadu	Drepanocladus	aduncus	Common hook moss
322	Drepflu	Drepanocladus	fluitans	Water hook moss
323	Drepspp	Drepanocladus	spp	Hook moss spp.
324	Drepunc	Drepanocladus	uncinatus	Sickle moss
325	Eurhhia	Eurhyncium	hians	Moss spp.
326	Eurhpul	Eurhyncium	pulchellum	Common beaked moss
327	Evermes	Evernia	mesomorpha	Spruce lichen
328	Haplmic	Haplocladium	microphyllum	Moss spp.
329	Hylospl	Hylocomium	splendens	Stair-step moss
330	Hypnlin	Hypnum	lindbergii	Clay pigtail moss
331	Hypnpal	Hypnum	pallescens	Stump pigtail moss
332	Jameaut	Jamesoniella	autumnalis	Liverwort spp.
333	Livespp	Liverwort	spp	Misc. liverworts
334	Marcpol	Marchantia	polymorhpa	Green-tongued liverwort
335	Meestri	Meesia	triquetra	Three-angled thread moss
336	Mniuspi	Mnium	spinulosum	Red-mouthed Mnium
337	Mniuspp	Mnium	spp	Misc. mosses Mnium family
338	Philfon	Philonotis	fontana	Aquatic apple-moss
339	Plagcav	Plagiothecium	cavifolium	Moss spp.
340	Plagcil	Plagiomnium	ciliare	Toothed mnium
341	Plagcus	Plagiomnium	cuspidatum	Woodsy leafy moss
342	Plagden	Plagiothecium	denticulatum	Moss spp.
343	Plagell	Plagiomnium	ellipticum	Marsh magnificent moss
344	Plaglae	Plagiothecium	laetum	Moss spp.
345	Plagmed	Plagiomnium	medium	Common leafy moss
346	Platjun	Platygerium	juniperinum	Juniper flat-brocade moss
347	Platsub	Platygerium	subtile	Common flat-brocade moss
348	Platspp	Platygerium	spp.	Flat-brocade moss spp.
349	Pleusch	Pleurozium	schreberi	Red-stemmed feathermoss
350	Pohlcru	Pohlia	cruda	Moss spp.

Reference Number	Short Form	Genus	species	Common Name
351	Pohlnut	Pohlia	nutans	Copper wire moss
352	Polycom	Polytrichum	commune	Common hair-cap moss
353	Polyjun	Polytrichum	juniperinum	Juniper hair-cap moss
354	Polystr	Polytrichum	strictum	Swamp hair-cap moss
355	Ptilcil	Ptilidium	ciliare	Liverwort spp.
356	Ptilcri	Ptilium	crista-castrensis	Knight's plume moss
357	Ptilpul	Ptilidium	pulcherrimum	Liverwort spp.
358	Pylapol	Pylasiella	polyantha	Aspen moss
359	Rhizpse	Rhizomnium	pseudopunctatum	Felt round moss
360	Rhizpun	Rhizomnium	punctatum	? round moss
361	Rhizste	Rhizomnium	stellare	? round moss
362	Rhodros	Rhodobryum	roseum	Rose moss
363	Rhynser	Rhynchostegium	serrulatum	Moss spp.
364	Rhytrug	Rhytidium	rugosum	Pipecleaner moss
365	Rhyttri	Rhytidiadelphus	triquetrus	Electrified cat's-tail moss
366	Sphaang	Sphagnum	angustifolium	Yellow-green peat moss
367	Sphacap	Sphagnum	capillifolium	Small red peat moss
368	Sphafus	Sphagnum	fuscum	Common brown peat moss
369	Sphagir	Sphagnum	girgensohnii	White-toothed (green star-shaped) peat moss
370	Sphamag	Sphagnum	magellanicum	Midway (red fat-leaved) sphagnum
371	Spharub	Sphagnum	rubellum	Red bog peat moss
372	Spharus	Sphagnum	russowii	Wide-tongued peat moss
373	Sphawul	Sphagnum	wulfianum	Wulf's peat moss
374	Tetrpel	Tetraphis	pellucida	Common four-tooth moss
375	Thuiabi	Thuidium	abietinum	Wiry fern moss
376	Thuirec	Thuidium	recognitum	Hook-leaf fern moss
377	Tomenit	Tomenthypnum	nitens	Golden fuzzy fen moss
378	Tortfra	Tortella	fragilis	Fragile screw moss
LICHENS				
379	Cladmit	Cladina	mitis	Yellow-green lichen
380	Cladran	Cladina	rangiferina	Reindeer lichen
381	Cladste	Cladina	stellaris	Coral lichen
382	Cladcen	Cladonia	cenotea	Misc. small lichens

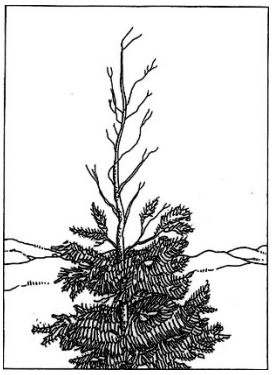
Reference Number	Short Form	Genus	species	Common Name
383	Cladchl	Cladonia	chlorophea	Misc. small lichens
384	Cladcon	Cladonia	coniocrea	Misc. small lichens
385	Cladcor	Cladonia	cornuta	Misc. small lichens
386	Cladspp	Cladonia	spp	Misc. small lichens
387	Cladsul	Cladonia	sulphurina	Misc. small lichens
388	Hypophy	Hypogymnia	physodes	Monk's-hood lichen
389	Parmsul	Parmelia	sulcata	Wax paper lichen
390	Peltaph	Peltigera	aphthosa	Freckle pelt lichen
391	Peltcan	Peltigera	canina	Dog's tooth lichen
392	Peltneo	Peltigera	neopolydactyla	Frog pelt lichen
393	Peltspp	Peltigera	spp	Misc. leafy lichens

Appendix 6: Tree Condition Code Explanations

Further information on codes which are not explained can be found in the following sources:

- A Field Guide to Forest Insects and Diseases of the Prairie Provinces (by Y. Hiratsuka, D.W. Langor, and P.E. Crane).
- Forest Tree Diseases of the Prairie Provinces (by Y. Hiratsuka, 1987).
- Tree and Shrub Insects of the Prairie Provinces (by W.G.H. Ives and H.R. Wong).

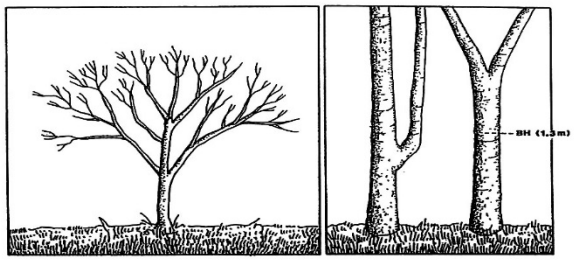
000	HEALTHY – No noticeable defects.
001	STANDING DEAD WITH TOP INTACT – Tree shows no signs of being alive – no green foliage or buds are present. The tree is <u>not</u> broken in the crown or bole. Fill out Wildlife Habitat Values information for this tree.
002	STANDING DEAD AND BROKEN – Tree shows no signs of being alive – no green foliage or buds are present. The tree is broken in the crown or bole (indicate which using the appropriate code). Fill out Wildlife Habitat Values information for this tree.
003	DEAD & DOWN – Tree was previously tagged and measured in the PSP plot but at the present time is now dead and no longer standing. The cause of death must be by natural causes (i.e. windfall, beavers, insects, disease, etc.) rather than cut down.
004	DEAD TOP / DIEBACK – Top is dead (dieback) without any indication of insect or climate (frost) damage.



DEAD TOP / DIEBACK
(Alberta Land & Forest Service, 1997)

005	DIEBACK WITH NEW LEADER – Trees with previous leader damage where a new leader has formed
006	BROKEN TOP – Tree stem has broken off within the crown.
007	BROKEN STEM – Tree stem has broken off below the crown and above breast height (1.3 m).

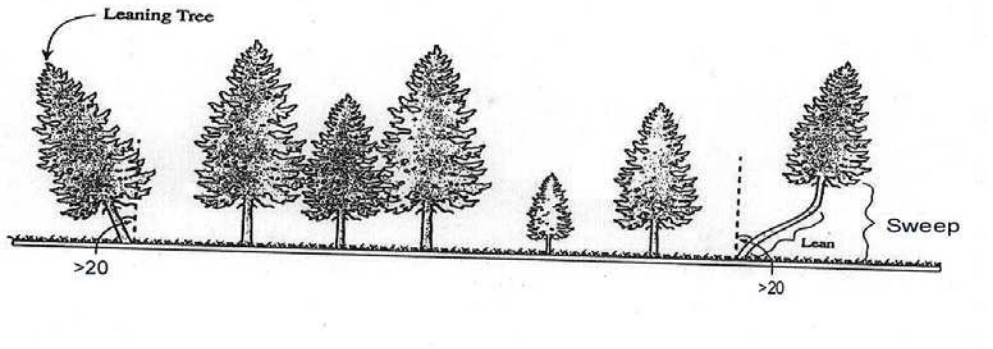
008	MISSING – Tree was previously tagged and measured in the PSP plot but at the present time cannot be located.
009	CUT DOWN – Tree shows evidence of having been cut down by humans.
010	FORKED – Forks usually develop when there is malformation, injury, or death of the terminal leader which results in the presence of two leaders. Forks tend to be V-shaped and will only be recorded when above 1.3 m (DBH level). Forks below this point are recorded as multiple stems (code 021). Natural branching on deciduous trees is not to be recorded.



Natural Branching Fork

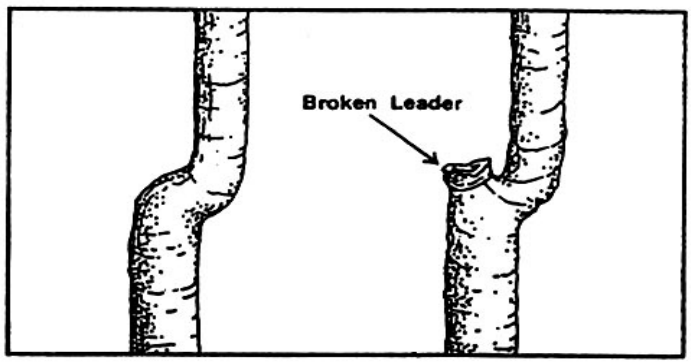
(Alberta Land & Forest Service, 1997)

011	MULTIPLE LEADERS – Tree has more than two leaders present. Only recorded when above 1.3 m (DBH level). Below this point the code "multiple stems" (code 021) is used. Natural branching on deciduous trees is not to be recorded.
012	LEANING – A tree is considered leaning if it is standing greater than 20^{o} off of vertical. If the angle is greater than 45^{o} off of vertical, the tree has a severe lean. Make a note of severe lean in the Comments section when it is present.



LEANING TREE
SWEEP (Alberta Land & Forest Service, 1997)

013	POOR FORM – Tree exhibits a general poor form generally due to previous damage of an indeterminable cause. In the Comments section, describe the tree's appearance.
014	PRONOUNCED CROOK – This condition develops from the death of the terminal leader or the breaking off of a forked leader. When this occurs, a lateral branch takes over apical dominance and results in the formation of a crook.



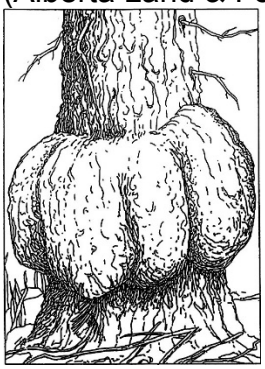
CROOK FORMATION OF CROOk
(Alberta Land & Forest Service, 1997)

015	SWEEP – A sweep or bend is the gradual bowing or curving of the main tree stem.
016	SPIRAL GRAIN – Spiral grain is the twisting of the grain see in exposed wood or in the direction of the bark fissures. Spiralling frost cracks and scars also indicate the presence of spiral grain.
017	FROST CRACK – A frost crack is a deep radial splitting of the trunk caused by uneven shrinkage of the wood after a sudden drop in temperature. The cracks usually start at the base and extend up the trunk. They may be reopened repeatedly by wind stresses or low temperatures.
018	WINDSHAKE – Windshake is a splitting in the wood along the grain or less frequently within an annual growth layer. It is caused by wind or snow stresses and is also known as ringshake.
019	SUCKER FROM OLD STUMP – Refers to stems that fallen down or have been cut-down and have started to sucker. Do not re-use the previous stem number, but assign a new number to each sucker.
020	CAVITIES PRESENT – Tree may be alive or dead but has cavities present which are 2.5 cm in diameter or greater. Fill out Wildlife Habitat Values information for this tree.

021	MULTIPLE STEMS – Used when 2 or more tree stems arise from the same base and can be distinguished above ground level but below DBH.
022	FOLIAGE INSECTS – Used when there is evidence of an insect infestation attacking the foliage of the tree but it cannot be determined what insect is responsible for the damage. If the type of insect attack can be determined more specifically, use the appropriate code to indicate it (Refer to descriptions of codes 117-133 for conifers, 144-153 for broadleafs).
023	FOLIAGE DISEASE – All diseases that infect the foliage of a tree and cannot be narrowed down to a more specific disease code, are documented using this code. Refer to the explanations of codes 71-76 for conifers and 144-153 for broadleafs to determine if a more specific disease code can be determined.
024	STEM INSECTS – Used when there is evidence of an insect infestation attacking the bole of the tree but it cannot be determined what insect is responsible for the damage. If the type of insect attack can be determined more specifically, use the appropriate code to indicate it. (Refer to descriptions of codes 137-140 for conifers, and 138, 157-160 for broadleafs)
025	STEM DISEASE – All diseases that infect the main stem of a tree and cannot be narrowed down to a more specific disease code, are documented using this code. Refer to the explanations of codes 026, 030, 079-086, and 105-110 to determine if a more specific disease code can be determined.
026	CONKS – Conks are woody, shelf-like basidiocarps (fruiting bodies) of wood-rotting fungi. Conks appear most frequently on the underside of dead branch stubs or on the underside of live branches in the crown.
027	OPEN SCAR – Open scars are wounds which have been penetrated through to the cambium. These wounds must not be healed over and may be caused by a variety of reasons such as fire, lightning, old blazing, machinery, animals, etc. Scars are considered to be entry points for decay fungi. Open scars include any scar which has not been healed over and re-covered with bark, regardless of whether the wound is still seeping or not. If the cause of the open scar can be determined, specify the cause using the appropriate code. Be sure not to mistake a stem disease such as atropellis canker for an open scar.
028	CLOSED SCAR – Wounds that had penetrated the cambium but have now healed over and been covered with bark are considered closed scars. A closed scar is characterized by an irregular indentation in the bole of the tree. Before healing over, the scar provided an entry point for disease. If the cause of the closed scar can be determined, specify the cause using the appropriate code.
029	RUBBING BY A FALLEN TREE – Use this code when there is evidence of the tree being rubbed by a fallen neighbouring tree as it was falling to the ground. The tree being documented must have had branches torn

	off or have an open or closed scar present (refer to codes 027 & 028) resulting from the rubbing. Indicate whether an open or closed scar is present using the appropriate code.
030	BURLS & GALLS – Burls are abnormal swellings of the main stem or branches resulting from abnormal wood cell development following disturbance to the cambial layer. Galls are localized trunk and branch swellings of mainly tissue. There is little or no damage to the underlying wood in the formation of a gall. Do not mistake western gall aphid for a gall; it is a foliar insect.

BURL ON A MAIN STEM
(Alberta Land & Forest Services, 1997)



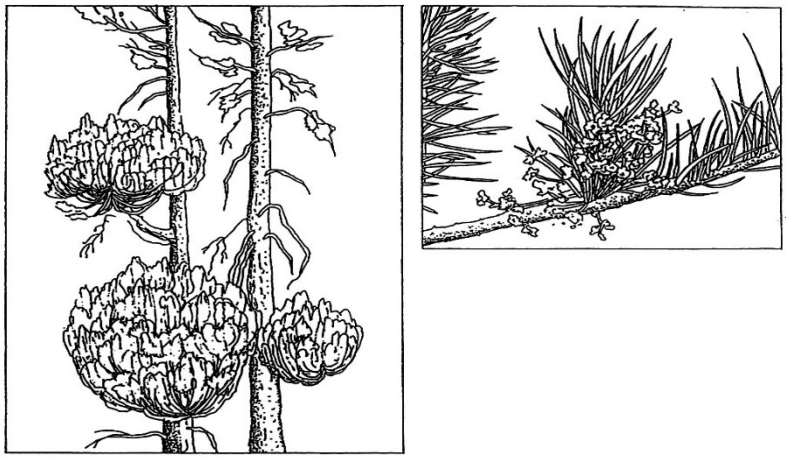
031	LIMBY – A tree is recorded as limby if more than 75% of the tree has live, low sweeping branches.
032	SUPPRESSION – Trees which have been suppressed by the surrounding vegetation for a period of time long enough to damage or kill them. Suppression may result from a severe lack of light, water, nutrients (removed by the competition) or by physical smothering (i.e. heavy grasses the case of seedlings, or very close neighbouring trees or shrubs resulting in the suppression of a sapling's or tree's lateral branches.)
033	NUTRIENT DEFICIENCY – Used when a tree is not receiving sufficient nutrients to remain vigorous, and results in a chlorotic appearance. May be confused with flooding damage.
034	WITCHES' BROOM – A witches' broom is an abnormally bushy, local growth of plant shoots on a tree, characterized by a shortening of the internodes and prolific branching. This code is used to indicate the presence of witches' broom(s) when it is difficult to determine the cause of the broom. Causes of the formation of witches' brooms include dwarf mistletoe, rust infection, and abiotic stress (Use a more specific code if the cause of the witches' broom can be determined – refer to codes 75 & 76).

035	LATERAL DIEBACK – Lateral branches have dieback.

038	FLOODING – Trees damaged or killed by drowning. Look for evidence of high water marks on the tree, or in the immediate area.
039	FIRE DAMAGE – Mortality or damage due to actual burning of the tree or scorching by nearby flames. This code is not to be used when the tree has been damaged by sunscald.
040	SUNSCALD – Sunscald produces a localized injury to the bark and cambium of a tree due to a sudden increase in exposure of a stem or branch to intense sunlight (insolation) and high temperatures.
041	FROST – Frost damage may result in the dieback, browning, reddening, or yellowing of conifer foliage, especially of the young foliage. It can also result in patchy foliage of broadleaf trees.
042	HAIL – Hail damage apparent.
043	WINDTHROW – This code is applied to trees which have been uprooted and have fallen or are in the process of falling to the ground.
044	EROSION – Damage or mortality due to the removal of the trees soil-bed, by the forces of water, wind, or soil slumping.
045	ICE/SNOW ACCUMULATION – This code is applied to trees whose branches have been warped or broken off due to an accumulation of ice or snow.
049	GENERAL ANIMAL DAMAGE – Damage or mortality due to animal activity not specified in codes 50-57. Record a description of the damage in the Comments section.
050	BROWSE – Damage or mortality due to browsing by ungulates, rabbits or other animals. If possible, be more specific in the Comments section (describe the damage). This code excludes damage caused by porcupines, beavers, and squirrels.
051	PORCUPINE BROWSE – Porcupines browse on and debark both softwood and hardwood trees to feed on the inner cambium layer of the bark. Incisor marks do not usually show when they de-bark softwoods, but when they feed on hardwood trees, incisor mark usually run across, or in most cases, at a slight angle to the branch or trunk.
052	SQUIRREL CONE (BRANCH) CLIPPING – The presence of nip twigs below conifer trees often indicates the presence of squirrel activity. The squirrels nip off the tips of conifer branches (4-7” long) to feed on the terminal buds or the cones, and then drop the twigs to the ground.
053	BEAVER DAMAGE - Includes beaver browse and trees felled by beavers. Beavers eat the cambium of trees such as alders, willows, aspens, and cottonwoods, as well as their leaves, buds, and twigs. A standing tree with beaver browse will show signs of gnawing around its base. A tree felled by a beaver may have stout branches and even the trunk completely stripped of bar, with wide incisor marks up to a quarter inch wide.
054	BEAR SCARRING – There are 3 types of bear scarring on trees: (1) Conifer trees with the bark stripped for the cambium and sap underneath. The strip marks are usually low on the tree. (2) Trees used for rubbing which may be either deciduous or coniferous. Rubbing trees

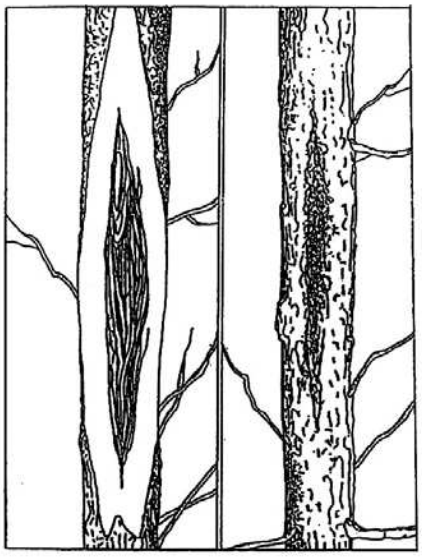
	may be used to relieve itching or to mark scent. Bears will stretch as high as they can to claw and bite the tree, possibly marking their height and dominance. Look for claw marks, with teeth marks just below them. Most markings will be 4 ½ to 6 ½ feet from the ground. (3) Trees that bears climb repeatedly for food. Look for claw marks up the sides of aspens, mountain ash and the smooth bark of some conifers.
055	UNGULATE DEBARKING – May be of 2 types: (1) Incisor scrapes indicated by individual teeth marks scraped in an upward motion or at a slight angle. (2) Antler rubs which have a smoother appearance than incisor scrapes and shows evidence of having been performed in both an upwards and downwards direction.
056	WOODPECKER FEEDING – This code is designed to record feeding cavities made by woodpeckers which are smaller than those that the wildlife cavity codes capture (i.e. <2.5 cm diameter). Do not confuse woodpecker feeding with sapsucker feeding (see below) or with insect feeding which is indicated by the presence of sawdust in, around, or below the hole.
057	YELLOW-BELLIED SAPSUCKER FEEDING – These birds drill rows of holes on the bark of young trees through to the sapwood and visit these trees periodically to lap up the sap that has oozed out of the holes. Holes drilled by the sapsuckers are always arranged in regular patterns.
058	BIRD'S NEST – Indicates that there is a bird's nest located in or on the tree/snag. Include a description of the size and location of the nest in the Comments section. Bald eagle nests are usually by lakes, or on large rivers. The nest is a large, conspicuous structure on a site with a wide view, in a large tree, or on a rocky outcrop. The nest is a massive structure of sticks and branches from 5 – 8 ½ feet across and up to 12 feet high. The great blue heron's nest is found near water and is usually built in tall trees, or sometimes in bushes, on cliff ledges or rock outcrops. The nest is a large flat platform of twigs, thin and small when newly built, added to annually, with a 25-40" diameter.
062	MECHANICAL DAMAGE – Tree has been damaged by some type of physical activity but it cannot be determined whether it was caused by humans, other animals, fallen trees, or some other means. Describe the damage and its location on the tree in the Comments section.
063	MAN – Trees damaged by people either through machinery, tools, or gunshot, etc. Describe the damage and its location on the tree in the Comments section.
064	HERBICIDE – Used when the area has received a recent herbicide treatment. Spruce seedlings exhibit needle loss and/or reddish brown colouration of stems and foliage. Deciduous species exhibit yellowish/brown leaf mottling and dieback of terminal growth. Hexazinone causes reddish brown colouration of conifer foliage and needle loss. Deciduous foliage turns red to black. Glyphosate causes chlorosis especially in new growing shoots. 2,4-D causes rapid growth and spiralling and twisting. If applied during conifer flush, dieback

	similar to frost damage may occur. Often chemical damage will also be indicated by phytotoxicity spotting on exposed foliage.
065	POOR PLANTING – Damage or mortality due to improper placement of nursery stock (hand or mechanical planting). Trees may have been planted too deep, too shallow, too loosely, at too acute of an angle, or in an improper microsite. Specify the source of the problem in the Comments section.
066	J-ROOT – A root that is bent into a J-shape because the seedling was improperly planted in a hole or slit that was too shallow or narrow.
067	MOULDY PLANTING STOCK – Grey mould is found around the root collar and lower branches. This is most commonly found on bare root stock.
071	SNOW MOULD – Snow mould diseases develop during the winter on lower branches of the host trees that are covered by snow for a long time. Affected needles become discoloured and die. The brown to black, felt-like mats of mycelium covering the lower branches of conifers are conspicuous and easily recognized.
76	DWARF MISTLETOE – Refer to pages 84-87 (Hiratsuka *et.al*, 1995).



DWARF MISTLETOE
(Alberta Land & Forest Service, 1997)

080	STEM CANKER – Refer to page 91 (Hiratsuka *et. al*, 1995).



STEM CANKER
(Alberta Land & Forest Service, 1997)

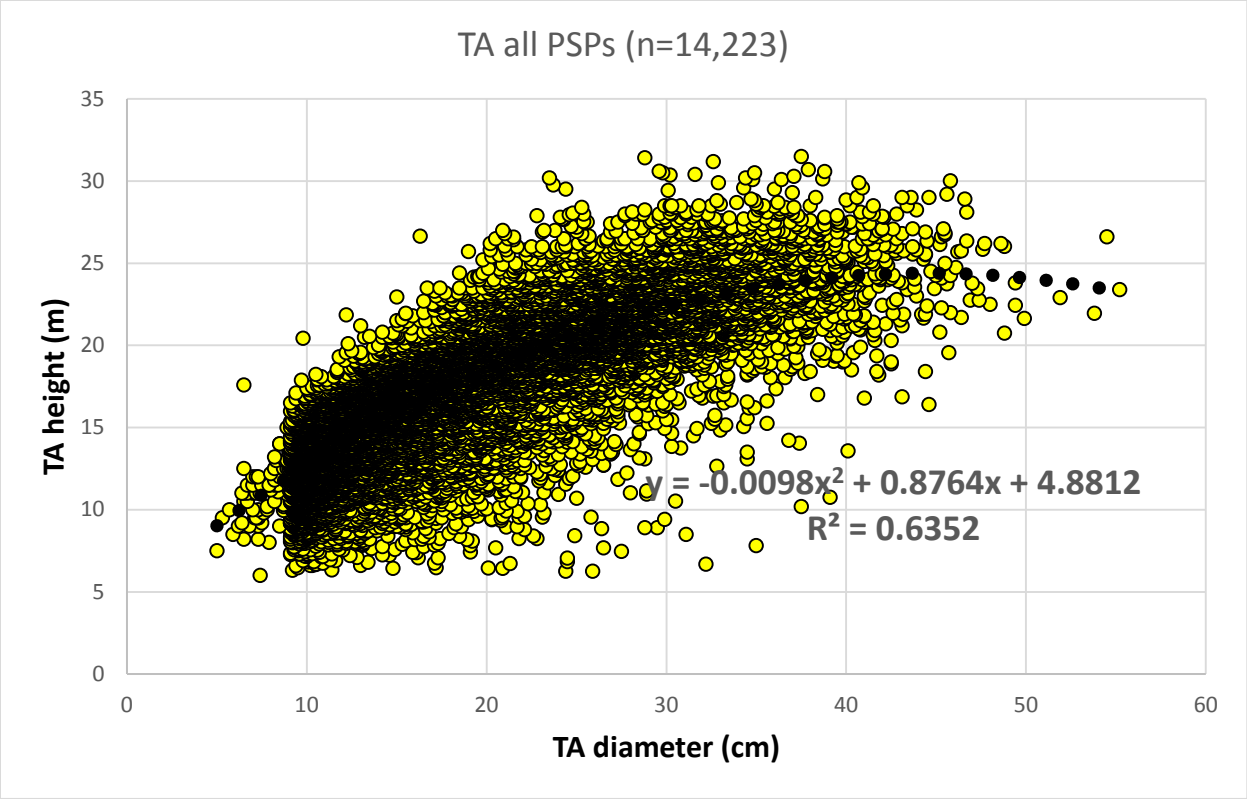
Appendix 7: Height-diameter relationships by species

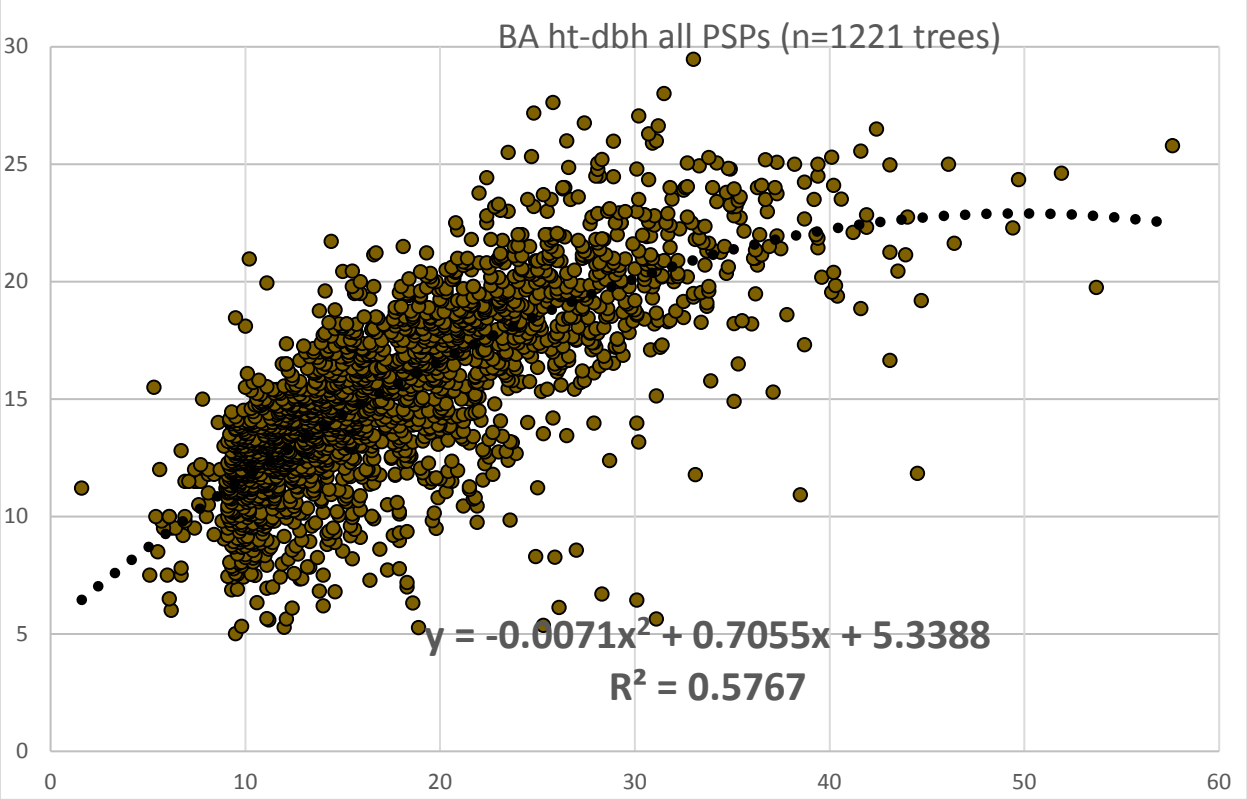
The following is the procedure to calculate the estimated heights for trees not receiving a height measurement (i.e. trees 21 to 40, 61 to 80, etc.). height is estimated based on DBH measurements.

