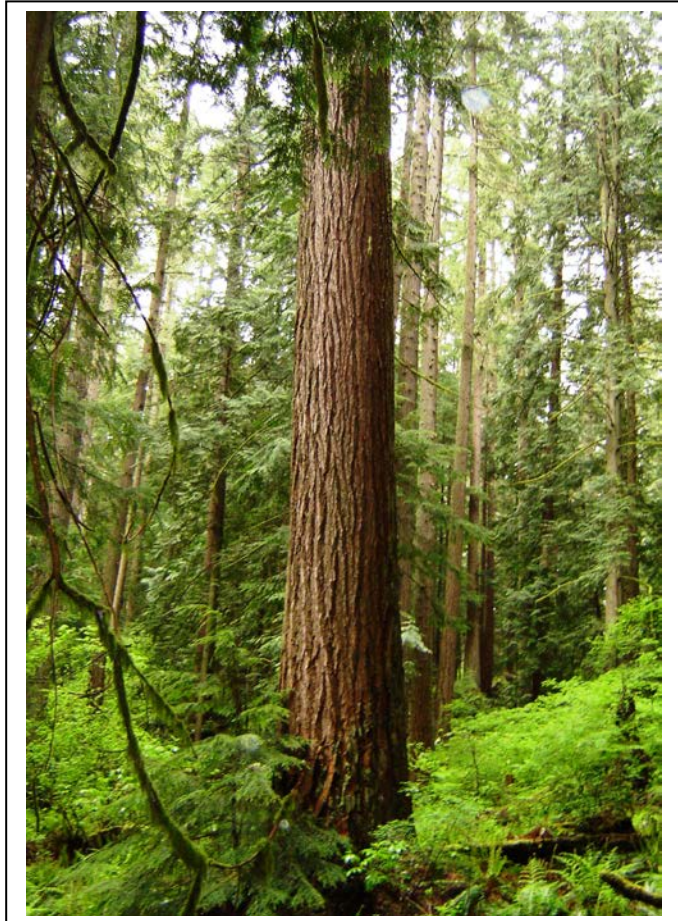


TIMBER CRUISING HANDBOOK

April 2014



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TIMBER CRUISING HANDBOOK

Acknowledgements

The Timber Cruising Handbook is the result of more than a year's worth of collaboration and contributions by Department cruisers and staff. I would like to thank all those who have also provided reviews and comments on this handbook.

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CHAPTER 1 - INTRODUCTION

The purpose of this handbook is to provide consistent and understandable timber cruising guidelines to Department of Natural Resources (DNR) staff involved with cruising timber sales on Washington State Trust lands.

This handbook may also be used as a training aid for new employees whose responsibilities include timber cruising.

Training resources in addition to this Handbook are available through each Region's designated training coordinator and the Product Sales and Leasing Division. Online resources are available on the Product Sales and Leasing Division's SharePoint site:

<http://sharepoint/sites/mld/teams/tc/default.aspx>

When is a Timber Cruise Required?

A [timber cruise](#) serves the specific purpose of providing an estimate of the quantity and quality of timber planned for a harvest activity. The cruise provides the basis to evaluate or appraise the value of the timber products being sold.

Instances when a cruise may be required include the following:

- When timber is offered for public auction.
- Timber is offered through a direct timber sale.
- Timber is involved with a land exchange.
- Timber is involved in a right-of-way being granted or acquired by DNR.
- Timber damage claim.
- Timber trespass.
- Request for a cruise by another agency.
- Any time an appraisal evaluation of timber is required.

The cruise also provides information for prospective purchasers about the quantity and quality of timber and is an important marketing tool used in DNR's timber sales program.

Pre-Cruise Planning

Pre-cruise planning is one of the most important tasks a cruiser must do prior to beginning a timber cruise. It is through pre-cruise planning that the cruiser largely determines how accurate a cruise is going to be and how much time it is going to take to complete the cruise. To develop a good plan the cruiser must answer the important question: "What is my cruise objective?"

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Too often a cruiser begins a cruise without an objective in mind, resulting in either wasted time, a poorly designed cruise, or a cruise that doesn't provide sufficient information to meet the objective.

To answer this question the cruiser should first answer these questions:

- How is my cruise information going to be used and how accurate must it be?
- Who is going to use it?
- How soon is the cruise information needed?
- What is going to be cruised? (High value products, lower value thinnings, non-commercial stands).

Once the cruiser has determined the cruise objective the cruise can be planned and designed for maximum efficiency and accuracy.

There are four types of cruises that this handbook will address; the recon cruise, timber sale cruise, stand assessment cruise, and the timber trespass cruise.

Recon Cruise

A "recon" cruise is intended to provide a limited amount of information and is usually designed for a specific purpose, such as determining if a sale is economically viable and warrants further planning. The recon cruise may also provide some preliminary information useful in determining the sample design and plot intensity. In this case, only a few [basal area](#) plots are taken and a few cruise trees measured to determine the variability and the appropriate Basal Area Factor. For this type of cruise the cruiser typically estimates basal area, DBH, heights, and grades.

There are no sampling error requirements for a recon cruise. The recon cruise should be quick and easily worked up. A recon cruise is not suitable for an appraisal of timber value.

Timber Sale Cruise

A cruise intended for the sale of timber must provide accurate information about species, sort, [grade](#), defect and volume to evaluate the timber's value and determine a "fair market" value. This cruise is also used to advertise the sale and attract prospective bidders to a sale. Every timber sale cruise must meet the minimum requirements as outlined in this Handbook.

The cruise information required for this type of cruise includes:

1. Gross and net board foot [Scribner volume](#) by species, sort, and grade.
2. Average diameter at breast height (DBH) by species.
3. Average ring count for Douglas-fir, Western hemlock, and Sitka spruce (Westside only).
4. Optional: Volume by log size (small end diameter inside bark - [d.i.b.](#)) and grade ([log stock](#) tables).

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5. Optional: Volume per acre by species and DBH (stand table).
6. Volume and weight (tons) by species.

Only trees identified for harvesting are included in timber cruise volumes. If trees not intended for harvesting or trees designated as “**Leave Trees**” are included in cruise volumes they must be clearly identified as such in all cruise reports.

Stand Assessment Cruise

A stand assessment cruise provides sufficient information to determine silvicultural prescriptions and may be used to determine the volume and grade information for timber to be removed through prescription. In a stand assessment, all trees are cruised whether they are intended for harvest or not.

After the cruise has been completed a stand table is produced that is used to determine the appropriate harvest prescription. A “leave/take” can then be applied to the cruise to provide an estimate of harvest volume and grade.

For a more detailed discussion of stand assessment cruises refer to DNR guidelines for cruising small-wood thinnings outlined in Appendix D of this handbook.

Timber Trespass Cruise

A timber trespass cruise, sometimes referred to as a “stump cruise”, must be done with great care and should be conducted by an experienced cruiser who potentially could be asked to appear as an expert witness in a court of law.

As with any potentially litigious matter it is important to maintain an accurate log of any cruising activity including dates, times and the names of any individuals involved in the cruise for future reference. It could be an extended period before the matter is resolved and you will need to remember what you did. Consider taking photographs showing a step by step process of how the stump cruise was conducted.

The following is a suggested procedure for conducting a timber trespass cruise.

1. **Every stump should be accurately measured** (a carpenter’s tape is appropriate).
2. Record: species, [stump height](#), diameter and any observed stump defect. Then number each stump face with paint.
3. Diameters are best measured outside the bark along the longest and shortest sides of the stump then averaged. Any abnormalities or extreme flaring may be excluded from the diameter measurement.
4. Group the stump data by species in 1-inch diameter classes and average each species’ stump heights.

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5. Conduct a comparison cruise from an adjacent timber stand. Base your selection of comparable trees by the frequency of the stump diameters and species. Record species, stump diameter, DBH, [form factor](#), [merchantable heights](#), log grades, and defect. Number each comparable tree with paint.
6. With this comparison data calculate the ratio of taper from the stump diameter to DBH by species. Example: DBH (12.5") divided by stump diameter (14.2") = stump factor (0.88).
7. Apply this ratio to the stump diameters to obtain DBH.
8. Example: Stump diameter (15.3") X Stump factor (0.88) = DBH (13.46").
9. Input the converted data into the [SuperACE](#) cruise program based on the comparison trees that were cruised.
10. Document all your field notes and office procedures in a professional narrative. Retain your records.

CHAPTER 2 - CRUISING EQUIPMENT

Certain specialized equipment is required to conduct a timber cruise. It is important to keep this equipment well-maintained. This chapter gives a brief description of cruise equipment and how to adequately maintain the equipment in good working order.

The equipment necessary to conduct a timber cruise includes the following:

1. 75-foot Spencer tape (“loggers tape”)
2. Compass
3. Relaskop (American scale)
4. Glass-wedge prism (if Relaskop is unavailable)
5. Increment borer (12-inch or longer)
6. Laser distance device, string box (optional)
7. Electronic data logger
8. GPS (Garmin 60 CSX or similar).
9. Field notebook, photo scale and calculator.
10. NWLRAG Log Scaling and Grading Rules book
11. Flagging
12. Cruising vest
13. Hard hat

Use and Maintenance

75-foot Spencer tape – Tapes should have lengths in tenths of feet and diameter graduations on the backside. Keep the tape’s “horseshoe” nail sharp to improve retention in the tree’s bark while taping a distance. Wipe the tape clean with WD-40 or other cleaner after use in the field to prevent the tape from rusting. Adjust the tension on the Spencer tape so that the tape will recoil completely.



Compass – “Silva-type” compasses are suited best for cruising. Compasses come in quadrant or azimuth models. Either is suitable. The compass should have a declination setting to offset for magnetic declination. Keep the compass’s declination offset adjusted to the current local declination. Current declinations for any location in the U.S. may be obtained off the Web from: <http://www.ngdc.noaa.gov/>



Relaskop – The Relaskop is the cruiser’s primary tool. It can be used for determining in and out trees, bole diameters, and heights. For a detailed description of the use of the Relaskop see “Spiegel – Relaskop American Scale Manual” by Dr. W. Bitterlich.

Glass Wedge Prism – Glass wedge prisms come with various basal area factor (BAF) calibrations and may be used to determine “in” or “out” trees in a [variable plot cruise](#). Common factors include 10, 20, 25, 30, and 40 BAFs. Prisms are useful when only tree counts are necessary. However, proper use of the prism is important.



The prism must be held directly over the plot center. To correct for slope the prism must be rotated on axis to the same slope angle to the sighting point on the tree.

Increment Borer – Normally an increment core is needed to sample for tree age and ring count estimates. A minimum 12-inch borer is needed to sample for age while a shorter borer is suitable if only rings per inch measurements are sampled. Borers should be kept clean and sharp. A .22 caliber gun cleaning kit is useful for cleaning the inside of the bore. Two-threaded borers are easier and quicker to drive in. Three-threaded borers are easier to start but slower to extract.



Laser Distance Device – There are a number of suitable laser distance tools that are now available. The Tru-pulse 200 is an ideal instrument that measures both distances and heights.



(See document). Other suitable devices include the Impulse laser, electronic range finders and the Vertex Hypsometers. A string box is less accurate than a laser, however under inclement weather conditions when a laser performs poorly a string box may come in handy. They are especially helpful when running a baseline in flat or gentle terrain.

Electronic Data Logger – The electronic data logger is used to collect and record cruise plot data and download the data into the PC when back in the office. The DOS Allegro Field PC is currently used as the standard cruising data logger. Current field data collection software is limited in supporting newer Windows handheld software.



GPS – GPS units are useful for recording plot locations, locating timber sale boundaries and reference points. The standard unit for DNR field use is the Garmin handheld 60 CSX or 62S models. These units require two AA batteries for operation and are small enough to fit in a vest pocket. The fast improving technology in GPS units have made them smaller, lighter and more accurate. Still, factors such as time of day, the topography, and overstory canopy cover can vastly affect the accuracy of a point location at any given time. Be aware of your GPS unit’s limitations and its functions.



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Field Notebook – A six-ring notebook is useful for keeping plot cards, field notes, and maps.



A photo scale or engineers scale is useful for laying out a grid on the cruise map. Calculators with a cosine function are useful for correcting slope distances.

NWLRAG Log Scaling and Grading Rules book – The Log Scaling and Grading Rules book provides a description of the acceptable Bureau Grade specifications. Copies of this book are available online at <http://www.nwlrags.com/> or may be purchased from any Northwest Log Rules Advisory Group member. This book lists all the standard log-grade rules used for DNR cruises.

Flagging – Plots must be marked with flagging including plot centers, wing points, reference points, and strip crossings. The color combination of red flagging with white flagging is typically used for DNR timber sale cruises. A pin flag or a stout stick stuck in the ground is used for marking the plot center.

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CHAPTER 3 - CRUISE REQUESTS

Cruise Packets – The Pre-cruise Narrative

The pre-cruise narrative (PCN) initiates the cruise request. It provides detailed information about the timber type, sale acreage, prescription, leave/take trees, Right of Ways, roads, restrictions, hazards, access, and locations. This information should be included with the final timber cruise packet.

The following information must be documented on the PCN:

1. Sale identification and the name of a contact forester.
2. The type of sale (log sort, scale, lump sum) and anticipated harvest system.
3. Unit acreages including legal, grant/trust code, gross acres, deductions from gross acreage (no harvest acres), net harvest acres, and method of acreage determination.
4. Harvest plan and special conditions (prescription markings, special management areas, or other conditions.)

Other information for estimated volume, access information, and photos and maps.

Who Initiates the Pre-cruise Narrative?

The PCN is initiated by the lead Forester for the sale, or by the Right of Way Sections/Departments (for right of way issues or trespasses.)

Where do I find the Pre-cruise Narrative?

A current copy of the Pre-cruise Narrative template is located on the Product Sales and Leasing Division's [Timber Cruising Sharepoint](#) site.

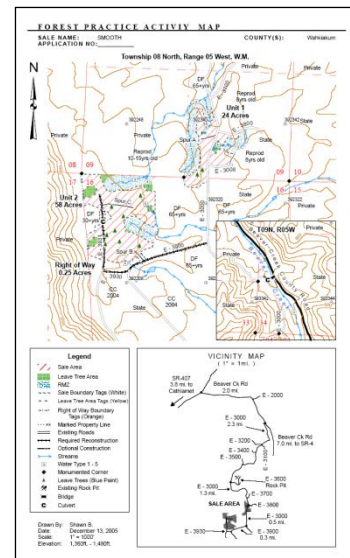
Cruise Maps

In addition to the PCN the cruise packet should include maps of the sale area(s) showing the accurate shape, scale, acreage, roads, leave-tree-clump locations, and boundary identification of the unit(s).

The maps should also show the map scale, a north arrow, legal subdivisions (section, township, and range), topographic contours, and access routes.

Driving Maps

These maps need to be accurate and updated on a regular basis to show new roads, abandoned roads, gates, timber sale units, and distances from known landmarks. Also, the starting point should be easy to identify by someone unfamiliar with



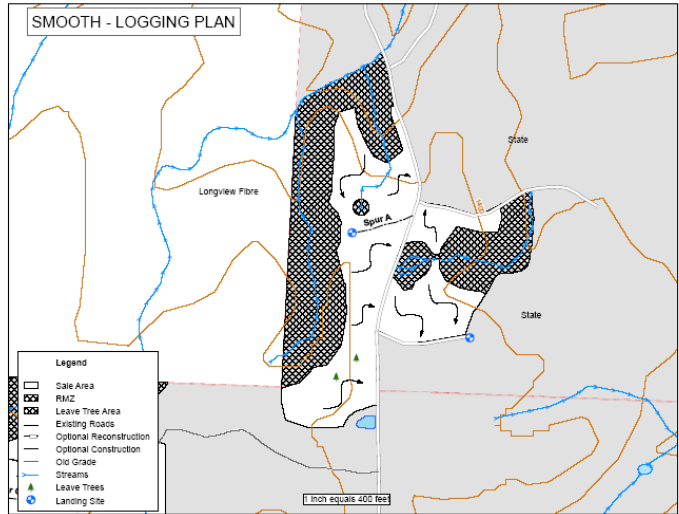
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the location.

When relying on old maps accuracy needs to be checked. Mileage points must be accurate.

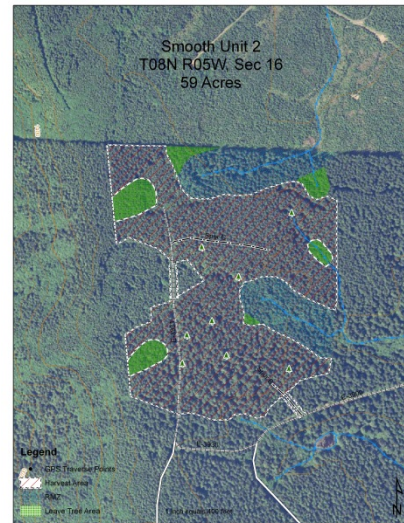
Logging Plan

The logging plan identifies the intended harvest system design. It also allows the cruiser to identify potential areas that may not be accessible using the proposed system design. The cruiser should make notes about any difficult logging areas in the cruise narrative.



Ortho Photos and Photography

Aerial photos are helpful identifying harvest boundaries on the ground. This will allow any voids to be located and aid in the grid design of the cruise.



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Ownership Map



An ownership map provides information on trusts and grants within the sale.

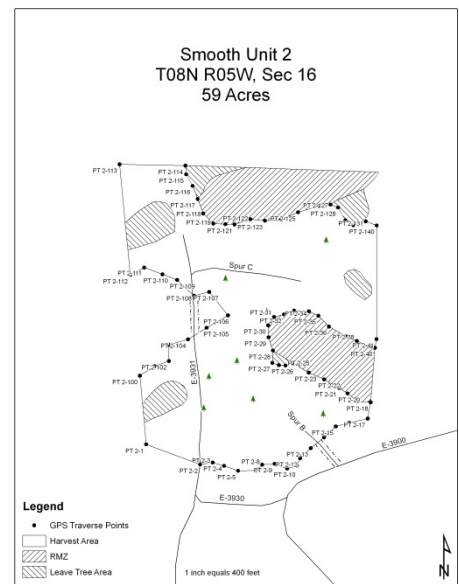
Traverse Map

The traverse map is used to design the cruise grid and locate plots. It should have the sale name, unit number, [traverse points](#), roads, right of way locations, gross acreage, leave areas, [RMZs](#), north direction, and map scale.

A traverse map should be at a scale of one-inch to four-hundred feet (1"=400'). For larger sales other scales may be more useful such as one-inch to one-thousand feet (1" = 1000"). Traverse points on the map represent GPS [nested points](#) or laser turning points and should be located at intervals of between two-hundred and three-hundred feet.

Mark the traverse points with a flagging color that “sticks out” and differs from other ribbon colors used.

Hang the flagging off the ground in easily visible locations.



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CHAPTER 4 - CRUISE STATISTICS

Statistics for Timber Cruising

Timber cruising is often accomplished through a sampling process. Whenever a sample is used to measure a population (the timber) sampling statistics are involved. Sample statistics simply provide a way of describing the sample values and estimating how “good” the sample represents the true population.

There are four statistical terms commonly applied to timber cruises: mean, standard deviation, coefficient of variation, and sampling error.

The Mean

The mean is simply an average¹. There are three types of averages commonly used in cruising; an arithmetic mean, weighted arithmetic mean, and a quadratic mean.

The *arithmetic mean* (simple average) is the sum of the sample observations divided by the number of sample observations. Arithmetic means are used, for example, to describe the mean number of trees per plot in a cruise. The arithmetic mean is shown as:

$$\frac{\sum i}{n}$$

where Σ is the sum of..., i is the sample value and n is the number of samples taken.

Weighted means are used when averages are calculated for several populations that contribute unequally to the whole. For example, you might have several timber sale units of different sizes with an average volume per acre for each unit. In order to get an overall volume per acre the average volume per acre in each unit must be weighted by the acres that each unit represents. The formula for a weighted arithmetic mean is:

$$\sum \left(p_j \frac{\sum i}{n} \right)$$

where p_j is the ratio of proportion for each units (j) arithmetic mean and $\frac{\sum i}{n}$ is the arithmetic mean of the sample.

¹ Iles, Dr. Kim: A Sampler of Inventory Topics. Kim Isles and Assoc. Ltd. Pg. 43. (2003).

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Example: The volume per acre of two units in a timber sale are 33,000 BF/acre in unit 1 and 42,000 BF/acre in unit 2. Unit 1 has 35 acres and Unit 2 has 47 acres.

$$P_1 = 35 \div (35+47) = 0.427$$

$$P_2 = 47 \div (35+47) = 0.573$$

The weighted volume per acre for the timber sale is:

$$0.427(33,000) + 0.573(42,000) = 38,200 \text{ BF}$$

Quadratic means are used when the values are squared first then summed. [DBH](#) is a common observation that is averaged in this manner. The quadratic mean diameter represents the diameter of the tree with the average [basal area](#)².

Standard Deviation and Coefficient of Variation

Whenever a sample is taken there is variability between observations. This variability, or dispersion, about the population's mean is called the *standard deviation*, (SD).

The SD is useful for determining how large a sample is needed to achieve some level of [accuracy](#). The larger the SD (the greater a stand's variability, that is) the larger the sample size must be in order to maintain the same level of accuracy.

The coefficient of variation, CV, is simply the SD of a sample expressed as a percentage. The CV may be calculated by dividing the SD by the mean and multiplying the result by 100.

$$CV\% = \frac{SD}{Mean} \times 100$$

Example: Stand A has a SD of 63 sq. ft. in basal area per acre with a mean basal area of 184 sq. ft. the CV is:

$$CV\% = \frac{63sq.ft.}{184sq.ft.} \times 100 = 34.2\%$$

Stand B has a SD of 95 sq. ft. and a mean of 240 sq. ft. per acre.

$$CV\% = \frac{95sq.ft.}{240sq.ft.} \times 100 = 39.6\%$$

The CV is useful for comparing variability between populations. Stand B in the example is therefore more variable in terms of basal area and would need a larger sample.

