Reasons and Techniques for Conducting Forest Surveys

1.0 Discuss the various reasons and techniques for conducting forest surveys.

1.1. Discuss the need for measurements in forestry.

Measurements are required in forestry for the obtainment of information. This information will be then used to provide sound decision-making practices. The more information one has on the forest, usually the better the decision one is able to make. A simple analogy of decision-making might be if a friend asked you to see a movie tonight, you might want to find out what is playing, what time, who else is going – requiring more information so you can make a better decision; the same applies in forestry. Getting information in forestry can be very costly – ranging from $800/day to $6000/day – depending upon crew size, access, camp operations, etc. Measurements cost money and it usually doesn't make the wood more valuable. Measurements are normally considered an expense to the people paying to have the work done, and these people would like to get the most information (where practical) for their money spent.

1.2 Describe the different types of information available through the various forest surveys.

Wood volume is the information most commonly sought in forestry. The unit(s) of wood volume in common usage in Canada is m^3, which is an amount of wood fibre equitable to 1m x 1m x 1m. Another unit commonly used in forestry is m^3 stacked and is usually abbreviated to m^3(S) which is the amount round of wood stacked into a space of 1m x 1m x 1m – but includes wood, bark and air space. The difference between the two is that bark and air space is not as valuable as wood fibre and therefore $1m^3$ us worth more than $1m^3$(S). To further clarify, most trees that are standing oftentimes have their volumes in m^3, while wood that is cut and piled will be measured in m^3(S). Further sampling of the cut wood can give a solid wood percentage to convert to m^3.

Example: A pile of round wood that measured 2.50m long, 1.78m high and 6.42m wide had 28.57m^3(S). Further sampling revealed that there was 66.41% solid wood. What is the m^3 of this pile?

Solution: 28.57m^3(S) x 66.41% (or 0.6641) = 18.97m^3.
Recall: m^3 will always be lower than m^3(S) because there isn't any bark or air space.

We use this unit of m^3 as a measure of volume/hectare (vol/ha) such as m^3/ha or as an amount of wood in a stand.
Example: A 21.7 ha stand of white spruce had a volume/ha of 276.497m^3/ha. What is the stand volume?

Solution: Stand volume = Stand area x vol/ha
= 21.7ha x 276.497m^3/ha
= 5999.985m^3 ~ 6000m^3

Other information available through forest surveys are forest growth, forest mortality, vol/ha by species, number of trees/ha by diameter, classes and species, access concerns, season of harvest, regeneration requirements, site capability, tree heights, yield tables for certain ages and stocking levels, slope and topography, trees/ha, m^3/tree and trees/m^3.

1.3 Discuss the potential uses of such information.
There are a lot of potential uses for information obtained from field measurements. A lot of this information is used at the planning and ultimately operational level, and most of these decisions are tied in to volume of wood and species (white spruce, trembling aspen, etc). Some species of wood are worth more than others (sometimes 2-3 times more), and some species are worth different amounts to different processing plants or mills. Also, worthy of note here is that there are some mills that will exchange wood for different sizes and species, with other mills.

As a general rule, road construction levels are built according to the volume of wood to come over this road. A temporary harvest area would have a low-grade road while a harvest area producing hundreds of thousands of m^3 would have a higher standard of road required for efficient movement of wood.

Methods of harvest are dependent upon vol/ha numbers as well as trees/m^3 (m^3/tree). When dealing with trees/ $m^{3\text{ or}}$ m^3/tree, when one is known, we can quickly figure out the other. For example, if we had 8 trees/ m^3 , then that is the same as 0.125 m^3/tree (1/8). For manual handling purposes, which do you think is better, 8 trees/ m^3 or 4 trees/ m^3?

Answer: 8 trees/ m^3 because it is smaller wood and easy to handle.

A lot of forestry harvesting is done by mechanical equipment and this equipment is usually designed with the harvestable material in mind. For example, a company harvesting plywood veneer logs and sawlogs might operate most efficiently at 3 tree/ m^3 and less but would have a hard time harvesting fence posts that are probably 8 trees/ m^3 and higher. Other items of concern is how much equipment would be required to harvest the wood volume, how much is required to forward the wood to roadside, how many truckers and trucks to have to move this volume of wood. The means of measuring this wood after it has been cut (commonly known as scaling) is an item of consideration. Forestry staff have to be employed to mark out the road location as well as identify the sensitive harvesting sites to keep machinery away from or take some precautions to not disturb the site (soils and plants) during harvest. All of these items are to be considered when it comes to meeting fire regulations and equipment requirements as well as adhering to Occupational Health and Safety (OH&S) standards. As a general rule of thumb, the more equipment and workers on a site, the more fire equipment and First-Aid resources required. Other information available from forestry measurements is the different species and products and the value of those products; according to the volumes available. Let's look at the last example of 21.7 ha stand of wood with a volume/ha of 276.497 m^3/ha and yielded 6000 m^3 harvestable wood. Let's say that 30% of this wood is available as sawlogs at a current value of \$45/ m^3 and the rest sold as pulpwood at \$34.50/ m^3. (Pulpwood is often chipped and is often made out of smaller dimension wood). What is the value of this stand in terms of its sawlogs and pulpwoods?