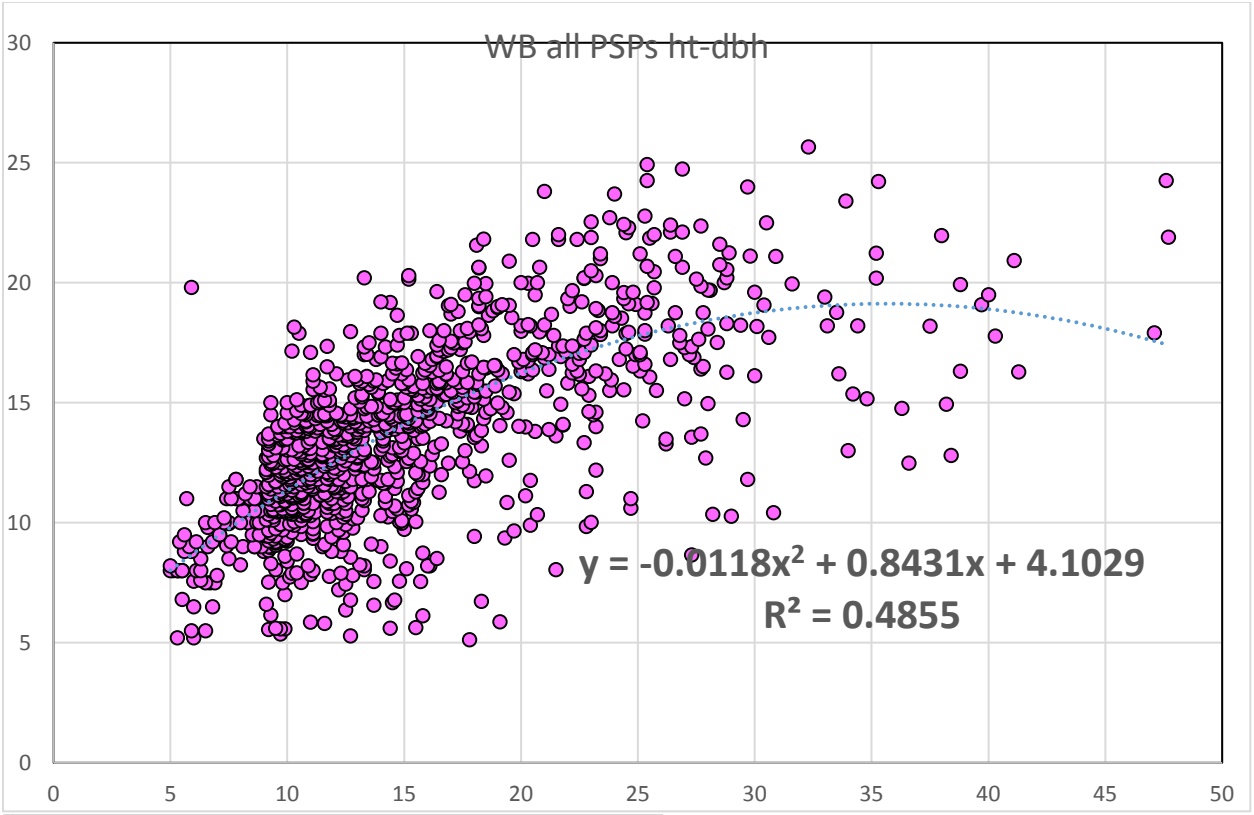
2nd-order polynomial height-diameter for all species

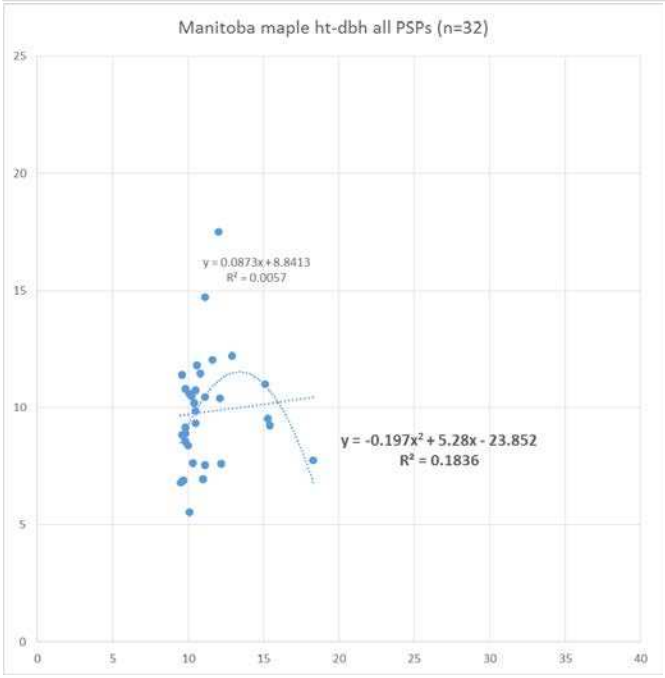
Estimated Height (m) = parameter1 X $(dbh)^2$ + parameter2 X dbh + parameter3

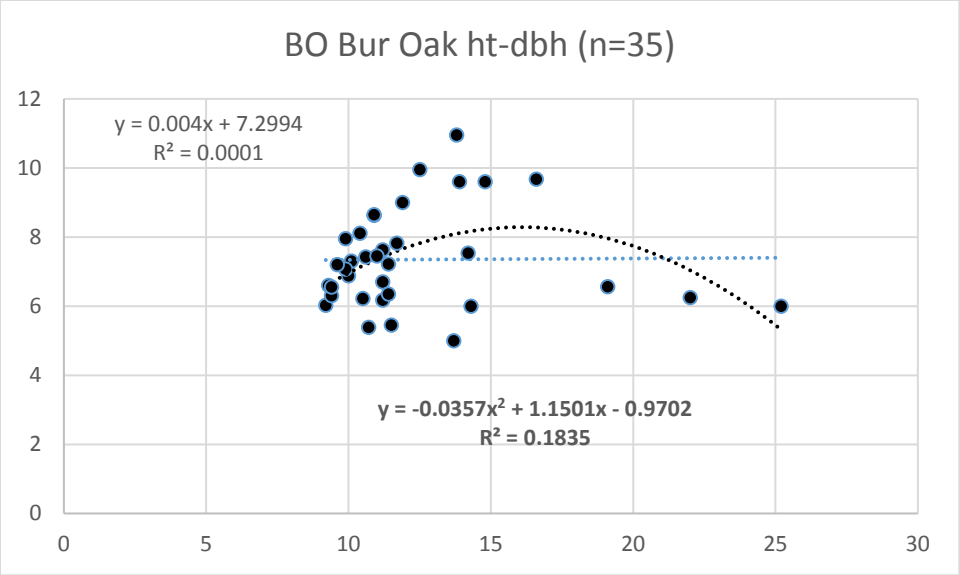
Species	Parameter 1	Parameter 2	Parameter 3	R^2	Sample size (# trees)
TA –trembling aspen	-0.0098	0.8764	4.8812	0.6352	14,223
BA – balsam poplar	-0.0071	0.7055	5.3388	0.5767	1,221
WB – white birch	-0.0118	0.8431	4.1029	0.4855	1,073
MM – Manitoba maple	-0.1970	-5.280	23.852	0.1836	32
BO – bur oak	-0.0357	1.1501	-0.9702	0.1835	35
GA – green ash	-0.0278	1.6914	-6.4840	0.8184	30
WE – white (American) elm	-0.1279	3.1789x	-9.3587	0.8577	7
WS – white spruce	-0.0056	0.7361	2.4803	0.7247	1,904
BS – black spruce	-0.0180	1.2136	-0.7643	0.5716	1,116
JP - jack pine	-0.0111	0.9533	1.4609	0.5703	1,207
BF – balsam fir	-0.0080	0.8351	1.9455	0.6182	389
TL –tamarack/larch	-0.0244	1.4670	- 1.9222	0.6668	100

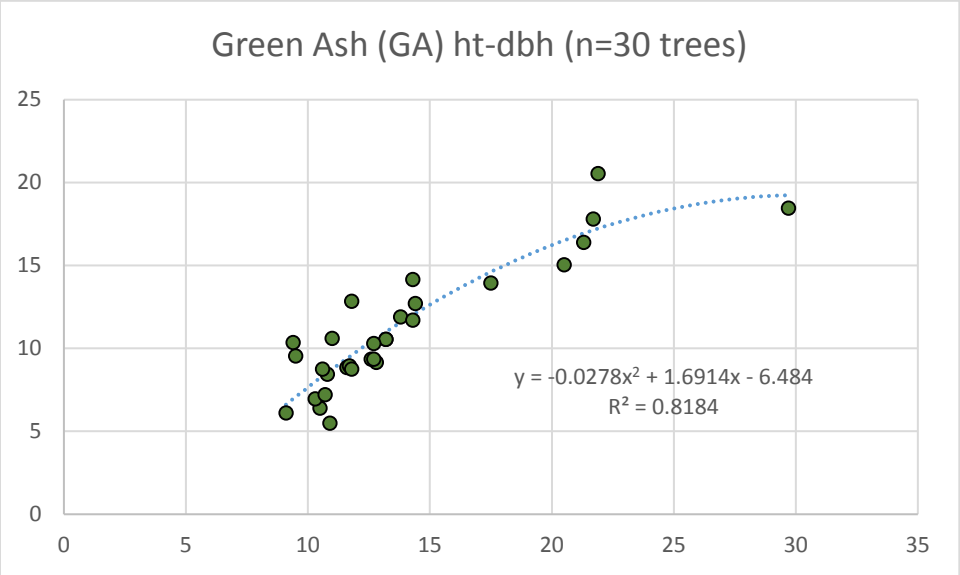

TA all PSPs (n=14,223)
TA height (m)
TA diameter (cm)
y = -0.0098x² + 0.8764x + 4.8812
R² = 0.6352
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60

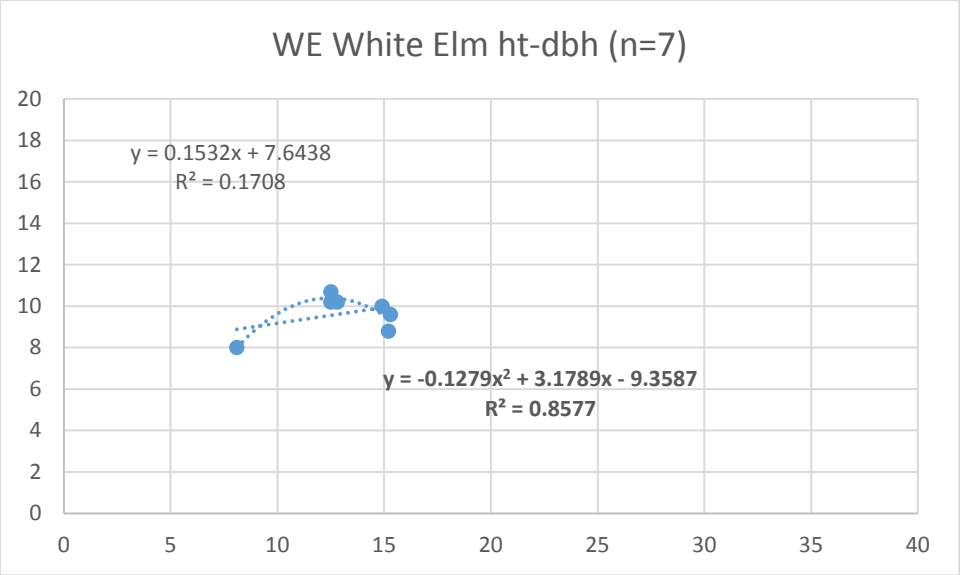

BA ht-dbh all PSPs (n=1221 trees)
y = -0.0071x² + 0.7055x + 5.3388
R² = 0.5767
0
5
10
15
20
25
30
0
10
20
30
40
50
60

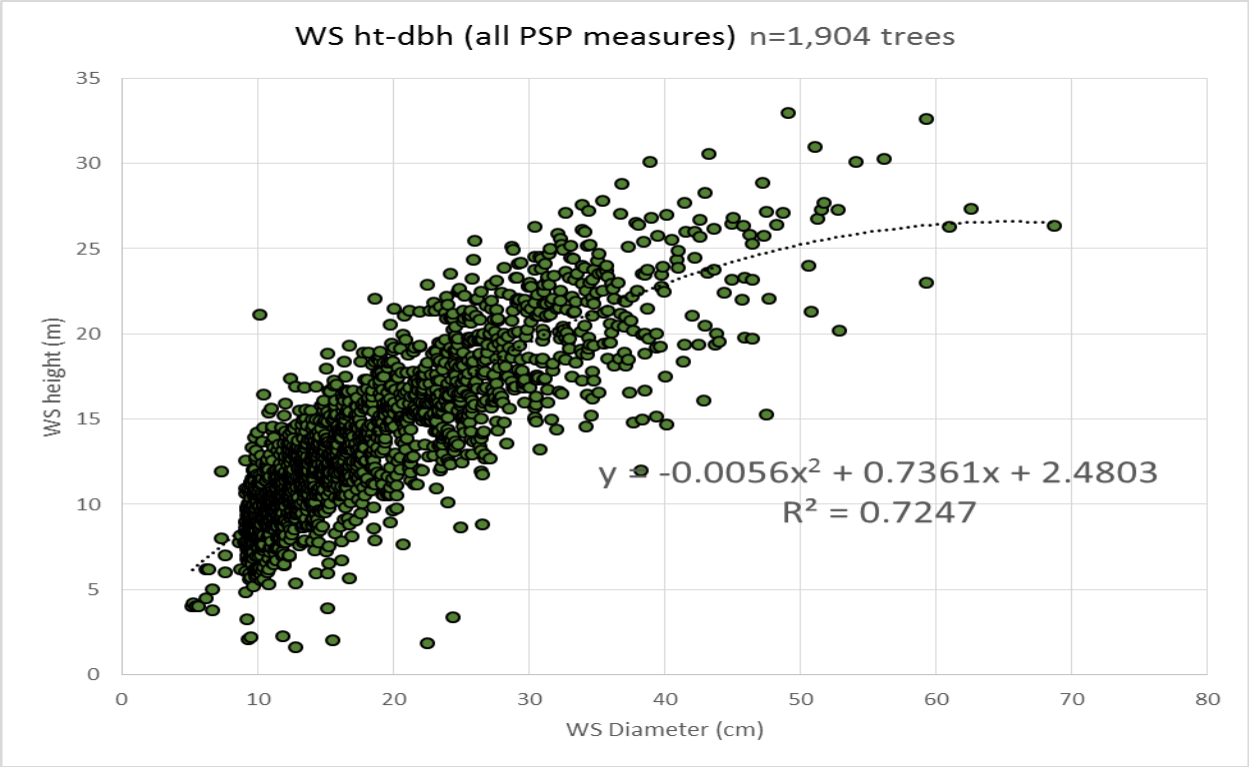

WB all PSPs ht-dbh
y = -0.0118x² + 0.8431x + 4.1029
R² = 0.4855

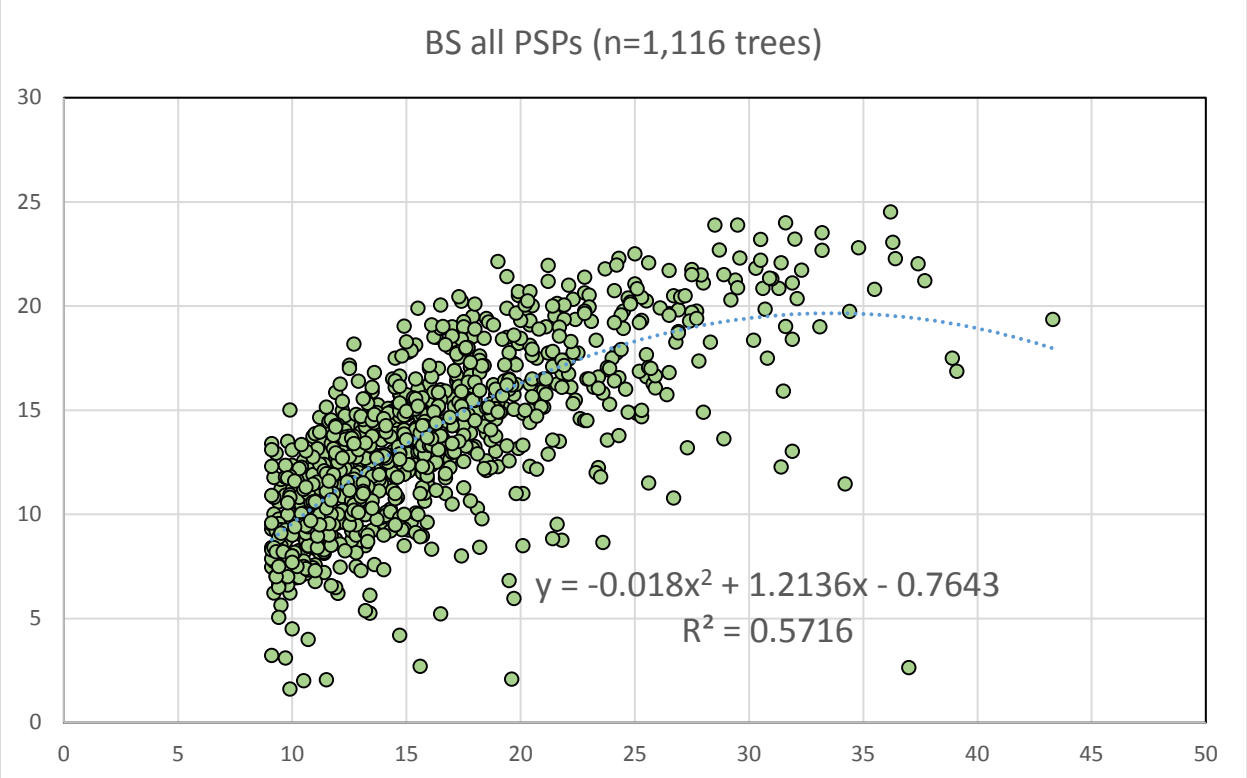

Manitoba maple ht-dbh all PSPs (n=32)
y = 0.0873x + 8.8413
R² = 0.0057
y = -0.197x² + 5.28x - 23.852
R² = 0.1836

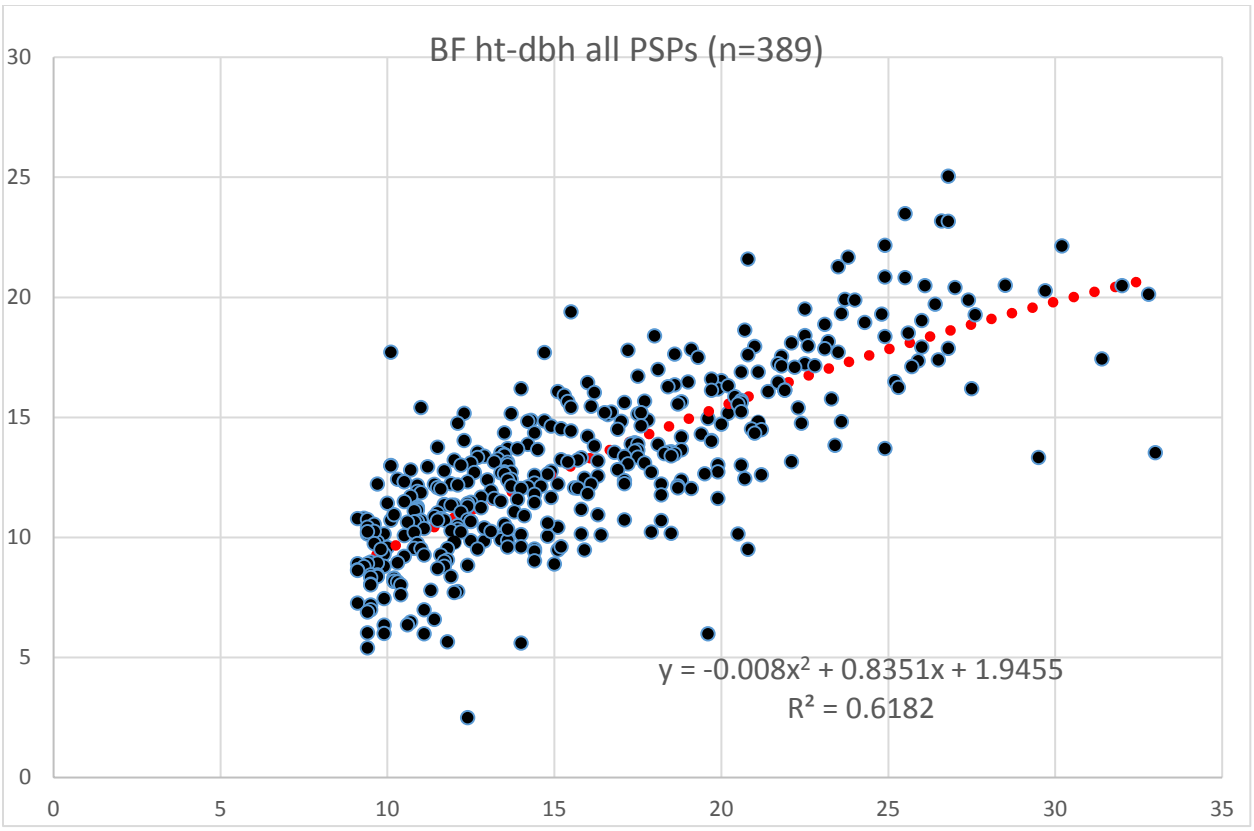

BO Bur Oak ht-dbh (n=35)
y = 0.004x + 7.2994
R² = 0.0001
y = -0.0357x² + 1.1501x - 0.9702
R² = 0.1835
0
2
4
6
8
10
12
0
5
10
15
20
25
30


Green Ash (GA) ht-dbh (n=30 trees)
y = -0.0278x² + 1.6914x - 6.484
R² = 0.8184
0
5
10
15
20
25
0
5
10
15
20
25
30
35


WE White Elm ht-dbh (n=7)
y = 0.1532x + 7.6438
R² = 0.1708
y = -0.1279x² + 3.1789x - 9.3587
R² = 0.8577
20
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
35
40


WS ht-dbh (all PSP measures) n=1,904 trees
WS height (m)
WS Diameter (cm)
y = -0.0056x² + 0.7361x + 2.4803
R² = 0.7247


BS all PSPs (n=1,116 trees)
y = -0.018x² + 1.2136x - 0.7643
R² = 0.5716


BF ht-dbh all PSPs (n=389)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
y = -0.008x² + 0.8351x + 1.9455
R² = 0.6182

2016 Pre-Harvest Survey Procedure Manual

April 18th, 2016

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

LP Canada Ltd. - Forest Resources Division (FRD) Swan Valley Manitoba has committed itself to the development and implementation of a process of site-specific, ecologically based operational planning. In accordance with Manitoba Environment Act License No. 2191E, LP / MFSRC performs site-specific investigations of all potential harvest sites. **"Pre-harvest survey"** means a site specific investigation of a potential harvest site, to document the stand characteristics and any non-timber values that may need to be protected, and to determine appropriate harvest and renewal treatments.

Section 4 of LP's Environment Act License No. 2191E dated December 11, 1996 states that the Licensee [LP] shall:

> *The Licencee shall, on a permanent basis, employ, or contract the services of, a field biologist, with expertise in forest ecosystem studies, to oversee the collection of flora and fauna information in the course of pre-harvest surveys, road construction planning and forest ecosystem monitoring and research.*

Section 11 of LP's Environment Act License No. 2191E dated December 11, 1996 states that the Licensee [LP] shall:

11 i) conduct pre-harvest surveys for all proposed timber harvest blocks according to the procedures outlined in the Standard Operating Procedures (Section 9 of the [1996] Forest Management Plan), or in revised the Standard Operating Procedures, that may be developed in consultation with the Stakeholders Advisory Committee, and approved by the director and the I.R.M.T.;

11 ii) determine, in consideration of the parameters being monitored in the pre-harvest surveys, and in consultation with the Director and the I.R.M.T., the level of training to be provided to pre-harvest survey staff, and ensure the required training occurs; and

11 iii) use the information collected by the pre-harvest surveys, to determine the harvest and renewal prescription for each harvest site.

Since 1995, LP's forestry staff has worked towards the development of the Pre-Harvest Survey manual. The manual presented here is the result of countless hours of discussion and constructive debate among Forest planners, Silviculture foresters, and Operation supervisors. Successive versions of this manual will build on this foundation and add to its improvement over time. Development in consultation with Company contractors, the Stakeholder Advisory Committee (SAC) and Manitoba Conservation has also occurred.

The original 1997 PHS manual was developed from an extensive review of pre-harvest survey procedures from the provinces of British Columbia, Alberta, Saskatchewan, and Ontario. The PHS manual is continuously improved each year.

1.1 DEFINITION

A Pre-Harvest Survey (PHS) is a site-specific assessment of a harvest area prior to logging. The assessment information is then developed into a site-specific integrated plan which addresses timber and non-timber resource concerns.