Sampling Error and [Confidence Interval](#)

The *percent sampling error* (%SE) represents the [precision](#)³ of the sample expressed as a percentage. Another way to look at the sampling error is to think in terms of how close a

² Isles, Dr. Kim: A Sampler of Inventory Topics. Kim Isles and Assoc. Ltd. Pg. 45. (2003).

³ Isles, Dr. Kim: A Sampler of Inventory Topics. Kim Isles and Assoc. Ltd. Pg. 41. (2003).

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cruise would be to the real value if it were repeated 100 times for the same population. DNR expresses sampling errors for timber cruising using a confidence interval of 68% (in other words: 68 times out of 100).

For example a cruise with a sampling error of 7% may be interpreted as “68 times out of 100 a cruise would be within 7% of the true value”.

Sample Size

Sample size when it is applied to a timber sale cruise refers to how many plots are needed to achieve a desired sampling error. A close estimate of the number of plots required may be made using the following formula:

$$N = \frac{t^2 \times CV\%^2}{A\%^2}$$

Where t is the Student T value for the distribution (a value of ‘1’ may be used for a 68% confidence interval), CV% is the percent coefficient of variation for bf per acre and A% is the desired sampling error expressed as a percent.⁴

In order to estimate the number of plots needed you need to know the CV% for the sale. This may be obtained by comparing cruises with similar sales or establishing a few recon plots in the sale prior to cruising.

A useful tool for determining sample size may be found in the Excel spreadsheet *star_bar5.xls* which can be found on John Bell’s website at <http://www.proaxis.com/~johnbell/>.

⁴ Bell, John F.: Log Scaling and Timber Cruising. Cascade Printing Co. Corvallis, OR. Pg. 243. (2002)

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CHAPTER 5 - CRUISE DESIGN

Timber cruise design involves the cruiser selecting an appropriate cruise method, sample size and sample grid for the assigned cruise. Factors the cruiser needs to consider when designing the cruise include:

- Cruise objective.
- Accuracy and sampling error desired
- Amount of time available for the cruise.
- Type of sale (for example: lump sum, scale, log sort).
- Variability of the stands and stratification if necessary.

The sample process usually involves placing [variable](#) or [fixed radius plots](#) distributed uniformly over the entire cruise area in an unbiased manner. All trees identified as products sold within the plots are counted or measured and expanded by the proper expansion factor and area to achieve the total sale volume. For a given cruise area, often several different cruise designs are acceptable; however, it is the cruiser's job to determine the most efficient and accurate design to achieve the cruise objective. This chapter will present guidelines to help you select the best cruise design for your project.

Variable Radius Plot Cruise

The vast majority of timber cruising is accomplished with variable radius plots (VP), also called point sampling or angle count plots. Using this method selects sample trees with a probability that is proportional to tree size (basal area); in other words, the larger a tree's diameter, the more likely that it will be sampled. This method is ideal for cruising timber sales when an accurate sale volume is a key objective of the cruise.

Use when:

- An accurate volume is needed on large acreages (20 acres or more). The larger the acreage the more efficient this method becomes.
- An accurate acreage is known.
- A well-defined harvest prescription is known, and boundaries and leave areas are marked.

Examples:

- Most DNR timber sales are cruised using this method.
- Right of ways.
- Recon cruises.
- Land exchange cruises.
- Inventory cruises.
- Can be used to determine percent insect damage, diseases, mistletoe or any other information that is related to [basal area](#).

Advantages:

- ☞ Greatly reduces the number of trees needed to measure.
- ☞ Easily done by one person.
- ☞ Cruise sample is easily repeated making check cruising more reliable and accurate.
- ☞ Generally faster to conduct than fixed plot methods.
- ☞ A greater emphasis can be placed on the most variable aspect of the stand (for example: basal area).

Disadvantages:

- ☞ Inaccurate acreages adversely affect the cruise volume accuracy.
- ☞ May need to obtain recon cruise data prior to the cruise for determining sample size.
- ☞ Incorrect tree count will greatly affect the volume.
- ☞ Theory is complex, but the field procedure is simple.
- ☞ Sampling statistics are involved.

Variable Plot Cruise Design

To design a Variable Plot Cruise the cruiser must decide on how many plots will be needed to achieve the desired accuracy expressed as a percent sample error and what Basal Area Factor (BAF) to use. Both of these choices should be made with the following considerations in mind.

- The variability of the stand
- How much time and what resources are available to complete the cruise.
- Terrain, access, and safety considerations.

Cruise Accuracy Requirements

The first step to determining a cruise design is to decide on a desired accuracy (or percent sample error, %SE). DNR requirements for timber sale cruise accuracy are expressed as the percent sample error (%SE) based on a 68% [confidence interval](#).

- *Regeneration, partial cuts, and marked thinnings:* **maximum 10%SE** for board foot volume per acre for the total timber sale volume. A range of 6%SE to 8%SE for timber sales is recommended.
- *Unmarked thinnings or partial cuts sold as Weight scale:* Maximum **10%** for basal area per acre for each unit in the sale.
- *Unmarked thinnings or partial cuts requiring a Stand assessment:* Maximum **10%** for basal area per acre for each unit in the sale.

Next, determine how variable the timber sale is in terms of the population. Typically, the most variable parameter in a cruise is the basal area per acre or the tree count per plot. This variability is expressed as the Coefficient of Variation (CV%). The CV% is often not known prior to cruising the sale; however, estimates may be determined by comparing cruises from previous similar sales or taking some recon plots.

The Super Ace Statistics Report will calculate the CV% for the cruise and will provide an estimate of the number of plots required to achieve a desired SE%. If time permits, take several recon plots scattered through the sale area (ten to fifteen plots for example) and run a Super Ace statistics report to get an estimate of the number of plots that will be needed. These recon plots will also help you choose the Basal Area Factor for the cruise.

Some general “rules of thumb”:

1. Plot intensity for lump sum sales should be from 1.25 acres per plot to 1.8 acres per plot for most Westside timber sales.
2. Generally, at least 50 to 70 plots will be needed for most cruises to achieve an adequate sample regardless of the size of the sale. (Iles, 2003)
3. A minimum of 150 cruise (graded) trees should be planned into the cruise. For example, if you expect to average 5 trees per plot with a cruise to count ratio of 1:1 you should plan for 30 cruise plots and 30 count plots.
4. A small acreage sale will likely need as many plots as a larger acreage sale. Variability determines the number of plots needed, not size.
5. More important than the number of plots is that the plots installed “cover the population”, (Iles, 2003). In other words, all areas inside the sale have an equal probability of being sampled.

The Star_bar.xls worksheet provides several useful worksheet functions for calculating sample size and cruise design efficiency. A copy of the worksheet may be downloaded from DNR’s Sharepoint Timber Cruising site.

Determine the Number of Cruise and Count Plots

[Cruise plots](#) are plots where every tree “in” the plot is cruised and graded. [Count plots](#) are plots where only a tree count by species is taken. Often, only a portion of the total number of plots are cruised; therefore, reducing the number of trees cruised and speeding up the cruise with count plots. The number of cruise plots and the number of count plots required is determined by the frequency of sampling. This frequency is determined by the formula:

$$\frac{Trees_{cr}}{Plot_{tot} \times TC_{avg}} = Plot_{ratio}$$

Trees_{cr} = total number of cruise trees needed.

Plot_{total} = total number of plots.

TC_{avg} = Average tree count per plot.

Plot_{ratio} = Ratio of cruise plots to total plots.

Convert the ratio of cruise plots to a frequency by dividing the ratio into “1”.

$$\frac{1}{Plot_{ratio}} = Plot_{freqcount}$$

Example:

Estimated average trees per plot – 4.5

Number of plots - 124

Number of cruise trees - 140

$$\text{Cruise plot ratio: } \frac{140}{124 \times 4.5} = 0.25$$

$$\text{Cruise plot frequency: } \frac{1}{0.25} = 4 \text{ plots}$$

You will cruise one plot out of every four plots or you will count three plots and cruise one plot.

This is a cruise/count frequency of 1:3.

Choose a Basal Area Factor

Select a basal area factor (BAF) to achieve an average of 4 to 7 “in” trees per plot. Taking a few recon plots is often the best way to determine the appropriate BAF. Once the BAF is chosen do not change the factor within the timber sale unit. BAFs may vary, however, from unit to unit.

Dual BAFS

Two BAFs may be used for sampling different species within a stand. If, for example, a stand has a small component of cedar or alder along with fir or hemlock then a smaller BAF may be used for the cedar or alder while the larger BAF is used for the more predominant species of fir and hemlock. In this manner the sample size for the more valuable species of cedar and alder will be increased while still maintaining a reasonable sample size for the predominant species.

Plot Spacing and Grid Pattern

Plots must be distributed throughout the area being cruised. Most often this is done using a systematic grid. Most common grid patterns are square and rectangular patterns. In order to maintain an equal probability for the area being cruised the grid starting point should be located using a random start. This may be done on a map by laying out ‘x’ and ‘y’ coordinates encompassing the sale area and choosing a random x and y coordinate using a random number generator for the initial starting point of the grid. GIS programs are also available that will do this for you automatically.

Generally, a square grid pattern will sample the variation within a stand better than a rectangular grid. However, in large stands (those greater than 100 acres) and stands with

uniformity a rectangular grid may be more efficient. *In no case should the distance between plots be less than one-half the distance between cruise strips.*

On large, uniform stands it is more productive to use a rectangular pattern to reduce the number of strips needed to cover the area. Strips should be run in the direction that crosses the variability. Most often this means that the strips should be perpendicular to the contour of the ground (see Figure 1 for example: up and down the hill). If there are long draws or ridges running downhill then the strips may be better run side-hill to better sample the different timber types.



Figure 1- Rectangular Grid Pattern

If a stand has a hardwood component along the one edge then the strips should run perpendicular to the hardwood edge so that the hardwood component is sampled proportionately. Often, topography and ground cover can affect the number of sample points that are required. If the ground is too steep or brushy more sample points can be added to make up for a larger BAF that may be needed due to the inability

to accurately measure trees that are further away from plot center. It is better to have fewer trees per plot accurately measured than a larger number of trees per plot inaccurately measured.

Example 1: 20 plots are required to sample a 45 acre timber sale unit. What is the plot spacing using a rectangular grid pattern with a strip interval of 330 feet?

- $45 \div 22 = 2.0$ acres per plot.
- $2.0 \text{ acres} \times 43,560 \text{ square feet per acre} = 87,120 \text{ sq. ft. per plot.}$
- $\text{Distance between plots} = 87,120 \text{ sq. ft.} \div 330 \text{ ft.} = 264 \text{ ft.}$

Example 2: What is the plot spacing using a square grid pattern?
Find the square root of the square feet per plot:

$$\sqrt{87,120 \text{ ft}^2} = 295 \text{ feet}$$

Once a grid pattern is determined it is essential to continue the pattern throughout the sample area to ensure coverage of all portions of the cruise area. Plots should be located using a hand compass and pacing. Some type of measuring device such as a laser rangefinder or stringbox can be useful in steep or brushy terrain. GPS devices are useful for locating plots in areas with difficult or brushy terrain.

Variable Plot Field Procedure:

1. Gather the following pre-cruise information prior to cruising.
 - a. [Precruise packet](#).
 - b. Net sale acres.
 - c. A BAF that will average 3 to 6 trees per plot.
 - d. Number of plots needed and the grid size (see cruise design section).
 - e. Number of cruise trees needed to get an acceptable sampling error.
 - f. A map with [traverse points](#) or GPS [nested points](#).
2. Lay out cruise lines or plot grid on map.
 - a. If nested points are not available, then a base line must be established on the ground first.
 - b. Base lines must be accurately measured, located, and marked on the ground. A hip chain or laser works well for running a base line.
 - c. Preferably use a single straight line, which runs at right angles to cruise line direction.
3. Locate each cruise line and mark it with dual flagging. (Flagging colors: red flagging tied with white flagging)
 - a. Write the cruise line on the flagging. Hang flagging in between cruise strips if necessary.
 - b. Locate the base line so that all necessary cruise lines will intersect it.
 - c. Mark the beginning and the end of each cruise strip with dual flagging and indicate the line number and the direction of travel.
4. Pace in one-half the distance between plots and set the first plot.
5. Plot centers should be marked with dual flagging with strip number and plot number written on it using a paint pen.
6. Hang another dual flag (referred to as the “ace” flag) to the left of plot center in a visible location.
7. Number plots in sequence, unless plot numbers have been predetermined.
8. Starting at the “ace” swing the plot in a clockwise direction. Examine each tree using a Relaskop and the correct BAF to determine if the tree is “in”.
9. For borderline or “hidden” trees determine if the tree is “in” by measuring the plot radius.
10. Measure the [DBH](#) to the nearest one-tenth inch.
11. Measure the horizontal distance from the center of the tree⁵ to the plot center.

⁵ The distance from the “face” of the tree may also be used. However, the appropriate factor must be used. Refer to the limiting distance factor (LDF) when using the “face” of the tree.

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12. Using the [plot radius factor](#) (PRF) (see Table 3 - BAFs Available on the Relaskop) for the BAF multiply the tree's DBH by the factor to get the maximum distance the tree can be from plot center.
 - a. Alternative method: The [limiting distance factor](#) (LDF) may also be used. Using the LDF factor from Table 4, measure the distance from the "face" of the tree nearest plot center.
 - b. If the PRF/LDF distance is greater than the measured distance the tree is "in". If the PRF/LDF distance is less the tree is "out".
13. Cruise/count plot method – decide on the ratio of count plots to cruise plots. Typical ratios are 1:1, 1:2 or 1:3.
 - a. Cruise plots: If the plot is a "cruise" plot cruise each tree on the plot. Determine which trees to measure based on the cruise to count ratio (1 in 4, 1 in 3, or 1 in 2)
 - b. Count plots: Tally each tree by species.
14. "Big BAF/Little BAF" method – In this technique all plots are considered cruise plots. The cruise trees are selected on each plot using a much larger BAF than the BAF used to tally basal area (BA) trees. The following is an example where the cruise to count ratio is one tree out of every four trees counted will be cruised.

Example:

- i) Cruise to count is 1:3
- ii) BAF is 40
- iii) Determine big BAF
 - (1) By multiplying Little BAF by 4 (1 cruise + 3 counts) find closest BAF to that number on the BAF chart (see Table 6 - BAFs on the Relaskop).
 - (2) $40 \times 4 = 160$. The closest is 160.
- iv) Swing the plot using the Big BAF (160) and cruise only those trees that are "in".
- v) Swing the plot using the little BAF (40) and count by species those trees that are "in".
Do not double count the trees cruised with the big BAF. The big BAF is only for selecting the trees for cruising.

15. In either method cruise the first minor species tree encountered regardless of selection criteria.
16. Cruise all trees using the guidelines in tree measurement section.
17. When a plot falls close to or on the "edge" of the sale use the "walk through method" for determining tally trees. See Appendix C - The Walk Through Method for Edge Plots for details on using the "walk-through" method.

18. At the end of the cruise strip record the remaining distance to the boundary. Tie up dual flagging marked with strip number and write “end of strip” on the flagging.
19. Check the accuracy of your strip bearing.
20. Off set to next cruise strip.
21. Continue with your pacing from where you ended on the previous strip to set the next plot.
22. Continue until all plots have been completed.

100% Cruising

This is not technically a cruise sample because every tree in the population is cruised. The cruise is conducted by measuring all trees in the cruise area for gross and net volumes.

Use when:

- Tree counts are small (less than 200 trees usually).
- Acreage is small (usually 10 acres or less).
- Trees are widely distributed and infrequent so as to make it difficult to apply a sampling system
- Stand variability is high.
- High value products are being sold.
- A higher accuracy is required.

Examples:

- Small right of ways.
- Private right of ways.
- Trespass cruises.
- Small pole sales.

Advantages:

- ☞ No sampling error.
- ☞ Easy to understand.
- ☞ Accurate tree count.

Disadvantages:

- ☞ Time consuming and costly on large areas or sales.
- ☞ Large amounts of data to collect and process.
- ☞ May force cruiser to do a lot of estimating to maintain production.

Field Procedure When Using A 100% Cruise:

1. Use a two or three person team.
2. Visit each tree and measure with a diameter tape.

3. Measure with a Relaskop tree heights and [form factor](#) for at least 1 tree in 10. Estimate the heights of other trees and use the average form factor by species.
4. Determine call [grade](#) and [defect](#) for each log segment of every tree.
5. Use care to avoid missing or double-counting trees.
6. Mark trees in some manner after they have been cruised.

Individual Tree Sampling (ITS)

This type of cruise is conducted by counting every tree in the cruise area by species and selecting trees to cruise through some random or systematic manner designed to give a statistically adequate number of sample trees.

All sample trees (cruise trees) are measured for gross, net volume, and grade.

Random selections may be made with the help of random number tables or something like colored marbles pulled out of a pocket.

Systematic selections may be made by cruising every n^{th} tree (the third, fourth, or fifth tree encountered, for example) or by putting in regularly spaced fixed plots or strips.

Use when:

- It's convenient to visit every tree (in order need to band each tree with paint).
- There are 200 to 1,500 trees.
- Acreage is small but a 100% cruise is not practical.

Examples:

- Right of ways.
- Scattered overstory removal.
- Leave tree cruises.

Advantages:

- 👉 Takes less time than a 100% cruise
- 👉 Fewer trees are cruised when compared to a 100% cruises.
- 👉 Easy to understand and use.
- 👉 An accurate tree count is obtainable.

Disadvantages:

- 👉 Sampling error is introduced.
- 👉 Some advanced knowledge of the stand is needed for a tree selection system.
- 👉 Time consuming on large projects.
- 👉 As variability increases the number of sample trees is increased.
- 👉 Check-cruising is difficult when trees are randomly selected.

Field Procedure When Using ITS

1. Obtain an estimate or a 100% tree count of harvested trees prior to cruising.

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2. Obtain an estimate of coefficient of variation of the tree volume by doing recon cruise or from data of a similar stand of timber.
3. Determine the number of cruise trees by using the following formula:

$$T_c = \frac{T_p \times CV\%_v^2}{T_p \times SE^2 + CV\%_v^2}$$

Where:

T_c = number of cruise trees

T_p = total number of trees

$CV\%_v$ = coefficient of variation of tree volume

SE = desired sampling error percent

4. Cruise every n^{th} tree as they are visited.
5. Systematic sample - use a tally counter.
6. Random sample- draw colored marbles from your pocket.
7. Continue until every tree in unit has been accounted for.

Example:

A sale contains 5,000 marked tree counted by species. The coefficient of variation for the tree volumes is estimated at 120%.

$$T_c = \frac{5000 \times 120^2}{5000 \times 6^2 + 120^2} = \frac{72,000,000}{194,400} = 370.4$$

370 of the 5,000 trees needs to be cruised. Rounding down to the nearest whole tree that works out to cruising every 13th tree.

Fixed Plot-Strip (FPS) Cruising

This method employs running fixed width strips across the cruise area and measuring all trees located within the strips for gross and net volume.

Circular or square fix plots may be used instead of strips. In Table 1 - Fixed Plot Sizes are some examples of distances for circular and square fixed plots.

Plot size (acres)	Circular (radius in feet)	Square (side in feet)
1	117.8	208.8
½	83.3	147.6
¼	58.9	104.4
1/5	52.7	93.3
1/10	37.2	66.0
1/50	16.65	29.5
1/75	13.60	24.1
1/100	11.78	20.9

Table 1 - Fixed Plot Sizes

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The strips should be broken into fixed segments (330 feet long) for statistical analysis and check cruising.

The distance between strip centerlines is set to give the percent of cruise needed to provide a statistically adequate sample.

Use when:

- The unit is larger than 20 acres.
- The stand variability is relatively low.
- The take trees are marked and there is a tree count of them.
- The acreage is not known.
- Variable plot tree expansion is not accurate enough such as in pole cruising.

Examples

- Pole sales.
- Marked take trees (tree count is needed).
- Blow down sales.

Advantages:

- ☞ Reduces the number of trees to measure (compared to a 100% cruise).
- ☞ Does require visiting every tree.
- ☞ Fairly easy to understand.
- ☞ Usable where acreages are not firm, if strip spacing is accurate and adjustments are made for irregular boundaries.

Disadvantages:

- ☞ Sampling error is present.
- ☞ Usually requires more trees to measure than any other method except 100%
- ☞ There greater possibility of tree count error than with 100% ITS or 3P.
- ☞ Some advanced stand information needed prior to cruising.

Field procedure Using FPS:

1. Gather the required information prior to cruising.
 - a. Acres.
 - b. Cruise design (see cruise design section).
 - c. Make a systematic sample of the sale area being cruised. Properly designed systematic samples normally produce superior results for [fixed plot cruises](#) than those completed on a random basis.
 - d. A map with nested points and cruise lines.
2. To determine the number of plots needed to get the desired standard error use the following formula. Remember that a strip is usually divided into ½ acre (66' wide by 330' long) plots.
 - a. Needed Information:
 - i. Acres of project

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- ii. Acres of plot size
- iii. Estimated coefficient of variation (by recon cruise or local knowledge)
- iv. Target standard error

Formula:

$$P = \frac{A_s \times CV\%^2}{A_s \times SE^2 + CV\%^2}$$

Where: P = the number of plots needed
A_s = the sale acres divided by the plot size in acres
CV% = coefficient of variation of the volume
SE% = desired sampling error in percent.

Example 1:

You plan to put a [strip cruise](#), broken into ½ acre plots, on an 80 acre unit with an estimated coefficient of variation of 45% for half acre sampling units.

$$P = \frac{80 / 0.5 \times 45^2}{80 / 0.5 \times 6^2 + 45^2} = 41.6 \text{ or } 42 \text{ plots}$$

You need 42 half acre plots which equals 21 acres of plots. To determine percent cruise divide total plots acres (21) by the total unit acres (80) and multiply by 100. This equals 26%.