Solution: Quality of sawlogs = 30% x 6000 m^3 = 1800 m^3

Quality of pulpwood = 70% x 6000 m^3 = $\underline{4200\ m^3}$

Total = 6000 m^3

Value of: sawlogs $= 1800\ m^3 \times \$45/\ m^3 =$ 81,000
Pulpwood $= 4200\ m^3 \times \$34.50/\ m^3 =$ 144,900
Total value of forest stand $225,900

Question: If the average semi-trailer hauled 45 m^3/load, how many truckloads would it take to haul all 6000 m^3 of wood?

Solution: $$6000\ m^3 \times \frac{1\ \text{truckload}}{45\ m^3} = 133.33\ \text{truckloads}$$

There is a multitude of forest products available and the more markets available, the more valuable the forest will be to the owner. Knowledge of forest species and products greatly enhance the forest value. Besides lumber and pulp, what other products come from our forests?

Other information available is that of the site itself – how rich/poor is the site, how much wood is growing there per year, is the site wet/dry, is harvest available all year round or winter/summer only, what is in the understory, is this site good for wildlife and for what types, will this site come back naturally or does it have to be planted.

There's an old saying in forestry that says "Good sites are good all around". This means that a site that is very good for tree growth can usually support a diversity and abundance of wildlife, has good road-building potential and may be harvested all year round.

Question: Why are some sites recommended to harvest in winter only?

Answer:
The frozen ground in winter will prohibit rutting and damaging the site. Sometimes access to the site is only available over the frozen ground (i.e.: Muskeg) or via ice road. Another advantage of winter harvest is if there is some natural young trees growing in the understory (regeneration) and we want to save these trees for the future forest after it's been harvested, then harvesting in winter can reduce the impact on these young trees.

1.4 **Distinguish between forest samples and forest populations**.
There are very few times when a whole forest is sampled – usually under limited circumstances where there are small areas of high value trees. Most of the time a sample of a forest area is taken and applied to a large population. For example, a sample taken of an area measuring 10m x 10m = 100m^2. This 100 m^2 = 0.01ha as can be seen from the calculation; 1 hectare is100m X 100m or 10000 m^2

$$100\ m^2 \times \frac{1\text{ha}}{10000\ m^2} = 0.01\text{ha}$$

To find how much that this 0.01ha sample represents on a per hectare basis, we use an expansion factor (EF) which is calculated from the formula of : $EF = \frac{1}{\text{Sample size (ha)}}$

This sample of 0.01ha would have an expansion factor of : $EF = \frac{1}{} = 100$

0.01(ha)

An expansion factor of 100 means that whatever is the volume of trees or number of trees inside this plot would be multiplied by 100 to get it on a vol/ha basis. For instance, if there was 41 trees/plot, with an EF of 100, then this sample would have 4100 trees/ha.

We need forest samples to predict forest populations. A forest is made up of different stands, and a stand is made up of a given area (ha). We need the sample area to get the vol/ha and stand volume. Let's look at another sample and determine the stand volume if the stand area was 16.9 hectares. The volume of the 0.02ha sample was 4.129 m^3, then we could determine the vol/ha and stand volume.

Given: Volume/plot or volume/sample = 4.129 m^3
Plot size 10m x 20m = 200 m^2 = 0.02ha
Stand size 16.9ha

Solution: We need to determine EF, vol/ha and stand volume.

$$EF = \frac{1}{\text{Sample size (ha)}} = \frac{1}{0.02} = 50$$

Vol/ha = volume/sample x EF
= 4.129m^3 x 50
= 206.450m^3/ha

Stand volume = vol/ha x stand size
= 206.450m^3/ha x 16.9ha
= 3489.005m^3 ~ 3489m^3

In this example, we actually extrapolated from a sample area of 0.02ha to a stand size of 16.9ha. This means that we inferred a sample of 0.02ha to 16.9ha which is expanding it by:

$\frac{16.9ha}{0.02ha}$ - or 845 times. Very worthy of note is that if something is wrong at the plot level then it is exaggerated 815 times.

1.5 Describe the various plot sizes, shapes and location commonly used in forest sampling.
There are various sizes, shapes and locations in common usage in forestry. A very important comment on a plot size to use is that of "The smaller the item to sample, the smaller the plot size – the larger the item to sample (i.e. mature trees), then the larger the sample size. For example counting regeneration (young seedlings 1.3m tall and shorter) could use plot sized of 5m^2 (0.0005ha) to 50 m^2 (0.005ha). A mature tree sample size might range from 100m^2 (0.01ha) up to 800m^2 (0.08ha) in size. The above matter of matching plot size to item size also corroborates the motto of "matching sampling size to value of samples" – meaning high-value items would normally have a larger plot size. There are a variety of shapes/arrangements used in plot layout. Plot shape is important for the concerns of ease of layout and borderline (perimeter) trees, (is the tree in or out). Triangles are very difficult to layout and are rarely used. Square and rectangular shapes are easy to layout and are often used. Circular plots (laid out with a rope that acts as a radius) are often used in regeneration plots where the rope is above the seedling's height, but is often used less frequently in mature trees where there is a continual hauling of the rope (radius) to check borderline trees.

Some different shapes with the same area will have different amount of perimeter and therefore more chances for borderline trees. Your teacher may help you to determine the amount of perimeter relative to a plot of a given area (ie $200m^2$) for the shapes of circle, square, and rectangle (10m x 20m). A comparison of these three shapes reveals that the perimeters for:

Rectangle = 60m
Square = 56.56m
Circle = 50.14m

The circle has the least amount of perimeter and therefore the least amount of borderline trees. The circle is known as an "efficient shape" and can help one to readily see why most cans are round – because you have the least amount of tin/aluminum required to give you the most volume.