LP has developed a two-phase process:

(i) Ecological assessment and classification of the site (PHS)

(ii) Development of the Pre-Harvest Silviculture Prescription (PHSP).

1.2 OBJECTIVES

The operational objectives of a PHS are to:

- Ecologically classify all sites in order to provide data to help prescribe the appropriate Silviculture/Harvesting System
- Identify operational site limitations and potential constraints such as compactable soil types or the presence of competitive plant species
- Incorporate non-timber values into the planning process including exceptional features such as mineral licks, in-block streams or active trap lines.
- Accurately evaluate the timber values, volumes, and operational net-down deductions such as rot.

Although the primary purpose of the PHS is to collect operational data for the short-term annual planning process, a properly designed survey can provide data for numerous long-term planning applications. All MFSRC's PHS plots are geo-referenced in a Geographical Information System (GIS). Although the surveyed area will in most instances be harvested, the data collected acts as a snapshot in time. PHS's are actually temporary sample plots (TSP), and although not as valuable as Permanent Sample Plot (PSP) for projecting future trends, they still have tremendous value. The PHS database accumulates more data each year, and contains a vast array of data, such as:

- Soils data that can be used to create local soil maps;
- Forest Ecosystem Classification (FEC) V-types and S-types;
- Critical wildlife habitat and features that can be used to develop long-term Wildlife Management Plans;

- Forest Health data that may help project future insect and disease trends; and
- Mensurational data that can be used to develop yield curves.

1.3 SCHEDULING AND TIMING

The field season for performing a PHS is in the late spring, summer and early fall during leaf-out. During this time, the soil is not frozen, and the ecosystems can be correctly classified. Performing a PHS before 'leaf-out' in the spring or after 'leaf-off' in the fall and winter is not recommended.

It is LP / MFSRC's goal to PHS all proposed harvest sites one year in advance of harvesting. Therefore, during the 2012 field season, cutblocks planned for harvest in 2012 and 2013 will receive a PHS. Performing PHS's shortly before logging may not provide enough time to address any potential conflicts or concerns. Planners also may need time to modify cutblocks based on the PHS data. Performing PHS's too far in advance (*e.g.* > 5 years) can prove to be inefficient due to potential changes on the landscape, forest practices and management objectives.

1.4 IMPORTANCE OF DATA

The PHS data is the most crucial component in LP / MFSRC's short-term planning process. Therefore it cannot be stressed enough, how important it is for each surveyor to follow the protocol in this manual! The surveyor must realize that they are the "eyes and ears" for LP's planning team and are the key to the success of each cut-block prescription. Since the data will also be used for long-term planning, an error may have repercussions for many years into the future. A simple error in the timber cruise will result in an incorrect cutblock volume, which in turn may increase the time, effort and money LP / MFSRC's operational staff and independent contractors will have to spend during it's harvest. If a critical wildlife feature, such as a mineral lick or a raptor nest, is missed by a surveyor, it will have serious repercussions to LP / MFSRC under Manitoba's regulations, and may result in that feature being lost from the landscape. Surveyors must remember how important their work is, each and every day.

1.5 SAFETY

Every employee has the right to a safe and healthy working environment. MFSRC provides safety training to all employees and they all must read and follow the SPL Safety Policy Manual. This safety training will provide an employee with knowledge of the safety polices and minimize the risk of accidents.

2. PHS METHODOLOGY AND PROCEDURES

2.1 PRE-FIELD SEASON PREPARATION

1. The planner draws the cut block boundaries using aerial imagery or photography. Proposed cutblock boundaries are input into the Geographic Information System.
2. The PHS supervisor uses the GIS to generate a PHS grid on each block to be surveyed. Once a PHS grid is established on a block, two maps are be created and printed; one with an ortho-photography background and one plain grid map. Both these maps show the block number, and plot numbers
3. The plot UTM coordinates for each block must also be printed out.
4. The aerial photographs, grid maps and UTM coordinates are then filed in the "Blocks to be completed" area of the PHS file cabinet.
5. The planners develop a PHS priority list. From that list a detailed survey schedule is developed taking into consideration block access, ATV availability, proximity of other blocks etc. This schedule must be produced well in advance of the survey to have efficient mission planning.

2.2 PRE-FIELD ORGANIZATION

1. Retrieve the appropriate block package containing the photo, grid map, and UTM coordinates from the PHS supervisor, or found in the PHS file cabinet.
2. Ask the appropriate planner or the PHS supervisor about the area to be surveyed to learn about features of interest you may encounter, the best access route, or if there is any active logging or stakeholder activity in the area.
3. Confirm compass declination and prepare field equipment (Appendix I).
4. Field equipment and supplies required:
    - Cruise vest, tally book and bubble cards, GPS unit, UTM coordinates, maps, FEC field guide, and plant ID book
    - Pink candy striped flagging, and hip chain with extra string
    - Spade and trowel
    - Rulers, pencils, black marker, 2.0 Basal Area Factor prism, increment borer, compass, Suunto clinometer, 30 m tape, and DBH tape
    - first-aid kit, hard-hat, eye-protection, bear-repellent, rain-gear, toilet paper, and bottle of water

5. Mark your destination (block number) on the sign-out board, and whom you are working with.

2.3 PHS DATA COLLECTION

The field assessment is the most crucial part of the PHS process. Surveyors will adhere to the PHS protocol listed below.

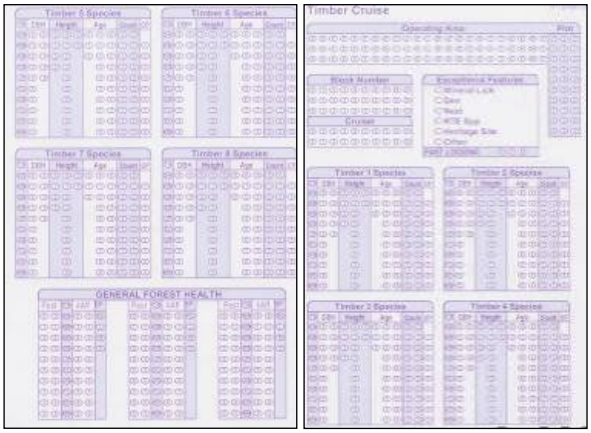
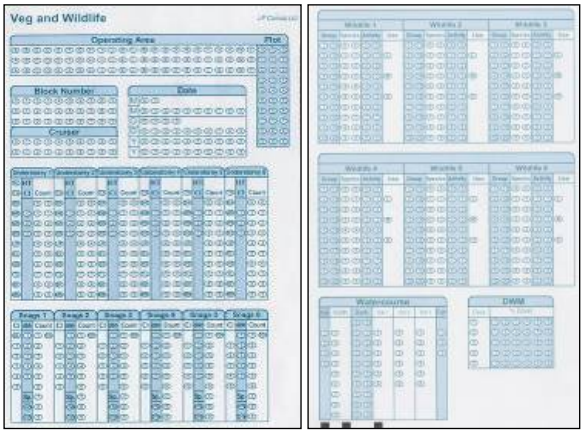
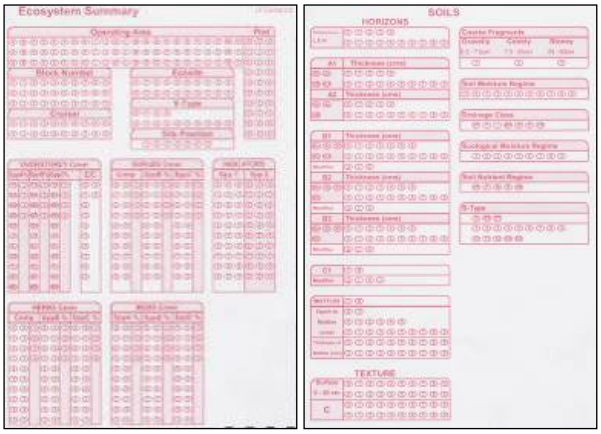
2.3.1 PHS plot location and establishment procedure

1. Review aerial photos and grid map, divide up the block, and proceed to your first plot.
2. At the first plot,
    - Check the location of the plot using the GPS and plot coordinates.
    - Tie two (2) candy-striped pink ribbons to represent the plot center.
    - Write the block and plot number on both of the ribbons.
3. Continue to hang two (2) pink candy-striped ribbons at every plot, and check the GPS coordinates on at least 30% of the plots within the block. Double tie all ribbons to ensure they remain for a couple years, as they are used by contractors when harvesting the cutblock.
4. Visit and mark all plots that fall outside of the block even though most of these plots will not require a survey. At plots that fall within the block and are close to the block boundary, you must proceed 50 meters beyond the boundary and document your findings on the grid map.

2.3.2 PHS Tally Cards (Bubble Cards)

All PHS data is recorded on “Bubble Cards”, except for field sketch maps. This system allows the large amount of PHS data to be scanned directly into the master database for planning purposes. This is valuable to the planning process because the planners write a PHSP (pre-harvest site prescription) as soon as the PHS data is available.

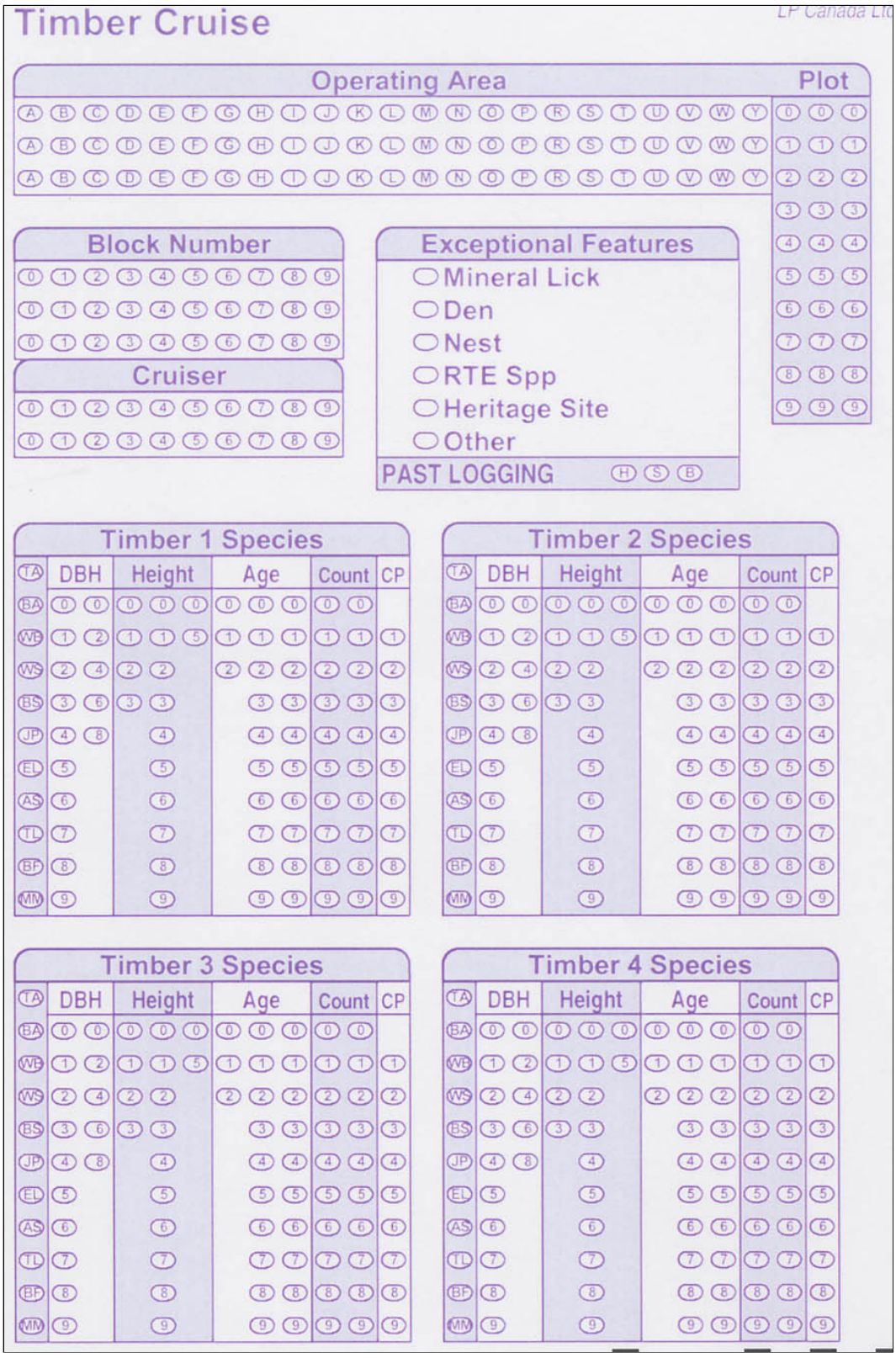
There are three bubble cards (two-sided) for each plot:

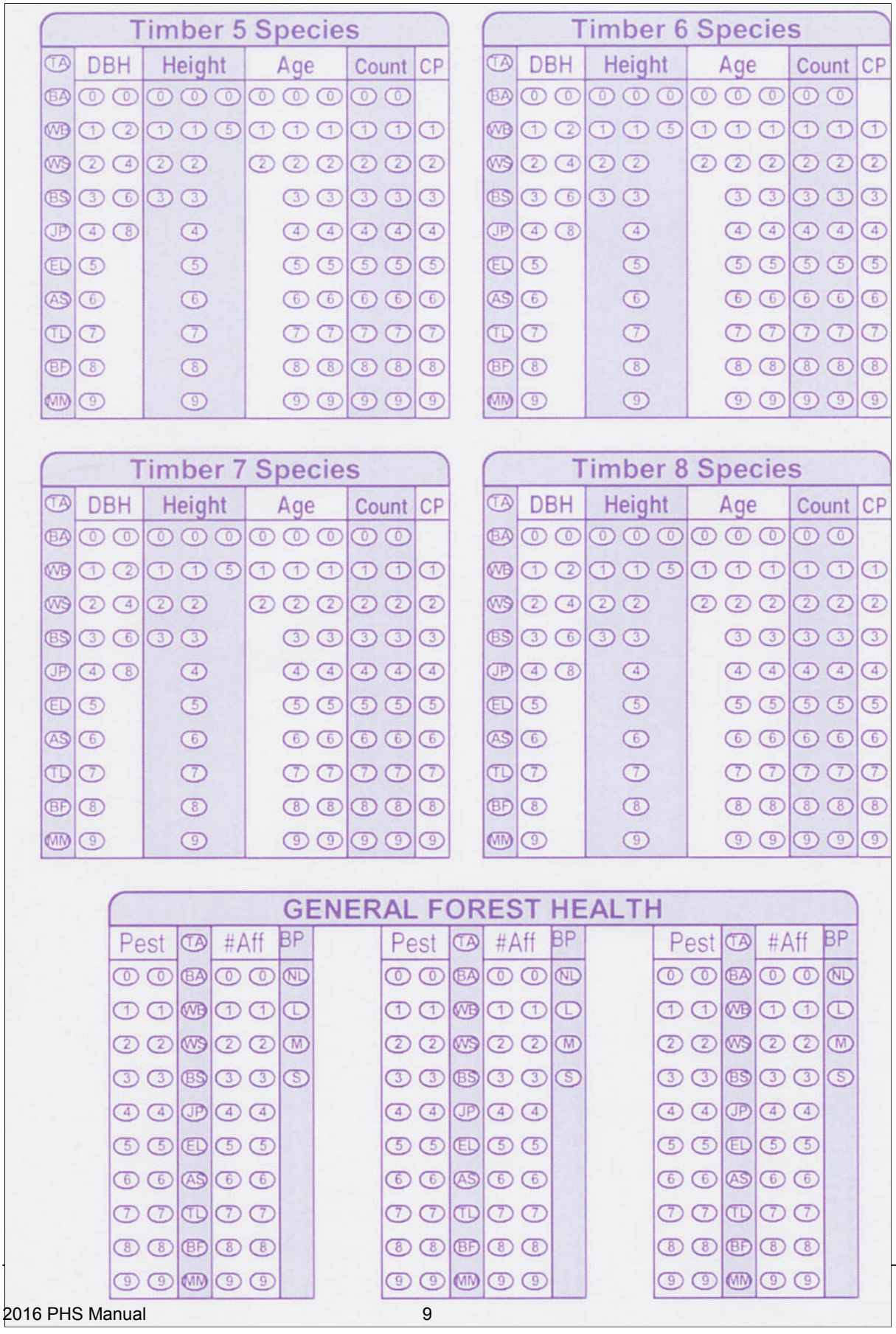
1	Timber Cruise (purple) 
2	Veg & Wildlife (blue) 
3	Ecosystem Summary (red) 

As with any data collected in the field, it is imperative that it is recorded as clear and concise as possible. This is especially true when using the bubble cards. The bubble cards must be clean and unwrinkled to successfully go through the scan machine.

- All applicable bubbles must be completely colored in.
- There should be no marks on the black bar codes on the sides of the cards.
- If a card has gotten wet or is bent, or crumpled, it will need to be recopied.
- There must be 3 cards (Timber Cruise, Veg & Wildlife, and Ecosystem Summary cards) completed for every plot within the block boundaries, even if nothing appears in the Timber cruise. This situation should be noted on the grid map.

3. TIMBER CRUISE




Timber 5 Species
TA DBH Height Age Count CP
BA WB WS BS JP EL AS TL BF MM
Timber 6 Species
TA DBH Height Age Count CP
BA WB WS BS JP EL AS TL BF MM
Timber 7 Species
TA DBH Height Age Count CP
BA WB WS BS JP EL AS TL BF MM
Timber 8 Species
TA DBH Height Age Count CP
BA WB WS BS JP EL AS TL BF MM
GENERAL FOREST HEALTH
Pest TA #Aff BP
BA WB WS BS JP EL AS TL BF MM
NL L M S
Pest TA #Aff BP
BA WB WS BS JP EL AS TL BF MM
NL L M S
Pest TA #Aff BP
BA WB WS BS JP EL AS TL BF MM
NL L M S

3.1 TIMBER CRUISE HEADER

The top one-third of the timber cruise bubble card sheet contains bubbles for header information on:

- Operating Area
- Plot Number
- Block Number
- Cruiser #

Use the following for cruiser numbers:

51 – Ryan Cable

52 – Korbin Proctor

53 – Jackie Twilley

54 – Kirsten Eggie

55 - Tayler Fleming

3.2 EXCEPTIONAL FEATURES

Record any exceptional features that you come across throughout the block. These include Mineral Licks, Wolf dens, major stick nests, Rare, Threatened, or Endangered (RTE) plants, heritage sites, or any other significant or exceptional features. This information should be recorded on the grid map and inform your supervisor.

If you encounter a RTE plant, you should take note of the surrounding area, the abundance of the plant, record the GPS coordinates, and complete a Manitoba Conservation RTE Plant form in the Appendices.

3.3 PAST LOGGING

If there are old stumps or other evidence of past logging, record this on the bubble cards as:

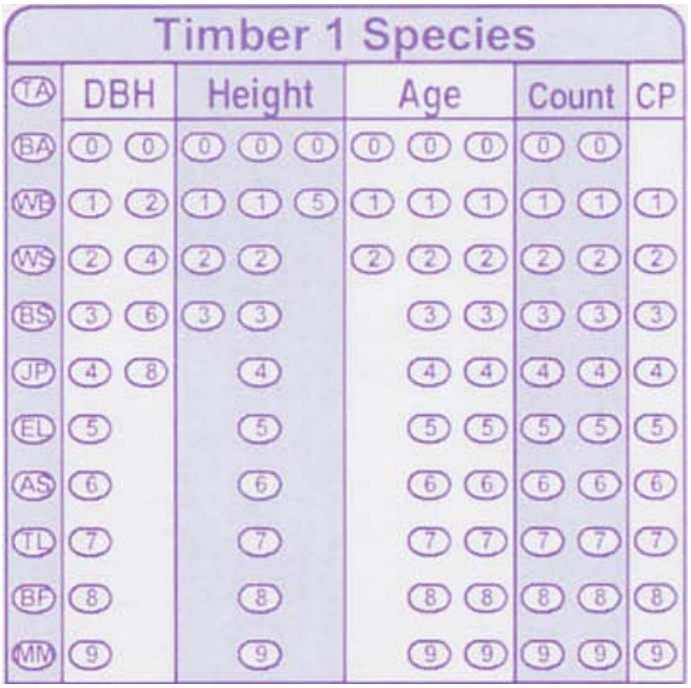
(H) hardwood;

(S) softwood; or

(B) both.

Only one bubble may be filled per card for this section. Map logged areas on your grid map.

3.4 TIMBER



3.4.1 Species

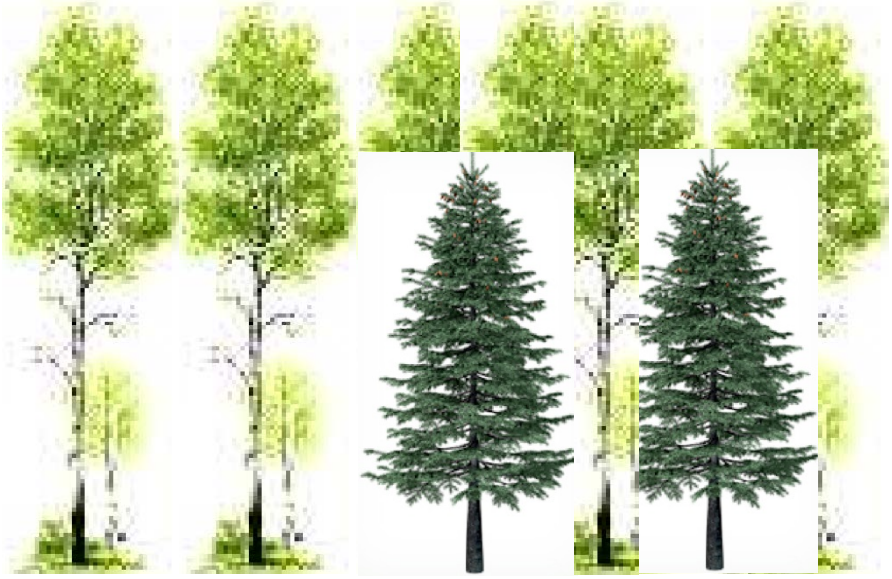
Species abbreviations are listed below.

Hardwoods (deciduous)	Softwoods (coniferous)
TA – trembling aspen	**WS** - white spruce
BA – balsam poplar	**BS** – black spruce
WB – white birch	**JP** – jack pine
AS – green ash	**TL** – tamarack / larch
EL – white elm	**BF** – balsam fir
MM – Manitoba maple	

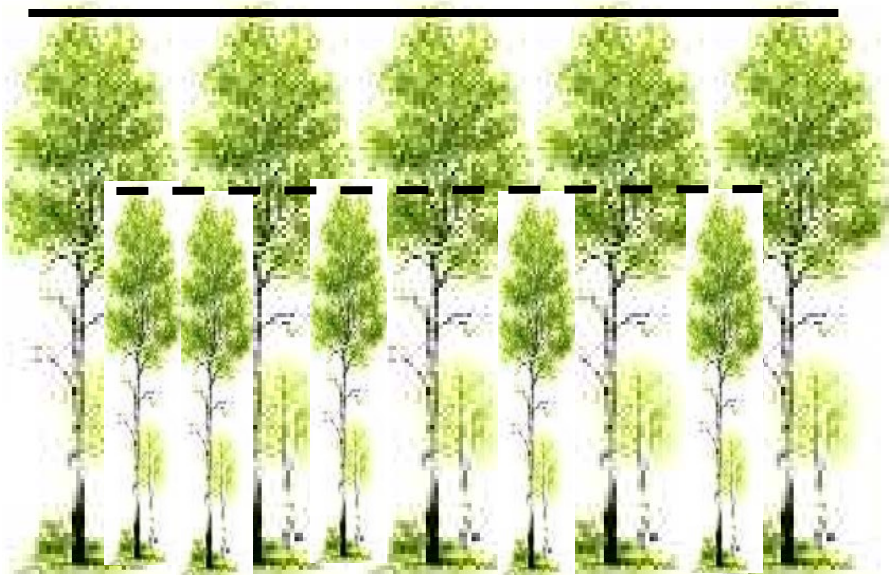
3.4.2 DBH

Using a diameter tape, determine the average diameter class (in 2 cm increments) for each canopy layer of trees counted 'in' by the prism sweep, for each trees species.

Example 1: if a PHS plot has both uniform TA and WS in the prism sweep, then choose one TA of average DBH and measure it. Then chose one WS of average DBH and measure the WS (and flag them both).



Example 2: if a PHS plot has all TA but there are obviously two different height classes, provide an average DBH for each TA height class.



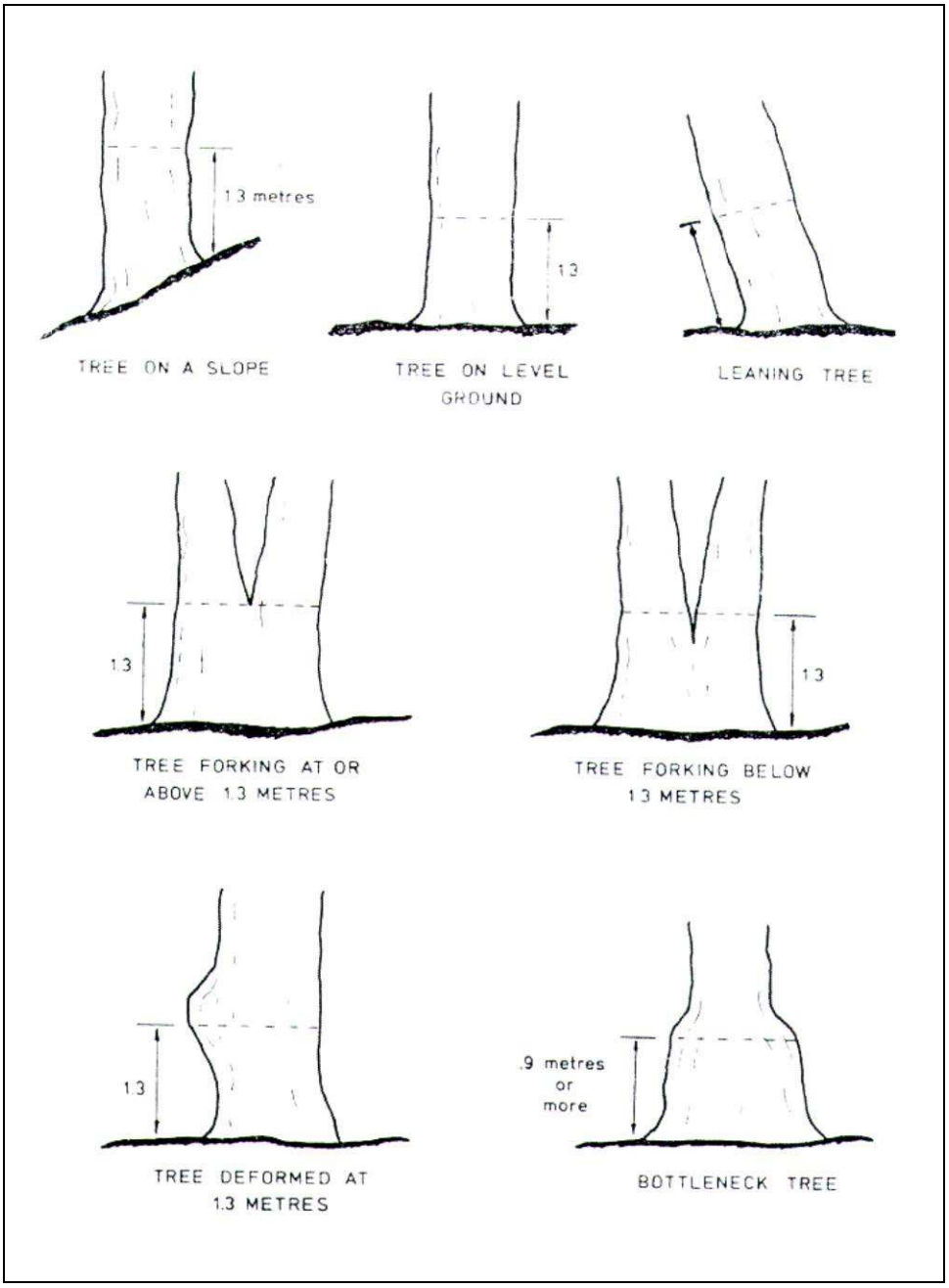
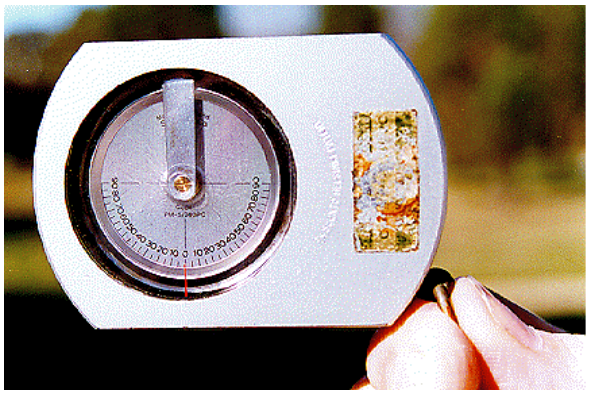
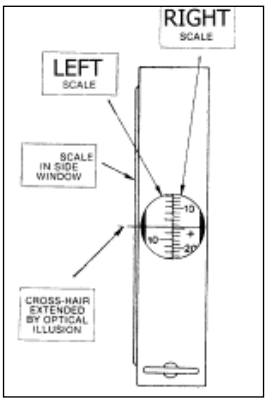


Figure 3.1 Proper height of dbh measurements.