Determine distance between the strips for this 26% cruise. Convert the percent back to its decimal (26% / 100 = .26). Then divide the intended strip width by this decimal to get the distance between center lines of strips.

Using our example:

Strip width 66' / .26 = 253.8' between strip centerlines.

Determine the expansion factor by dividing 1 by the percent of cruise expressed as a decimal.

Using our example:

1 / .26 = 3.846

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Example 2:

You plan to use 1/5 acre circular plots to cruise an 80 acre unit with an estimated coefficient of variation of 42%.

$$P = \frac{80 / 0.2 \times 42^2}{80 / 0.2 \times 6^2 + 42^2} = 43.6 \text{ or } 44 \text{ } 1/5 \text{ acre plots}$$

Determine equal distance grid between plots by:

$$D = \sqrt{\frac{43,560 \times A}{P}}$$

Where: *D* = the distance in feet between plots

A = the total acres in the cruise unit.

P = the number of plots needed

$$D = \sqrt{\frac{43,560 \times 80}{44}} = 281 \text{ ft.}$$

You will set your plots on a 281' by 281' grid.

Your 44 1/5 acre plots equals 8.8 total plot acres. To determine percent cruise divide total plots acres (8.8) by the total unit acres (80) and multiply by 100. This equals 11%.

Determine the expansion factor by dividing 1 by the percent of cruise expressed as a decimal.

Using our example:

$$1 / .11 = 9.090$$

Acres	% Cruise	Cruise line spacing	Expansion Factor
60 +	20%	330 feet	5.0
41-59	30%	220 feet	3.3
21-40	40%	165 feet	2.5
20 or less	100% or ITS		1

Table 2 - FPS Expansion and Spacing

3. Cruise strip location is critical when using this cruise method. Locate cruise lines so they cross water courses and ridges at right angles as nearly as practicable. Heavy stands often occur in narrow strips along creeks and draws. If cruise strips are run parallel to these strips or bands of heavy timber, the cruise sample will not be representative of the sale area.
 - a. Run all cruise strips so that all types and age classes are adequately sampled. A reliable type map, topographic map and photograph can be most helpful in the efficient planning of a timber cruise.
4. Tree count of "take" trees.
5. For circular plots use nth acre plots set at equal distances on cruise strip.

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6. If nested points are not available, then a **base line** must be established on the ground.
 - a. All base lines should be accurately located, measured and marked on the ground.
 - b. Preferably use a single straight line, which runs at right angles to cruise strip direction.
 - c. Locate the base line so that all necessary cruise strips will intersect it.
7. From the sale boundary set the first cruise strip at a distance along the base line, which is $\frac{1}{2}$ the distance between cruise strips.
 - a. For example, on a 20% cruise the cruise strips are set 330 feet apart the first cruise strip should be set 165 feet from the boundary.
 - b. Measure the distance from the last strip to the boundary to make sure that it is $\frac{1}{2}$ the distance between cruise strips.
8. Cruise the area between centerline and the boundary with ITS using the same expansion as the cruise.
 - a. *Example:*
 - i. *20% cruise you would cruise every fifth tree.*
 - ii. *Or adjust the strip width in proportion with the distance to the boundary.*
 - b. To do this:
 - i. *Multiply the distance to the boundary by the decimal percentage.*
 - c. *Example:*
 - i. *Distance to boundary is 120' instead of 165' on a 20% cruise.*
 - ii. *$120' \times .20 = 24'$. The strip width on the side next to the boundary should be 24' instead of 33'.*
9. Locate each cruise strip along the base line and mark it with flagging. Write the cruise strip on the flagging. Hang flagging on the base line in between cruise strips if necessary to help in locating cruise strips.
10. After the base line has been established locate the beginning of the first cruise strip on the ground, marking the beginning and the end of each cruise strip with flagging and indicate the line number and the direction of travel.
11. Mark the centerline with intervisible white flagging. Mark beginning and end of each plot with flagging.
12. Write plot number on the flagging with a paint pen.
13. Pace or chain the cruise strip to set plot length.
14. When accurate sale acres and actual total length or cruise strip are known, cruise strip acres can be calculated and true percent of cruise can be computed. This method eliminates the need to adjust for irregular shape sale boundaries or cruise strip spacings.

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15. Use continuous one-half acre rectangular plots 66 feet in width and 330 feet in length.
16. Cruise for volume and grade all merchantable trees, green or dead, standing or down, on both sides of the centerline of the plot.
17. Measure strip width frequently. Strips usually are 66 feet or 1 chain in width.
18. Measure strip width from the center line, 33 feet on either side of the center line.
19. Always measure borderline trees. If the tree's center at DBH is within 33 feet of the center line the tree is "in".
20. Irregular boundaries that parallel the cruise strip use ITS with the same expansion factor as the strip. For example: On a 20% FPS cruise every fifth tree on the boundary side of the center line.
21. 100% cruise high value minor species.
22. Use sufficient time to obtain an accurate cruise.
23. Works best with two people.
24. Take time to measure DBH & heights.
25. Measure the DBH of most all trees and definitely all larger trees using a diameter tape.
26. Cruiser shall not work strictly from the strip centerline. Height, defect and grade will require moving to various locations for a complete look at the tree.
27. Measure a minimum of one tree for height on each plot using a Relaskop tape.
28. Cruise all blowdown trees situated so that that junction of the root wad and centerline of bole is within the cruise strip.

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CHAPTER 6 - TREE MEASUREMENTS

Entering Cruise Data and Tree Measurements

This chapter explains how to enter cruise data into the [SuperACE](#) cruise program and how to make the various tree measurements.

Cruise data may be entered into SuperACE two ways, manually from plot cards or electronically from a data collector using the SuperEasy data collection program.

This chapter describes how cruise data is entered on the SuperACE tree input screen. The abbreviations shown on the input screen are shown inside brackets []. Items shown as (Required) must be filled in.

Type Master Screen

The type master (Figure 2) contains information about the cruise such as the legal description, acres, cruiser, plot expansion factors and age class. Once the new cruise is entered the legal description, tract name and type number can no longer be edited.

User tip! Do not use a space or special characters such as periods, dashes or commas in any of the top row of fields.

Figure 2 - Type Master Screen

1. Township [TWN] (Required)

Enter the township designation including N.

2. Range [RGE] (Required)

Enter the range designation including E or W.

3. Section [SEC] (Required)

Enter the section number. If a timber sale unit occurs in more than one section use the section number containing the largest portion of the unit.

4. Tract (Required)

Enter the timber sale name. Up to twelve characters, alphanumeric. Spaces are ok.

5. Type (Required)

Enter the timber sale unit number. Up to four characters, alphanumeric. No spaces or special characters.

6. Acres (Required)

Enter the net or cruised unit acres. May be entered to the nearest tenth acre.

7. Cruiser

Enter the cruiser's initials or name, alphanumeric

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8. Month (Required)

Enter the current month in numeric. 1 = Jan, 2 = Feb etc.

9. Year (Required)

Enter the current year. (Ex. 2006)

10. Basal Area Factors [BAF]

Enter the basal area factor with up to two decimals used for a variable plot cruise. (Ex. B1 = 40.0)

Up to 5 BAFs may be entered. See Table 3 for available BAFs on the Relaskop and the figure below for identifying the scales on the Relaskop.

Beginning from the left: *	plus this # of small bars:	BAF	PRF (center)	LDF (face)
0 to 10	0	10.00	2.750	2.708
20 to a	3	11.79	2.533	2.491
10 to a	1	13.61	2.357	2.315
20 to a	4	15.69	2.196	2.154
10 to a	2	17.78	2.062	2.021
0 to 20	0	20.00	1.944	1.903
10 to a	3	22.50	1.833	1.792
20 to a	6	25.15	1.734	1.692
10 to a	4	27.78	1.650	1.608
10 to a	5	33.61	1.500	1.458
0 to a	0	40.00	1.375	1.333
0 to a	1	46.94	1.269	1.228
0 to a	2	54.44	1.179	1.137
0 to a	3	62.50	1.100	1.058
0 to a	4	71.11	1.031	0.990
0 to a	5	80.28	0.971	0.929
0 to b	0	90.00	0.917	0.875
10 to c	-	160.00	0.687	0.646
0 to c	-	250.00	0.550	0.508
0 to d	-	360.00	0.458	0.417

Table 3 - BAFs Available on the Relaskop

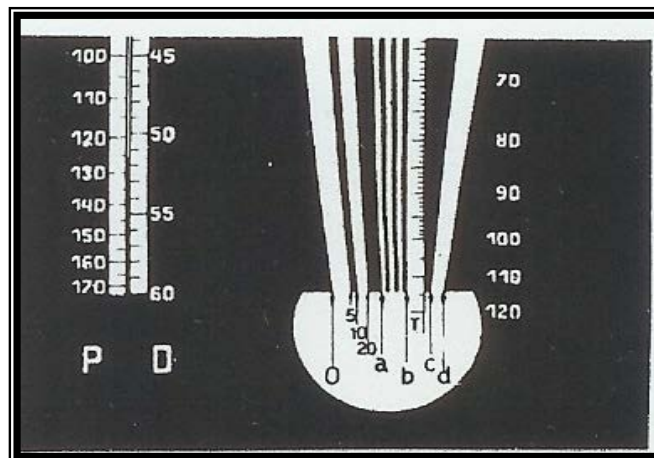


Figure 3 - Scales on a Relaskop

11. Fixed Area Plot

Enter the fixed plot size as a decimal fraction of an acre. (Example: 1/10th acre plot = 0.1)

12. Strip Cruise

Enter the expansion factor for a strip cruise as a decimal fraction. (Example: 25% strip cruise = 4.0) A 100% cruise may be entered as a 1.0 expansion.

13. Age (Required)

The average age for age class components of the stand. Enter the stand age in years. Up to nine ages may be used for different age class components. Over 40 years: Round ages to the nearest 10 years. Under 40 years: Determine ages to the nearest five years.

More than one age class may be given if the stand has two or more ages separated by more than 50 years.

TC - Tree Input Screen

14. Plot Number (Required)

Enter up to a four digit plot number, alphanumeric.

15. Tree Number (Required)

Tree numbers are entered automatically. Three digits numeric.

16. Expansion factor [PF] (Required)

Enter the code from the master screen. Two digit alphanumeric. Enter as “B1”, “B2”, “B3” etc. BAFs may also be entered directly, if there are no decimals needed.

User tip! For two digit BAFs the number may be entered instead, such as “20”, “30”, or “40”.

100% - Expansion factor – code “S1” from master page.

Fixed Plot – expansion factor – Code “F1” from master page.

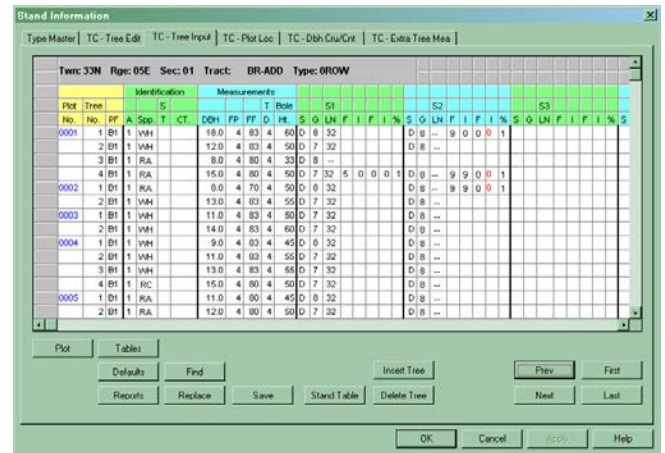


Figure 4 - Tree Input Screen

Tree Identification

17. Age [A] (Required)

Enter the age code “1 through 9” from the type master for the appropriate tree age.

18. Species [Spp.] (required)

Enter the alpha or numeric code for the species shown in table 4. *Note that species in red italics are considered non-commercial and are not normally included in a timber sale evaluation.*

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Numeric Code	Alpha Code	Description
2	DF	Old Growth Douglas-fir
4	DF	Douglas-fir
6	WH	Western Hemlock
8	GF	Grand Fir
10	SS	Sitka Spruce
12	WR	Western Red Cedar
14	WP	Western White Pine
16	NF	Noble Fir
18	AF	Subalpine Fir
20	AY	Alaska Yellow Cedar
22	MH	Mountain Hemlock
24	PP	Ponderosa Pine
26	LP	Lodgepole Pine
28	ES	Engelmann Spruce
30	WL	Western Larch
32	BM	Big Leaf Maple
34	CW	Black Cottonwood
36	RA	Red Alder
38	BR	Birch
40	AS	Aspen
42	WB	White Bark Pine
44	CH	Cherry
46	OK	Oregon Oak
48	OA	Oregon Ash
53	PY	Pacific Yew
54	MA	Pacific Madrone
57	DGW	Dogwood
61	CAS	Cascara
62	WIL	Willow

Table 4 - Species Codes

19. Status [ST] (optional)

Use Status to identify specific information about a tree such as “leave” or “take”, “grant”, tree class or damage. The code is alphanumeric and must be a single digit. Status Codes are defined in the Status Table.

20. Count [CT.] (Optional)

Enter the number of trees or “0” if a “void plot”.

Tree Measurements

Measuring DBH

Using a diameter tape accurately measure each tree’s DBH. The DBH point is measured 4.5 feet from the high side of the ground or 4.0 feet from the lowest possible stump height. Tree diameters may be recorded to the nearest one-tenth inch or recorded in one inch classes.

When using one-inch classes round the diameter down on the 0.5. Measure the DBH at a right angle to the center line of the tree.

Measuring DBH on forked trees: Measure the forks as two separate trees if the fork occurs below DBH. If the fork occurs above DBH then measure as one tree. In this case the tree may require a [defect](#) deduction.

Swelled butt trees should be measured as is. A volume reduction may be needed. The [form factor](#) will take care of butt swell.

In a VP cruise accurate DBHs are needed for trees per acre expansion. As a rule of thumb measure DBH on trees up to 16 inches to the nearest one-tenth inch. On larger trees, measure the trees to the nearest one inch.

Estimating DBH: Most cruisers will estimate DBH on some trees to save time and increase their plot production. It's important to keep in mind that any estimation may introduce a bias into the cruise. Usually, this bias is not as significant to volumes as other measurements like basal area or bole height. However, if trees per acre is an important measurement the bias can be significant.

21. Diameter at breast height [[DBH](#)] (Optional)

The DBH recorded represents the outside bark diameter at 4 feet above lowest possible [stump height](#) (typically with a six inch stump).

Sighting Height

Sighting height is the point on the tree's bole at which "in/out" is determined when using a variable plot. By default the sighting height is 4 feet above the [stump height](#). However, if excessive brush makes this point difficult to see, a sighting height of 16 feet above the stump may be chosen. Be consistent in choosing a sighting height throughout a cruise.

22. Sighting height [FP] (Required for measure trees)

By default this is entered as a '4' for four feet above the stump where the tree is sighted "in" or "out".

Form Factor

Form factor is the ratio of the [form point](#) diameter outside the bark to the DBH. The form factor is determined by dividing diameter outside bark at 16 feet above stump height by the DBH. Record the ratio to two decimal places. Form factor must be less than 1.00.

Methods and examples for determining form factor:

At sixteen feet from the tree using the percent scale on the Relaskop measure down to [stump height](#). Subtract that percent reading from 100 and measure up the tree to that percent. That point is 16 feet above the stump. Each bar has a value of 1 inch at this distance. So, count the number of bars it takes to span the diameter of the tree. To get Form factor, divide the number of bars at 16 feet by the DBH.

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Example:

Stump reading 25%

Form point reading 100% - 25% = 75%

DBH = 18.4 inches

Form point Diameter = 15.5 inches

Form factor = 15.5 / 18.4 = .84

At 33 horizontal feet from the tree, use the Topo scale on the Relaskop to measure down to stump height. Subtract that Topo reading from 33 and measure up the tree to that Topo reading. That point is 16 feet above the stump. Each bar has a value of 2 inches at this distance. So, count the number of bars it takes to span the diameter of the tree. To get Form factor divide the number of bars times 2 at 16.5 feet by the DBH.

Example:

Stump reading 12 Topo

Form point reading 33 Topo - 12 Topo = 21 Topo

DBH = 24.8 inches

Form point = 11 bars X 2 = 22 inches Diameter

Form factor = 22 / 24.8 = .89

At any distance from the tree estimate 16.5 feet above the stump and with the Relaskop count the number of bars. Next count the number of bars at DBH. To get Form factor divide the number of bars at 16.5 feet by the number of bars at DBH. See Cruising equipment to understand the use of Relaskop.

Example:

Bars at DBH = 8.5

Bars at form point = 7

Form factor = 7 / 8.5 = .82

Ideally, form factor could be measured on each tree cruised. To save time, however, a common practice is to average the form factor by species and apply it to all trees of that species. This is satisfactory if the average form factor is arrived at through proper sampling. The number of trees to sample for form factor can be computed statistically; however, in most cases 15-25 trees in each of the major species per sale will be adequate. More should be sampled, of course, when the form factor is more variable. The selection of form factor sample trees should be unbiased, but must be selected proportionally to their volume or weighted proportionally to their volume weight in the cruise area. Suggested selection systems are as follows:

When VP sampling a good technique is to select every nth tree tallied on the points based on the number of trees you expect to tally and the number of trees you want to sample for form factor. VP trees are selected proportionally to their size which correlates very closely to volume, and therefore, the form factors collected can just be averaged.

Form factor sampling under FPS or [ITS](#) sampling would again be done by taking every nth tree tallied based on expected number of trees to be tallied and the number of sample trees needed. However, since trees are not selected proportionally to volume the sample form factor by tree should be weighted by the approximate volume of the tree.

23. [Form Factor](#) [FF] (Optional)

Record the form factor for each cruise tree. If the form factor field is left blank the form factor value entered into the Species table for that tree's species will be used by default.

Determining Top Diameter

The top diameter determines the point on the tree at which the tree's height is measured. You may vary this from tree to tree or be consistent throughout the stand. Being consistent, however, will often increase both accuracy and efficiency. In any case the diameters are always determined using diameter outside the bark (D.O.B).

Using total tree height:

Enter a '0' for TD to indicate that the bole height represents total tree height. It's recommended, however, total tree height only be used for trees smaller than eighteen (18.0) inches DBH. Often it is easier to see the top of smaller trees than a lower point on the bole obscured by branches. There is also less error in measurement if the top of the tree is clearly visible. Do not use total height on trees with broken or highly deformed tops.

Using percentage of form point:

For most merchantable conifer measuring the bole height to a percentage of form point is often more accurate and efficient. Typically, 40% of the form point d.o.b. is a good approximation of a tree's merchantable height. Enter a '4' for TD to indicate bole height represents 40% of the [DOB](#) at form point (16 feet above the stump height). For some species which have higher taper a higher percentage ratio may work better. Large Western Red Cedar and older Ponderosa pine are examples. In this case use 50% by entering "5" in the TD column.

Using a fixed top diameter:

Measure the bole height to a fixed top diameter for trees with broken tops or where the top is forked or obscured by branches. The minimum [merchantable top](#) diameter should not be less than five-inches (5.0) d.i.b. westside scale, (4.5 inches dib eastside scale). Use the alpha code from Table 8 to represent a bole height to a fixed top diameter. Note that the minimum [merchantable top](#) diameter for all species is five inches inside bark, except for Ponderosa pine which is six inches. Bark thickness must be accounted for when determining the location on the bole where the minimum merchantable height occurs.

24. **Top Diameter** [TD] (Required for measure trees)

Enter a number from 0 to 9 representing a fractional top diameter or the alpha code from the Table 5 matching the top diameter that's measured.

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Inches Top <u>DOB</u>	Inches Top <u>DIB</u> *	Alpha code	Inches Top DOB	Inches Top DIB	Alpha code	Inches Top DOB	Inches Top DIB	Alpha code
1.0	0.9	A	10	9.0	J	19	17	S
2.0	1.8	B	11	10	K	20	18	T
3.0	2.7	C	12	11	L	21	19	U
4.0	3.6	D	13	12	M	22	20	V
5.0	4.5	E	14	13	N	23	21	W
6.0	5.4	F	15	14	O	24	22	X
7.0	6.3	G	16	14	P	25	22	Y
8.0	7.2	H	17	15	Q	26	23	Z
9.0	8.1	I	18	16	R			

Table 5 – Fixed Top DIB Codes

*DIB based on a bark thickness ratio of 0.90.

Methods for measuring bole height.

[Bole height](#) measurement requires two steps. The first step is to locate the point on the tree's bole at which to measure the tree's height. This point is usually a minimum merchantable diameter or a percentage of the [form point](#) diameter outside the bark and must be recorded for all cruise trees (See Top Diameter section 24).

The second step is to determine the distance between this point on the bole and the tree stump. Both the upper stem diameter and the height determination should be made with instruments such as a Relaskop or laser as accurately as possible.

Relaskop method:

With a Relaskop you may measure a tree's height from various distances depending on terrain, visibility and/or the tree's height. Pick a good location at which the tree's bole is

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clearly visible. Using a laser the horizontal distance to the tree can then be easily determined. Depending on the distance you may either use the topo scale or percent scale in the Relaskop. Table 6 summarizes some common scale multipliers to use at different horizontal distances. For example, at 66 feet each graduation on the Topo scale equals one foot of height and each single bar equals four inches of diameter

Using the Relaskop measure down to stump height. Then measure up the tree to the appropriate top diameter. If one measurement is negative and the other is positive, add the two together to get the correct height. If both measurements are positive, subtract the smaller number from the larger number to get the correct height.

User tip! Using the Relaskop look at 16.5 feet above the stump height and estimate the width of the bole in number of bars. Multiply the number of bars by the TD factor to determine the width of the bole at which to measure bole height.

Distance from tree in feet	Bar value in inches	Scale to use	Scale multiplier for height meas.
33	2	Topo	0.5
50	3	Percent	0.5
66	4	Topo	1
100	6	Percent	1

*Example:
Bole width at 16.5 feet 5 bars.
5 bars x 0.40 = 2 bars
This method works at any distance.*

Table 6 - Relaskop Scale Ratios

25. Bole height [Bole Ht] (Required for all cruise trees)

Enter the height in whole feet from the base of the bole to the point on the bole where the top diameter (TD) was determined.

Log Sort

26. Sort [S] (Required for measure trees)

Each tree's log segment must have a sort code. The sort code is used to distinguish logs suitable for making higher value products from saw logs. By default, each log must have a sort code of "D" for a domestic saw log. Additional codes for other products are listed in Table 7.

Code	Description
D	Domestic Saw Log
H	High-Quality
M	Mini-Peeler
P	Pole

Table 7 - Sort Codes

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Log Grade

27. Grade [G] (Required for measured trees)

Enter the grade code for each log segment. See table 8 for West side grade codes and grade descriptions and table 9 for Eastside grade codes and descriptions. For a more detailed description of grades refer to the [NWLRA Grading Bureaus Log Scaling and Grading](#) publication.

West Side Code	Grade Name	Species group †	Min. small-end DIB	Min. length ft.	Max. Knot size in.	Min. ring count per in.	Recovery Rule ††
1	#1 Peeler	DF	30	17	90% clear	8	50%
2	#2 Peeler	DF	30	17	75% clear	8	35%
3	#3 Peeler	DF	24	17	1.5 in. *	6	100%
	Select	SS	30	16	90% clear	8	50%
	Peeler	WH	24	17			50%
	Peeler	CW	24	8			
4	Special Mill	All except RC	16	17	1.5 in. **	6	65% lumber or 100% veneer
5	1 Saw	DF	30*	16	90% clear	8	50%
		WH	24	16			35%
		SS	24	12		8	25%
		RC	28	16	90% clear		500 BF
		RA	16	8	75% clear		50%
		CW	10	8	4 knots		
6	2 Saw	DF, SS, WH	12	12	2.5 in.		60 BF
		RC	20	12			210 BF
		RA	12	8	50% clear		33%
		CW	6	8			33%
7	3 Saw	DF, SS, WH, RC	6	12	3 in		50 BF
		RA	10	8			33%
8	4 Saw	DF, SS, WH, RC	5	12			10 BF
		RA, CW	5	8			10 BF
9	Utility	ALL	2	12			10 BF
0	Cull	ALL					

Table 8 – Westside Log Grade Codes

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East Side Code	Grade Description	Species group †	Min. small-end DIB	Min. length ft.	Max. Knot size in.	Min. ring count per in.	Recovery Rule ††
P	#3 Peeler	DF	24	17	1.5 in. *	6	100%
	Peeler	WH	24	17			50%
S	Special Mill	All except RC	16	17	1.5 in. **	6	65% lumber or 100% veneer
1	1 Saw	DF	30*	16	90% clear	8	50%
		WH	24	16			35%
		PP	30	16	90% clear	8	50%
		WP	20	16	75% clear	8	25%
		RC	28	16	90% clear		500 BF
2	2 Saw	DF, SS, WH, WP	12	12	2.5 in.		60 BF
		RC	20	12			210 BF
		PP	24	12	75% clear	8	35%
		CW	6	8			33%
3	3 Saw	DF, SS, WH, RC, WP	6	12	3 in.		50 BF
		PP	24	12	50% clear	8	50%
4	4 Saw	DF, SS, WH, RC, WP	5	12			10 BF
		PP	12	12	2.5 in.		50%
5	5 Saw	PP	6	12			33%
6	6 Saw	PP	5	12			10 BF
9	Utility	ALL	2	12			10 BF
0	Cull	ALL					

Table 9 - Eastside Grade Codes

† Refer to table 10 for species applicable to specie groups.

†† Recovery rule is the % Net scale that must be recoverable or the minimum net scale in board feet.

* Knot indicators must be well-scattered a max. of one indicator per foot of log length.

** Knots must be well-scattered a maximum of one knot per foot of log length.

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Primary species rule	Applicable Species	Primary species rule	Applicable Species
Douglas-fir	No other	Western hemlock	All true fir (abies sp.), mountain hemlock, western larch
Red cedar	No other	Western white pine	Lodgepole, Engelmann spruce
Sitka spruce	No other	Red alder	Big leaf maple, birch, Oregon ash, other hardwoods
Ponderosa pine	No other	Black cottonwood	No other

Table 10- Applicable Grade Species

Table 10 presents the applicable Log Grade for species other than those listed as the primary species for the grade rule.

Log Length

28. Log (segment) length [LN] (Required for measured trees).

Each log (segment) must have a length entered. A maximum length of 99 feet may be entered for each segment. A variable log length should reflect how you expect the tree will be processed when it is harvested. Generally, log segments should not be less than 12 feet and no more than 40 feet. An exception to this is when cruising poles which may be up to 95 feet in length. The top log length may be left unspecified by using the special log length code “dash dash” (- -).

Using the “dash dash” for log length.

When a dash dash (- -) is entered for the log length in the last segment of the tree the log length will be calculated by the program. The length of the log will be determined by the bole height and the minimum top diameter specified for the species in the species table. The program will segment the tree into logs beginning from the stump up to either the point on the bole which is equal to the minimum top diameter or the entered bole length, whichever comes first.

For example, a tree with a bole length of 70 feet is given two 32-foot logs and a “- -“ in the third log. The minimum top for the species is 5 inches. If a 5-inch top diameter is calculated at 68 feet the third log will receive a length of 2 feet (including trim allowance).

If the top diameter of five inches is calculated at 78 feet the third log length will be truncated at 4 feet (trim included) because the bole length is less than the height to the five inch top.

Log Defect Deductions

29. Log defect deduction [F, I, %] (Optional)

Defect deductions on a log-by-log deduction may be made as a percentage of the log's gross volume, or as a length and/or diameter deduction as would be done by a log scaler. The deduction refers to the proportion of the log's gross volume that is defective and not suitable for the manufacture of lumber or veneer.

Defect may be entered for both board foot defect and cubic feet defect. The first two columns Defect containing 'F' and 'I' are used for entering board foot defect. The second two 'F' and 'I' columns are used for entering cubic defect.

All sides of the tree should be scanned for defect indicators. Often, very small indicators on the surface may be the only evidence of a sizable defect.

Check previously logged areas nearby for stump defect and net volume recovery factors. Making frequent visits to log yards and talking with trained log scalers about common defect and indicators in your area is also strongly encouraged.

Accurate net volumes are the true measure of a cruiser's skill and experience. The ability to make good defect calls are imperative to consistently accurate cruises.

Percent deduction

Up to a 99 percent deduction per log segment may be entered.

Enter the percent defect under the first "F" column (tens) and the first "I" column (ones). Follow this with two more "0"s in the cube section. Enter a "1" in the % column.

Example:

25% defect - 25001

Cull log - 99991

Length deduction

Enter the number of feet deducted from the log in the first "F" column. Up to nine feet may be deducted. If more than nine feet must be deducted then a percent deduction must be made instead.

Examples of length deductions are for defect such as crook, conks, forks and sweep.

Diameter Deduction

Up to a nine-inch scale diameter deduction may be made. This deduction is entered under the "I" column. Examples of inch deductions are ring shake, sap rot or frost checking.

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CHAPTER 7 – LOG UTILIZATION

Log utilization varies from region to region and even sale to sale. Utilization depends on the type of harvest system, the mill where the log is processed and the end product that is produced from the log. Cruise volume is determined by the utilization specifications that are employed in the cruise calculation.

Prior to cruising a sale, the cruiser should have a good understanding of the potential log markets the sale is available to. Most mills and processing facilities have very specific requirements for minimum and maximum log size, desired species and desired log lengths. Frequent visits to facilities and log yards within the cruiser's working area are a necessity for gaining this understanding.

This chapter provides guidelines on some of the more common utilization specifications employed in DNR timber sale cruises.

Minimum Log Size

1. Minimum log lengths and diameters by grade and volume are stated in the Official Rules for Log Scaling and Grading published by NW Log Rules Advisory Group. These minimums should not deviate from those specified in the Grading Rules.
2. All harvestable commercial species (see Table 11) in the cruise sample that meet the minimum log size are cruised. The tree should contain at least one twelve-foot log to a five-inch DIB top with a net scale of ten board feet. Generally, a tree with a seven or eight inch DBH will make a 12-foot long, five-inch diameter log and 10 board feet net scale.
3. Trees suitable only as utility logs may be cruised depending on market conditions. Utility logs may be cruised to a 2.0 inch minimum top DIB.
4. A top log that is less than 12 feet in length may be culled by the program. This volume may be recovered by changing the log lengths in the lower log segments to achieve maximum utilization.

Variable Log Length

1. Log segments may be cruised and graded in 2-foot multiples not exceeding 40 feet plus one foot per log segment for trim.
2. Log segment lengths should be chosen to maximize sort and grade recovery.
3. Envision how the tree would be bucked by a cutter or processor during harvest operations to help determine log lengths.
4. Peeler log lengths are generally 17 ft, 26 ft. and 34 ft.

Minimum Top DIB

1. Trees are cruised to a 5-inch DIB top or 40% of form point [DOB](#) at 16 feet above the stump, whichever is larger.

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2. Total height may be used for bole height, however, do not use on trees larger than 18 inches DBH or on trees with broken or deformed tops.
3. Utility logs may be taken down to a minimum 2.0 inches DIB.

Commercial Species

The following commercial species are recognized for including in DNR timber sales.

Name	Numeric Code	Abbreviation
Douglas Fir	04	DF
Western Hemlock	06	WH
Silver Fir	07*, 08	SF
Grand Fir	08*, 07	GF
Sitka Spruce	10	SS
Red Cedar	12	RC
White Pine	14	WP
Noble Fir	16	NF
Alpine Fir	18	AF
Alaska Yellow Cedar	20	YC
Mountain Hemlock	22	MH
Ponderosa Pine	24	PP
Lodgepole Pine	26	LP
Engelmann Spruce	28	ES
Western Larch	30	WL
Bigleaf Maple	32	BM
Black Cottonwood	34	BC
Red Alder	36	RA
Birch	38	BR
Whitebark Pine	42	WB

Table 11 - Commercial Species

* Indicates code used in the East-Side species code table.

Log Sorts

Log sorts identify the suitability of a log to meet certain product specifications. The default value for sort is “D” which identifies a Domestic saw-log sort, in other words, any log that may be utilized as a merchantable saw-log. The following sort definitions pertain to specific products that a tree or log may produce.

Mini-peeler (Sort code “M”)

- Species: Douglas-fir and western hemlock only.
- Suitable for rotary cutting veneer: no heart rot, checks, or shake.
- Maximum knot diameter: 1 inch and well scattered (less than one per foot of log length)
- Minimum top D.I.B.: 8 inches
- Maximum top D.I.B.: 11 inches (variable, may be larger depending on max. acceptable butt diameter)
- DBH range: 12 inches through 24 inches (Some processing facilities manufacture larger logs. Explore the market to determine how large of a log or maximum butt diameter, the local market will accept.)

High-quality Saw log (Sort code “H”)

- Species: Douglas-fir only.
- Maximum knot diameter: 1 ½ inch and well scattered (no more than one per foot of log length)
- Minimum top [D.I.B.](#): 12 inches
- Maximum top D.I.B.: none (variable, may be limited depending on max. acceptable butt diameter)
- DBH range: 16 inches and larger (Some processing facilities manufacture larger logs. Explore the market to determine how large of a log or maximum butt diameter, the local market will accept.)

Oversize Saw log (Sort code “O”)

- Species: Any
- Maximum butt diameter: 30 inches

Roughcut Saw log (Sort code “R”)

- Species: Douglas-fir and western hemlock.
- Knots are 3 inches or larger inside the scaling cylinder of the log segment. Knots are measured by the heartwood diameter of the limb so it takes an outside bark diameter much larger than 3 inches to create a heartwood diameter large enough.
- Lumber recovery is less than 65% net scale for standard and better grade.
- Minimum top: 12 inches DIB.

Douglas-fir poles (Sort code “P”)

- Suitable for the manufacture of utility poles.
- Trees with greater taper produce higher value poles on an MBF basis
- Pole segment shall be line straight⁶ from the center of the butt to center of the top of the pole.
- Minimum 1-inch sapwood
- No allowable defects in pole segment including knot clusters, rotten knots, crooks, scars, spike knots, decay or rot.
- Maximum knot diameter: 3 inches
- DBH range: 12 inches through 27 inches.

Red cedar poles (Sort code “P”)

- Suitable for the manufacture of utility poles
- Trees with greater taper produce higher value poles on an MBF basis

⁶ Line straight means that a straight line projected from the center of the top of the pole to the center at the base does not pass outside the body of the pole.

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- Pole segment shall be line straight from the center at ground line⁷ to center of the top of the pole
- No allowable defects in pole segment including knot clusters, rotten knots, crooks, scars, spike knots. Hollow butt rot not to exceed 10% of the butt area and at least 2 inches from the surface.
- Maximum knot diameter: 3 inches
- DBH range: 12 inches through 25 inches

Red alder sawlog (Sort code “D”)

- Any red alder suitable for the manufacture of lumber. Alder sawlogs are generally 8 inches DIB or larger. A 10 in. DBH tree or larger usually produces an 8 inch or larger saw log.
- Watch for black knots and grown over rotten knots.
- Free of large knot clusters and stain.
- #1 saw 16 in. DIB or larger
- #2 saw 12 in. to 15 in. DIB
- #3 saw 10 in. DIB or larger
- #4 saw 6 in. DIB or larger and 10 BF

Grading and Defect

1. Log grading defines a log’s surface and size characteristics according to specific Grade Rules defined by the Log Scaling and Grading Bureaus. Grades must be applied consistently and accurately according to established grade definitions.
2. Defect recognizes deformities, rot, checks, scars, and other forms of damage to a log that affects the amount of lumber recovery from a log. Defect reduces the gross [Scribner volume](#) and can affect the grade. Only defect occurring inside the [scaling cylinder](#) is considered because only Scribner volume is reported. Cubic volume defect is not considered in DNR timber sale cruises.
3. Visit log yards and sawmills to gain a better understanding of defect and defect indicators.

Scaling Rules

1. DNR uses scaling rules as defined by the Northwest Log Rules Advisory Group in the Westside Log Scaling handbook and the Eastside Log Scaling handbook. (www.nwlrags.com).
2. Westside log scaling rules are used for all regions west of the Cascade Crest and the portion of Southeast Region west of the Klickitat River.
3. Ponderosa pine in the Southeast Region is scaled using Eastside scaling rules.
4. Eastside log scaling rules are used in the remainder of Southeast Region and all of Northeast Region.

⁷ Ground line is measured at a point 6 feet from the base of the pole.

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5. A one-foot trim allowance is added to all logs.

CHAPTER 8 - CRUISE EDITING AND REPORTING

The Cruise Narrative and Report

The cruise narrative provides a detailed summary of the cruise design and field observations made during the cruise. The Cruise Report provides a detailed report on species, volumes, grades, sorts and cruise sample statistics for the cruise.

Who Initiates the Cruise Narrative and Report?

The lead cruiser initiates the Cruise narrative and report. The lead cruiser may also be responsible for the cruise sample and compilation of the cruise data.

Where can I find the Cruise Narrative template?

A template for the Cruise Narrative may be found on the [Product Sales and Leasing Division's](#) Sharepoint site. A copy may also be requested from the region's Cruiser.

What information is needed for the Cruise Narrative?

The cruise narrative documents who is responsible for the cruise, the cruise design, the cruise acreage by cruise unit, the average ring count, the cruise intensity and any field observations about high value timber products, access information, logging conditions and other relevant information.

Cruise Narrative							
Sublicense:		Region: Pacific Coast					
App. #:		Dist. #:					
Lead cruiser:		Complete date:					
Other conditions:							
Notes on specific features:							
Unit	Cruise size	Cruise acreage (acres)	Volume (cu ft)	Intensity (log/acre)	Ring count (log/acre)	Species (log/acre)	Total number of plots
1	100	100	100	100	100	100	100
2	100	100	100	100	100	100	100
3	100	100	100	100	100	100	100
4	100	100	100	100	100	100	100
5	100	100	100	100	100	100	100
6	100	100	100	100	100	100	100
7	100	100	100	100	100	100	100
Total	700	700	700	700	700	700	700
Notes on specific features:							
Unit	Sublicense (100, 1000)	Volume (cu ft)	Intensity (log/acre)	Ring count (log/acre)	Species (log/acre)	Plot size (log/acre)	Total number of plots
1	100	100	100	100	100	100	100
2	100	100	100	100	100	100	100
3	100	100	100	100	100	100	100
4	100	100	100	100	100	100	100
5	100	100	100	100	100	100	100
6	100	100	100	100	100	100	100
7	100	100	100	100	100	100	100
Notes on specific features:							
Major species:		Cruise or appropriate notes:					
Minor species:		Notes on Form-Forester: 1. 16 (see DNR 01-10-10)					
Avg. ring count:		RF =	WH =	SA =			
Log volume:							
Other conditions:							
Field observations:							
Notes:							
Prepared by:							
Title: Forest Officer							
CC: File							

Where to save the Cruise Narrative?

A PDF copy of the Cruise Narrative should be attached to the cruise report packet and stored in the Timber Sales Document Center (TSDC) Sharepoint site.

Who gets a copy of the Cruise Narrative and Report?

The lead Cruiser, lead forester, district forester, Product sales, management forester, and Product Sales and Leasing Division each receive a copy of the Cruise Narrative and Report.

SuperACE Cruise Reports

Prior to completing the cruise report each cruise report should be carefully reviewed by the cruiser looking for miscoded species, sort or grade codes, missing or incomplete data or inaccurate data. Any cruise report corrections or edits should be made prior to submitting the final cruise report packet.

How do I Read SuperACE Cruise Reports?

SuperACE has the capability to produce a wide range of cruise reports detailing cruise information from individual tree volumes to general cruise volume summary reports. This section identifies those reports that are commonly used in DNR for reporting timber sale cruise volumes. There are three general types of reports.

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- 1) **Project reports** – summarize the cruise information for one or more timber sale units (types) in a cruise. A “project” is defined as an individual timber sale consisting of one or more units (types). Project reports may be identified by the word “Project” or the (P) designation next to the report name in the Report Selection screen.
- 2) **Type reports** - reports that summarize cruise information for an individual type or sale unit. These reports may be identified by the word “Type” or the (T) designation next to the report name in the Report Selection screen.
- 3) **Edit reports** – these reports are intended for editing and reviewing cruise data.

Each report is identified by a title that appears both on the Report Selection screen and at the top of each page of the report. The header of each report includes the *project name*, *date* and *time* the report was run, and a *legal description* of the type or types included within the report.

Project reports show the total *acres* for all types included in the report. When there are multiple types included in a report only the first and last type’s legal description may be shown in the box in the upper left corner of the report.

Type reports summarize individual timber sale units. The header for the type report will include the full legal description of the unit, acres, the number of plots in the cruise and the number of trees sampled.

Which Reports are required for a Timber Sale Cruise Report?

The following four reports are required to report timber sale cruise volumes. Every timber sale cruise should include a copy of each report as a standard part of the cruise information packet. Additional reports, such as a stand table, log stock table, etc., may be included in certain instances.

- 1) Species, Sort Grade – Board Foot Volumes (Project)
- 2) Species, Sort Grade – Board Foot Volumes (Type)
- 3) Project Statistics
- 4) Statistics (Type)

How do I read the Species, Sort, Grade – Board Foot Volumes?

The Species, Sort, Grade – Board Foot Volumes reports (Sort/Grade folder) may be created for the entire timber sale (Project) or for individual units (Types) in the sale. Each report provides a summary of volume by species, sort, grade, and tree status. Each column in the report identifies the attribute and the unit of measure.

- 1) **Spp** – two letter alpha code for the species.
- 2) **ST** – a single digit code identifying the tree’s status. The status code may designate green, dead, leave or take trees. This is a user defined code.
- 3) **Sort** – identifies a log sort code. D is for domestic sawmill. CU is cull. The cruiser may define additional sort codes as needed.

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- 4) **Grad** – identifies the log grade. For example, 2S – 2 sawmill, 3S – 3 sawmill etc.
- 5) **% Net Bd Ft** – this is the percentage of the TOTAL volume within each species the grade represents.
- 6) **Bd. Ft. per Acre:**
 - a) **Def %** - the percentage of defective (non-merchantable) volume expressed as a percentage of the Gross BF volume per acre.
 - b) **Gross** – gross Scribner board foot volume per acre.
 - c) **Net** – gross Scribner board foot volume per acre less defective volume.
- 7) **Total Net MBF** – the total volume for the unit or project represented in units of thousand board feet (MBF).
- 8) **Percent of net board foot volume:**
 - a) **Log scale dia.** – Percentage of net volume in several log scale diameter classes. The user may redefine these classes.
 - b) **Log length** – the percentage of net volume in several log length classes. The user may redefine these classes.
- 9) **Average Log:**
 - a) **Ln ft.** – The average length of a log in linear feet.
 - b) **Dia In.** – The average scale diameter of a log in inches inside bark.
 - c) **Bd. Ft.** – the average log volume in board feet.
 - d) **CF/lf** – the average cubic foot volume per linear foot of log length.
 - e) **Logs per acre** – the number of logs per acre.

How do I read the Statistics Report?

Statistics reports may be created for both project and type summaries. Each report provides stand level and statistical information about the cruise sample. The report header lists the legal description of the type(s), acres, number of plots, number of trees sampled, the cubic foot volume equation, and the board foot scaling rule used. Below the header are report sections summarizing the cruise sample, the stand, and statistics for selected parameters.