3.4.3 Height

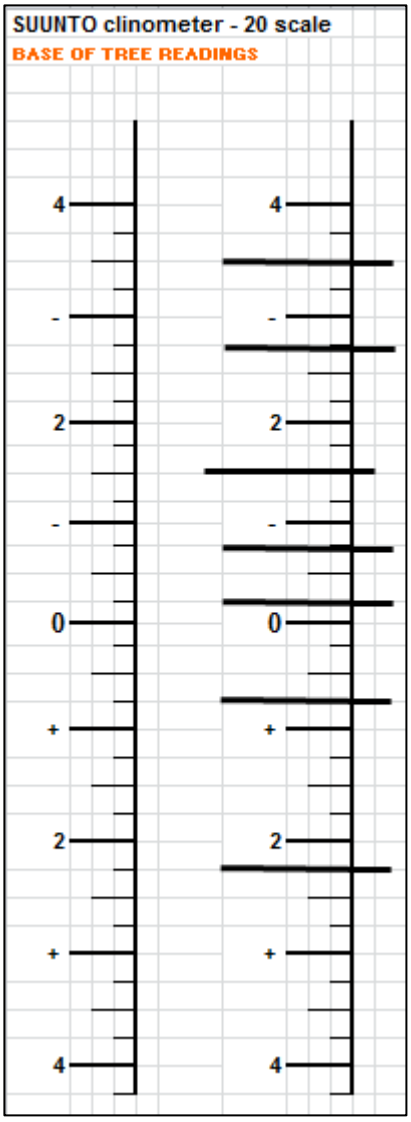


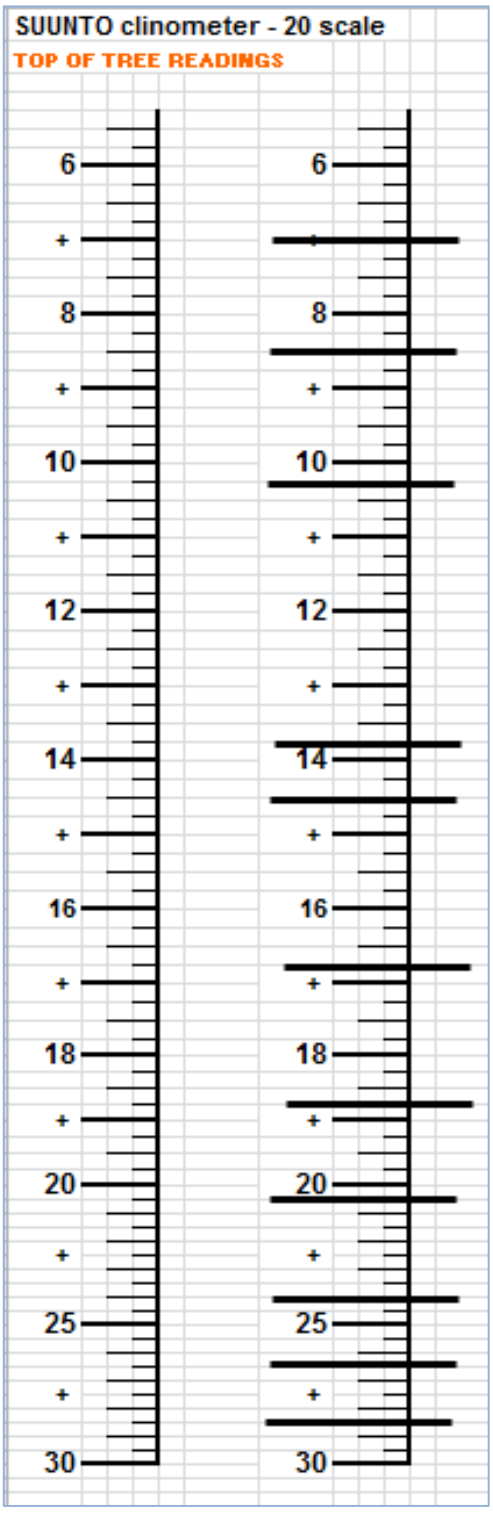


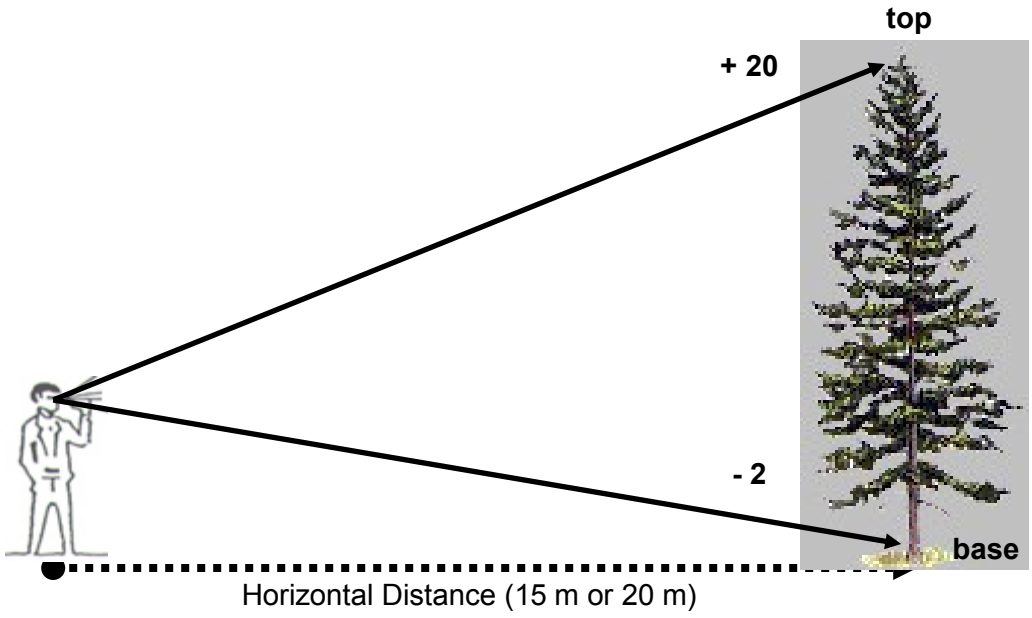
Using a Suunto clinometer, measure the height of a representative tree for each species and dbh class.

1. Measure the horizontal distance from the base of the tree (or the position directly beneath the required point) to a position where the required point on the tree (e.g. tree tip) can be seen.
2. Sight at the required point on the tree:
    - Using one eye: Close one eye and simultaneously look through the Suunto at the scale and 'beside' the Suunto at the tree. Judge where the horizontal line on the Suunto scale would cross the tree.
    - Both eyes: With one eye looking at the Suunto scale and the other looking at the tree, allow the images to appear to be superimposed on each other. Note: If you suffer from astigmatism, use the one eye approach.
3. Read from the percent scale and multiply this percentage by the horizontal distance measured in step 1.
4. Site to the base of the tree and repeat steps 2 - 3.
5. Combine the heights from steps 3 and 4 to determine total tree height:
    - Add the 2 heights together if you looked up to the required point in step 2 and down to the base of the tree in step 4.
    - Subtract the height to the base of the tree from the height to the required point if you are on sloping ground and had to look up to **both** the required point and the base of the tree.
6. Check all readings and calculations.

Reading the Suunto clinometer.







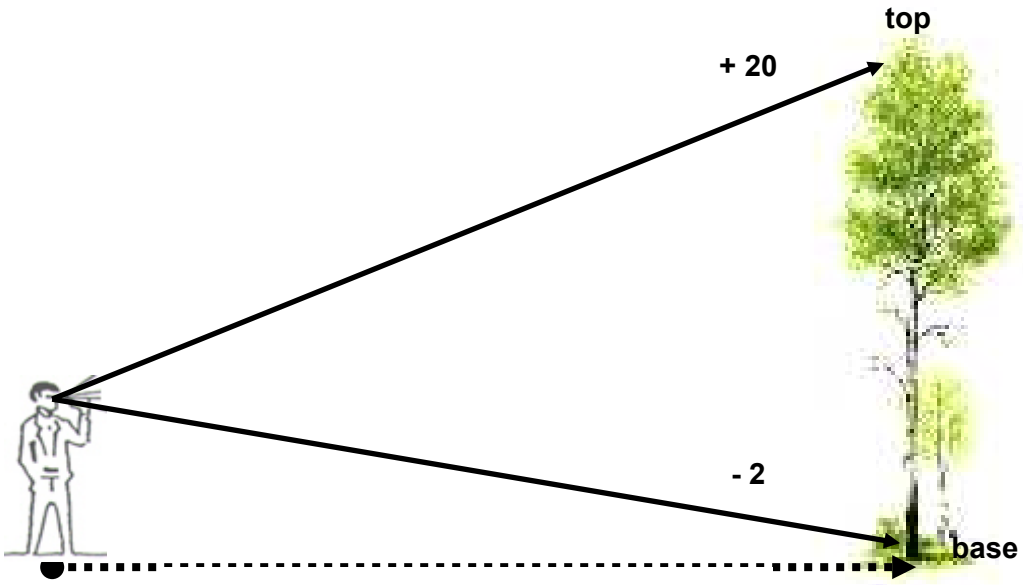


Figure 3.2 Proper tree height measuring techniques

In the example height readings above, the:

top measurement = + 20

base measurement = - 2

Therefore using the formula: (Top minus base)

+ 20 minus – 2

= 22 m tall tree

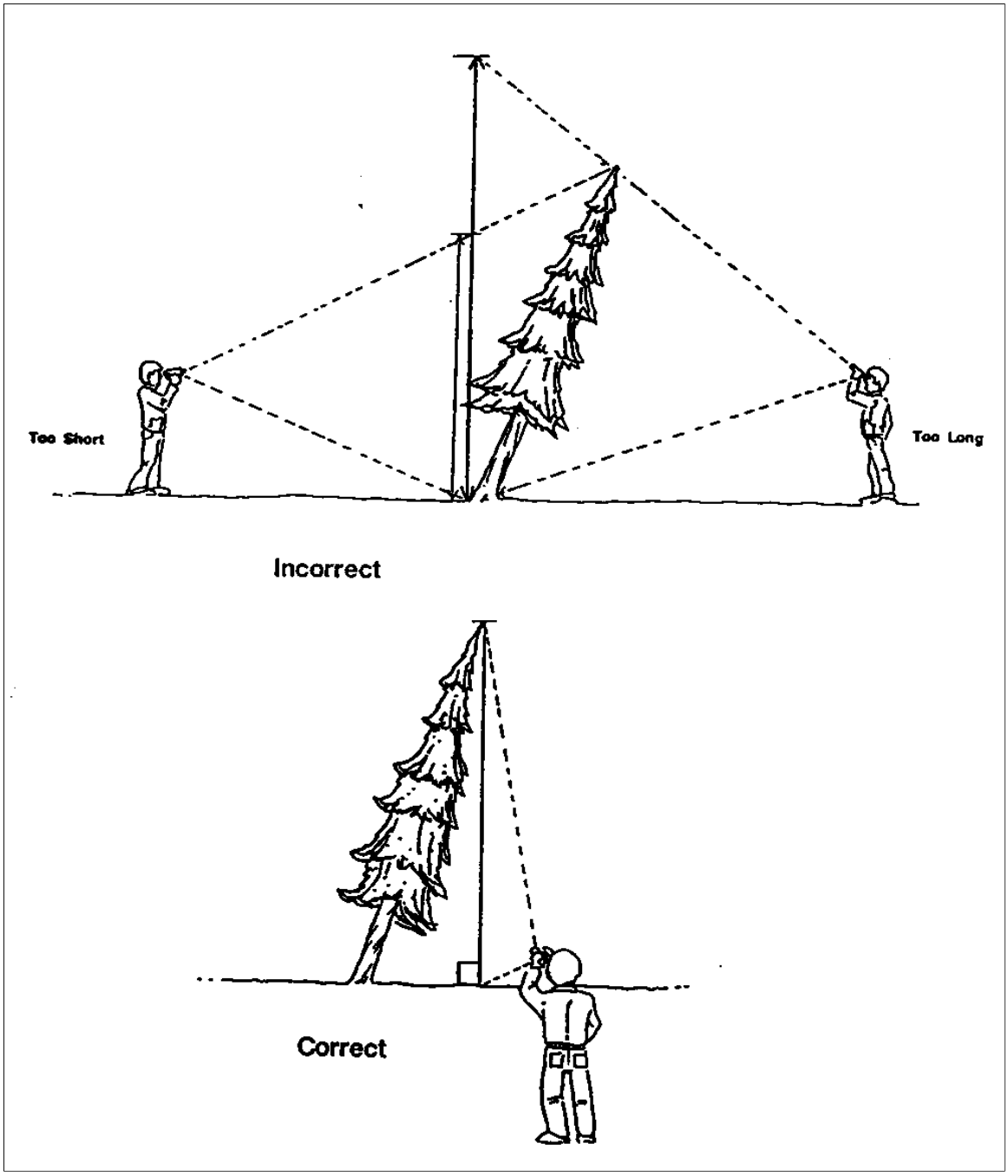


Figure 3.3 Proper tree height measuring techniques for leaning trees.

3.4.4 Age

Using the increment borer, determine the age of a characteristic tree for each dbh class and species, at breast height (1.3 m above ground), and record the number of rings that you count. Do not add an age correction factor. If the tree contains excessive rot, do not attempt to estimate the age, instead, bore another characteristic tree. Ensure ages are taken on large diameter trees and some smaller classes as well.

3.4.5 Count

Using the prism, record the number of 'in' trees that are 12 cm or larger, by species. The tree's dbh must be at least 12 cm to be considered in.

Using a 2.0 m^2/ha Basal Area Factor (BAF) prism, stand directly over the plot center and do a prism sweep. It is very important to hold the prism at exactly 1.3 m in height **and** keep the prism over plot centre (*i.e.* you rotate around the prism). Close your left eye, and look through the prism with your right eye.

The number of trees counted 'in' from the prism sweep is a very critical and sensitive number. Each tree counted 'in' is about 20 m^3/ha or 10-15% of the total volume.

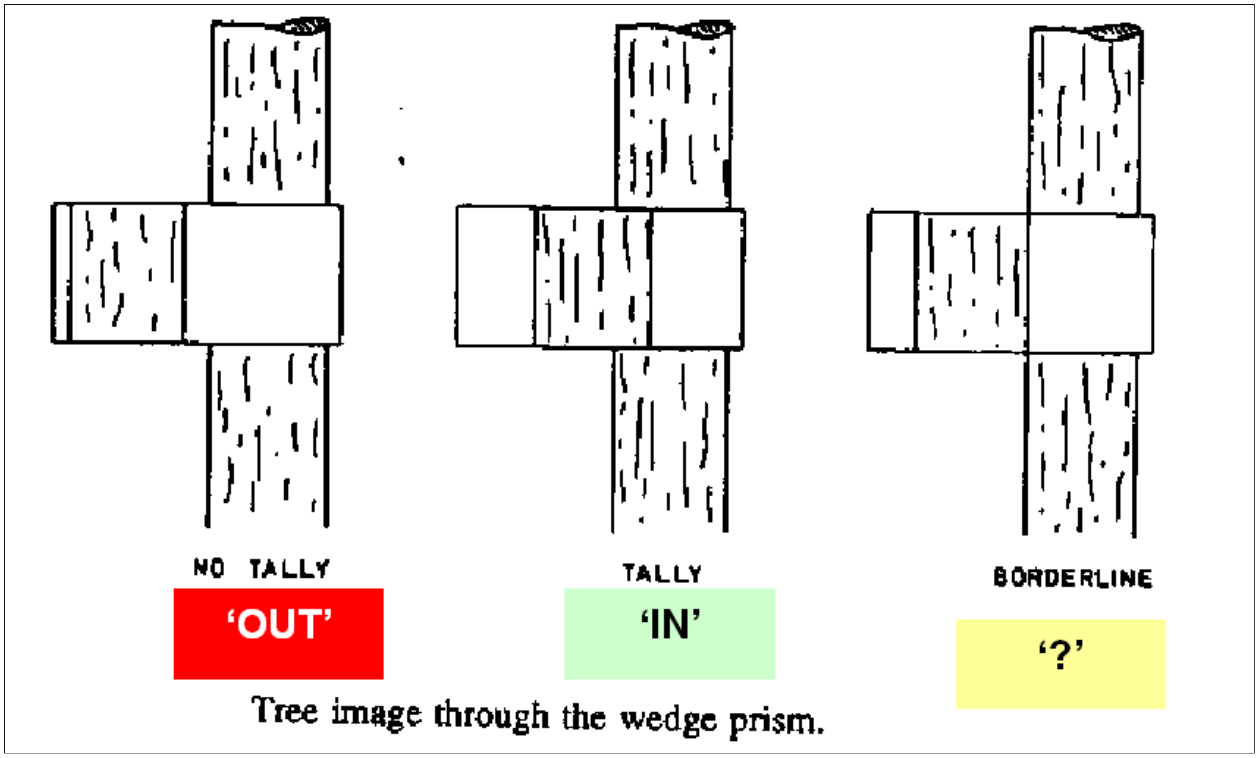


Figure 3.3 Wedge prism tallying technique.

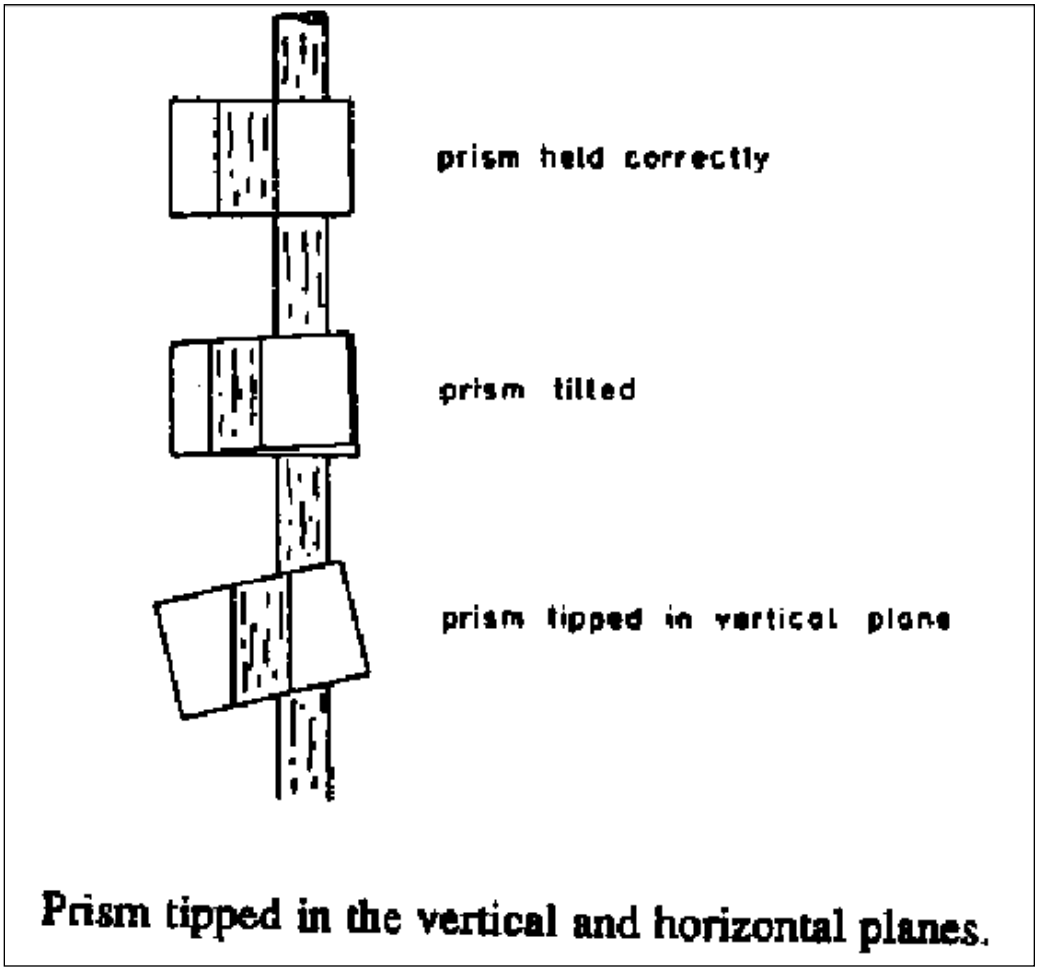
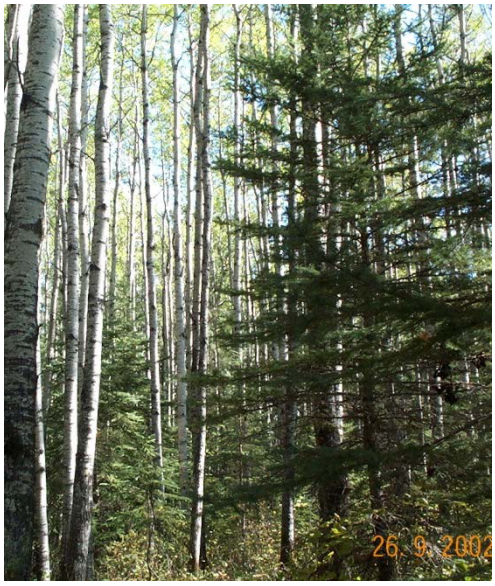


Figure 3.4 Prism proper usage.

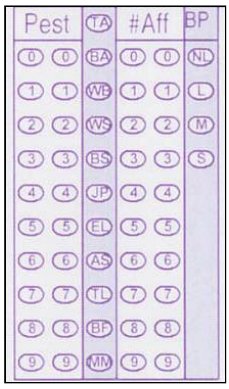
3.4.6 Crown Percent – CP



Determine the crown percent on conifer trees only to the nearest 10% (i.e. 10%, 20%, 30%…). This information is used to determine windfirmness of any conifer wildlife trees left behind.

Only record crown percent on conifer trees that are **shorter** than the main canopy. For example, in a mixedwood stand of 22 m aspen and 15 m white spruce, the spruce is shorter than the main canopy and would get a crown percentage. Example 2 – 22 m aspen with 22 m white spruce, don't record crown percentage since the conifer is part of the main canopy.

3.5 GENERAL FOREST HEALTH



The forest health data is recorded as outlined by Manitoba Conservation in "The Forest Health Requirements for the Pre-harvest Assessment Guidelines". Refer to supplemental forest health cards in the PHS field binder.

Record all forest health problems at each plot. At the plot, record the pest, tree species affected, and number of trees that are infected within your 5.64 m radius plot. Also record the presence of that forest health problem from your present plot to the next plot.

3.5.1 Pest Codes

Code	Code	
01 - Dwarf Mistletoe 	**05 -** Armillaria Root Rot 	**09 -** Yellow Stringy Rot 
02 - Western Gall Rust 	**06 -** Brown Cubical Rot 	**10**- Budworm 

03 - Hypoxylon Canker 	**07 -** Hardwood Stem Decay 	**11** - Poplar Borer 
04 - Stem Canker 	**08 -** White Pocket Rot 	**12** - Root Collar Weevil 

3.5.2 Tree Species Affected

Record the tree species affected by the pest (*e.g.* TA, BA, WB, WS…).

3.5.3 Number Trees Affected

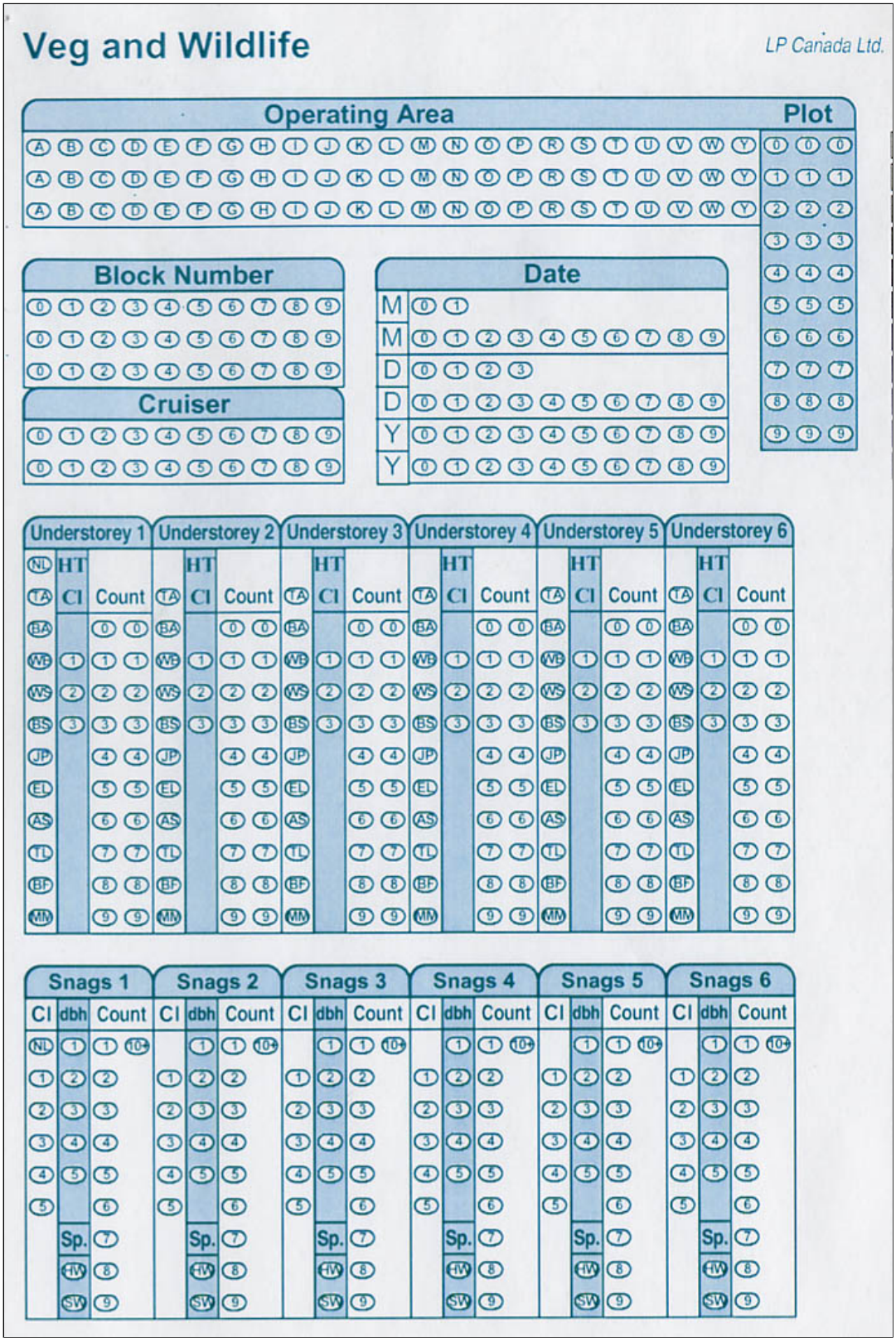
Record the number of trees affected (*e.g.* 01, 02, 03 …) within the 100 m^2 plot.

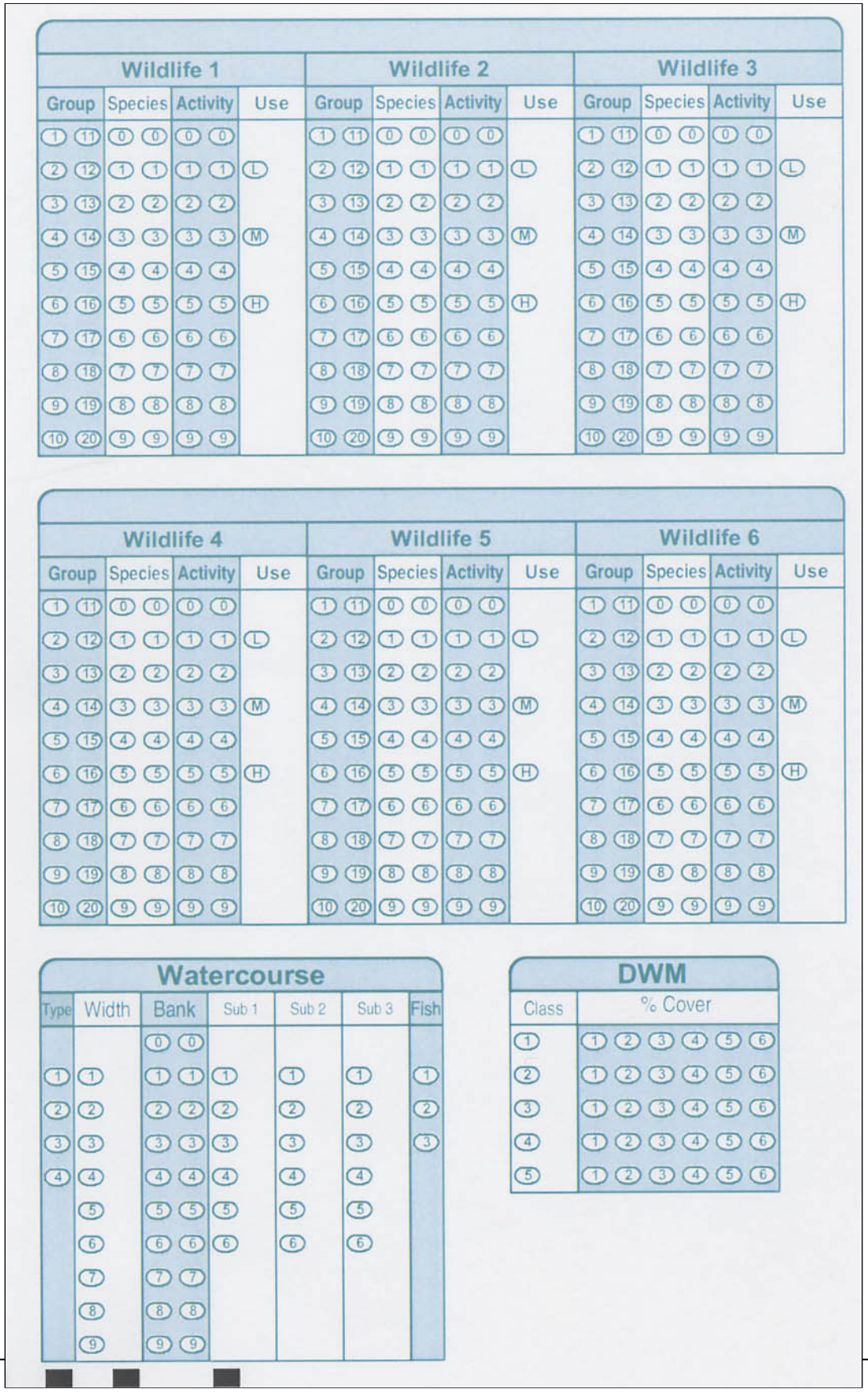
3.5.4 BP (Between Plots) Severity Level

Use the following severity guide for between plots only.

NL	No evidence of forest health problems
L (Low)	One to 5 stems affected between plots, rarely or infrequently seen
M (Moderate)	Six to 20 stems affected between plots, occasionally seen; possibly some openings developing
S (Severe)	More than 21 stems affected; frequently seen throughout the stand; possibly some noticeable large openings formed.

4. VEG AND WILDLIFE




Wildlife 1
Group Species Activity Use
Wildlife 2
Group Species Activity Use
Wildlife 3
Group Species Activity Use
Wildlife 4
Group Species Activity Use
Wildlife 5
Group Species Activity Use
Wildlife 6
Group Species Activity Use
Watercourse
Type Width Bank Sub 1 Sub 2 Sub 3 Fish
DWM
Class % Cover

4.1 VEG AND WILDLIFE HEADER

The top one-third of the Veg and Wildlife bubble card sheet contains bubbles for header information:

- Operating Area
- Plot
- Block Number
- Cruiser
- Date

4.2 UNDERSTORY

The understory data is collected in the 5.64-meter radius circular plot (100 m^2). Up to six occurrences of understory can be recorded on the bubble card.

Conifer understory trees have:

- a height that is less than 10.1 meters tall
- a height that is greater than 0.25 m

Hardwood understory trees are <u>not</u> tallied if their dbh >12 cm.

4.2.1 Understory Species

Each species and height class group must be recorded, both hardwood and softwood. Again, hardwood understory trees are <u>not</u> tallied if their dbh >12 cm.

4.2.2 Understory Height Class Code (HT CL)

1 6-10 meters

2 2-6 meters

3 0.25-2 meters

4.2.3 Understory Count

The number of understory trees in the 100 m^2 plot. Please fill in <u>both</u> bubbles (*e.g.* one tree is recorded as '01', not just '1').

4.3 SNAGS

Snag data must be collected in the 5.64-meter radius plot (100 m^2) for all snags greater than 1 meter in height:

4.3.1 Snag Class (CL)

Classify snags using height and branch form of each individual tree using snag decay classes 1 to 5. If there are no snags, use the NL (nil) bubble.

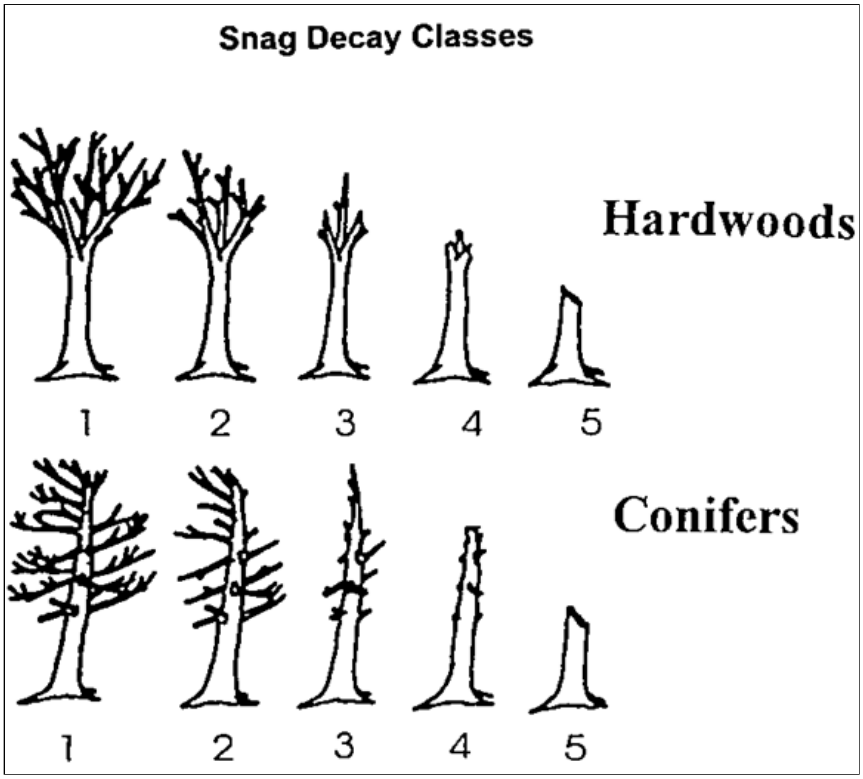


Figure 4.1 Snag decay classes.

	Tree Top	Branches	Bark
Decay Class **1** *(recently dead)*	intact	most fine branches still present	intact
Decay Class **2**	intact	most fine branches have dropped	bark loosening
Decay Class **3**	intact	fewer than 50% of coarse branches are left	may or may not have sloughed off (WB holds bark longer)
Decay Class **4** *(height at least 6m)*	broken	no coarse branches are left	may or may not have sloughed off
Decay Class **5** *(height less than 6m)*	stub	no coarse branches are left	may or may not have sloughed off

note: trees that have died before attaining a height of 6 m should be assessed using the diagrams (they are not automatically Decay Class 5). Similarly, if the tree has never attained a height of 6 m, it cannot be coded as Decay Class 4.

4.3.2 Snag DBH Class

Record groups of snags of the same DBH, species and snag decay class. If any of the snag characteristics (DBH, Species, and class) differ, record it as another group of snag(s).

The snag DBH codes are:

Code	DBH
1	<10 cm
2	10 cm-15 cm
3	15 cm-25 cm
4	25 cm-30 cm
5	>30 cm

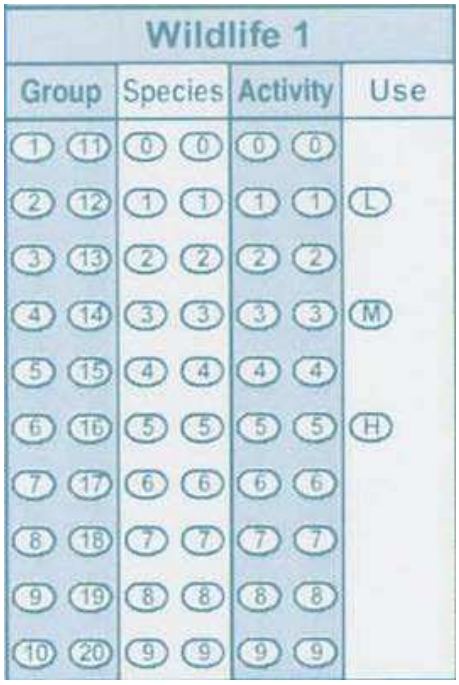
4.3.3 Snag Species (Sp.)

Choose either hardwood (HW) or softwood (SW).

4.3.4 Snag Count

Count the **number** of both hardwood and softwood snags.

4.4 WILDLIFE ACTIVITY



The wildlife data is collected within the 100 m2 (5.64 m radius circular plot) established at the center of the plot. Within the circular plot assess the following wildlife activity:

4.4.1 Wildlife (Species) Group

Groups of species are shown below.

1) Carnivores	2) Grouse	3) Rodents & Lagomorphs	7) Ungulates

4.4.2 Wildlife Species

The wildlife species is very important but may not always be determinable (*e.g.* moose browse *vs*. elk browse). If the species cannot be identified, leave the bubbles blank.

1) Carnivores	2) Grouse	3) Rodents & Lagomorphs	7) Ungulates
01) black bear	01) Ruffed Grouse	01) Mice	01) Caribou
02) Coyote	02) Sharptail Grouse	02) Shrews	02) Elk
03) Ermine	03) Spruce Grouse	03) Snowshoe Hare	03) Deer
04) Fisher		04) Squirrel	04) Moose
05) Fox	**XX**) woodpeckers (new for 2009+)	05) Vole	
06) Lynx		06) Woodchuck	
07) Marten		07) Beaver	
08) Skunk		08) Porcupine	
09) Wolf			
10) Mink			

4.4.3 Wildlife Activity

Wildlife activity codes are:

02 –Browse

06 – Scat

09 – Tracks or trails

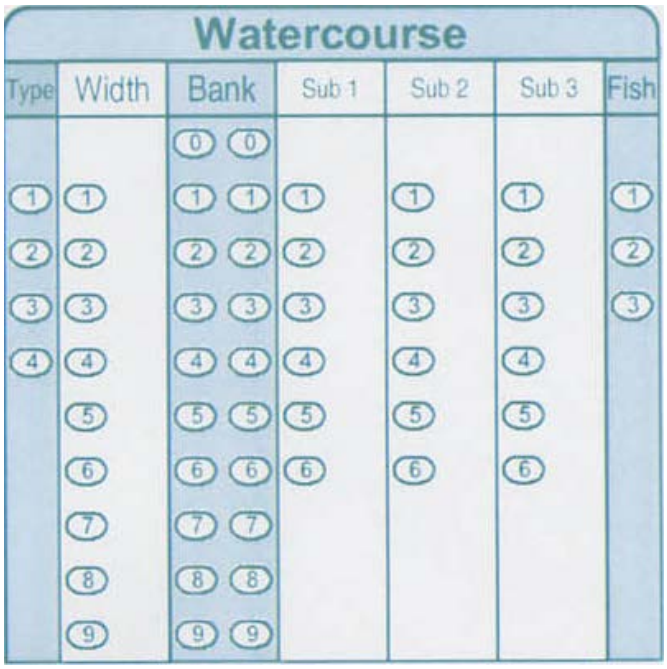
Browse - look for the presence of preferred browse species such as red osier dogwood, birch, aspen, poplar, mountain maple, and willow. Locate up to a maximum of 10 plants of the top 3 species present. Assign percent browsed by determining the number of shrubs browsed over those available and assign browsing pressure.

4.4.4 Wildlife Use

L - low	M - Medium	H - High
1-3 plants browsed	4-6 plants browsed	7-10 plants browsed
1-2 pellet groups	3-4 pellet groups	5+ pellet groups

4.5 WATERCOURSE

All watercourses encountered must be mapped and classified. When crossing a watercourse record the following information:



4.5.1 Watercourse Type

1- Permanent

Channels that are characterized by water flowing continuously throughout the year. These channels also possess continuous definable banks.

2) In-block swale

Channels that do not possess continuous definable banks and flow only at certain times of the year (*e.g.* spring melt, heavy precipitation events).

3- Beaver Flood

Channel flooding occurring as a result of dam construction by beavers. Can be found along stream channels or in wetland environments.

4 - Seasonal

Channels that flow briefly in response to precipitation events and possess continuous definable banks.

4.5.2 Watercourse Width

Watercourse width is the bank-to-bank channel width. Codes are:

1 <0.5 meters

2 0.5 to 1.0 meters

3 1.0 to 2.0 meters

4 > 2 meters

Write estimated channel width on PHS grid map if class 4 (greater than 2 meters).

4.5.3 Watercourse Bank Height

Measure stream bank height in meters to 1 decimal (*e.g.* 0.9 m, 1.1 m, 1.2 m).

4.5.4 Substrate 1, 2 & 3

Up to three types of substrate (stream bottom type) can be recorded on the bubble card (Sub1, Sub2, and Sub3). List the most dominant substrate type first.

	Substrate Type	Description	
1	**Rubble/ Cobble**	rocks with a maximum length of 64 -256 mm	
2	**Gravel**	rocks with a maximum length 2 - 64 mm	
3	**Sand**	inorganic particles - maximum length .062 - 2 mm	
4	**Silt**	fine inorganic particles - maximum length .004 -.062 mm	
5	**Clay**	Very fine particles – texture is gummy and sticky; maximum length .004 mm.	
6	**Muck**	soft material largely of organic origin without sand or gravel intermixed but composed of silt and clay	

4.5.5 Fish Presence

Choose one of the three possibilities:

1 Fish - visually observed (even minnows);

2 No Fish – use if no defined channel (*e.g.* alder swale, small wetland); or

3 Unknown – use if defined channel and no fish observed.

4.5.6 Watercourse Mapping

Ensure that all watercourses are mapped on the PHS sketch map and an <u>arrow defines direction of flow</u>. Where possible, map the whole reach of the watercourse that falls within the proposed harvest block. Also indicate whether the stream has FLOW (F) or whether it is DRY (D) on the map.

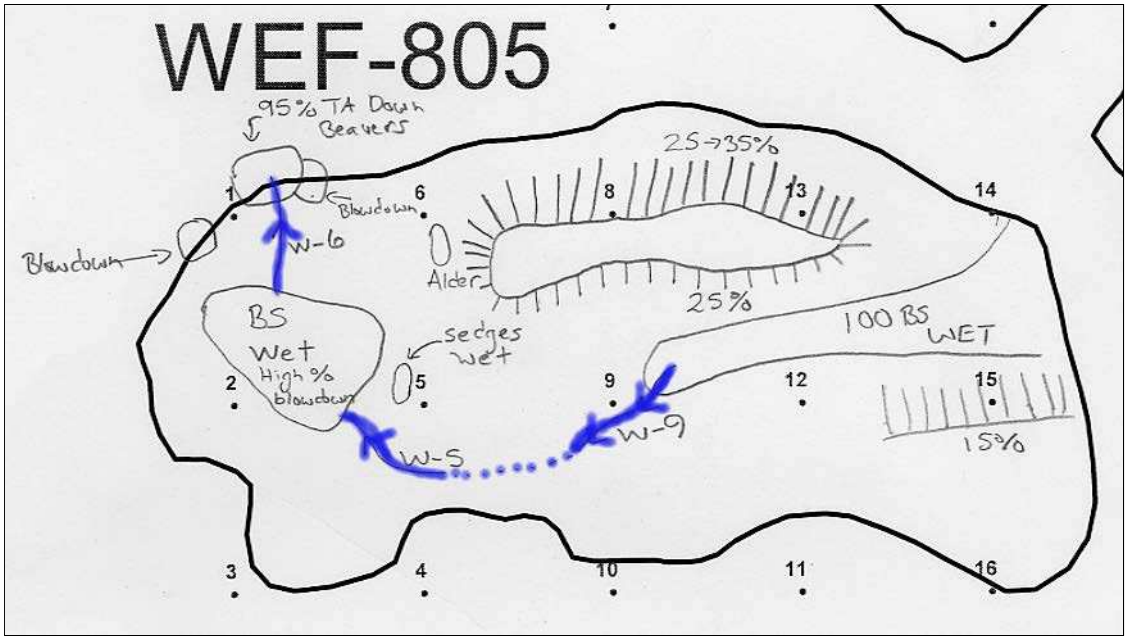
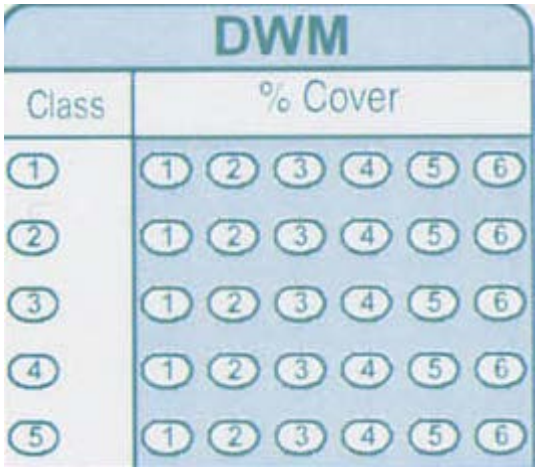


Figure 4.2 Well-mapped watercourses on a PHS sketch map.

All watercourses are numbered according to the plot number it follows. In the WEF-805 sketch map above, a watercourse was discovered on the way to plot 9 (from plot 12). Therefore, the watercourse is labeled W-9, and the field card in which to enter data on would be for plot 9.

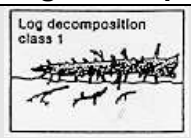
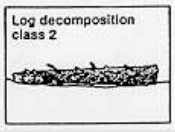
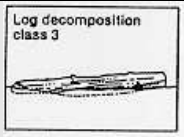
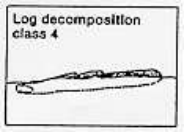
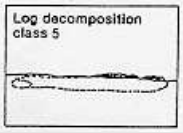
4.6 DOWNED WOODY MATERIAL

Within the 5.64-meter radius circular plot (100 m^2), determine the percent cover for each of the five DWM Classes (not all five may be present).



4.6.1 Decomposition Class

There are five classes are based on level of decomposition. Class 1 is recently fallen while class 5 is very decomposed.

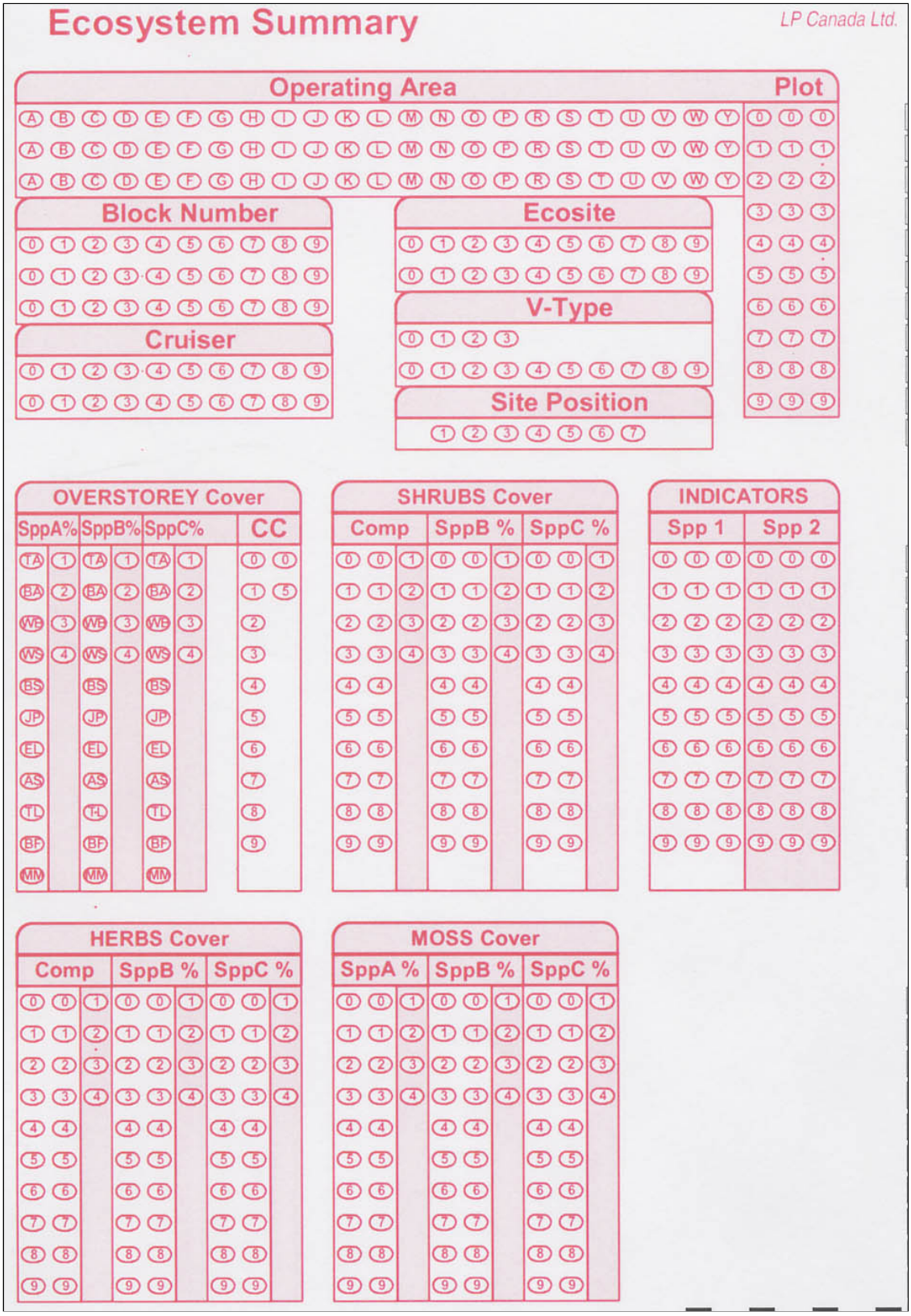
Log Attributes	Log Decomposition Class				
					
	1	**2**	**3**	**4**	**5**
Bark	intact	intact	trace	absent	absent
Twigs < 3 cm	present	absent	absent	absent	absent
Texture	intact	intact to partly soft	hard, large pieces	small, soft, blocky pieces	soft and powdery
Shape	round	round	round	round to oval	oval
Colour of Wood	original colour	original colour	original colour faded	light brown to faded brown or yellowish	faded to light yellow or gray
Portion of Log on Ground	log elevated on support points	log elevated on support points, but sagging slightly	log is sagging near ground	all of log on ground	all of log on ground

4.6.2 Percent Cover

The percent cover classes of DWM are:

Code	Cover %
1	<1%
2	1-10%
3	11-25%
4	26-50%
5	51-75%
6	76-100%

5. ECOSYSTEM SUMMARY



SOILS

HORIZONS

Thickness(cms)	0 1 2 3 4
L,F,H	0 1 2 3 4 5 6 7 8 9

A1	Thickness (cms)
Ah Ae	0 1 2 3 4
AB N/A	0 1 2 3 4 5 6 7 8 9
A2	**Thickness (cms)**
Ah Ae	0 1 2 3 4
AB	0 1 2 3 4 5 6 7 8 9

B1	Thickness (cms)
Bm Bt Bf	0 1 2 3 4 5 6
BC N/A	0 1 2 3 4 5 6 7 8 9
Modifier	g j k
B2	**Thickness (cms)**
Bm Bt Bf	0 1 2 3 4 5 6
BC	0 1 2 3 4 5 6 7 8 9
Modifier	g j k
B3	**Thickness (cms)**
Bm Bt Bf	0 1 2 3 4 5 6
BC	0 1 2 3 4 5 6 7 8 9
Modifier	g j k

C1	Y N
Modifier	g j k x

MOTTLES	Y N
Depth to	0 1
Mottles	0 1 2 3 4 5
(cms)	0 1 2 3 4 5 6 7 8 9
Thickness of	0 1 2 3 4 5 6 7 8 9
Mottles (cms)	0 1 2 3 4 5 6 7 8 9

TEXTURE

Surface	0 1 2 3 4 5 6 7 8 9
0 - 20 cm	0 1 2 3 4 5 6 7 8 9
C	0 1 2 3 4 5 6 7 8 9
	0 1 2 3 4 5 6 7 8 9

Coarse Fragments		
Gravelly	Cobbly	Stoney
0.2 - 7.5cm	7.5 - 25cm	25 - 60cm
1	2	3

Soil Moisture Regime
-1 0 1 2 3 4 5 6 7 8 9

Drainage Class
VP P I MW W R VR

Ecological Moisture Regime
1 2 3 4 5 6 7 8 9

Soil Nutrient Regime
VP P M R VR

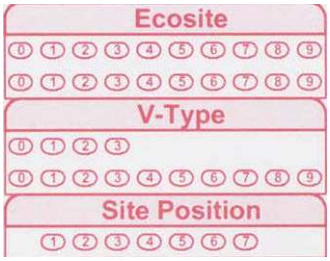
S-Type
S SS ST
1 2 3 4 5 6 7 8 9
10 11 12 12S 12F

5.1 ECOSYSTEM SUMMARY HEADER

The top one-third of the Ecosystem Summary bubble card sheet contains bubbles for header information:

- Operating Area
- Plot
- Block Number
- Cruiser

5.2 ECOSITE

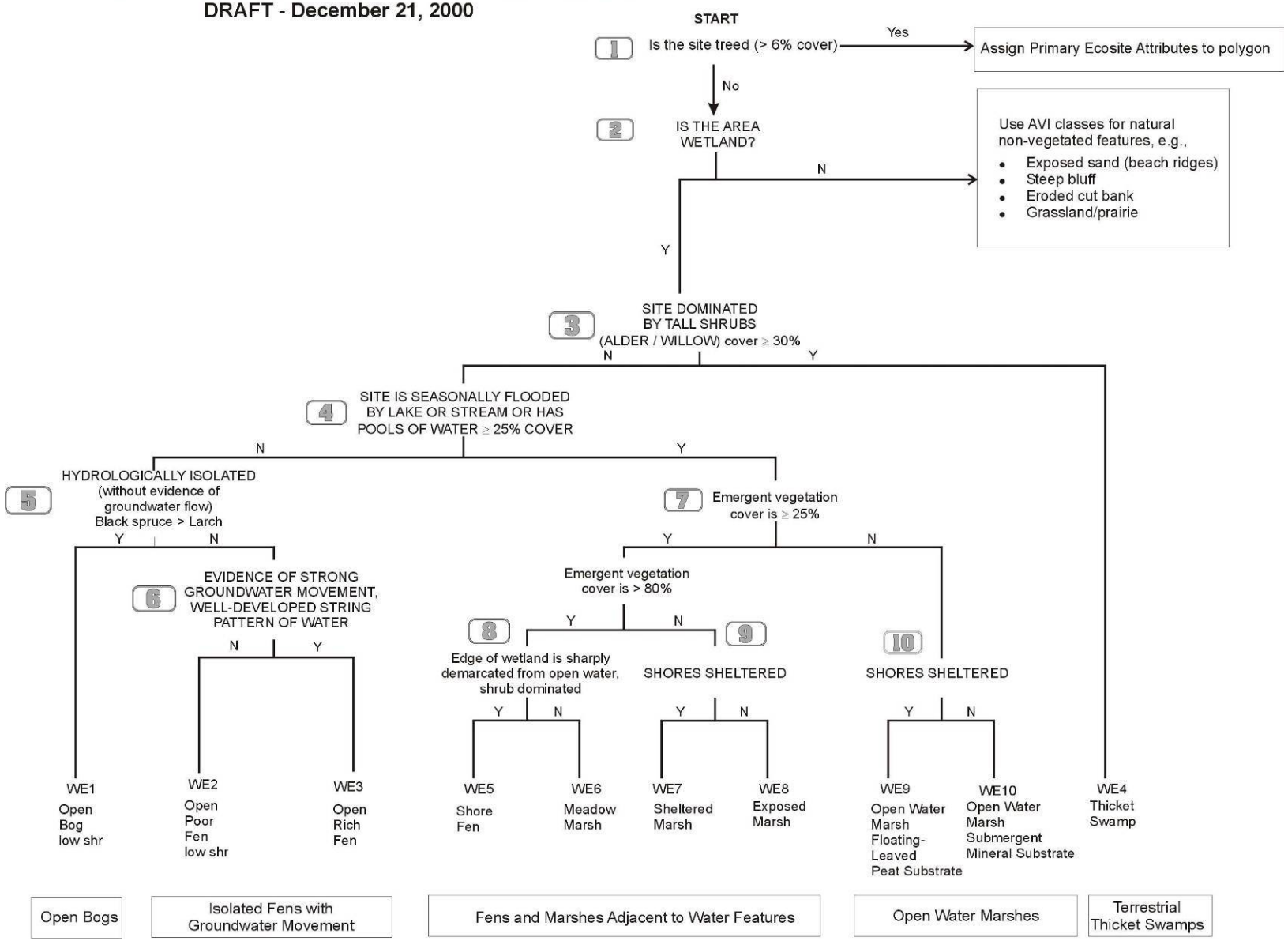


Ecosites can only be keyed out on PHS plots that have a soil pit. However, an ecosite applies to an entire stand. Ecosites are unique and distinct combinations of soil moisture, 'C' horizon soil texture and vegetation, as shown in the table below.