1. Cruise Sample Section:

This section summarizes the cruise by plot type (for example: cruise plots, count plots, DBH count, etc).

- *Plots* – the number of plots for each plot type making up the cruise.
- *Trees* – the number of trees sampled on each plot type.
- *Trees per plot* – the average number of trees per plot for each plot type.
- *Estimated total trees* – this is the estimated total number of trees in the population for each plot type.
- *Percent sample trees* – the percentage of the estimated number of trees in the population sampled.

2. Stand Summary Section:

This section summarizes species and status the type or project by common stand parameters.

- *Sample trees* – the number of trees sampled in the cruise.
- *Trees/acre* – the number of trees per acre in the project or type.
- *Average DBH* – the quadratic mean diameter
- *Bole len* – the average length in feet for bole length. This is not the same as merchantable length.
- *Rel den* – Relative density or RD
- *Basal area* – basal area per acre in square feet.
- *Gross BF/AC* – gross Scribner board foot volume per acre
- *Net BF/AC* – net Scribner board foot volume per acre
- *Gross CF/AC* – gross cubic foot volume per acre
- *Net CF/AC* – net cubic foot volume per acre

3. Sample Statistics Section:

These sections summarize statistical information regarding the cruise. There are six attributes for which the statistics are summarized. All statistics are calculated to a 66% [confidence interval](#) by default.

- *Sample Trees – BF*: Describes the coefficient of variation (CV), percent sample error (SE%) and the number of cruise trees required for three levels of sampling errors. The values are based on the board foot volume of the cruised trees.
- *Sample Trees – CF*: Describes the same as Sample Trees - BF expressed in cubic foot volume.
- *Trees/acre* – Describes the CV and SE% for trees per acre by species. Reports the number of plots required to achieve three levels of sampling errors.
- *Basal area/acre* – Describes the CV and SE% for the basal area in square feet per acre. Reports the number of plots required to achieve three levels of sampling errors.
- *Net BF/acre* – Describes the CV and SE% for the net volume per acre in board feet. This is the parameter used in determining if the cruise meets the DNR cruise standard for the acceptable sampling error. Reports the number of plots required to achieve three levels of sampling errors.
- *Net CF/acre* – Describes the CV and SE% for the net cubic volume per acre in cubic feet. Reports the number of plots required to achieve three levels of sampling errors.
- *V Bar/acre* – Describes the volume to board foot ratio for each species. The volume to board foot ratio is the ratio of a tree's volume in board feet to its basal area in square feet.

What Cruise Reports are needed?

1. Regeneration Harvests:

- Species, Sort, Grade – Board Foot Volumes (P) (entire project)
- Project Statistics
- Species, Sort, Grade – Board Foot Volumes (T) (report for each Unit)
- Statistics (Type) (for each Unit)
- Species Summary – Tree, Logs, CCF, MBF (P) (entire project)

2. Thinnings

- Species, Sort, Grade – Board Foot Volumes (P) (entire project)
- Project Statistics
- Species, Sort, Grade – Board Foot Volumes (T) (report for each Unit)
- Statistics (Type) (for each Unit)
- Stand Table (Project) (entire project)
- Stand Table (Type) (for each Unit)
- Species Summary – Tree, Logs, CCF, MBF (P) (entire project)

Where do I save the Cruise data?

The Cruise Reports should be saved in you timber sale file on your local server, and/or your computers hard drive.

The Super Ace Cruise Backup Procedure.

It is very important that cruise data is routinely backed up during data entry and after completion of final editing of the cruise. When cruise data is being entered on a laptop pc by hand from plot cards there is always a potential that something may happen to the laptop and cruise data may become irretrievable. The process of backing up the cruise data is quick and very simple and potentially can save many hours of reentering lost data.

In addition once the cruise is completed and the cruiser is satisfied with the cruise data the project must be backed up to the region's network server. This insures that the project is stored in a location that is safe and also allows others to access the cruise information.

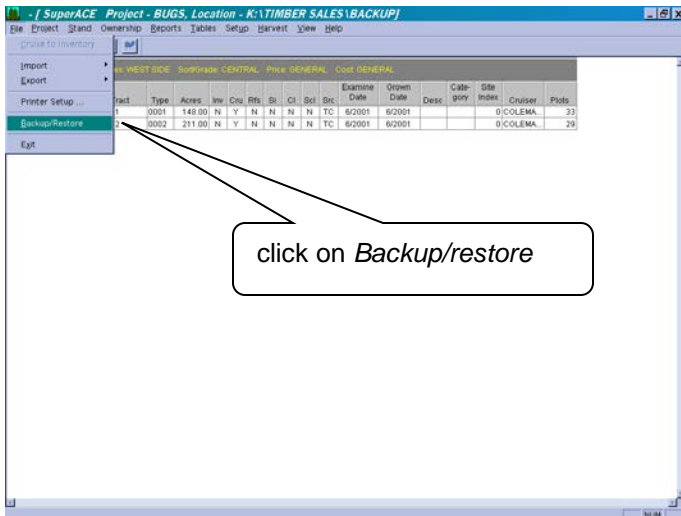
Follow these instructions to successfully backup a cruise project.

How do I save a SuperACE Cruise Project?

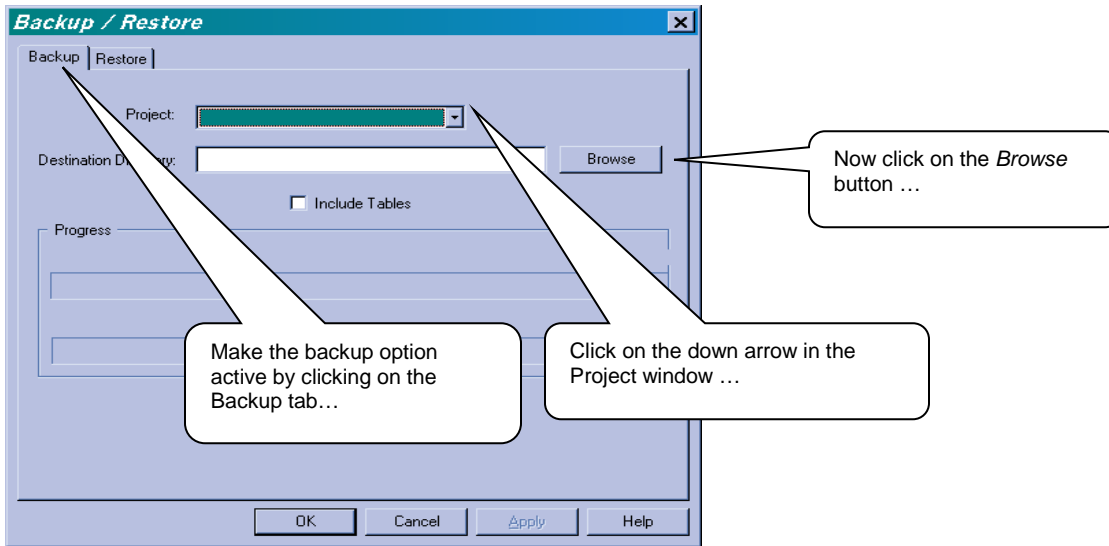
Interim backups are done while the cruiser is entering or in the process of editing cruise data. These backups are done on an as-need basis and should be stored on a local drive or jump drive. To perform interim backups follow these steps:

1. Start SuperACE if it is not already running.
2. Click once on *File* in the menu bar to open the drop-down menu and click on *Backup/restore* to bring up the backup/restore window.

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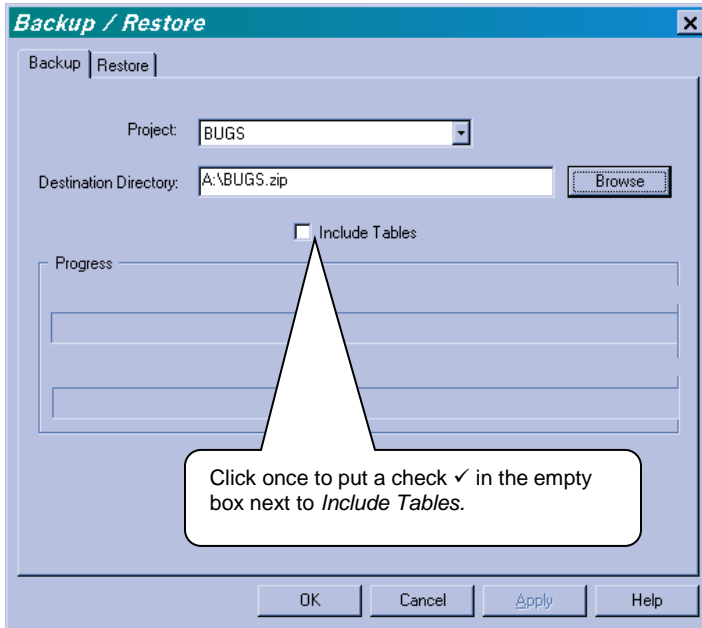
3. Make the backup option active by clicking on the Backup tab near the top of the window. The screen should look like this:



4. Click on the down arrow in the Project window to bring up the list of projects on your PC. Select the project you want to backup by clicking once on it.

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7. The backup window will now show the project name to be backed up and the destination where the backup file is to be stored. The backup file will automatically be given the project name with a zip extension after it.



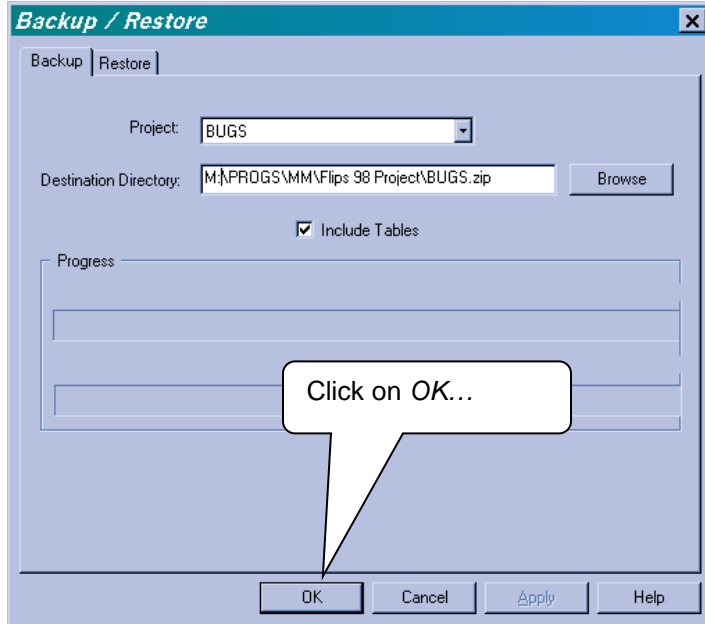
8. Click once to put a check ✓ in the empty box next to *Include Tables*. By doing this you will make a copy of the species, sort and grade tables that are active for this project. While not necessary it is always a good practice to include the tables since you may sometimes have set different merchantability standards to a particular cruise. This way there is a copy of these tables stored with the backup file.
9. Now click on the OK button. Be sure a disk is inserted in the drive and click OK. The project will now be backed up in a zip file on the drive.
10. If a backup of the same project was stored previously on the same disk the file will simply replace the previous backup with a new one.

Final Backup Procedure

When the cruise is complete and you are satisfied with the results you must make a backup of the final cruise onto your region's network. This is **REQUIRED** for all cruises completed for board or region sales.

1. Connect the laptop to the network and login if you have not already done so.
2. Startup the SuperACE program and follow steps 3, 4, 5 and 6 above. When you have reached the browse window for the destination select the M: drive and select the following path:
... \progs\mm\Flips98_project\data\FY_xx.

Note: Drive designations may differ between regions, for example: N or H drives may be used. Check with your IT coordinator for the specific drive in your region. The Backup/restore window should look similar to this when you are done.



3. Click on *OK* and the backup file will be copied to the network.

For additional information on backing up SuperACE projects refer to SuperACE on-line Help or the SuperACE user's manual.

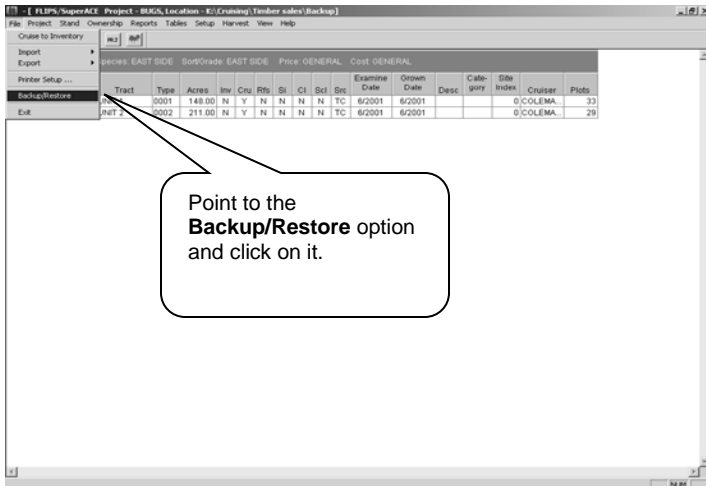
How do I restore a SuperACE Cruise Project?

Restoring a cruise in SuperACE is simple. By restoring a cruise you are simply making a copy of the cruise from the archived cruise data and storing it on your hard drive. Once you have the cruise restored you can run cruise reports, enter or change cruise data or modify the merchantability specifications for the cruise. Only the region cruiser, however, can modify the archived cruise data. This protects the integrity of the original cruise data. Thus, the restore option is helpful if you want to analyze several "what if" scenarios in a cruise.

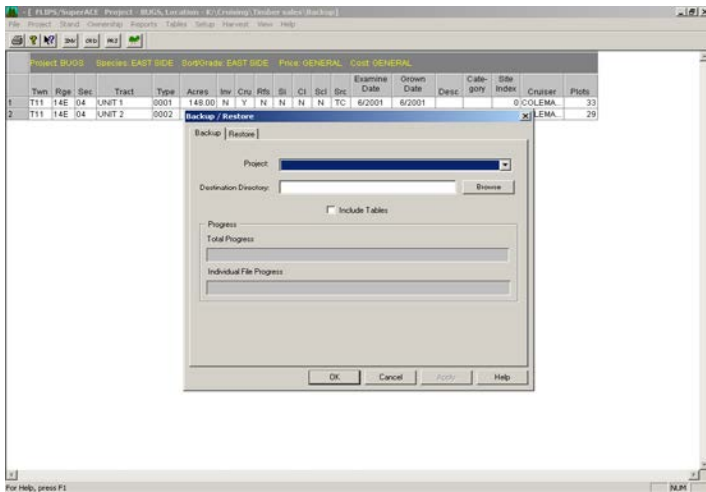
In order to restore a cruise you must first have SuperACE installed on your computer. If you do not, check with your IT coordinator about having it installed. Use the following steps to restore a cruise:

1. Start SuperACE by clicking on the desktop icon. Click once with the mouse on **File** located on the menu bar. A drop down menu will appear. Point to the **Backup/Restore** option and click on it.

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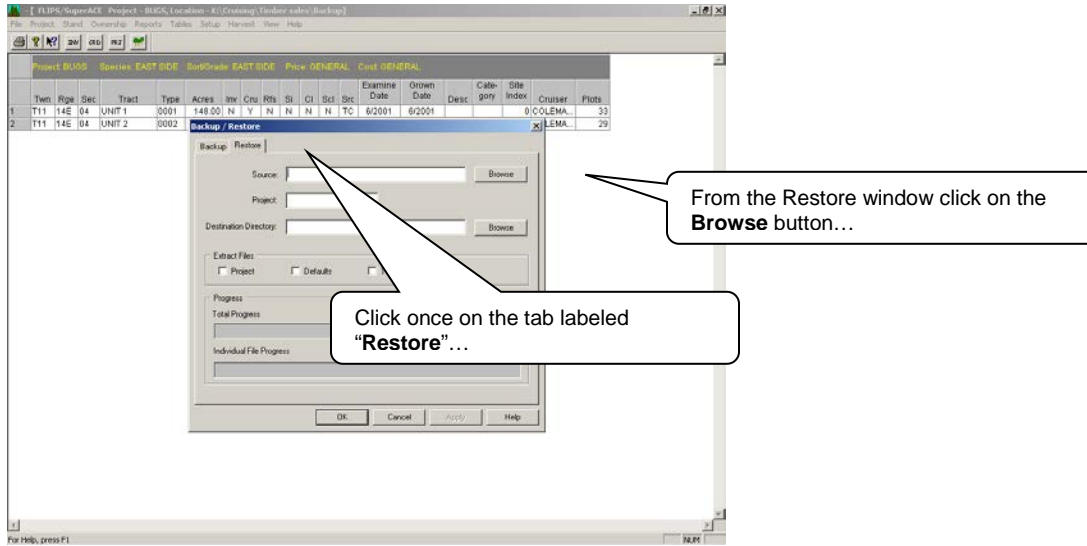


2. A Backup/Restore window will appear.

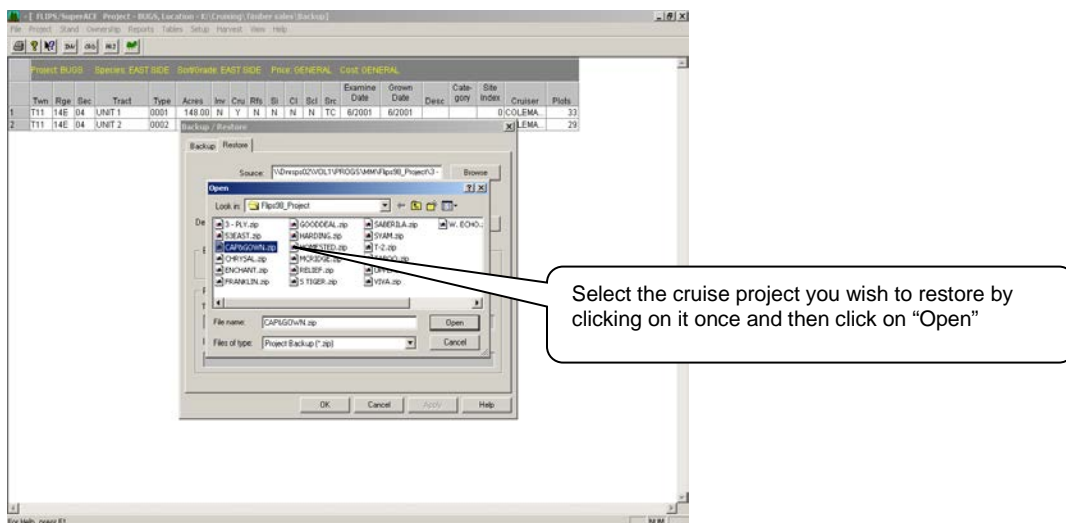


3. Click once on the tab labeled “Restore” to bring the restore option to the front.

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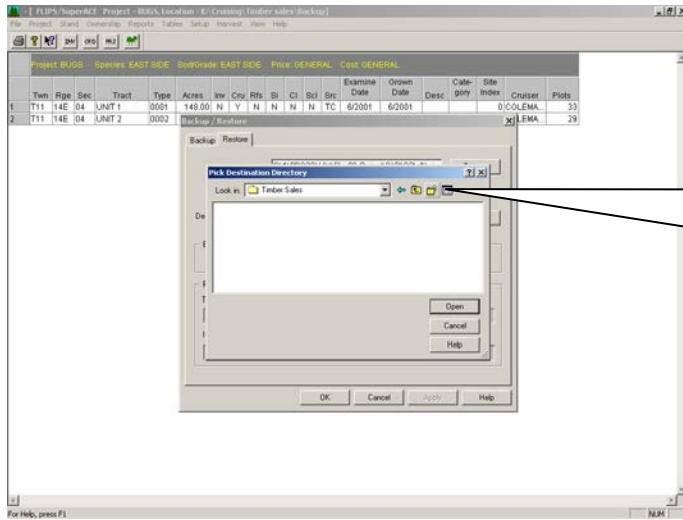
4. From the Restore window click on the **Browse** button and locate the source folder (the directory where the cruise archive is stored). When the Browse window pops up click on the down arrow (▼) next to the "Look in" window and navigate to the appropriate source directory. In most cases (Cruisers), the path should be: M:\progs\mm\Flips98_project.
5. Once the correct source folder appears in the "Look in" window the backup cruise project files will be shown in the window below. Select the cruise project you wish to restore by clicking on it once and then click on "Open". Note: the cruise project must have a ".zip" extension after the file name. The Restore window will now show the path to the source folder in the source window and the project name in the "Project" window.



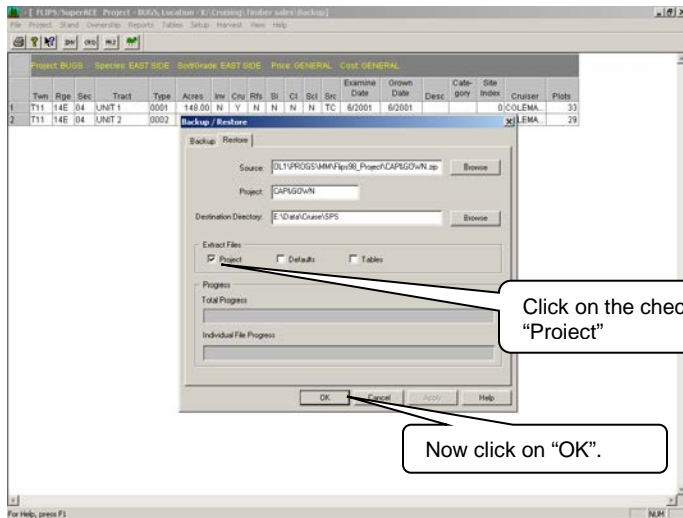
6. Now select the destination folder where the cruise project will be restored. This is usually located on your C:\ or D:\ drive at ...**data\timber sales**. If you do not have a folder on your C: or D: drive you can create one from the browse window. Click once on the new folder

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icon (the 2nd icon from the right next to the “Look in” window) and type the name of the folder in the “new folder” box.