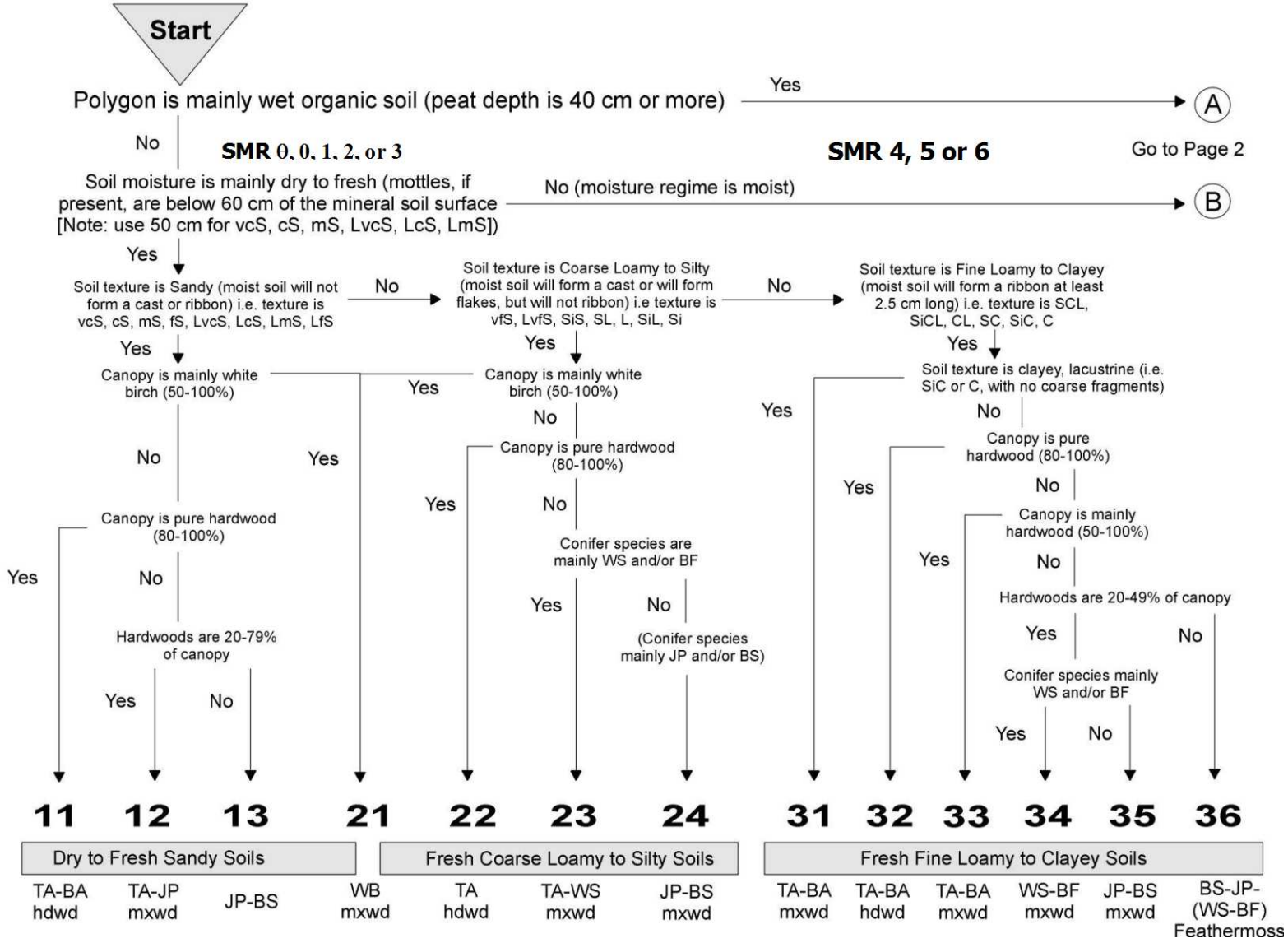
Ecosites are at the stand-level scale, while FEC V-types are at the sub-stand (100 m^2) or ecoelement scale.

Ecosite field keys are shown below.

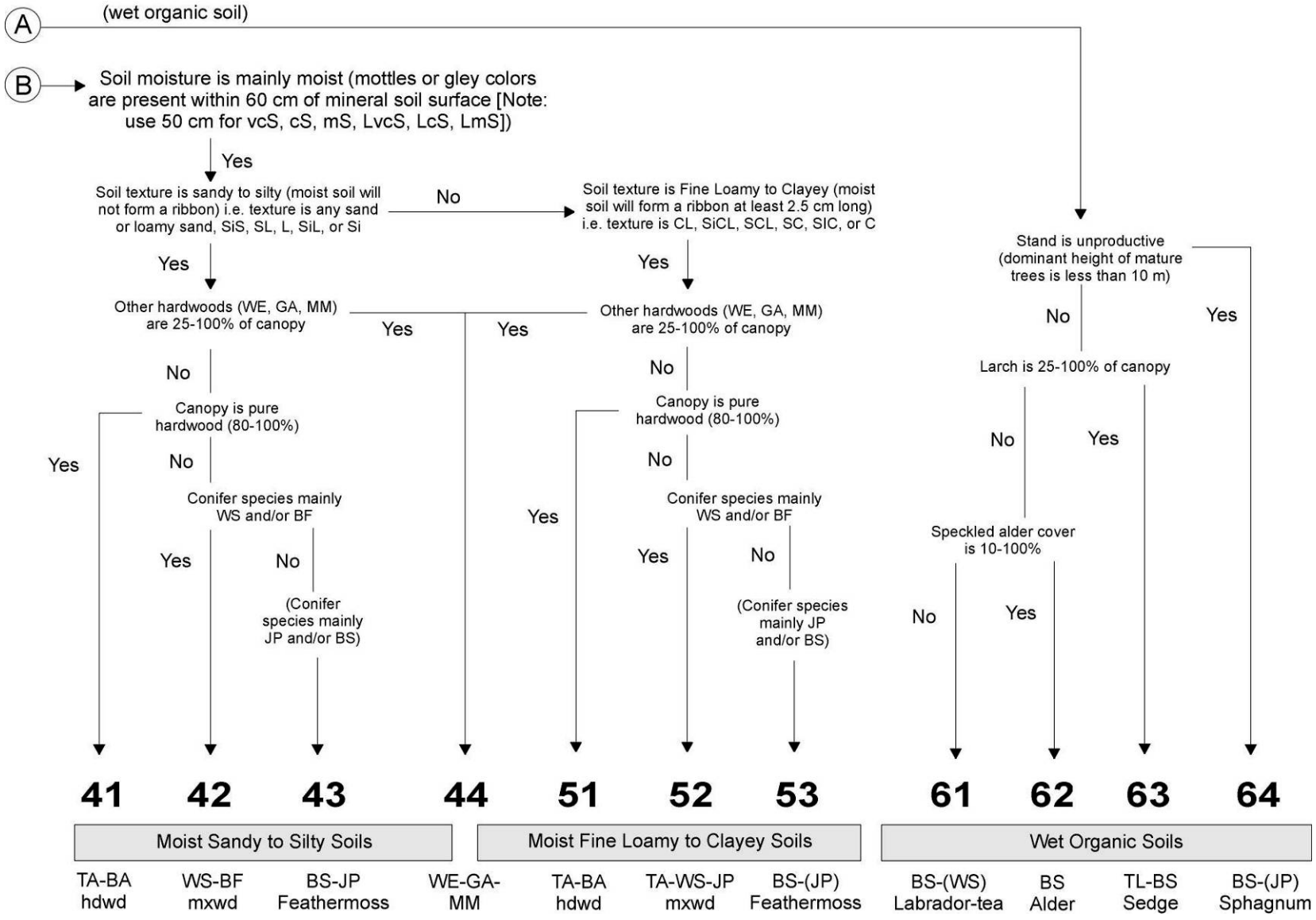
PROPOSED SCHEMATIC KEY TO PHOTO INTERPRETATION OF NON-FORESTED WETLAND ECOSITES - DUCK MOUNTAIN AREA
DRAFT - December 21, 2000



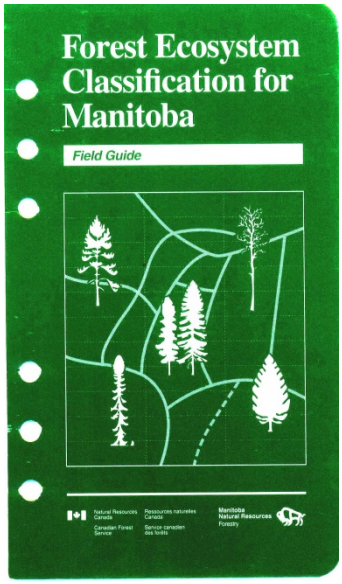
Field Key to Forested Ecosites of the Mid-Boreal Upland Ecoregion of Manitoba



Field Key to Forested Ecosites of the Mid-Boreal Upland Ecoregion of Manitoba



5.3 VEGETATION TYPE (V-TYPE)



The Manitoba Forest Ecosystem Classification (FEC) field guide was developed by Zoladeski *et al.* 1995, and is a calibration of the North Western Ontario FEC (Sims *et al.* 1990). The Manitoba FEC classifies vegetation into 33 V-types (V1, V2, V3…V33) and soils into 22 S-Types. Separate field keys are provided for classifying vegetation and for classifying soils. Average conditions of V-types and S-types are described in factsheets.

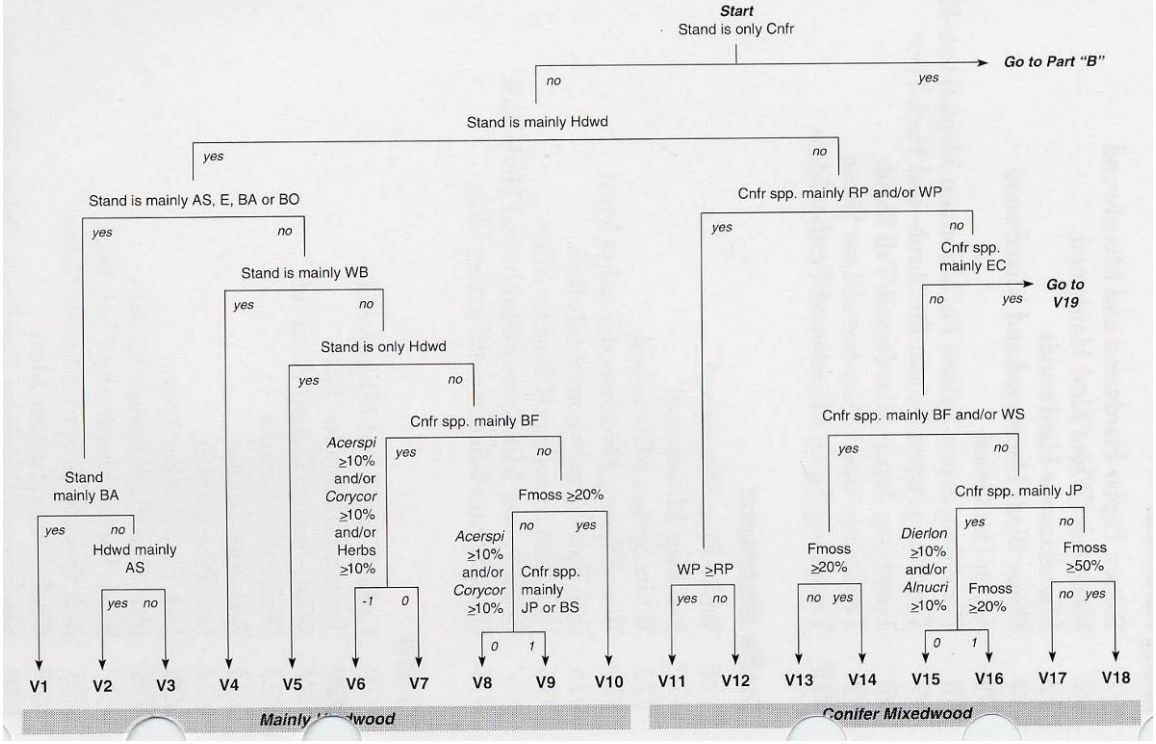
Using the overstory cover, vegetation cover and timber cruise information, determine the V-type from the FEC V-type key. To determine the correct V-type, you must look around the area, not only at the area within the 100 m^2 PHS plot. If a plot falls within a large area that cannot be classified to an FEC V-type, the code 00 should be recorded (*i.e.* opening, beaver flood). A V-type of 00 would have nothing recorded in the timber cruise for that plot.

	Hardwood and hardwood mixedwood V-types		***Conifer V-types***
V1	BA hardwood and mixedwood	**V19**	cedar conifer and mixedwood
V2	black ash (WE) hardwood	**V20**	TL / lab tea
V3	misc hardwoods	**V21**	WS/BF shrub
V4	WB hardwood and mixedwood	**V22**	WP conifer
V5	TA hardwood	**V23**	RP conifer
V6	TA-BF mountain maple/herb-rich	**V24**	JP conifer
V7	TA-BF shrub and herb-poor	**V25**	JP / Feather moss
V8	TA mixedwood / tall shrub	**V26**	JP-BS / lichen
V9	TA mixedwood / low shrub	**V27**	BS shrub & herb-poor
V10	TA mixedwood / Feather moss	**V28**	JP-BS / Feather moss
	Conifer Mixedwood V-types	**V29**	BS / Feather moss
V11	WP mixedwood	**V30**	BS / lab tea / Feather moss (Sphagnum)
V12	RP mixedwood	**V31**	BS / herb-rich / Sphagnum (Fmoss)
V13	WS mixedwood	**V32**	BS / herb-poor / Sphagnum (Fmoss)
V14	WS mixedwood / Feather moss	**V33**	BS / Sphagnum
V15	JP mixedwood / shrub-rich		
V16	JP mixedwood / shrub & herb-rich		
V17	BS mixedwood / shrub & herb-rich		
V18	BS mixedwood / Feather moss		

shaded V-types do not occur or rarely occur in the Mountain Forest Section

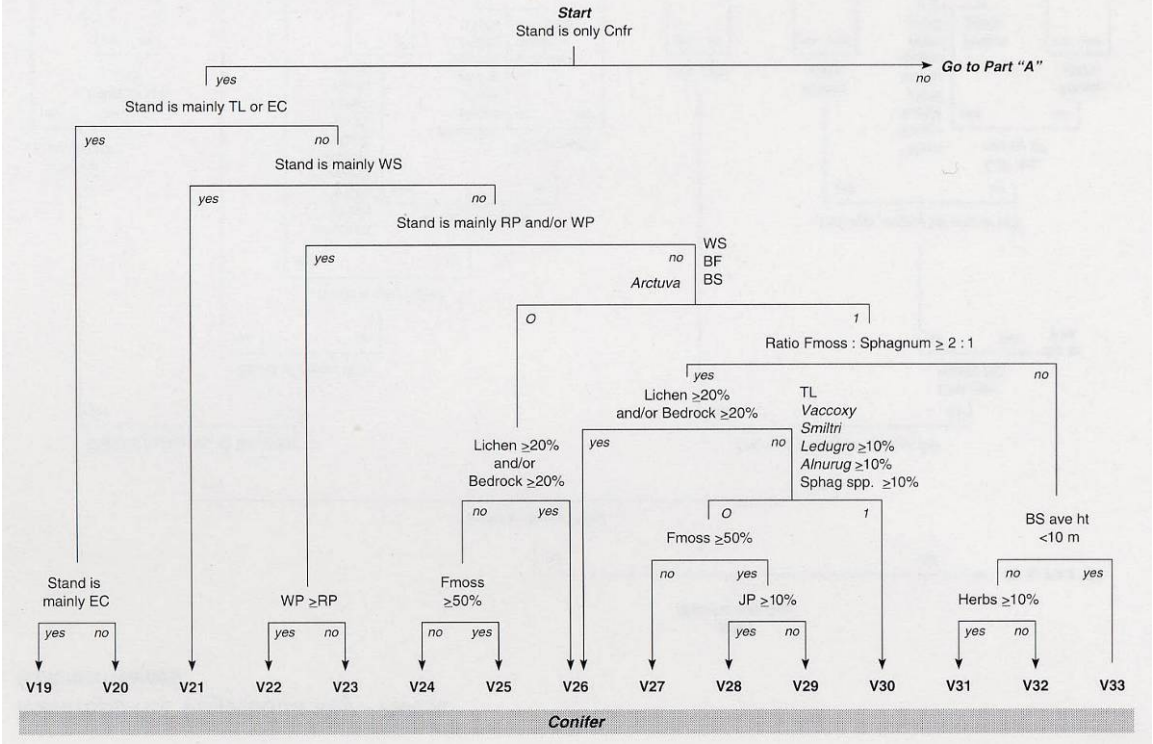
Manitoba FEC Vegetation Key - Part A

(Scientific Names of Understory Species)



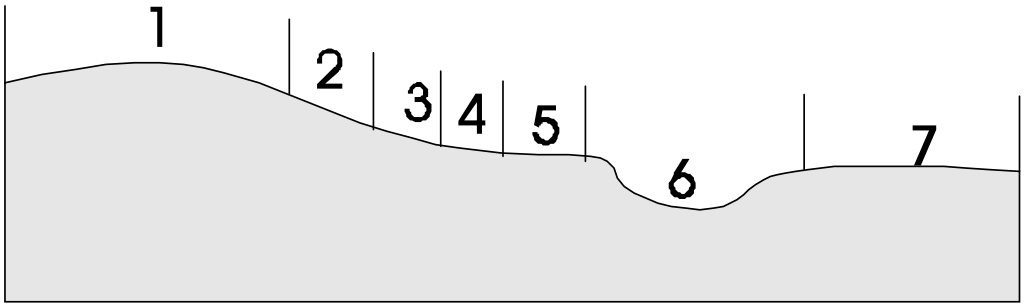
Manitoba FEC Vegetation Key - Part B

(Scientific Names of Understory Species)



5.4 SITE POSITION

Site position is to be recorded at each plot and is determined using the following table:



	1 **Crest**	2 **Upper slope**	3 **Middle slope**	4 **Lower slope**	5 **Toe**	6 **Depression**	7 **Level**
Description	The upper most portion of a slope, shape usually convex in all directions with no distinct aspect.	The upper portion of the slope immediately below the crest, slope shape usually convex with a specific aspect.	The area of the slope between the upper slope and the lower slope, where the slope is usually straight with a specific aspect.	The lower portion of the slope immediately above the toe, slope shape usually concave with a specific aspect.	The lower most portion of the slope immediately below and adjacent to the lower slope, slope shape concave grading rapidly to level with no distinct aspect.	Any area that is concave in all directions, usually at the toe of a slope or within level topography.	Any level area excluding toe slopes, generally horizontal with no distinct aspect.

5.5 OVERSTORY COVER (CC)

Dropped in spring 2009

5.6 SHRUBS COVER

Within the 100 m^2 circular plot (5.64 m radius), determine the top three (3) **shrub** species present (by abundance). Record the species code and the percent cover in the Comp (competitor) column. If there is no competitor shrub, leave the Comp column blank.

The six shrub species considered to be competitors are:

36 - Willows (any);

38 – Mountain Maple;

40 - Alder (speckled);

43 - Beaked Hazel;

52 - Prickly Rose; and

54 – Raspberry.

Beaked Hazel, mountain maple and willow are both competitor and indicator species.

SHRUBS - Competitor

36 – willows;

38 – Mtn. maple; **40** – speckled alder

43 – beaked hazel;

52 – prickly rose

54 - raspberry;

In order of abundance, list competitor shrub species in the Spp B and Spp C columns and their percent cover in order of abundance.

SHRUBS - Sorted by common name (ascending). Competitor species are shaded in yellow.

SHRUBS		
COMMON Name	**CODE**	**LATIN binomial name**
Alder (Green)	**39**	*Alnus viridus ssp. Crispa*
Alder (Speckled)	**40**	*Alnus incana ssp Rugosa*
Alder-leaved Buckthorn	**10**	*Rhamnus alnifolie*
Beaked Hazelnut	**43**	*Corylus cornuta*
Bearberry (Kinnikinnick)	**41**	*Actostaphylos uva-ursi*
Blueberry	**56**	*Vaccinium sp.*
Bog-laurel	**46**	*Kalmia polifolia*
Bog (mountain) Cranberry	**59**	*Vaccinium vitis-ideas*
Buffalo berry	**21**	*Shepherdia canadensis*
Cherry (Choke)	**35**	*Prunus pensylvanica*
Cherry (Pin)	**49**	*Prunus virginiana*
Cloudberry	**53**	*Rhubus chamaemorus*
Creeping Snowberry	**45**	*Gaultheria hispidula*
Currant (Bristly Black)	**19**	*Ribes lacustre*
Currant (Skunk)	**50**	*Ribes glandulosum*
Currant (Wild Red)	**51**	*Ribes triste*
Dogwood (Red Osier)	**33**	*Cornus stolonifera*
Dwarf Birch	**37**	*Betula pumila*
Dwarf Raspberry	**55**	*Rubus pubescens*
Gooseberry (Northern)	**13**	*Ribes oxyacanthoides*
Honeysuckle (Bush)	**44**	*Diervilla lonicera*
Honeysuckle (Fly)	**1**	*Lonicera villosa*
Honeysuckle (Twining Red)	**3**	*Lonicera dioica*

SHRUBS (continued)		
COMMON Name	**CODE**	**LATIN binomial name**
Juniper	**23**	*Juniperus communis*
Labrador Tea	**47**	*Ledum Groenlandicum*
Leatherleaf	**42**	*Chamaedaphne calyculata*
Mooseberry (Squashberry)	**60**	*Viburnum edule*
Mountain Maple	**38**	*Acer spicatum Lam.*
Prickly Rose	**52**	*Rosa acicularis*
Prince's Pine	**24**	*Chimaphila umbellata*
Raspberry	**54**	*Rubus idaeus*
Saskatoon	**9**	*Amelanchier alnifolia*
Shrubby Cinquefoil	**20**	*Potentilla fruticosa*
Small Bog Cranberry	**58**	*Oxycoccus microcarpus*
Snowberry	**25**	*Symphoricarpus sp.*
Spreading Dogbane	**26**	*Apocynum androsaemifolium*
Twinflower	**48**	*Linnaea borealis*
Western Mountain Ash	**14**	*Sorbus scopulina*
Willow	**36**	Salix sp.

5.7 INDICATOR PLANTS

Indicator plants can be shrubs, herbs, or mosses. Some plants indicate site characteristics. For example, black spruce - feathermoss stands are drier than stands of black spruce - Sphagnum moss stands. Another example is ferns in long corridors show us that there are localized wet areas present.

Within the 100 m^2 circular plot (5.64 m radius), record the presence of up to two **indicator plant species** present (shrub, herb, moss or lichen). Leave the first column blank, species are only 2 digits for indicators.

Shrubs		
Beaked Hazel	43	*Cornus cornuta*
Bearberry	41	*Arctostaphylos uva-ursi*
Blueberry	56	*Vaccinium sp.*
Mountain Cranberry	59	*Vaccinium vitis-ideas*
Mountain Maple	38	*Acer spicatum Lam.*
Red-Osier Dogwood	33	*Cornus stolonifera*

Herbs, Grasses & Ferns		
All Ferns	18	
Dwarf Enchanter's-Nightshade	12	*Circaea alpina L.*
All Horsetails	82	*Equisetum sp.*
Bedstraw	67	*Galium sp.*
Fireweed	65	*Epilobium angustifolium*
Pink Lady's Slipper	17	*Cypripedium acaule Ait.*

Lichens & Mosses	
All Feather mosses	95
All Lichens	88
All Sphagnum	94

INDICATOR Plants



12 - Dwarf Enchanter's-Nightshade; **17** - Pink Lady's Slipper; **18** – all FERNS




33 - Red Osier Dogwood; **36** – Willows**;** **38** – Mtn. maple; **41** - bearberry;



43 – beaked hazel; **56** – blueberry; **59** – bog cranberry; **65** – fireweed


67 – bedstraws; **82** – horsetails;

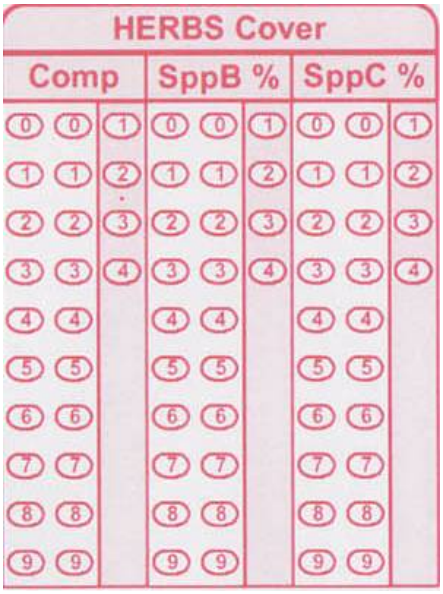
MOSSES & LICHENS – Indicator

88 – all lichens

94 – Sphagnum mosses;

95 – Feather mosses

5.8 HERBS COVER



For the HERBS Cover, only record the **competitor herb species** and its' percent cover class. If there is no competitor herb, leave the Comp column blank.

Herb competitor species are:

79 - blue-joint grass (*Calamagrostis spp*);

65 – fireweed; and

32 – Canada thistle (now an invasive species!)