7. Once the “Timber Sales” folder appears in the “Look in” window click on “Open”. The Restore window will now have the full path in the destination directory window.
8. Click on the check box labeled “Project” so that a check appears in the box.



9. Now click on “OK”. The project will be extracted and stored on your hard drive.
10. Click on the project button to bring up the list of projects. The restored cruise project will now appear in the project list.
11. Note that the restored cruise is really a copy of the original cruise. You may run reports on

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Regeneration Harvests:

- 1) Cruise Narrative
- 2) Species, Sort, Grade – Board Foot Volumes (P) (entire project)
- 3) Project Statistics
- 4) Statistics (Type) (for each Unit)
- 5) Species, Sort, Grade – Board Foot Volumes (T) (report for each Unit)
- 6) Species Summary – Tree, Logs, CCF, MBF (P) (entire project)

Thinnings

- 1) Cruise Narrative
- 2) Species, Sort, Grade – Board Foot Volumes (P) (entire project)
- 3) Species, Sort, Grade – Board Foot Volumes (T) (report for each Unit)
- 4) Species Summary – Tree, Logs, CCF, MBF (P) (entire project)
- 5) Project Statistics
- 6) Statistics (Type) (for each Unit)
- 7) Stand Table (Project) (entire project)
- 8) Stand Table (Type) (for each Unit)

Contract Harvests:

- 1) Cruise Narrative
- 2) Species, Sort, Grade – Board Foot Volumes (P) (entire project)
- 3) Project Statistics
- 4) Species, Sort, Grade – Board Foot Volumes (T) (report for each Unit)
- 5) Statistics (Type) (for each Unit)
- 6) Log Stock Table MBF and Tons (Project only)
- 7) Species Summary – Tree, Logs, CCF, MBF (P) (entire project)

How do I convert SuperACE Cruise Reports into a PDF file?

After the Cruise Narrative has been finished and all the cruise data has been input and errors corrected, the final cruise reports must be converted to an Adobe PDF format.

User tip! Prior to converting the cruise reports into PDF it is important to set the paper size to Letter.

1. On the printer setup window select “Letter” for paper size by clicking on the drop-down menu next to Size.
2. Select all the project units by holding down the control key and dragging it down all the units until they all turn black.
3. Go to Reports under the toolbar and drag down to cruise.
4. Under the Cruise- Reports/Graphs window select the reports needed by holding down the control key while clicking on the reports needed.

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File Project Stand Ownership Reports Tables Setup View GIS Link TES FVS Help

Project: TARANTULA Species: WEST SIDE Sort/Grade: WEST SIDE Price: GENERAL Cost: GENERAL

	Tw	Rge	Sec	Tract	Type	Acres	Inv	Cru	Rfs	Si	Cl	Sci	Src	Date	Grown	Desc	Category	Site Index	Cruiser	Plots
1	16N	06W	25	TARANTULA	00U1	45.30	N	Y	N	N	N	N	N	TC	6/2013	6/2013				
2	16N	06W	25	TARANTULA	00U2	68.00	N	Y	N	N	N	N	N	TC	6/2013	6/2013				
3	16N	06W	25	TARANTULA	00U3	55.00	N	Y	N	N	N	N	N	TC	6/2013	6/2013				
4	16N	06W	25	TARANTULA	00U4															
5	16N	06W	25	TARANTULA	00U5															

Go to Reports under the toolbar and drag down to 'Cruise'.

Select all the projects units by holding down the control button by dragging it down all the units until they all turn black.

1. Under Sort/Grade select:
 - a. Species, Sort, Grade Foot Volumes (P).
 - b. Species, Sort, Grade Foot Volumes (T).
2. Under Species select:
 - a. Species Summary- Trees, Logs, Tons, CCF, MBF (P).
3. Under Statistical Select:
 - a. Project Statistical.
 - b. Statistical (Type).

File Project Stand Ownership Reports Tables Setup View GIS Link TES FVS Help

Project: TARANTULA Species: WEST SIDE Sort/Grade: WEST SIDE Price: GENERAL Cost: GENERAL

Tw	Rge	Sec	Tract	Type	Acres	Inv	Cru	Rfs	Si	Cl	Sci	Src	Examine Date	Grown Date	Desc	Site Index	Cruiser	Plots	
1	16N	06W	25	TARANTULA	00U1	45.30	N	Y	N	N	N	N	TC	6/2013	6/2013			0KD	27
2	16N	06W	25	TARANTULA	00U2	68.00	N	Y	N	N	N	N	TC	6/2013	6/2013			0KD	40
3	16N	06W	25	TARANTULA	00U3	55.00	N	Y	N	N	N	N	TC	6/2013	6/2013			0KD	38
4	16N	06W	25	TARANTULA	00U4	3.80	N	Y	N	N	N	N	TC	6/2013	6/2013			0AA	3
5	16N	06W	25	TARANTULA	00U5	3.30	N	Y	N	N	N	N	TC	6/2013	6/2013			0AA	7

Click the process button to run reports

Cruise - Reports/Graphs

- Sort/Grade
 - Species, Sort, Grade - Board Foot Volumes (P)
 - Species, Sort, Grade - Board Foot Volumes (T)
 - Species, Sort, Grade - Cubic Foot Volumes (P)
 - Species, Sort, Grade - Cubic Foot Volumes (T)
 - Species, Sort, Grade - Doyle Scribner Counts (P)
 - Stand Summary By Sort & Cubic Grade Percents (WEY)
- Species
 - Board Area/Acre by Species (Bar)
 - Species by QUANTS (Pie)
 - Species by MBF (Pie)
 - Species by Trees Per Acre (Bar)
 - Species Summary - Logs and Volumes (Project)
 - Species Summary - Trees, Logs, Tons, CCF, MBF (P)
 - Volume Relationships by Species (Project)
- Statistical
 - Project Statistics
 - Project Statistics - Yield Table Species
 - Statistical Equation

Balance Taper Equation

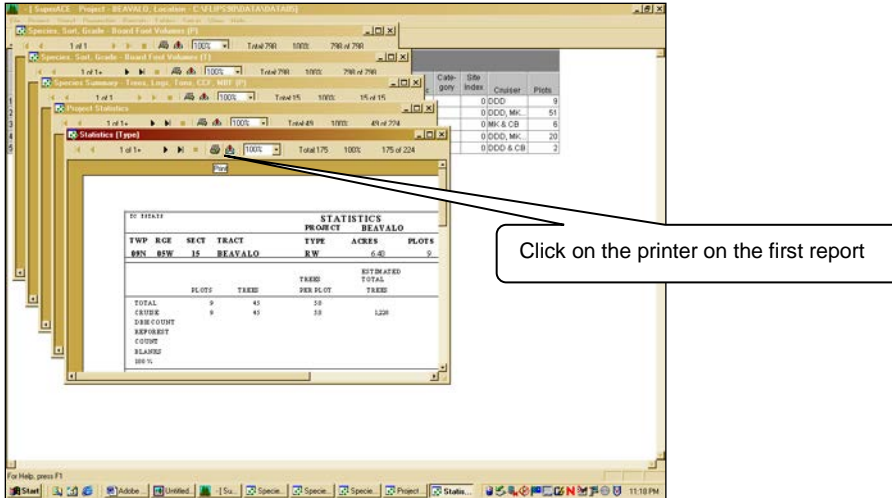
Foot Rule: Cubic Foot Rule:

Preview Apply Cruise Adjustments Include Status of Species

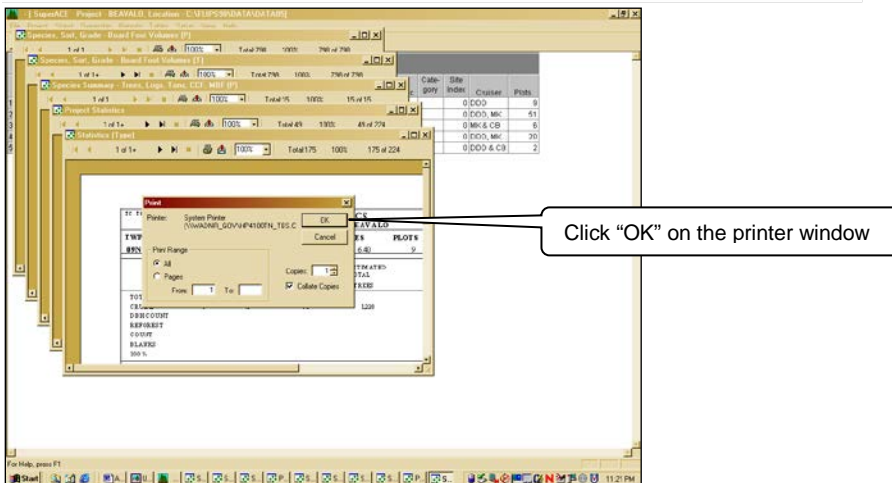
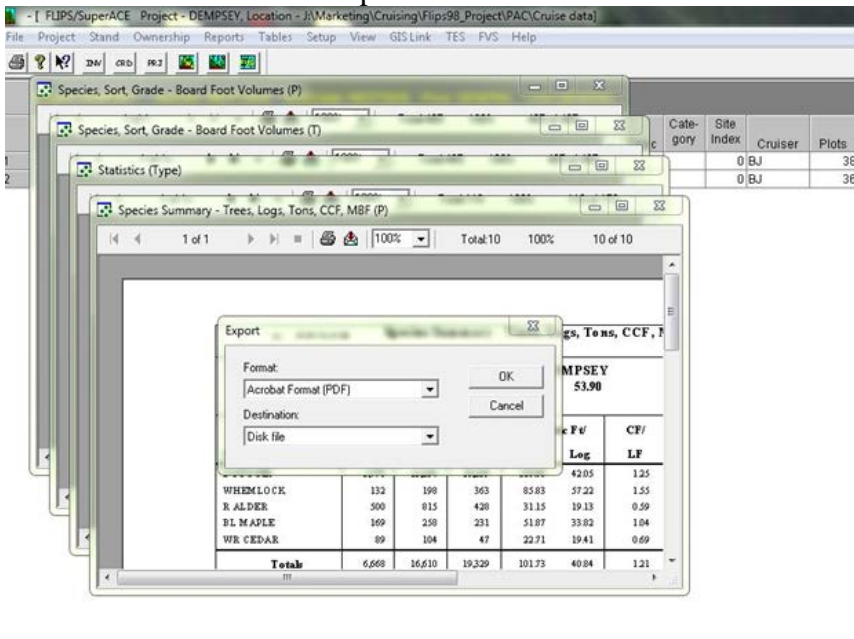
Process Cancel

4. Click the process button to run reports.
5. Click on the printer on the first report.

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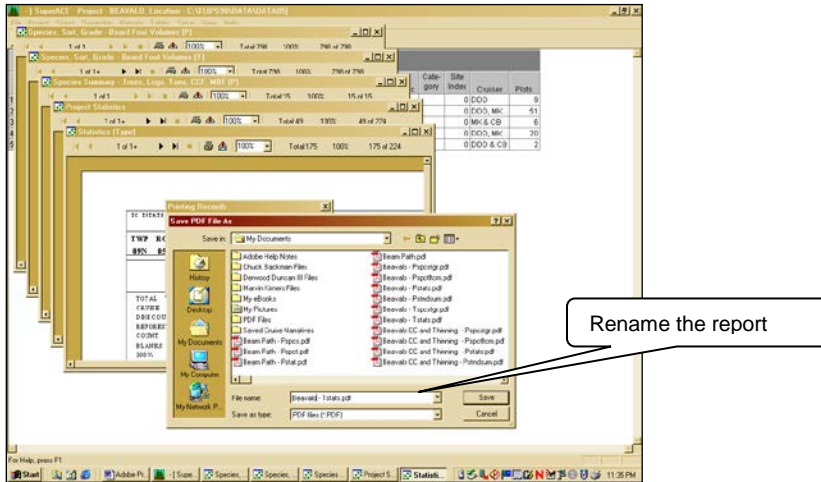


6. Click "OK" on the printer window.



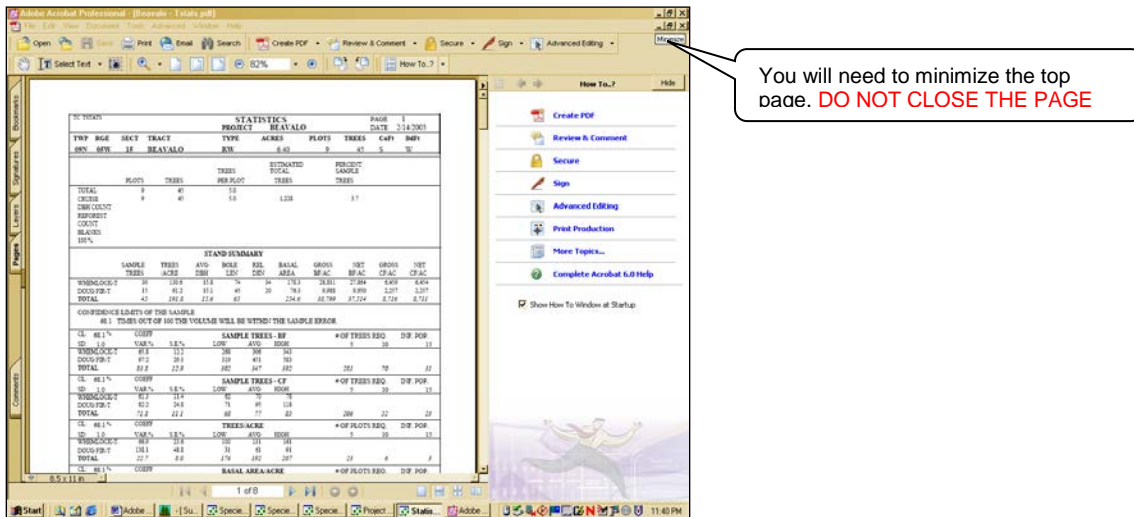
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- Rename the report (it is important to leave everything after the dash. This allows you to identify the report later).



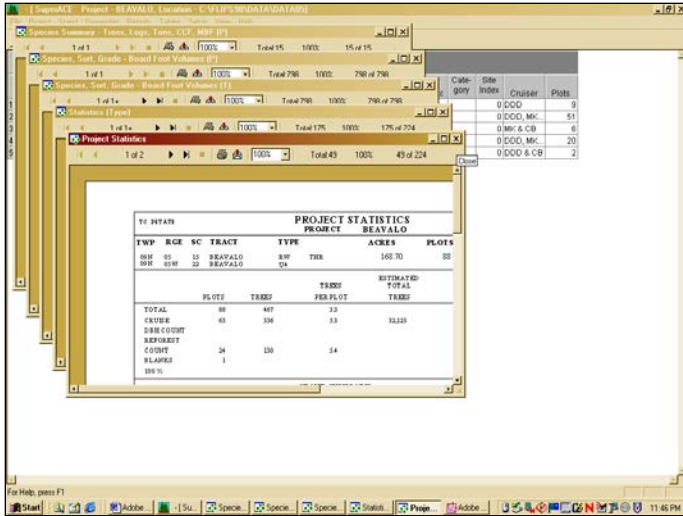
- Click save.

- Adobe will open. You will need to minimize the top page. **DO NOT CLOSE THE PAGE.**

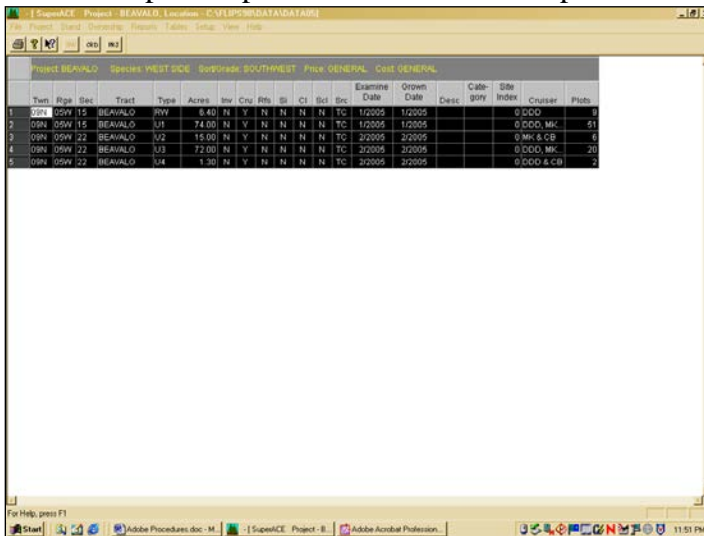


- Close out the report you just put into Adobe.

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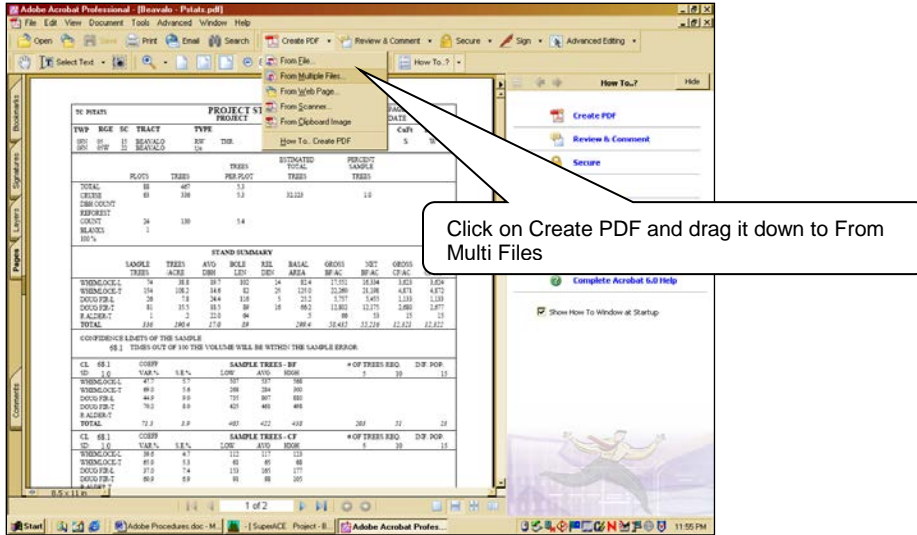
11. Repeat steps 5-10 for the other 5 reports.



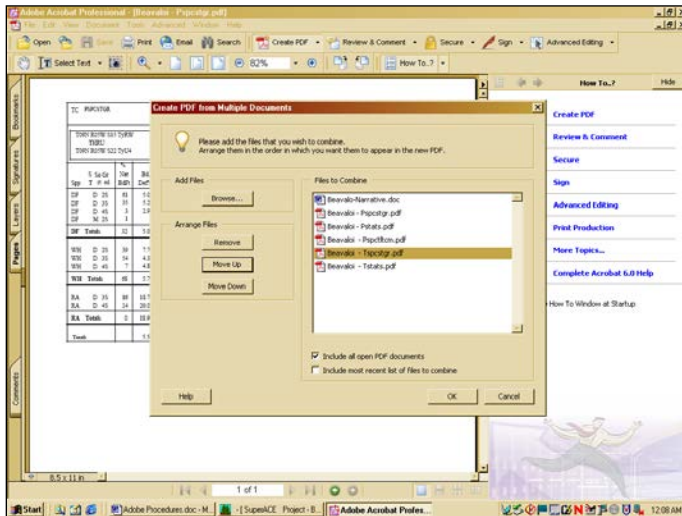
12. After closing the last report open Adobe by clicking on it below.

13. Click on Create PDF and drag it down to From Multi Files and select it.

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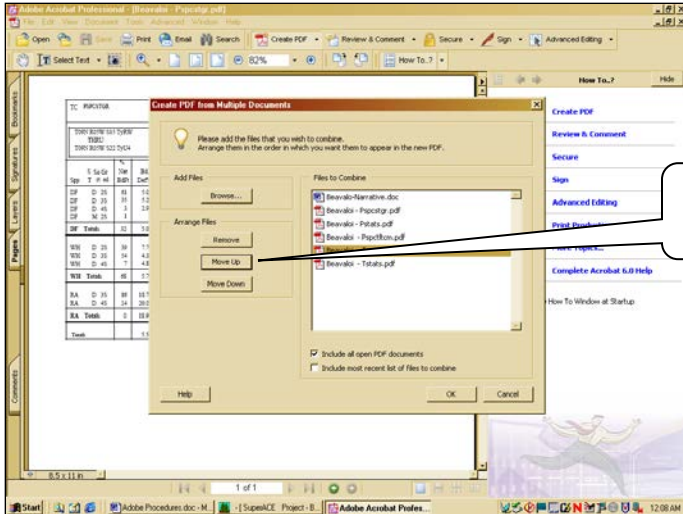
14. Add Cruise Narrative by going to browse to locate the narrative and click on the add button.



15. Arrange the reports in the appropriate order by using the move up or move down buttons.

- Cruise-Narrative.
- “sale name”-Pspclgr.pdf
- “sale name”-Pstats.pdf
- “sale name”-Tspclgr.pdf
- “sale name”-Tstats.pdf
- “sale name”-Pspctlton.pdf

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16. Press the ok button to merge all the PDF files into one file.

17. After Adobe converts and merges the reports and narrative save it by going to save under file in the upper left toolbar.

An alternative method for printing reports to Adobe PDF format.

Once the Superace reports have been run each report may be exported directly to an Adobe PDF format by clicking on the “Export” icon and then follow steps 11 – 21.

How and where do I save the PDF file?

In the upper header click and drag down to Save as: Once the window opens name the file and select a destination to save it to and click on save to save the file.

Who gets a copy of the PDF file?

The lead Cruiser, lead forester, district forester, Product sales, forester, and Division need a copy of the Cruise Narrative.

CHAPTER 9 - CHECK CRUISING

Check Cruising Standards

Check cruising plays a vital role in helping to maintain the high degree of accuracy and consistency required by the DNR Timber Sales Program and providing on-going training opportunities for DNR cruisers. Check cruises ensures that consistent cruising standards are applied and maintains cruising expertise in fundamentals such as accurate tree measurements, efficient sample designs and accurate grade and defect estimates.

A region or division Check Cruiser is responsible for conducting frequent and regular check cruises of DNR foresters and staff responsible for cruising DNR timber sales. The following guidelines provide an outline for DNR's check cruisers in developing and maintaining a robust quality control program.

1. Cruisers whose duties require 50% or more of their time timber cruising should be check cruised a minimum of once per year. Cruisers whose duties call for less than 50% of their time cruising may be check cruised on at least twice annually or on an "as needed" basis. New cruisers that are in training should be checked more frequently, or at least twice annually depending on the check cruise results.
2. The Check Cruiser may select all or a portion of the original cruiser's plots. If less than 100% of the cruiser's plots are checked then the check cruise should only include the initial cruise plots that are checked. Exception: if the check cruiser determines that the initial cruiser's sample is not adequate, an additional or different sample maybe taken.
3. Accuracy: The comparison is considered acceptable if the initial cruiser's net Scribner volumes fall within +/- 7% of the check cruiser's net volume for each major species & the total volume. A major species is one which comprises 15% or more of the cruise total net volume. Based on the check cruise, both cruisers should consider intensifying grading of high value minor species (for example, red cedar or alder, etc.). Be sure to use the check cruiser's net volumes as the basis for determining percent differences.
4. Responsibility: The check cruiser should be reviewing the SuperACE Project Statistics to compare number of plots, trees/acre, basal area, average DBH, etc. and documenting these comparisons. Both cruiser and check cruiser should discuss any differences and determine what the cause of the differences might be. When a cruise comparison is not acceptable, the check cruiser will meet with the initial cruiser on-site to determine the reason for the difference and resolve the difference.

Resolving differences. Again review all cruise reports, species and sort/grade Tables, etc. together before returning to the field. Calibrate both Relaskops and return to the field together with the plot tree lists and utilize this as a retraining opportunity.

Cruise Editing

1. The pre-cruise and cruise narratives should be directly compared for gross vs. net acres, take/leave descriptions, etc. and all differences resolved or clearly documented.
2. The SuperACE stand information screen should be reviewed for correct BAF, acres, stand age, etc. The SuperACE tree edit screen should also be reviewed for length and grade errors.
3. The SuperACE plot tree list should be directly edited by unit.
4. The species/sort grade tables should be double checked.
5. Species, sort grade Board Foot Volumes (type) should be reviewed for volume, acres, grade. Log scaling diameters can be reviewed from the species, sort grade bd. ft. volume reports or the MBF [log stock](#) table.
6. Project Statistics should be the final review for sample error of the Bd. Ft. volume per acre percent.

APPENDIX A - GLOSSARY

100% Cruise – A timber cruise where all trees within a population are cruised. Typically used when there are only a few trees in a population to be cruised.

Accuracy – An expression of how close the sample mean is to the correct answer or the true population mean.

BAF (basal area factor) - The factor representing the basal area in square feet per acre applied to a variable radius plot. The number of “in” trees on a variable radius plot multiplied by the BAF equals the stand basal area represented by the plot (in sq ft/ac).

Basal area - The cross sectional area of a single stem measured at breast height (SAF). For DNR management of forested state trust lands, BA is generally expressed in square feet. Compare to stand basal area (SBA), a measure of stocking.

Bole height – The height of the tree measured in feet from the stump (or high-side of the ground) to a point on the trees bole either determined by a fixed top diameter, a percentage of the form point diameter or the top of the tree.

Confidence interval – The range of possible sample means about the true population mean. Expression is usually as a percentage of samples that will be within the sampling error. For example, a 68% confidence interval is the probability the cruise answer is within X% of the correct answer.

Count plot – A plot in which only “in” trees are counted and recorded by species. No measurements or grades are made.

Cruise plot – A plot in which “in” trees are counted and cruised including DBH, form factor, bole height, grades and defect are recorded. May be referred to as “measure plots” or “grade plots”.

DBH (diameter breast height) - The diameter of the stem of a tree as measured at breast height 4.5 feet above the high side of the ground.

Defect – The amount of wood unsuitable for utilization as lumber or fiber. Usually represented as a percentage of the gross volume.

D.i.b. (Diameter inside bark) - Calculated by multiplying the outside bark diameter by

the bark thickness ratio for the species.

D.o.b. (Diameter outside bark) – The diameter outside the bark as measured directly with a diameter tape or a Relaskop.

Fixed plot cruise – A timber cruise where sample plots use a fixed radius plot sampling method. Typically used for regeneration surveys, inventory cruise, or other cruises where stocking or trees per acre is a primary parameter to be sampled.

Form Point – The point at which the tree's bole shape turns from convex to concave. By convention this is set at 16 feet from the stump height.

Fixed radius plot – A plot sampling method where the plot size is constant and circular around a plot center. Typically, a plot radius represents a plot measured in terms of a fraction of an acre, for example $1/10^{\text{th}}$, $1/20^{\text{th}}$, or $1/50^{\text{th}}$ of an acre.

Form factor – The ratio of taper measured by diameter outside bark measured at the form point (usually 16 feet above the stump) to the diameter at breast height.

Grade – A classification of a log or log segment by standardized grading rules such as the NW Log Rules Advisory group.

Individual Tree Sample (ITS) cruise – A timber cruise where all trees within a population are counted but only a portion of them are cruised. Trees may be selected from the population either systematically (for example, every fifth or tenth tree is cruised) or at random (for example, using five colored marbles with one color representing a cruise tree then pulling one marble out of a pocket at a time.)

Limiting distance factor (LDF) – the limiting distance factor is similar to the plot radius factor except that the distance from the “face” of the tree (that point at DBH facing plot center) is compared to the limiting distance factor multiplied by the tree's DBH. It may often be easier to reach the “face” of the tree than the “center” especially on very large trees or on very steep ground.

Log stock tables – Summary tables showing volume by species, sort, grade and log segment diameter inside bark.

Merchantable height – The total height of the stem of a tree from the ground to a minimum size top diameter representing the customary log utilization.

Merchantable top – The smallest diameter point on the tree bole which is suitable for utilization as lumber in the customary market. This may vary by region or species and market conditions.

Nested points – Reference points identified along a sale boundary as part of a GPS traverse.

Plot radius factor (PRF) – The plot radius factor determines the maximum distance from a tree before it is “out” on a variable radius plot. The plot radius is determined by multiplying the DBH by the plot radius factor for the selected BAF. The distance measured from the “center” of the tree to the plot center is compared to the plot radius. If the tree is “inside” the plot radius then the tree is “IN” and counted, if “outside” the tree is “OUT” and not counted.

Precision – The consequence of repeatability. How close the final answer is to the final average value each time. A tight grouping of answers. The Standard error of the mean is an expression of precision.

Precruise packet – A packet of information supplied by the management forester to the cruiser. The packet normally contains the precruise narrative, traverse map, ownership map, logging plan and other pertinent information.

RMZ (riparian management zone) - A narrow band of moist soils and distinctive vegetation along banks of lakes, rivers, and streams; in DNR’s HCP for forested state trust lands, the RMZ is the portion of the riparian ecosystem between the aquatic zone and the direct influence zone.

Scaling cylinder – The imaginary cylinder as projected through a log beginning at the small end of the log. This defines the gross Scribner Volume for the log.

Scribner volume – Merchantable board foot volume using Scribner Decimal C.

Sort – A classification of a log or log segment by product utilization.

Strip cruise – A timber cruise where a strip of a fixed width (usually one chain or 66 feet in width) is run through a sample area at a fixed interval. All trees within a population that are within the “strip” are sampled. The ratio of the strip width to the strip interval determines the “percent” of area that is sampled. For example a 66 ft. wide strip at a 330 ft. interval represents a ratio of 0.20 or 20% sample.

Stump height – The lowest possible point at which a tree would normally be severed.

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This is usually expected to be six inches from the high side of the ground.

Timber cruise – A formal stand assessment that estimates merchantable wood volume (or other merchantable measure such as weight) on the stump according to species, size quality, possible products, or other characteristics. A cruise generally leaves out stand properties other than those of merchantable value or interest, for example, non-merchantable stand cohorts.

SuperACE – The cruising software used for calculating and reporting timber cruise volumes. The current version of software is produced by Atterbury Consultants, Inc. of Beaverton, OR.

Traverse points – Reference points identified along a sale boundary as part of a compass and distance traverse.

V-BAR – Volume to basal area ratio. Calculate the V-bar by dividing the total tree volume by the tree basal area in square feet.

Variable plot cruise – A timber cruise where sample plots use a variable radius plot sampling method and with systematically established point centers on a grid pattern throughout a population (or sample area such as a timber sale unit or FIU). A basal area factor (BAF) is selected that will average from 4 to 8 trees sampled per point throughout the sample area. Typically used for timber sale cruises, inventory cruise, or other cruises where basal area and/or volume are a primary parameter to be sampled. Also a “VP” cruise, point sample cruise, prism cruise.

Variable radius plot – A plot sampling method where trees are selected with a probability proportional to its size (diameter), in other words, the larger the diameter of the tree, the more likely that the tree will be sampled. Each tree is assumed to have its own fixed radius plot with the tree at the center of the plot and the radius determined by the tree's diameter. The tree is “in” if the variable plot center is within the tree's plot. The tree is “out” if the variable plot center is outside of the tree's plot.

APPENDIX B – CRUISING FOR SMALLWOOD THINNINGS

The objective for this section is to provide guidelines to design a cruise for a small-wood thinning. The process used to cruise a small-wood thinning is different than cruising a variable retention harvest or an older aged variable density thinning which generally require more intense and detailed cruises.

A small-wood thinning is defined as a uniform stand consisting of only one or two primary species and forty years old or less with few high value products such as peelers, poles, or high quality saw logs. Typically most, small-wood thinnings are homogeneous. Although it is not uncommon to find other species growing in the stand or areas where the plantation did not take hold and a stand of another species is growing. *It is important to count all trees for all species to insure an accurate stand table.* It may be desirable to stratify the area prior to cruising. Cruise these areas where another species becomes dominant separately to correctly account for the acres and a prescription change.

The following information is usually needed to arrive at an appropriate silvicultural prescription. This information is derived from the cruise data collected during the cruise. Most of the data that is collected will be used in one way or another while writing the silviculture prescription.

1. Basal Area per Acre
2. DBH
3. Tree Count By Species
4. Trees per Acre
5. Tree Count By Species
6. Relative Density
7. Basal Area per Acre and Trees per Acre
8. Site Index
9. Total Height
10. Growth Rate
11. Height to Diameter Ratio
12. Total Height
13. DBH
14. Growth Modeling
15. Crown Ratio
16. Height
17. Total Age
18. Growth Rate
19. Site Index
20. Trees per Acre
21. Basal Area per Acre
22. Relative Density
23. Volume ~ Only to see if it's economically feasible.
24. Total Height

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- 25. Form Factor
- 26. Log Grades
- 27. Defect
- 28. DBH

I. Suggested Equipment.

- 1. Spencer Tape with DBH tape
- 2. Clinometer
- 3. Field Book
- 4. Compass
- 5. Increment Borer
- 6. String Box (Not necessary if comfortable with pacing)
- 7. Prism (Not necessary)
- 8. Calculator
- 9. Red and White Flagging

II. Choose a Fixed Plot Radius.

The size of the fixed radius plot should give you an average of five to eight trees per plot. Not all plots need to have the minimum number of trees per plot or the maximum, but should result in an average of at least five trees per plot. The fixed plot radius should be chosen by doing a couple of quick plots, or using two different radiuses for a couple of plots and then choosing one. Once a plot radius has been chosen it will be used on the entire unit.

Fixed plot radius and their expansion factors:

Plot Radius FT	Expansion Factor (EF)	SuperACE
35.00	1/11.32 th Acre	.0883
30.00	1/15.41 th Acre	.065
25.00	1/22.18 th Acre	.045
20.00	1/34.66 th Acre	.029
15.00	1/61.62 th Acre	.016

Plot Radius FT	Expansion Factor (EF)	Super Ace
37.24	1/10 th Acre	.10
26.33	1/20 th Acre	.05
21.50	1/30 th Acre	.033
18.62	1/40 th Acre	.025
16.65	1/50 th Acre	.02

III. Cruise intensity.

How many plots are needed? This is done by taking five recon plots and recording the tree count for each plot. Multiply the tree count by the expansion factor to get the trees per acre at each plot.

The DNR uses a Sample Error of +/- 10% to 67% confidence interval (t=1). See example below using 1/40th acre plots.

Plot	Trees/Plot	Trees/Plot X EF =	Trees/Acre
1	7	7 x 40	280
2	5	5 x 40	200
3	6	6 x 40	240

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4	4	4 x 40	160
5	1	1 x 40	40

A. Calculate the Standard Deviation of the TPA.

$$SD = \sqrt{\frac{\sum (X - \bar{X})^2}{(n-1)}} \quad \text{Mean}(\bar{X}) = \frac{920\text{Trees}}{5\text{Plots}} = 184\text{TPA} \quad SD = \sqrt{\frac{33920}{(5-1)}} = 92.08\text{TPA}$$

The above calculations as a chart.

TPA	(x-Mean)^2	
280	(280-184)^2	9216
200	(200-184)^2	256
240	(240-184)^2	3136
160	(160-184)^2	576
40	(40-184)^2	20736
	Sum	33920

B. Calculate the Coefficient of Variation ~ CV%

$$CV\% = \left(\frac{SD}{\bar{X}}\right) \times 100 \quad CV\% = \left(\frac{92.08}{184}\right) \times 100 = 50.04\%$$

C. Calculate how many plots to take.

$$\frac{CV\%^2}{SE\%^2} = \text{Plots} \quad \frac{50.04^2}{10^2} = 25.04 \approx 25\text{Plots}$$

IV. Calculate the Plot Spacing.

Using 50 acres, as an example, calculate the spacing for 1 plot for every 2.08 acres. To get a better estimate of variability, it is best to space your plots evenly throughout the stand using a square grid.

$$1. (2.0\text{Acres} / \text{Plot}) \times (43,560\text{Sqft} / \text{Acre}) = 87,120\text{SqFt} / \text{Plot}$$

$$2. \sqrt{87,120\text{SqFt} / \text{Plot}} = 295\text{Ft. or}$$

4.5 Chains⁸ between plots and 4.5 Chains between strips.

Using the same calculations for 350 acres will give the following spacing:

$$3. \left(\frac{350\text{Acres}}{25\text{Plots}}\right) \times (43,560\text{SqFt} / \text{Acre}) = 609,840\text{SqFt} / \text{Plot} = 14\text{ac} / \text{plot}$$

$$4. \sqrt{60,9840} = 781\text{ft. or about 12 Chains between Plots and 12 Chains between strips.}$$

This plot density is too light and runs a risk of not sampling enough of the variability in tree count, diameter and species mix. A higher density of plots will be needed for a more accurate stand table. *The maximum amount of acres per plot should be held at five acres.* This way one

⁸ A chain is equal to 66 feet.

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plot only carries the weight of five acres instead of fourteen. On 350 homogeneous acres of thinning, there would need to be 70 plots on a 7 Chain by 7 Chain grid.

V. Cruise Plots/Count Plots.

For cruises other than small wood thinnings an estimate of the variability in tree volume is used to determine the Cruise to Count Plot ratio. The intensity in which to cruise a thinning stand is relatively insignificant since the trees on a whole are going to look the same and have very similar volumes. Generally speaking, the less species variability and size variability in a stand the fewer cruise trees are needed.

Since tree size is fairly uniform in a small wood thinning stand, species composition in the stand should be used determine the ratio of cruise to count plots. On all plots DBH should be taken to the nearest inch to determine Basal Area. This will also be helpful when generating a stand table in SuperACE and choosing take trees.

Study the ortho photos and or stereo pair photos of the stand to determine an estimate of species mix and to stratify any areas that are another species stand type. Use the guide below to help determine the intensity of cruise to count plots.

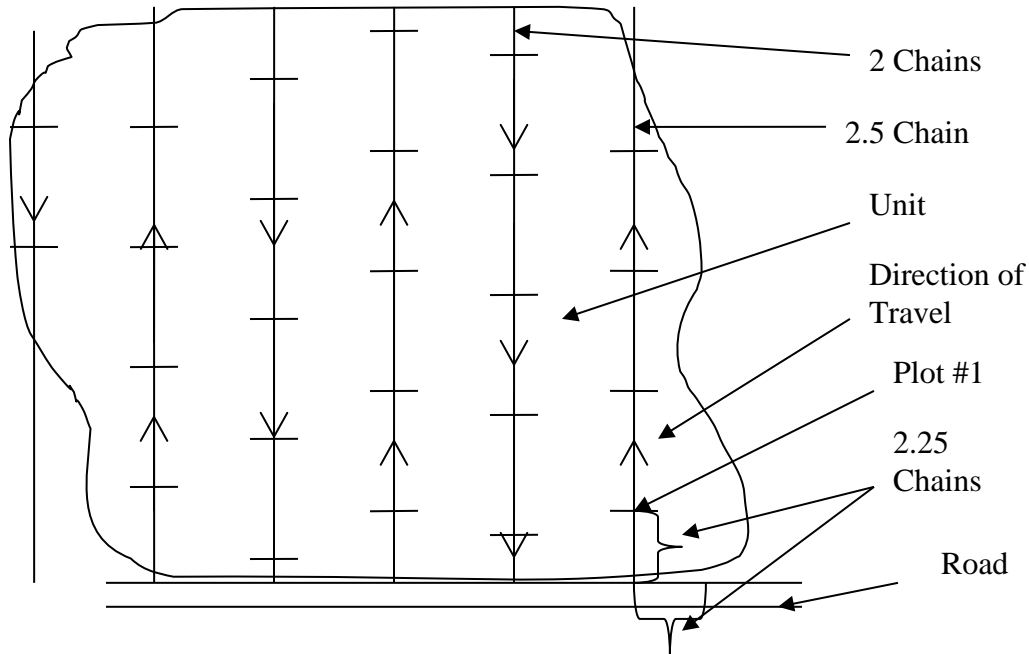
Species Mix	Cruise/Count
Homogeneous ~ <i>Less than 50 Acres</i>	1 Cruise:1Count ~ Cruise All Minor Species on Plot
Homogeneous ~ <i>Greater than 50 Acres</i>	1 Cruise:3 Count ~Cruise All Minor Species on Plot
Mostly Homogeneous with Pockets of Minor Species ~ <i>Less than 50 Acres</i>	1 Cruise:1Count ~ Cruise All Minor Species on Plot
Mostly Homogeneous with Pockets of Minor Species ~ <i>Greater than 50 Acres</i>	1 Cruise:3Count ~ Cruise All Minor Species on Plot
10%-30% Evenly Mixed Minors in Stand ~ <i>Less than 50 Acres</i>	1 Cruise:1 Count ~ Cruise All Minor Species on Plot
10%-30% Evenly Mixed Minors in Stand~ <i>Greater than 50 Acres</i>	1 Cruise:2 Count ~ Cruise All Minor Species on Plot
50%-50% even or other mix	1 Cruise:1 Count ~ Cruise All Minor Species on Plot

VI. Starting the Cruise.

Find a boundary and go ½ the distance of your plot spacing to your first strip. Mark and label red and white flagging as Strip 1. Go ½ the distance again into the stand for your first plot.

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Hang red and white flagging and mark plot number on flagging. See example below using our 50 acre unit.



Pace out the end of the strip to the boundary and then pace back into your next strip the remaining distance to your next plot. This will accomplish two things. One it will stagger your plots on the strip and second it will also check your acres. The map above shows two extra plots. This should be an indicator to double check the acres. Place your plot numbers on your map for reference at a later time.

An alternate approach is to use a GIS application such as the “Cruisers Sample Toolbox” to establish a grid over the unit and transfer those plot locations to a hand-held device such as the Garmin 60 CSX. Locating plots by use of a GPS device can sometimes speed the process of establishing plot locations by eliminating the need to pace or run strips through very brushy or steep terrain. On the other hand, GPS devices are still somewhat variable in their ability to receive good signals under dense tree cover or during certain times of the day.

VII. Data Collection and Quick Calculations

The desired data to be collected for small wood thinnings are listed below:

1. Species (SP)
2. Tree DBH to nearest inch (DBH)
3. Total Tree Height to nearest foot (TH)
4. Crown Ratio % (CR)
5. Breast Height Age
6. Form Factor (FF)
7. Total Age
8. Log Grades
9. Log Defects

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Species – Use the species codes listed in table 5 (page 38).