Herb competitor cover classes:

1 - 1% to 25% cover

2 - 26% to 50% cover

3 - 51% to 75% cover

4 - 76% to 100% cover

SppB% and SppC% - dropped in spring 2009.

5.9 MOSS COVER

Dropped in spring 2009.

Note that groups of mosses are still indicator plants (Feathermoss and Sphagnum moss)

HERBS, GRAMINOIDS & FERNS - Sorted by common name (ascending). Competitor species are shaded in yellow. Note that Fireweed is both a competitor and an indicator plant.

HERBS, GRAMINOIDS & FERNS		
COMMON Name	**CODE**	**LATIN binomial name**
Bedstraw	**67**	*Galium spp.*
Bluebell (Northern)	**70**	*Mertensia paniculata*
Blue-Joint Grass	**79**	*Calamagrostis*
Bunchberry	**64**	*Cornus canadensis*
Canada Thistle	**32**	*Cirsium arvense*
Ciliolate Aster	**62**	*Asteraceae Family*
Club Moss	**2**	*Lycopodium annotinum*
Coltsfoot (Palmate)	**72**	*Petasites palmates*
Creamy Peavine	**68**	*Fabaceae family*
Dwarf Enchanter's Nightshade	**12**	*Circaea alpina*
Fairybells	**11**	*Disporum trachycarpum*
Fern (Lady)	**97**	*Athyrium filix-femina*
Fern (Ostrich)	**99**	*Matteuccia struthiopteris*
Fireweed	**65**	*Epilobium angustifolium*
Goldenrod (Canada)	**22**	*Solidago canadensis*
Ground-Cedar	**85**	*Lycopodium complanatum*
Horsetails	**82**	*Equisetum sp.*
Lily of the valley	**69**	*Maianthemum canadense*
Marsh marigold	**98**	*Caltha palustris*
Meadow Rue	**16**	*Thalictrum*
Mitrewort	**71**	*Mitella nuda*
Pyrola (Wintergreens)	**73**	*Pyrola sp.*
Rock polypody	**86**	*polypodium virginianum*

HERBS, GRAMINOIDS & FERNS (continued)		
COMMON Name	**CODE**	**LATIN binomial name**
Sarsaparilla (Wild)	**61**	*Aralia nudicaulis*
Solomon's-seal	**75**	*Smilacina trifolia*
Starflower	**77**	*Trientalis borealis Raf.*
Stinging nettle	**15**	*Urtica dioica*
Strawberry (Wild)	**66**	*Fragaria virginiana*
Sedges	**80**	*Carex sp.*
Twisted-stalk	**76**	*Streptopus rosus Michx.*
Violets	**78**	*Viola sp.*
LICHENS & MOSSES		
Lichens	**88**	*Cladina*
Broom Mosses	**90**	*Dicranum*
Plume Moss	**93**	*Ptilium cristacastrensis*
Schrebers Moss	**92**	*Pleurozium schreberi*
Stair-Step Moss	**91**	*Hylocomium splendens*
Sphagnum	**94**	*Sphagnum sp.*
Feathermosses	**95**	

5.10 SOILS

Establish one soil pit per block that is representative of the majority of the block. Soil types are described in the Manitoba FEC Field Guide (Zoladeski *et al.* 1995) as well as a section on soil description.

5.10.1 Soils Horizons

HORIZONS

Thickness(cms)	⓪ ① ② ③ ④
L,F,H	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

Measure depth of the LFH (*e.g.* 01, 02, 03 …40 cm). The LFH are the upper organic horizons, consisting of leaves, needles, twigs and other organic matter.

A Horizons

A1	Thickness (cms)
Ah Ae	⓪ ① ② ③ ④
AB N/A	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
A2	**Thickness (cms)**
Ah Ae	⓪ ① ② ③ ④
AB	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

Classify the 'A' soil horizon(s) as either:

A**h** - humus;

A**e -** elluviated;

AB - transitional; or

not applicable (if there is no 'A' soil horizon)

Measure the thickness (cm) of the 'A' soil horizon.

B Horizons

B1	Thickness (cms)
Bm Bt Bf	0 1 2 3 4 5 6
BC N/A	0 1 2 3 4 5 6 7 8 9
Modifier	g j k

Classify the ‘B’ soil horizon(s) as either:

B**m** - modified,

B**t** - clayed added

B**f** - ferrous (extra iron added)

BC – transitional zone of B & C horizons; or

not applicable (if there is no B horizon).

Add any modifiers (*i.e.* g - gleyed, k - carbonates (fizzes with acid), or j - juvenille).

Measure the thickness(es) of the ‘B’ soil horizon(s).

C Horizons

C1	Y N
Modifier	g j k x

Determine if you dug deep enough to expose a ‘C’ horizon (**Yes** or **No**).

Determine any modifiers of the ‘C’ soil horizon (if any):

C - no modifiers to the parent material

C**g** - gleyed; Cgj for gleyed (juvenile) or

C**k** - carbonates (fizzes with acid); Ckj –barely fizzes with acid

C**x** – frozen layer

Mottling

MOTTLES	Y N
Depth to Mottles (cms)	0 1 0 1 2 3 4 5 0 1 2 3 4 5 6 7 8 9
Thickness of Mottles (cms)	0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9

Determine if there is any mottling (**Yes** or **No**).

Examples of mottling in soil (photo: University of Saskatchewan)

If there is mottling and/or gleying, record the depth to mottles (cm). Also record the and thickness of the layer with mottles. If there is mottling or gley in the C horizon, ensure the C horizon is labeled as **Cg**. If there is mottling or gley in the B horizon, ensure the B horizon is labeled as **Bg**.

Examples of gley in soil (greyish-blue in colour).

5.10.2 Soils Horizons
Mineral Soil Texture

Determine the Surface Texture (0-20 cm depth) and the texture of the ‘C’ horizon .

TAKE A SOIL SAMPLE in a plastic bag and label it – LP will texture the bagged soils, and complete the remainder of the PHS soils bubble card.

Coarse Fragments

Record the presence of coarse fragments (anything > 0.2 cm in diameter), if present in substantial amounts (0 – 40 cm depth).

Coarse Fragment (class name)
Gravel (0.2 to 8 cm) 
Cobbles (8 – 25 cm) 
Stones (25 cm +) 

6. FIELD MAPPING

The ortho field map will contain the block boundaries, block number, plot numbers, and any known exceptional features. The PHS plots are always based on a 150-meter plot grid. These ortho field maps are to be used to record site-specific features such as streams, slopes, forest health problems, beaver floods, trails, etc.

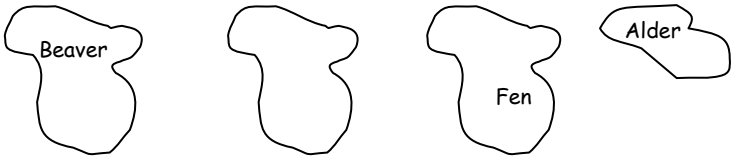
Slopes should be mapped as percentage slope only, starting at 20 % (or approx. 10 degrees). Only record slopes to the nearest 10 % (*i.e*. 20, 30, 40 up to 100%). Draw a line indicating the top of the slope, with the arrows always pointing down slope. If an area is too hummocky (small slopes everywhere) to accurately transfer the slope information from, it is acceptable to record the area on your field map as simply “Hummocky” or “Hilly”.

Wetlands should be classified and mapped as accurately as possible. All watercourses in the block and within 50 m of the block must be classified and mapped. Direction of water flow for creeks should also be indicated.

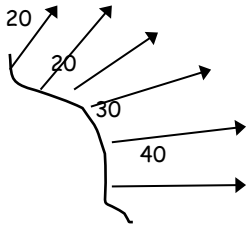
After finishing PHSing a block, the information collected on the ortho field maps should be neatly transferred onto a blank PHS grid map and filed in the block folder. Additional comments may also be written on this map.

The information recorded on the PHS field maps is extremely important, therefore, when proceeding from plot to plot, be aware of everything around you. The following is a list of typical features that must be recorded:

Wetland Features:



Slope 30%



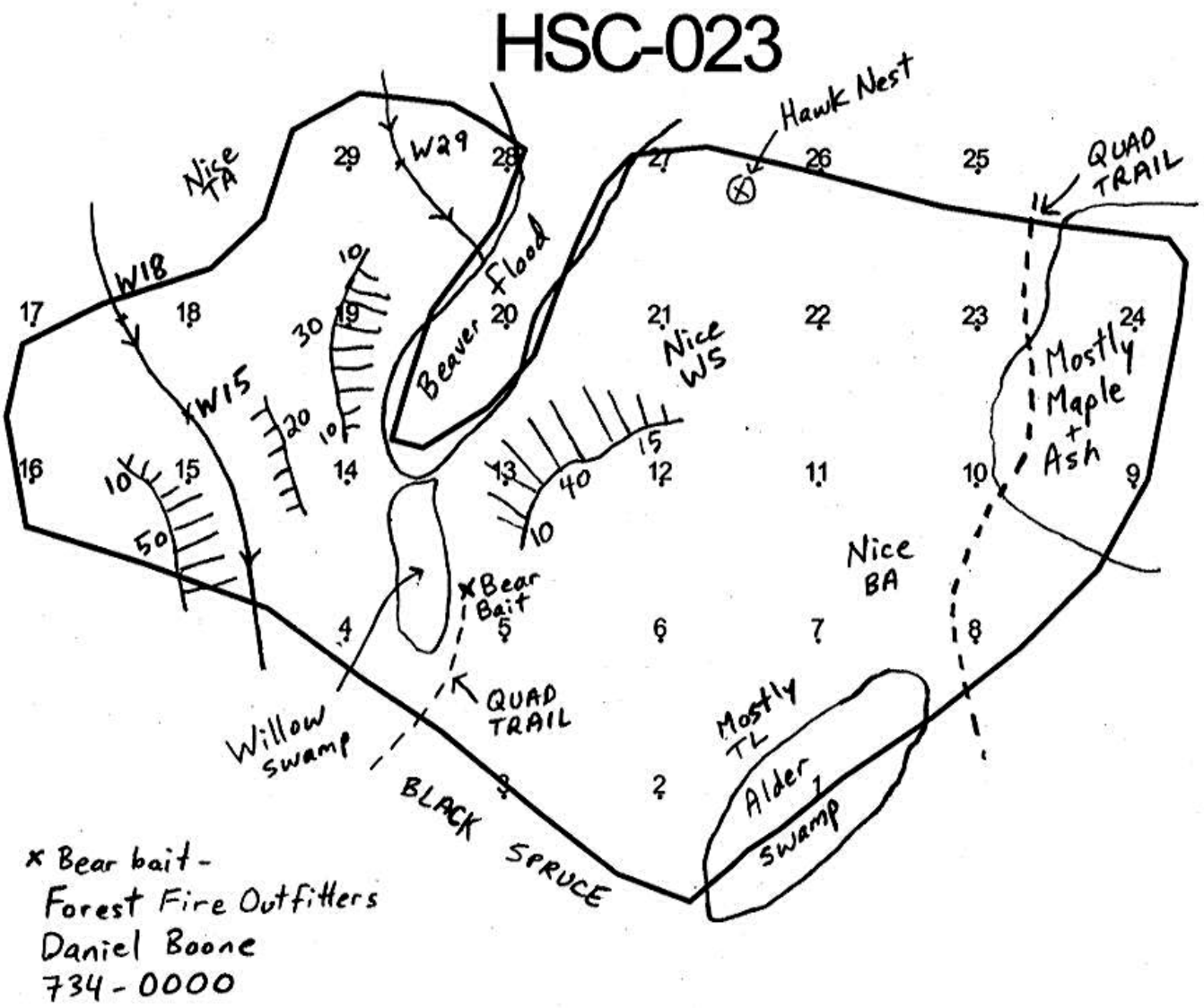
Heavy Game Trail - - - - - - - - - - GT

Stream

Existing Trail = = = = = = = E.T

Nest ⊗ Eagles Nest **Mineral Lick** ⊗ Mineral lick

Den ● **Heritage Site** †



An example of a completed field map

PHS Grid Map

1. Clean and Dry
2. Clear (no smudges), and large enough writing
3. Slopes in %
4. Entire creek with stream crossing numbers
5. Complete quad trail
6. Description of area outside block
7. Wildlife features identified
8. Non-merchantable areas within block identified
9. Forest health concerns identified

7. POST-FIELD PROCEDURES

7.1 DAY'S END

Field crews at the end of each day:

- Ensure all PHS information is complete:
  - All bubbles on tally cards are filled in correctly.
  - All information is transferred onto one neat PHS grid map.
- File all PHS data in the "Completed Blocks" area of the PHS file cabinet and check "PHS done" for the block on the PHS block tracking chart.
- Prepare for the following day.
- Ensure field equipment is placed out to dry (*i.e.* Increment borer, FEC book).

The scanning software (Cruiser) will detect errors on the bubble cards such as an uncolored bubble or an unacceptable value. If any errors are identified, they will have to be corrected. This process can sometimes become time consuming and hold things up; therefore it cannot be stressed enough how important it is to have clean, clear, concise and complete data!

7.2 END OF SHIFT

Field crews at the end of each shift or operating area:

- Must meet with the appropriate planner to discuss the previous shift or operating area. This discussion will include passing on as much information regarding the cut blocks as possible such as any exceptional features, access, timber volume, harvest season, or renewal concerns etc.

Note: LP's PHS data provides the planning team with a great deal of information, however, a verbal exchange between the planner and the field crews can be equally as beneficial as the tallied data.

7.3 PHS SUPERVISOR

- Review the current shifts submitted PHS data.
- Double check the "PHS done" box on the PHS block tracking chart.
- Scan PHS bubble cards and field maps regularly.

- Using the CRUISER program, fix any remaining errors in the data and load data into the database.
- Inform area planner of any exceptional features to be digitized into the appropriate GIS theme.
- Produce a forest health report for the most recently completed blocks and submit to MB Conservation Forestry branch in Winnipeg.
- Prepare for and accomplish check cruising of completed blocks.

8. CHECK CRUISE/AUDIT PROCEDURE

All aspects of the PHS must be collected in a consistent and accurate manner. As with most survey programs a check will be done of all cruisers to ensure the data is being collected properly without individual bias.

Ten percent of proposed cutblocks will be randomly chosen for check cruising. A minimum of two (2) plots per cutblock will be checked. However, the actual number of check plots within the randomly selected cutblock will be dependent upon the accuracy. For example, fewer plots will be checked of a surveyor who consistently scores well on the check survey. More plots will be checked if a surveyor is scoring low, in order to help correct problems before a great deal of data is collected improperly.

Each aspect of the survey will be checked including:

Compassing

- plot must be established within 10 meters of exact location

Ecosystem Summary

- V-type must be correct
- Shrub, Herb and Moss species identification must be correct
- Indicator species must be recorded and correct

Soil Classification

- There must be a soil pit dug in each V-type encountered, excluding small slivers or 'fingers' of different forest type
- LFH Thickness must be within $\pm$1 cm

Veg and Wildlife

- Understory species and height class must be correct.
- Understory count must be within one tree if under 10 trees, or reasonable if over 10 trees
- Snag class and DBH class must be correct

- Snag count must be within one tree if under 10 trees, or reasonable if over 10 trees
- Wildlife Group, Species, Activity and Use must be reasonable
- DWM class and cover must be within one class
- Watercourses measurements must be reasonable

Timber Cruise

- Tree species identification must be correct
- DBH classes must be reasonable
- Heights and Ages must be ±10%
- Prism sweep count of 'in' trees must be within one tree. However, if the prism sweep has more than 10 trees, the count of 'in' trees must be within two trees.
- Obvious forest health concerns must have been recorded on bubble cards and field map

Field Map

- Exceptional features mapped
- All Features must be mapped within 25 meters of actual location
- Slopes must be within 10%

9. REFERENCES

Alberta Land and Forest Service. 1997. **Permanent Sample Plot Field Procedures Manual**.

BC Ministry of Forests. **PHSP Manual**. Pre-harvest Silviculture Prescription Course. BC Continuing Studies Network.

Halfpenny J., and Biesiot E. 1986. **A field guide to animal tracking in North America.** Johnson Pub. Company.

Louisiana-Pacific Canada Ltd. 1995. **Ten Year Forest Management Plan 1996-2006.** Sec 9.

Louisiana-Pacific Canada Ltd. 1998. **LP Stream Assessment Manual 1998.** 22 pp.

Lutterding, H.A., Demarchi, D.A., Lea D.C., Meidinger D.V., and T. Vold. 1990. **Describing ecosystems in the field**. British Columbia Ministry of Envirionment, Lands and Parks and Ministry of Forests. Victoria, BC. MOE Manual 11.

Manitoba Conservation Forestry Branch, Forest Health and Ecology, January 2000. **Forest Health Requirements for the Pre-Harvest Assessment Guidelines**.

Manitoba Natural Resources, Conservation Data Center. 1999. **Biodiversity Database, Plant Species Information.**

Ontario Ministry of Natural Resources. **An Approach to Pre-harvest Silviculture Prescriptions in Boreal Ontario**.

READING AND TECHNICAL SUPPORT DOCUMENTS

Carmean, W.H. 1993. **Soil Properties and Soil Formation**. Ontario Advanced Forestry Program. Lakehead University.

Johnson, D. and et. al. CFS. 1995. **Plants of the Western Boreal Forest and Aspen Parkland**. 392 pp.

Natural Resources Canada, CFS**.** 1995. **Forest Ecosystem Classification for Manitoba: Field Guide**. Edmonton. AB. Spec. Rep. 2. 205 pp.

Ontario Institute of Pedology. **Field Manual for Describing Soils**,

Harvesting & Roads Monitoring/Inspection Form

Part 1 General Information (must be completed)	Part 2 Specific Information Section 1 Status of Operations						
Date:	Status	Road Construction	Falling	Skidding	Processing	Hauling	Deactivation
Block:	Active						
Contractor Name:	Complete						

Section 2 Requirements								
	AP#			AP#			AP#
HARVESTING COMPLIANCE								
STRAYS			BUTTING			RUTTING \ COMPACTION	
TOP DIAMETER			STUMP HEIGHTS			WORK PERMIT CONDITIONS	
TOPPING \ LIMBING AT STUMP			SLASHER UTILIZATION			WITHIN BOUNDARY	
LIMB PILES SPREAD			LOG QUALITY			OTHER	
PLAN REQUIREMENTS								
UNDERSTOREY PROTECTION			INBLOCK DRAINS			OPERATOR KNOWLEDGE	
WILDLIFE TREES			SPECIAL REQUIREMENTS			OTHER	
ROADS								
ROW WIDTH			CUT/FILL SLOPES			ROAD CLOSURES	
MERCHANTABLE TREES UTILIZED			EROSION CONTROL MEASURES				
BORROW PITS			WATER CROSSINGS			OTHER	
FUEL\HAZ MATERIALS			**CAMP\GENERAL**			**SAFETY**	
HAZARDOUS MATERIALS CONTAINED			LITTER \ GARBAGE			SIGNS IN PLACE	
MINOR SPILLS ADDRESSED			GREY WATER\SEWAGE			PPE, FIRST AID, EPRP	
SPILL KITS AS REQUIRED			SUPERVISION ON SITE			FIRE EQUIPMENT	

Part 3 – Action Plans / Comments / Instructions

AP #	Action	Who	Due Date

Company Signature:	Contractor Signature:

Operations Supervisor:_____ Area Forest Manager: _____

SWAN VALLEY FRD

WATER CROSSING CHECKLIST

SV-SOP-Form-06
Rev. 09-Mar-30

Crossing ID	Date:	Inspector/Supervisor(s):

Maintenance ☐	Culvert ☐	Pictures Across _____	Road Status: Open ☐ Closed ☐
Monitoring ☐	Snow & Ice ☐	Up _____	Action Required ☐
Supplement ☐	Bridge ☐	Down _____	Risk Ranking: Low ☐ Medium ☐ High ☐

Permanent Stream ☐ Seasonal Stream ☐ Swale/ Drain ☐ Beaver Flood ☐ Natural Spring ☐ Runoff ☐

Culverts

Culvert Length: (m)	Culvert Diameter: (mm)	ROW Slope Ratio:

Problems							
Barrel Damage	☐	Not vegetated	☐	Culvert Size: Length	☐	Other User Damage	☐
Barrel Corrosion	☐	Perched/Scouring	☐	Culvert Size: Diameter	☐	Freezing/Flooding	☐
Poor Flow Alignment	☐	Erosion/Sediment	☐	Fish Passage Restricted	☐		
Barrel Blockage	☐	Beaver Damage	☐	ATV Damage	☐		

Bridges

Type of Bridge:	Rail Car ☐	Portable ☐	Span (ft):

Problems							
Fill Containment	☐	Bridge/Cribbing Stability	☐	ATV Damage	☐	Other User Damage	☐
Erosion/Sediment	☐	Signage	☐	Beaver Damage	☐	Freezing/Flooding	☐

Snow and Ice Crossings

Problems							
Freezing/Flooding	☐	Beaver Damage	☐	Dirt and/or debris	☐	ATV Damage	☐
Other User Damage	☐	Erosion/Sediment	☐				

Erosion Control Measures Used

ROW Sloping	☐	Rip Rap	☐	Seeding	☐
Blankets	☐	Settling Ponds	☐	Wing Walls	☐
Slash	☐	Straw	☐	Cross Drains	☐

Comments

	2018-2019 Road Construction, Closures, and Decomissioning						
		as of July 31, 2019					
FMU	**LP or Quota Holder**	**Season of Use**	**Existing Roads (km)**	**New Roads (km)**	**Total Length (km)**	**Temporary Closure (km)**	**Decomissioned (km)**
11	LP	Dry/Frozen	2.2		2.2	1.9	
		Frozen					
		In-block		2.6	2.6	2.0	
		Designated Route					
	QH	Dry/Frozen					
		Frozen	2.8	0.5	3.2	2.8	0.5
		In-block		9.0	9.0		9.0
		Designated Route	2.5		2.5		
		FMU 11 Total	**7.5**	**12.1**	**19.6**	**6.6**	**9.5**
13	LP	Dry/Frozen	39.0	6.6	45.6	40.5	
		Frozen	11.9	3.6	15.5	14.9	0.6
		In-block	3.1	46.7	49.8	12.4	37.4
		Designated Route	26.8		26.8		
	QH	Dry/Frozen	23.6	3.9	27.5	25.2	1.5
		Frozen	31.1	12.1	43.1	38.3	4.8
		In-block	3.9	45.2	49.1	2.5	46.6
		Designated Route	29.6		29.6		
		FMU 13 Total	**169.0**	**118.0**	**287.0**	**133.7**	**90.9**
		FML 3 TOTALS	**176.5**	**130.1**	**306.6**	**140.4**	**100.4**

Bureau Veritas Certification
North America, Inc.
SFI Fiber Sourcing Audit Report

16800 Greenspoint Park Dr. Suite 300 S
Houston, TX 77060
Phone (281) 986-1300: Toll Free (800) 937-9311

Company Name	Louisiana Pacific Corp.
Contact Person	Doug Rodman
Address	414 Union Street, Suite 2000 Nashville, TN 37219-1765
Phone / Fax	Tel-615-986-5751/ Fax-866-726-6982
PQC Code	E01E
Contract Number	US.1966165

Certification Audit:		Re-Certification Audit:		Surveillance Audit:	3	Scope extension audit:	

Audit Summary

Introduction

A surveillance audit of Louisiana Pacific Corporation's (LP) wood procurement program was conducted from July until November 2018, at locations across the continent. Brian Callaghan RPF EP(EMSLA) lead the audit and was assisted by Paul Chenard. Mr. Callaghan is a registered professional forester and certified environmental auditor with 30 years of experience in forest planning, operations and analysis.

Audit Scope, Objectives and Process

The scope of the audit was "Fiber Sourcing activities for company mills in Canada and the United States". The objective was to verify the effectiveness and conformance of Louisiana Pacific's wood procurement activities to the requirements of the SFI 2015-2015 Standard and Rules. The audit consisted of a thorough review of documents and a review of the implementation of policies, programs and plans in the field. Prior to the audit, the auditor selected field sites to be sampled at each location based on all management operations and activities conducted over the past 12 months.

Audit Plan

An audit plan was prepared which covered the fiber sourcing audit as well as the forest management audit and chain of custody audits which occurred at the same time. The audit plan covered site audits at the Jasper Texas, Carthage Texas, Swan River Manitoba and East River Nova Scotia along with a visit to headquarters in Nashville. The audit plan was provided to the client prior to the start of the audit. The audit plan identified the various activities which would be carried out at each Company facilities. A copy of the audit plan is on file at the Bureau Veritas Certification office in Houston Texas.

Six of the ten SFI Objectives (2, 3, 4, 5, 9 and 10) including all of their Performance Measures and Indicators were verified through a review of documents and field verification of sites to meet the intent of the SFI 2015-2019 Standard. The Louisiana Pacific Corporation Forest Management System Handbook, office documents, records, field files and interviews were used to verify conformance. A debriefing was conducted at the end of the day by the lead auditor.

Company Information

Louisiana Pacific Corporation is a leading manufacturer of high quality building products. LP Building Products manufactures LP Solid Start Engineered Wood Products such as Laminated Strand Lumber (LSL), Laminated Veneer Lumber (LVL), Oriented Strand Board (OSB), Siding, I-Joists and Rim Board. Products are used primarily in new construction, repair and remodeling, and manufactured housing. LP operates production facilities in the U.S., Canada and South America.

Multi-Site Requirements

Louisiana Pacific Corporation maintains a multi-site certification consisting of headquarters and 18 facilities throughout the U.S. and Canada which are certified to the SFI fiber sourcing standard. Headquarters for all management systems is in Nashville, Tennessee. The company qualifies as a multi-site certification since the management system is controlled and directed by the central office. There is one set of procedures that applies to the entire system, and the SFI manager is the sole person responsible for maintaining the procedures. Individual sites are responsible for conforming to the company's SFI program, and for providing corrective actions to the SFI manager when necessary. The company has a reliable internal audit program and monitoring system carried out at headquarters to determine conformance at facilities or sites and to implement corrective actions when appropriate. There is good coordination and communication between the central office and each site. Internal audits were conducted at all sites within the last year and a management review was conducted on June 6, 2018. Louisiana Pacific Corporation meets all multi-site requirements.

Sites covered during this surveillance audit were selected based on a randomized schedule developed by Bureau Veritas Certification at the time of contract renewal. Five sites were audited this year for SFI Fiber Sourcing; the Jasper Texas, Carthage Texas, Swan River Manitoba, East River Nova Scotia, and Minwaki Quebec. The Nashville, TN headquarters office is audited annually.

Multi-Site	✓	Group Certification	

Sites	Sites Audited During this Event
Nashville (Central Office)	✓
Hanceville - OSB	
Jasper - OSB	✓
Roxboro - OSB	
Two Harbors - Siding	
Peace Valley - OSB	
Carthage - OSB	✓
Hayward - Siding	
Newberry - Siding	
Sagola - OSB	
Dawson Creek - OSB	
Swan River - Siding	✓
Maniwaki - OSB	✓
Clark County - OSB	
Houlton - EWP	
Roaring River - Siding	
Tomahawk - Siding	
Golden - EWP	
East River - Siding	✓

Audit Results

During the field portion of the fiber sourcing audit, a total of 18 field sites were reviewed for BMP monitoring and compliance. The majority of the sites inspected (16) were gatewood sales and two sites were stumpage sales. All operations/activities were found to be in compliance with all regulations and BMP's.

Louisiana Pacific Corporation's fiber sourcing system does a very good job of documenting BMP compliance on their wood suppliers. The Wood Supply On-Site Visit Report is well developed and documents findings of Best Management Practices (BMP) compliance and forest management activities. Site visit reports from all fiber sourcing facilities are collected and summarized annually at headquarters to provide insight on any compliance issues or areas of concern. Louisiana Pacific provides communication packets to all suppliers and maintains records of contractor training. Documentation was found to be consistent between mills and in conformance with the standard.

Objective 1-Biodiversity in Fiber Sourcing:

This objective was not directly audited during this year's surveillance audit. However in Swan River the auditor visited two harvest sites within Duck Mountain Provincial Park in Saskatchewan. Louisiana Pacific has purchased stumpage contract in the park as part of an effort to increase the amount of early successional forest within the park (Figure 1). This contract has the Company undertaking large clear cuts in a provincial park which could be considered a risk activity.

Figure 1. Recent harvest in Duck Mountain Provincial Park creating early successional forests.

Objective 2-Adherence to Best Management Practices:

Louisiana Pacific monitors the sites where it obtains timber to ensure that they are in compliance with

Best Management Practices and local regulations. In order to deliver fibre to a Louisiana Pacific mill each supplier signs a timber purchase agreement which specifies training requirements and adherence to BMPs. Each supplier signs an agreement that that includes BMP requirements. LP's Timber Products Purchase Agreement (TPPAs) and supplements include the requirement for use of BMPs, trained loggers, and required signage from the supplier.

A wide variety of harvest sites were visited on the audit including aspen clear cuts, pine plantations, spruce and fir clear cuts. All harvests were well executed with no apparent BMP issues (Figure 1).

Wood procurement staff at each mill plan wood supply deliveries around seasonal weather constraints by stockpiling wood in winter when everything is frozen. Most mills have both off-site and on-site storage

Objective 3-Use of Qualified Resource and Qualified Logging Professionals:

Louisiana Pacific requires that all loggers be trained to the standard of the applicable Implementation Committee. Training includes the application of best management practices to protect soil and water quality, knowledge of species at risk and rare/threatened/endangered species, safety, and environmental protection. All suppliers must sign a Timber Products Purchase Agreement which requires loggers to be trained. All loggers interviewed were fully trained.

Objective 4-Legal and Regulatory Compliance:

Company staff have access to all relevant laws and regulations through an electronic service which maintains access and provides updates when laws or regulations change. Each location has a SFI Handbook which contains a complete list of regulations that apply to their operations with website listings. Relevant laws and regulations are stated in all contracts and purchase agreements. Any issues with operations that arise are documented in Report of Corrective Action. LP utilizes site visits and follows BMP Procedures to ensure compliance. These visits and checklists note compliance with laws and regulations.

Louisiana Pacific is a responsible employer and business venture. They employ a Code of Business Conduct to guide all their relationships. The Company provides a full range of benefits and rights to its employees. It contracts responsible suppliers to provide service and complies with all labor laws.

Objective 5-Forestry Research, Science and Technology:

Louisiana Pacific is a member of NCASI which conducts research on forest health, water quality, wildlife habitat, climate change, etc. NCASI recently assembled information on Climate Change and prepared a presentation that was made available to LP personnel. Louisiana Pacific is working with a number of cooperators on a project to identify the NRV – Natural Range of Variation at the landscape scale, and how to incorporate this information into their upcoming forest management plan.

Objective 6-Training and Education:

Not Audited

Objective 7-Community Involvement and Landowner Outreach:

Not Audited

Objective 8-Public Land Management Responsibilities:

Not Audited

Objective 9-Communications and Public Reporting:

The 2017 Louisiana Pacific SFI Audit Report is posted on the SFI Website. All records necessary for reporting to SFI are maintained electronically and were reviewed as part of this audit. The 2017 SFI Annual Progress Report was submitted to SFI, Inc. prior to the deadline.

Objective 10-Management Review:

The internal audit and management review system is mature, fully functioning and effective. LP has a well-documented procedure for collecting information, conducting an internal audit and reporting results of all monitoring to management. An internal audit is conducted annually at each facility. A checklist is completed listing evidence for each indicator in the standard. Where necessary non-conformances are issued when standard requirements are not met. A corrective action procedure is followed to remedy any non-conformances. A management review meeting is conducted annually where monitoring results are presented and discussed.

Objective 11-Promote Conservation of Biological Diversity, Biodiversity Hotspots and High-Conservation Wilderness Areas:

Not Applicable. All wood sourced in Canada and the United States of America

Objective 12-Avoidance of Controversial Sources including Illegal Logging:

Not Applicable. All wood sourced in Canada and the United States of America

Objective 13-Avoidance of Controversial Sources including Fiber Sourced from Areas without Effective Social Laws:

Not Applicable. All wood sourced in Canada and the United States of America

Findings

Previous non-conformances: *None.*

Non-conformances: *None*

Opportunities for Improvement: *None*

Notable Practices:

1) Louisiana Pacific's collaboration with Saskatchewan Parks to undertake landscape scale harvesting in Duck Mountain Provincial Park to increase early succession habitats. This partnership is working to improve landscape diversity in the Duck Mountains. (1.1 1)

Logo/label use:
Louisiana Pacific users the SFI Trademark for promotional purposes. They seek approval from SFI Inc. before using the trademark. They do not use the Bureau Veritas trademark at this point.

SFI reporting:
During this audit verification of the SFI website was consulted on September 20th to ensure that the

previous audit report was submitted and posted.

Conclusions

A closing meeting was held November 14th in the Company's corporate offices in Nashville. The lead auditor chaired the meeting and provided findings from all sites audited. The audit team found that Louisiana Pacific operates a sophisticated information system which can capture, track and store all the information requirements of the standard. The auditor recommended continued certification to the 2015-2019 SFI Fiber Sourcing standard is recommended.

SEE SF61 FOR AUDIT NOTES

Summary of Audit Findings:												
Audit Date(s):	From: July 16, 2018							To: November 14, 2018				
Number of SF02's Raised:				Major:				Minor:				
Is a follow up visit required:		Yes		No	X	Date(s) of follow up visit:						
Follow-up visit remarks:												
Team Leader Recommendation:												
Corrective Action Plan(s) Accepted		Yes		No		N/A	X	Date:				
Proceed to/Continue Certification		Yes	X	No		N/A		Date:	Nov. 14 2018			
All NCR's Closed		Yes		No		N/A	X	Date:				
Standard audit conducted against:												
1)	SFI 2015-2018 Fiber Sourcing		3)									
2)			4)									
Team Leader (1):		Team Members (2,3,4…)										
Brian Callaghan RPF		2) Paul Chenard										
		3)										
		4)										
		5)										
Scope of Supply: (scope statement must be verified and appear in the space below)												
Forest management activities on all company held and managed crown licenses in Canada, and the procurement of logs, pulpwood and other wood fiber in the United States and Canada using both stumpage and gatewood systems.												
Accreditation's	ANAB											
Number of Certificates	1											
Proposed Date for Next Audit Event												
Date	Summer/Fall 2019											
Audit Report Distribution												
Liliana Ramirez - liliana.ramirez@us.bureauveritas.com												
Doug Rodman – doug.rodman@lpcorp.com												

Clause	Audit Report
Opening Meeting	Participants: Paul LeBlanc, Ted Unrau, Todd Yakielashek, Keith Proctor Discussions: ➢ Introductions ➢ Scope of the audit ➢ Audit schedule/plan ➢ Nonconformance types – Major / Minor ➢ Review of previous nonconformances - 0. ➢ Process approach to auditing and audit sampling ➢ Confidentiality agreement ➢ Termination of the audit ➢ Appeals process ➢ Closing meeting timing
Closing Meeting	Participants: Doug Rodman, Matt Matwijec, Donna Kopeky, Dan Toivenan Discussions: ➢ Introductions and appreciation for selecting Bureau Veritas Certification. ➢ Review of audit process - process approach and sampling. ➢ Review of OFIs and System Strengths ➢ Nonconformances - 0 ➢ Date for next audit. ➢ Reporting protocol and timing

	SF02/NA NONCONFORMITY REPORT

Company Name and Site:			SF02#:
Contract #:	Type of audit (e.g., initial, surveillance):		Team Leader:
Date:	Standard and Clause #:		Team Member:
Major / Minor	Other Documents (if applicable):		Company Representative:

REQUIREMENT OF AUDITED STANDARD:
OBSERVED NONCONFORMITY:

ROOT CAUSE ANALYSIS AND CORRECTIVE ACTION PLAN (To be completed by the Company. Plan to be submitted in 30 days)			
Corrective Action Plan Date:		Company Representative:	
Root Cause Analysis and Corrective Action			
Root Cause: Corrective Action Plan:			

ROOT CAUSE AND CORRECTIVE ACTION PLAN ACCEPTANCE REPORT (To be completed by Bureau Veritas Certification – Verify effective identification of Root Cause and acceptance of Corrective Action Plan)						
Root Cause: Corrective Action Plan:						
Plan Accepted:	Yes		No		Comments:	
Auditor:					Date:	

CORRECTIVE ACTION IMPLEMENTATION To be completed by Company – Provide objective evidence. Not to exceed: 90 Days ☐ 1 Year ☐			
Corrective Action Completion Date:		Company Representative:	
Corrective Action Implementation: Method used to verify effectiveness of action taken:			

CORRECTIVE ACTION IMPLEMENTATION ACCEPTANCE REPORT (To be completed by Bureau Veritas Certification – Acceptance of Corrective Action taken)									
Accepted:	Yes		No		Nonconformance Closed:	Yes		No	
Follow Up Comments:									
Auditor:					Date:				

Development of Seasonal Moose and Elk Habitat RSPF Models (V3)

Proposal for Louisiana Pacific Canada and Manitoba Wildlife Branch

Aug 19th, 2020

Contents

Project Background and Objectives

Moose and elk are important ungulate species in Manitoba. Moose are found throughout the province of Manitoba ranging south from the U.S border, north to the Nunavut Territory, including the Mountain Forest Section of Manitoba, where moose is an important ungulate species. (Manitoba Moose Fact Sheet). It is valued by almost all people, but in different ways. For example, Indigenous communities have spiritual, social, and economic connections to moose populations. Although the population is relatively stable at the Provincial level, in the Mountain Forest Sections (Duck Mountain (GHA 18-18C), Porcupine Mountain (GHA 13, 13A), Turtle Mountain (GHA 29, 29A), and GHAs 12, 14 and 14A.) a moose conservation closure has been necessary, due to a decline in moose populations. Therefore, all agencies are working to manage moose populations at levels where risk to ecological and socio-economic values are simultaneously minimized.

The Duck Mountains hosts the 2nd largest herd of Elk in Manitoba (Chranowski 2009). Considered one of Manitoba's most valued wildlife resources, this species is an integral part of the landscape for the aspen-parkland and mixed prairie-parkland habitats. Elk are valued by many and provide special enjoyment for viewing and hunting by licensed and rights-based hunters. There are*10 identified populations located in the south central third of the province, including the forest mountain areas of Riding Mountain, Duck Mountain, Porcupine Mountain, and Turtle Mountain.*

Elk populations are driven by a variety of factors, including hunting, predation, disease, and food availability. Elk is an adaptable species and can feed on a variety of herb and forb plant species, depending on their availability throughout the year. Elk habitat is principally found within the northern boreal forest, aspen parkland, bur oak savannah, grasslands, private agricultural lands, and eastern deciduous forest. Important tree species include trembling aspen *(Populus tremuloides),* balsam poplar *(Poplar balsamifera),* white birch *(Betula papyrifera),* white spruce *(Picea glauca),* black spruce *(Picea mariana),* bur oak *(Quercus macrocarpa),* balsam fir *(Abies balsamea),* jack pine *(Pinus banksiana)* and tamarack *(Larix laricana).* (Manitoba Elk Fact Sheet).

Development of seasonal resource selection probability function (RSPF) models to evaluate the importance of various habitat configurations would help in ensuring that appropriate habitat conditions are available for Moose and Elk through development of the 20-Year Forest Management Plan (2020). Although these ungulate populations are driven by multiple factors, it is important that suitable habitat is available to allow ungulate populations to fluctuate at sizes that will minimize risk of local extirpation under multiple sustainable uses. A range of factors influence ungulate habitat including environmental change, fire disturbance, herbivory, and human activity.

RSPF Development Strategy

Hierarchical hypotheses and prior knowledge: Model development will be based on evaluating model support for alternative hypotheses. For moose, initial hypotheses will be based in part on coefficients and/or variables from the General Moose Winter RSF model (Sana Zabihi-Seissan 2018 report), as this model performed the best among the 3 versions assessed in the report. For elk initial hypotheses would be based in part on variables used in the 1998 Elk HSI model and research by Chranowski (2009) and Brook (2010). Three broad research hypotheses, expressed as models, will be evaluated during model development:

1. Ecosite Model (*Ecosite Model*). This is the initial "neutral model", where it is hypothesized that independent of forest vegetation management and road effects, moose and elk habitat is sufficiently defined by the enduring ecosite features of upland and wetland ecosites that provide food, predator escape cover, thermal cover, and wetland vegetation. These ecosites are associated with a range of soil moisture and fertility conditions that affect vegetation composition that are relatively stable over time.

2. Forest vegetation management model (*Ecosite and Forest Model*). In addition to enduring ecosites, it is further hypothesized that it is necessary to understand (model) the effects of overstory composition and age-structured (which is actively managed through forest management) to sufficiently predict habitat use by moose and elk. Forest vegetation management can ensure a continuous supply of young browse in close proximity to predator escape cover. This model will include variables used by Sana Zabihi-Seissan (2018) for the moose model, and variables used by Chranowski (2009) and Brook (2010) for the elk model.

3. Road effects model. (*Ecosites, Forest, and Roads Model*). In addition to ecosite and forest management effects on habitat, it is further hypothesized that it is necessary to understand (model) both the positive and negative influences of large secondary roads and small forest roads to effectively predict moose and elk habitat use. Ungulates may avoid larger, busy secondary roads, but may either be positively associated with smaller forestry roads where active forest management is occurring, or negatively associated with smaller roads when they facilitate wildlife harvest.

Model selection will be hierarchical in nature, where the best of alternative *Ecosite Models* will be selected. Next, the best *Ecosite and Forest Model* will be selected if this improves upon on the *Ecosite Model* (i.e., delta AIC value is > 2). Finally, the best *Ecosite, Forest, and Roads Model* will be selected if this improves upon the *Forest Model*.

Estimated time – 2 days to develop and vet hypotheses for moose and elk

AIC and Model Selection (2 days): We propose to use the Akaike Information Criterion (AIC) for selection of *a priori* defined models (hypotheses). Note that selection of models using AIC is based on performance of the overall model, not assessment of p-values associated with individual variables. AIC provides a penalty for each variable included, and this helps to protect against over specification of the model. This method can evaluate whether the inclusion of additional variables representing more complex models is statistically supported and justified.

Estimated time – 2 to 3 days to assess moose and elk models using AIC

Bayesian Approach to Model Development: The RSPF models will be developed using binary Bayesian logistic regression. This approach allows the model to be initially specified using "priors" based on existing knowledge. Priors can be either exact coefficients, or simply directional coefficients that indicate that relationship with the habitat variable is expected to be positive or negative. Thus the *a priori* hypotheses of high-quality food, food & cover, etc., can be specified using existing knowledge, such as existing HSI model, or selection coefficients determined from previous studies. The Bayesian approach will also allow future refinement of the model after new data is collected (as opposed to developing a new model completely uninformed by the previous model). Similar approach used in Ontario for developing seasonal specific RSPF models for caribou (Hornseth and Rempel 2016).

Estimated time – 3 to 4 days to develop RSPF models for moose and elk

Data Sources and Seasonal Models: Two principal sources of data will be used for model development: accurate locational data of cows using GPS (and possibly VHS) collars, and winter aerial survey data where location of detected animals was recorded. The collar data is collected throughout the year, whereas the aerial survey data is collected only in the winter, as snow covered ground is required for animal detection. A winter RSF model will be developed using a combination of collar and aerial survey data, and a non-winter RSF will be developed using collar data only. Patterns of habitat use will be explored to determine if evident differences occur in habitat use among the non-winter seasons (spring, summer, and fall).

For moose we would use recently collected moose aerial survey data (2019-2020) and moose observations from the aerial transect surveys in 2010, 2012 and 2017. We would eventually include data expected for 2020-2021. Following previous model development approach, we would generate a uniform distribution of points every 600 m along the transect lines to model available points for the RSPF. For elk we would assemble data collected under the Chranowski (2009) and Brook (2010) projects into GIS layers.

Estimated time – 4 to 5 days to assemble and format data for moose and elk

Development of RSPF and Kernel Density: The collar locational data will be processed to create kernel density estimating probability of use. The kernel density estimates (KDEs) will be used to create continuous surfaces that separate high use areas (top 10% of use) from low use areas (bottom 50% of use). This categorization does not imply that data between 10% and 50% is unimportant, rather the categorization is designed to separate the highest use from the lowest use to strength model development. Alternative categorizations may be tested during model development. These surface areas will then be sampled using a point sampling routine to create a data set of selected versus non-selected habitat. Additionally, aerial survey data will be used to determine areas that have been surveyed but where no ungulates have been detected. This will help to strengthen the model's ability to detect avoided habitat (i.e., negative selection).

Estimated time – 2 days to generate KDE surfaces and randomly create point sample data sets for each of moose and elk

K-folds to Improve Model Robustness: Once the best set of model variables has been selected, then further refinement and testing of the model will be conducted using stratified K-folds approach. This approach increases the robustness of the model (i.e., ability of the model to predict habitat-use outside of the data samples used to develop the model) and allows a better assessment of confidence in model predictions. The full data set is divided multiple (K) times into a larger training data set and smaller testing data set. Model development is performed on the training data set, and then tested on the smaller testing data set using area under the ROC curve (see below). Estimated coefficients and model performance are then averaged.

Estimated time – 2 days to generate K-folds data sets for moose and elk

Overall Model Performance and ROC: The overall performance of a binary classification model, such as an RSPF that predicts high-use versus low-use habitat, can be evaluated by plotting 1- model specificity (false positive rate) versus sensitivity (true positive rate). The resulting curve is called the resource operating characteristic (ROC), and the area under the resulting curve allows us to evaluate

how successfully the model can discriminate good habitat from poor habitat. The model should have as close to 100% sensitivity (true positive rate) and 100% specificity (true negative rate) as possible.

Estimated time – 2 days to generate ROC curves for moose and elk

Model Performance and Thresholds: Management application of a binary RSPF classification model requires a threshold value that classifies continuous values of predicted use (varying from 0 to 1) into one of the two categories. For an RSPF, any value of predicted high-use above the threshold is classed as high-use, and all others as low-use. Changing the threshold will change the relative occurrence of false-positives (habitat that is predicted as high-use, but is really low-use), and false-negatives (habitat that is predicted as low-use, but is really high-use). There are different approaches to determining the threshold, but for habitat management where false-negatives are as bad as false-positives, we suggest that a strong approach is to balance the occurrence of false-positives and false-negatives (i.e., attempt to maximize both sensitivity and specificity). The consequences of alternative thresholds on management decisions may be explored in future projects.

Estimated time – 2 to 3 days to generate performance statistics and select model thresholds for moose and elk

Habitat Data Structure and Variables: Model habitat layer would be based in part on the same LSL data structure as used in the LP Bird RSPF models (Rempel and Donnelly 2010; Rempel et al. 2016) and that has been used in development of other ungulate models (Elkie et al 2012; Kushneriuk and Rempel 2011; Rempel et al. 1997; Rempel 2011) (Table 1). This is comparable to a moving-window analysis for smoothing data at different spatial scales and would allow integration of biodiversity indicators and maintain linkages with the LP planning tool Patchworks. This could facilitate and expedite biodiversity analysis and application of the model to projected future forest conditions for the FMP's five-year report. This would also facilitate linkage to population dynamic models and population viability assessments (PVAs).

A preliminary list of variables has been suggested for the moose (Table 1) and elk (Table 2) models, but these would be refined through discussions with Manitoba Wildlife Branch and LP staff. Additional variables will be included based on specification of the *a priori* hypotheses related to habitat selection. For example, we would also include density of forestry roads as a possible variable under the *Roads Model.* Distance to road is likely a good predictor for the relationship with large roads and busy highways, as moose will tend to avoid these. However, there may be an opposite relationship with small forestry roads, as these will be associated with younger forest with high levels of aspen browse. Forestry roads may increase hunting pressure, but decommissioned roads less so. Density would be a more informative variable for these smaller forestry roads than proximity measures.

For the ecosite models we would include both wetland and upland ecosites as potential variables. Treed fens (wetland ecosites 11 - 12) and treed bogs and swamps (wetland ecosites 15 - 20) can provide thermal cover for moose, and marshes (wetland ecosites 5 – 6) can provide aquatic food rich in sodium. Upland ecosites could be grouped as conifer-mixed (ecosites 13, 24, 36, 43, and 52) , mixed-wood ecosites (23, 34, 35, 42, and 52) and these can provide escape cover, while aspen-hardwood ecosites (11, 12, 21, 22, 31 – 33, 41, and 51) could provide a good source of browse.

This structure would allow us to conduct multi-scale analysis of habitat selection by integrating local, meso, and regional scale analysis (e.g., proportion of hardwood at 50 ha local scale, proportion of wetland ecosites at 500 ha meso scale, and contrast weighted edge-density between young and old forest at the 5000 ha regional scale).

Habitat data will require assembling inventory data with dates similar to the elk and moose observation data, and processing through LSL.

Estimated time – 2 to 3 days to assemble and process habitat data in LSL

Application of Elk and Moose RSPF models to current inventory: The models will be encoded in the LSL scripting language and applied to the current forest inventory to create maps of expected habitat quality across the landscape. A report on the models and their application will be written

Estimated time – 4 to 5 days to code models, apply to current inventory, generate maps and statistics, write report.

Schedule

It is expected the project will begin after the Forest Management Plan is approved by the Province of Manitoba. These moose and elk RSF analyses will take 4 to 6 months to complete, assuming clean and timely data are provided. In addition, timely responses to decision points in the analyses will assist with project competition.

Responsibilities

Manitoba Wildlife Branch/LPC will provide:

i) All collar locational data for elk and moose;
ii) aerial survey data for elk (2018 plus any new surveys) and moose (2010, 2012, 2017, 2020 and any new surveys);
iii) a separate forest inventory layer for each relevant time period for each survey (see above);
iv) updated roads layer for each relevant time period (as above).

Manitoba Wildlife Branch and LPC will provide timely reviews of the proposed hypotheses, methods, list of potential environmental variables, and model outcomes, as well as participation in milestone conference calls to discuss progress and next steps.

FERIT will provide proposed: i) hypotheses, ii) methods, and iii) list of potential environmental variables. FERIT will deliver i) RSPF models for moose and elk (winter and non-winter seasons), ii) estimates of model performance, iii) implementation in the LSL spatial landscape assessment model and application to the current planning inventory, iv) project report detailing methods and outcomes, and v) structured dataset containing all data used in model development and testing, including appropriate metadata.

Cost Estimate and Terms

Total project cost not to exceed $30,000 (exclusive of GST). Total time and cost may be lower if data assembly and development work goes smoothly. No in-person meetings or travel are included in the cost estimate. Payment will be made upon delivery of the final report and models, to be paid within 30 days from invoice date. The province of Manitoba will be billed for 50% and LPC invoiced for the remaining 50%.

Potential Future Directions

Although not part of this proposal *per se*, data will be structured to facilitate development of models to predict moose and elk abundance and density using Poisson regression, and for developing population dynamic models, PVAs, and scenario analysis for population game management using the ALCES Online cumulative effects modeling environment. Data structure will facilitate incorporation of future data for model updating and refinement.

Table 1. Preliminary list of variables for RSPF development for moose.

LSL Variable	Possible Association with Moose
Average Age of Forest (50 ha)	Younger forest has more moose browse; older forest provides lateral cover and snow interception
Age Edge Density (5000 ha)	Food and cover. Moose like young forest in proximity to old forest because the old forest provides predator escape cover
Cover Type Edge Density (5000 ha)	This variable is related to a mixture of deciduous and coniferous. Combination provides food and cover
Percentage of Hardwood (50 ha)	Aspen provide a good source of browse
Mean Average Hardwood Height (50 ha)	Tree height can influence lateral cover from predators and hunters
Mean Average Softwood Height (50 ha)	Height can influence lateral cover from predators and hunters
Mean Crown Closure (50 ha)	High crown closure limits browse, but provides good interception of snow
Water Edge Density (500 ha)	Moose like availability of water
Proportion Open Water (500 ha)	Moose like availability of water
Riparian Ecosites (500 ha)	Moose like availability of water and marsh plants
Wet Soils Ecosites (500 ha)	These ecosites may provide good thermal cover in summer
Shrub Rich Ecosites (500 ha)	These ecosites may provide good sources of browse
Forestry Road Density (500 ha)	Forestry roads may be associated with good sources of browse, but may also cause heightened predation pressure

Proximity to Permanent Roads	Moose may avoid traffic associated with permanent roads
Proportion Agriculture	Moose may avoid agriculture and settled land

Table 2. Potential list of habitat variables for the Elk RSPF across spatial scales. This list will be refined based in part on the 1998 HSI and Chranowski thesis.

LSL Variable	Possible Association with Elk
Average Age of Forest (50 ha)	Younger forest has browse, grasses and forbs eaten by Elk. Older forest provides lateral cover to lower predation risk
Age Edge Density (5000 ha)	Food and cover. Elk like older forest in proximity to young forest (browse), as the old forest provides predator escape cover
Cover Type Edge Density (5000 ha)	This variable is related to a mixture landcover types. Certain combinations provide food and cover. May also evaluate edge between mature forest and grasslands/agriculture;
Percentage of Hardwood (50 ha)	Evaluate importance for Elk
Mean Average Hardwood Height (50 ha)	Tree height can influence lateral cover from predators and hunters
Mean Average Softwood Height (50 ha)	Height can influence lateral cover from predators and hunters
Mean Crown Closure (50 ha)	High crown closure limits browse, but provides good interception of snow
Water Edge Density (500 ha)	Evaluate importance for Elk
Proportion Open Water (500 ha)	Evaluate importance for Elk
Riparian Ecosites (500 ha)	Evaluate importance for Elk
Wet Soils Ecosites (500 ha)	These may be selected or avoided
Shrub Rich Ecosites (500 ha)	These ecosites may provide good sources of browse
Forestry Road Density (500 ha)	Forestry roads may be associated with good sources of browse, but may also cause heightened predation pressure
Proximity to Permanent Roads	Elk may avoid traffic associated with permanent roads
Proportion Agriculture	Elk may select agriculture and settled land

Definitions

AIC - The Akaike Information Criterion (AIC) is an estimator of out-of-sample prediction error and thereby relative quality of statistical models for a given set of data. Given a collection of models for the data, AIC estimates the quality of each model, relative to each of the other models. Thus, AIC provides a means for model selection. (https://en.wikipedia.org/wiki/Akaike_information_criterion)

Bayesian Logistic Regression model – In Bayesian logistic regression you begin with an initial (prior) belief about the distribution of model coefficients. This distribution is updated (posterior) by the likelihood based on data applied to the model. The priors can be absolute coefficients or simply directional beliefs (e.g., the model variable has a positive or negative effect on the outcome).

LSL - Landscape Scripting Language. LSL is a spatial modelling system consisting of a scripting language and Integrated Development Environment (IDE). LSL supports the development and testing of models that calculate habitat and landscape composition and configuration metrics, particularly over multiple spatial scales. By including an integrated reporter LSL facilitates model gaming and efficient round-trip engineering. (Kushneriuk and Rempel, 2011).

ROC – A receiver operating characteristic curve, or ROC curve, is a graphical plot that illustrates the diagnostic ability of a binary classifier system as its discrimination threshold is varied. (https://en.wikipedia.org/wiki/Receiver_operating_characteristic)

RSF/RSPF –Resource selection functions (RSFs) are a class of functions that are used in spatial ecology to assess which habitat characteristics are important to a specific population or species of animal, by assessing the a probability of that animal using a certain resource proportional to the availability of that resource in the environment (Manly et al. 2007). When absolute, rather than relative probabilities of selection are estimated, the function is termed resource selection probability function (RSPF). Clarification of key terms is provided by Lele et al. (2013). (https://en.wikipedia.org/wiki/Resource_selection_function)

K-fold Cross-validation – Cross-validation, sometimes called out-of-sample testing, is any of various similar model validation techniques for assessing how the results of a statistical analysis will generalize to an independent data set. In k-fold cross-validation, the original sample is randomly partitioned into k equal sized subsamples. Of the k subsamples, a single subsample is retained as the validation data for testing the model, and the remaining k − 1 subsamples are used as training data. (https://en.wikipedia.org/wiki/Cross-validation_(statistics)#k-fold_cross-validation)

QGIS - QGIS is a free and open-source cross-platform desktop geographic information system (GIS) application that supports viewing, editing, and analysis of geospatial data. (https://en.wikipedia.org/wiki/QGIS)

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