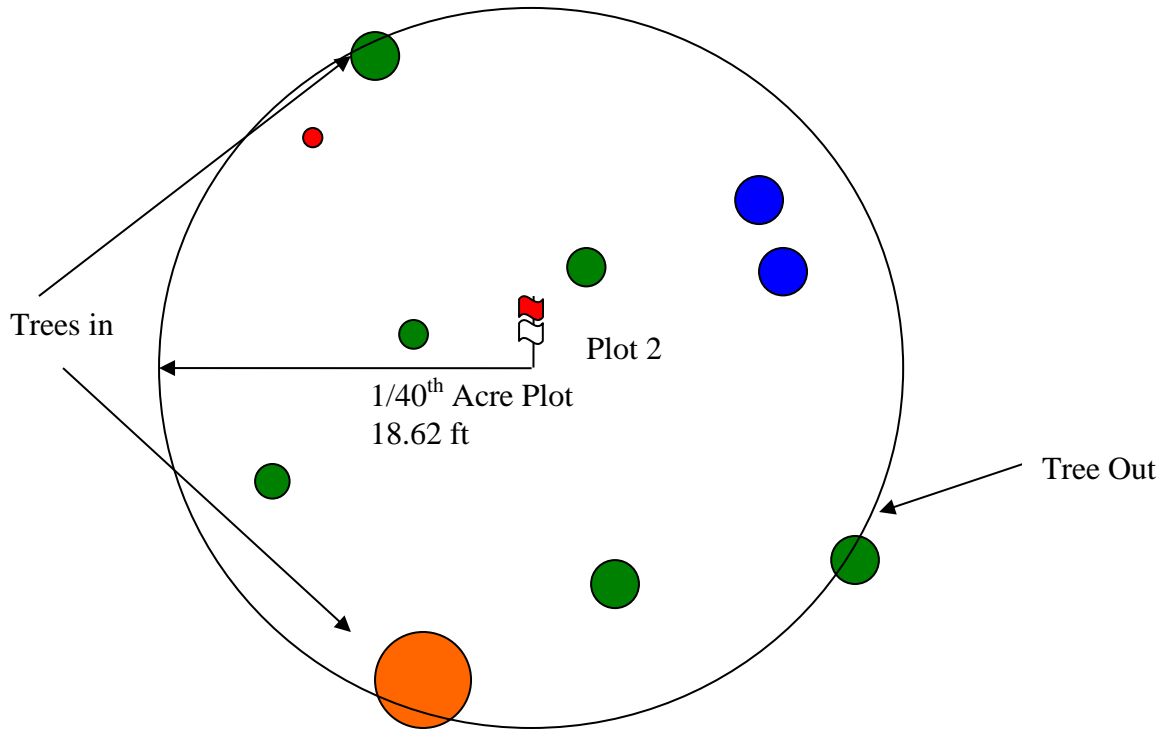
DBH – Measure the diameter breast height of the tree at 4.5’ above the ground on the high side of the tree.

Total Tree Height – Measure the total height of the tree to the nearest foot with your clinometer.

Crown Ratio – Estimate Crown Ratio to the nearest 10%. Crown Ratio is the length of crown in feet divided by the total height of the tree. Example: 40ft crown on a 75ft tree = 50%

Breast Height Age – Core and count the rings of the tree at DBH. Estimate the years of tree growth to DBH for the Total Age. Take enough of a sample to feel comfortable with the age. If you do not have an electronic data recorder for data recording you may use Write-in-the-rain plot cards. An example of how to organize cruise data in your field note book is shown below.

Biggie Flats Thinning U-1		1/40 th Acre Plots		18.62ft Radius		KJ	
Yacolt		4.5 CH X 4.5 CH				10-8-07	
Sec 26, T04N, R03E		1Cruise/3Count					
<u>Plot</u>	<u>SP</u>	<u>DBH</u>	<u>TH</u>	<u>CR</u>	<u>BH Age</u>	<u>FF</u>	<u>Grades</u>
1	DF	12	76	30		86	7 8
	DF	11	72	20		85	7 8/1
	DF	13	80	40	28	85	7/2 8
	DF	13	77	40		87	7/1 8
	DF	10	67	20		85	7 8
	DF	9	65	20		86	8 8
2	DF	11					
	DF	10					
	RA	12	76	30	28	78	8 8/9
	RA	11	75	30		80	8 8
	DF	11					
	DF	10					
	DF	9					
	WH	16	78	45	32	83	7/1 8



Trees are considered 'in' if the distance from plot center to the center of the tree is equal or less to the Plot Radius. In the example above there are three trees considered on the edge of which two are *in* and one is *out*.

Quick Calculations – Using the two plots above we can quickly calculate some generalities of the stand or a portion of the stand.

Trees per Acre –

$$TotalTPA = \left(\frac{\sum Trees}{\# Plots} \right) \times ExpansionFactor$$

$$TotalTPA = \left(\frac{14}{2} \right) \times 40 = 280Trees / Acre$$

Trees per Acre by Species –

$$DF = \left(\frac{11Trees}{2Plots} \right) \times 40 = 220Trees / Acre$$

$$RA = \left(\frac{2Trees}{2Plots} \right) \times 40 = 40Trees / Acre$$

$$WH = \left(\frac{1Tree}{2Plots} \right) \times 40 = 20Trees / Acre$$

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Basal Area per Acre –

$$BasalArea / Tree = (DBH)^2 \times 0.005454154 \rightarrow \frac{\pi}{4 \times 144} = .005454154$$

Area = $\pi \times r^2$

$$BasalArea / Acre = \left(\frac{\sum BasalArea / Tree}{\# Plots} \right) \times ExpansionFactor$$

<u>SP</u>	<u>DBH</u>	<u>Basal Area</u>
DF	12	0.79
DF	11	0.66
DF	13	0.92
DF	13	0.92
DF	10	0.55
DF	9	0.44
DF	11	0.66
DF	10	0.55
RA	12	0.79
RA	11	0.66
DF	11	0.66
DF	10	0.55
DF	9	0.44
WH	16	1.40
	Ave BA/Acre =	199.4 Sq Ft/Acre
	Sum BA=	9.99

Relative Density –

$$QuadraticMeanDiameter = \left(\frac{BA/Tree}{\sqrt{.005454154}} \right)$$

$$QMD = \left(\frac{\sqrt{.699873}}{\sqrt{.005454154}} \right) = 11.33"$$

$\frac{\sum BA}{\#Trees}$

$$RelativeDensity = \left(\frac{AveBA / Acre}{\sqrt{QMD}} \right)$$

$$\frac{\sum BA}{\# Plots} \times ExpansionFactor$$

$$RD = \frac{199.4}{\sqrt{11.33}} = 59.24 \approx 59$$

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Or Basal Area per acre can be taken by turning a prism on plot center and counting the number of in trees and multiplying them by the BAF of the prism and taking a fixed plot.

Calculating the Stands Relative Density (RD)

One useful attribute to calculate is the stand's Relative Density (RD). RD is a measure of competition between trees growing in a stand. Once a stand's RD reaches a certain level tree growth begins to slow and thinning should be considered. A quick and easy method for determining a stand's RD is to determine the stands stocking in terms of trees per acre and basal area per acre. Both of these attributes may be measured easily using a prism for basal area and a fixed radius plot for trees per acre. Using a variable plot and fixed plot at the same time an estimate for trees per acre and basal area per acre may be obtained. Using the table below, look up the basal area in the left column and the trees per acre in the top row. Where the two intersect in the table is the stand's RD at that point.

Once you have measured these two attributes on a few plots in the stand you can refer to the chart below and determine the stand's relative density based on some simple calculations.

		Tree/acre & Spacing																	
		25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450
		42x42	30x30	24x24	21x21	19x19	17x17	16x16	15x15	14x14	13x13	13x13	12x12	12x12	11x11	11x11	10x10	10x10	10x10
Basal Area	40	10	11	13	14	14	15	16	16	17	17	18	18	18	19	19	19	20	20
	60	13	16	17	19	20	21	22	22	23	23	24	24	25	25	26	26	27	27
	80	16	19	21	23	24	25	26	27	28	29	30	30	31	31	32	33	33	33
	100	19	23	25	27	29	30	31	32	33	34	35	36	36	37	38	38	39	40
	120	22	26	29	31	33	34	36	37	38	39	40	41	42	43	43	44	45	45
	140	25	29	33	35	37	39	40	42	43	44	45	46	47	48	49	49	50	51
	160	27	33	36	39	41	43	44	46	47	49	50	51	52	53	54	55	56	56
	180	30	36	39	42	45	47	49	50	52	53	54	56	57	58	59	60	61	62
	200	32	38	43	46	48	51	53	54	56	57	59	60	61	63	64	65	66	67
	220	35	41	46	49	52	54	56	58	60	62	63	64	66	67	68	69	70	71
	240	37	44	49	52	55	58	60	62	64	66	67	69	70	72	73	74	75	76
	260	39	47	52	56	59	62	64	66	68	70	72	73	75	76	77	79	80	81
	280	42	49	55	59	62	65	68	70	72	74	76	77	79	80	82	83	84	86
	300	44	52	58	62	66	69	71	74	76	78	80	82	83	85	86	88	89	90
	320	46	55	61	65	69	72	75	77	80	82	84	86	87	89	90	92	93	95
	340	48	57	63	68	72	75	78	81	83	86	88	90	91	93	95	96	98	99
	360	50	60	66	71	75	79	82	84	87	89	91	93	95	97	99	100	102	103
380	52	62	69	74	78	82	85	88	91	93	95	97	99	101	103	105	106	108	
400	54	65	72	77	81	85	88	91	94	97	99	101	103	105	107	109	110	112	

Figure 5 - RD from TPA and Basal Area

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Appendix C - The Walk Through Method for Edge Plots

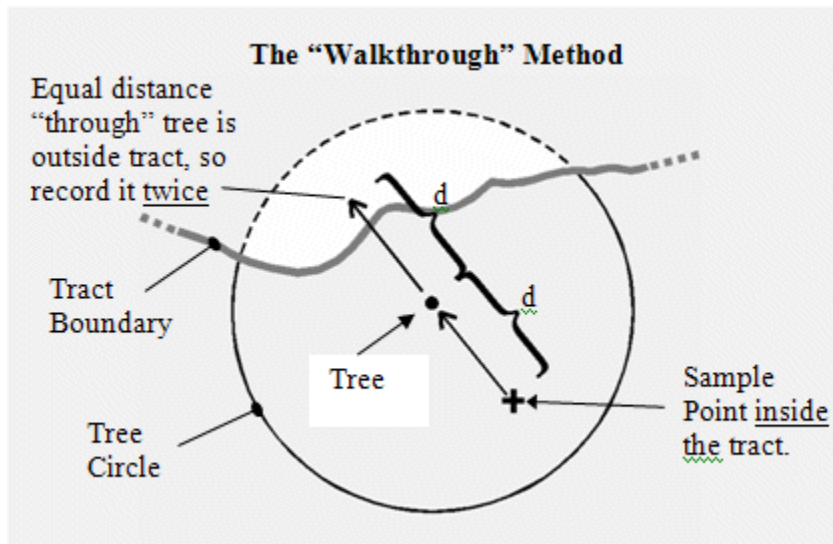
By Kim Iles

(Reprinted from [John Bell & Associates
Inventory & Cruising Newsletter](#))

There was a recent article, August, 2004 in the journal Forest Science, that was really useful – although perhaps not very readable, which is a common situation in Forest Science. I would like to bring it to your attention, if you have not already heard about it from the OSU short course or my book (which is the only discussion in a forest measurements book so far). The article was about the “Walkthrough Method”. This is one of those happy times when a practical problem produces a practical solution from the forest research community. The authors deserve real credit for one of the best ideas in a long time.

The method works with curved borders, small patches inside the stand, typed-out roads, and all those situations that make most other edge-effect methods impractical or make them incorrect. Try it. You’ll like it. It works with Variable or Fixed Plots. It is easy to teach, and easy to learn.

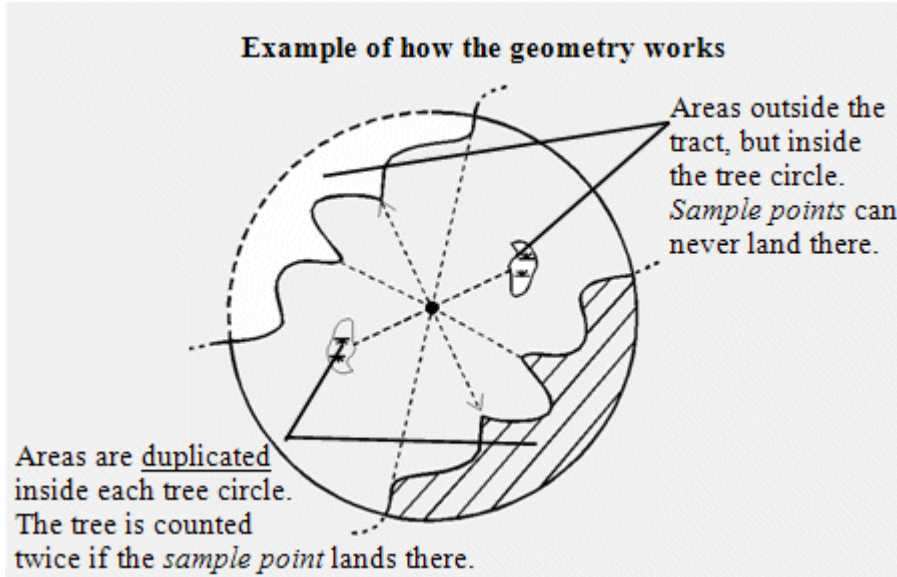
Every plot follows the same procedure. For any “in” tree, measure the distance (“d” in the illustration below) from the sample point to the tree, then duplicate that distance on the other side. If you fall outside the sample area at the end of this duplicated distance, record that tree twice. In most cases, you can simply estimate the distance, or the situation is obvious when you are not even near the



sample area border. This double counting makes it simple to do the computations, and computer programs do not require any modifications. For count trees, you would just count the tree twice. For measured trees, record it as two identical measured trees.

You will only have to check a few trees. Most of the situations will be obvious. One advantage is that you do not actually have to go beyond the sample area border (a good thing with

rivers, cliffs, and swamps), you just need to know that you would fall outside the sample area at that distance. The idea is shown in the illustration at the right.



What is really happening here? The key to the system is that any part of the tree circle around each tree that falls outside the sample area is “duplicated” by rotating it 180 degrees. If the sample point falls into the duplicated part, you count the tree twice (that is what the process of “walking through” the tree is detecting). The number of times you count it twice makes up for the number of times a sample point would not fall into the part of the tree circles lying outside the area being sampled. The geometry may be a bit odd, but the field procedures are really simple.

It is hard to imagine a simpler process, or a more flexible one. If the sampled area is really narrow, or when you are in corners of the tract, the process is not exactly correct – but much of the bias that is caused by edge effect is accommodated even in these circumstances. Reports from the field have been very positive, and the procedure is fast becoming a standard for companies and government organizations.

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APPENDIX D – SPECIES, SORT AND GRADE TABLES

Table 12 - West Side Species Table

Species Table Report																	
TblSpecies																Date:	5/5/2014
Table Name: WEST SIDE																Page:	1
Code	Abrv	Description	Bark Ratio	ASub Const	Form Factor	Wood Type	Component	Yield Table	Min Log Dia	Min Log Len	Max Log Len	Log Trim	Max Tree Dia	Max Tree Hgt.	BdFt Rule	CuFt Rule	Weight
2	OG	OGDF	.901	DF	.82	C	C	DF-EQUA-050	5	8	40	1.0	0	0	W	S	5600 C
4	DF	DOUG FIR	.920	DF	.86	C	C	DF-EQUA-050	5	8	40	1.0	0	0	W	S	5700 C
6	WH	WHEMLOC	.944	WH	.88	C	C	WH-EQUA-050	5	8	40	1.0	0	0	W	S	6400 C
7	GF	GRAND F	.940	SS	.84	C	C	WH-EQUA-050	5	8	40	1.0	0	0	W	S	5730 C
8	SF	PS FIR	.940	SS	.86	C	C	WH-EQUA-050	5	8	40	1.0	0	0	W	S	5730 C
10	SS	S SPRUCE	.962	SS	.78	C	C	WH-EQUA-050	5	8	40	1.0	0	0	W	S	5200 C
12	RC	WR CEDAR	.951	SS	.80	C	C	WH-EQUA-050	5	8	40	1.0	0	0	W	S	4700 C
14	WP	W PINE	.950	PP	.88	C	C	DF-EQUA-050	5	8	40	1.0	0	0	W	S	4800 C
16	NF	NOBLE F	.924	SS	.86	C	C	WH-EQUA-050	5	8	40	1.0	0	0	W	S	5730 C
22	MH	MHEMLOC	.944	WH	.87	C	C	WH-EQUA-050	5	8	40	1.0	0	0	W	S	6350 C
24	PP	PONDEROS	.870	PP	.82	C	C	PP-REF-050	6	8	40	1.0	0	0	E	S	4800 C
26	LP	LP PINE	.960	DF	.84	C	C	LP-EQUA-100	5	8	40	1.0	0	0	W	S	4800 C
32	BM	BL MAPLE	.953	BM	.80	H	H	RA-EQUA-050	5	8	40	1.0	0	0	W	S	5300 C
34	CW	COTWOOD	.940	RA	.82	H	H	WH-EQUA-050	5	8	40	1.0	0	0	W	S	4900 C
36	RA	R ALDER	.953	RA	.82	H	H	RA-EQUA-050	5	8	40	1.0	0	0	W	S	5500 C
38	BR	BIRCH	.953	RA	.82	H	H	RA EQUA 050	5	8	40	1.0	0	0	W	S	5500 C

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Table 13 - White Salmon Species Table

Species Table Report																		
TblSpecies															Date:	5/5/2014		
Table Name: WH SALMON															Page:	1		
Code	Abrv	Description	Bark Ratio	ASub Const	Form Factor	Wood Type	Component	Yield Table	Min Log Dia	Min Log Len	Max Log Len	Log Trim	Max Tree Dia	Max Tree Hgt.	BdFt Rule	CuFt Rule	Weight	
2	OG	OGDF	.901	DF	.80	C	C	DF-EQUA--050	5	8	40	1.0	0	0	W	S	5600 C	
4	DF	DOUG FIR	.920	DF	.83	C	C	DF-EQUA--050	5	8	40	1.0	0	0	W	S	5700 C	
6	WH	WHEMLOC	.944	WH	.84	C	C	WH-EQUA--050	5	8	40	1.0	0	0	W	S	6400 C	
7	SF	SILVER F	.940	SS	.86	C	C	WH-EQUA--050	5	8	40	1.0	0	0	W	S	5730 C	
8	GF	GRAND F	.940	SS	.86	C	C	WH-EQUA--050	5	8	40	1.0	0	0	W	S	5730 C	
10	SS	S SPRUCE	.962	SS	.85	C	C	WH-EQUA--050	5	8	40	1.0	0	0	W	S	5200 C	
12	RC	WR CEDAR	.951	SS	.73	C	C	WH-EQUA--050	5	8	40	1.0	0	0	W	S	4700 C	
14	WP	W PINE	.950	PP	.86	C	C	DF-EQUA--050	5	8	40	0.5	0	0	W	S	4800 C	
16	NF	NOBLE F	.924	SS	.86	C	C	WH-EQUA--050	5	8	40	1.0	0	0	W	S	5730 C	
18	AF	ALPINE F	.940	SS	.86	C	C	WH-EQUA--050	5	8	40	0.5	0	0	W	S	5730 C	
20	YC	AY CEDAR	.941	SS	.81	C	C	DF-EQUA--050	5	8	40	0.5	0	0	W	S	4700 C	
22	MH	MHEMLOC	.944	WH	.87	C	C	WH-EQUA--050	5	8	40	0.5	0	0	W	S	6350 C	
24	PP	PONDEROS	.870	PP	.82	C	C	PP-REF--050	5	8	32	0.5	0	0	E	S	4800 C	
26	LP	LP PINE	.960	DF	.84	C	C	LP-EQUA--100	5	8	32	0.5	0	0	W	S	4800 C	
28	ES	E SPRUCE	.962	SS	.85	C	C	WH-EQUA--050	5	8	40	0.5	0	0	W	S	5200 C	
30	WL	W LARCH	.900	DF	.83	C	C	PP-EQUA--100	5	8	40	0.5	0	0	W	S	4800 C	
32	BM	BL MAPLE	.953	BM	.81	H	H	RA-EQUA--050	5	8	40	0.5	0	0	W	S	5300 C	
34	CW	COTWOOD	.940	RA	.82	H	H	WH-EQUA--050	5	8	16	0.5	0	0	W	S	4900 C	
36	RA	R ALDER	.953	RA	.73	H	H	RA-EQUA--050	5	8	16	0.5	0	0	W	S	5500 C	
38	BR	BIRCH	.940	RA	.84	H	H	RA-EQUA--050	5	8	16	0.5	0	0	W	S	5500 C	
40	QA	ASPEN	.940	RA	.84	H	H	RA-EQUA--050	5	8	16	0.5	0	0	W	S	5500 C	
42	WB	WB PINE	.870	PP	.86	C	C	PP-EQUA--100	5	8	16	0.5	0	0	W	S	4800 C	
44	CH	CHERRY	.940	RA	.84	H	H	RA-EQUA--050	5	8	16	0.5	0	0	W	S		
46	OO	OR OAK	.953	RA	.84	H	H	RA-EQUA--100	5	8	16	0.5	0	0	W	S		
48	OA	OR ASH	.953	RA	.84	H	H	RA-EQUA--100	5	8	16	0.5	0	0	W	S		
53	YEW	PAC YEW	.940	WH	.84	C	C	WH-EQUA--050	5	8	16	0.5	0	0	W	S		
54	MDR	MADRONE	.940	RA	.84	H	H	RA-EQUA--050	5	8	16	0.5	0	0	W	S		
57	DGW	DOGWOOD	.940	RA	.84	H	H	RA-EQUA--050	5	8	16	0.5	0	0	W	S		
61	CAS	CASCARA	.940	RA	.84	H	H	RA-EQUA--050	5	8	16	0.5	0	0	W	S		
62	WIL	WILLOW	.953	RA	.84	H	H	RA-EQUA--050	5	8	16	0.5	0	0	W	S		
90	OC	CONIFER	WH	WH	WH	C	C	WH-EQUA--100	5	8	16	0.5	0	0	W	S		
95	OH	HARDWOO	RA	RA	RA	H	H	RA-EQUA--100	5	8	16	0.5	0	0	W	S		

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Table 14 - East Side Species Table

Species Table Report																	
TblSpecies																Date:	5/5/2014
Table Name: EASTSIDE																Page:	1
Code	Abrv	Description	Bark Ratio	ASubo Const	Form Factor	Wood Type	Comp- onent	Yield Table	Min Log Dia	Min Log Len	Max Log Len	Log Trim	Max Tree Dia	Max Tree Hgt.	BdFt Rule	CuFt Rule	Weight
2	OG	OGDF	.890	DF	.80	C	C	DF--EQUA--050	6	1	40	1.0	0	0	E	S	5600 C
4	DF	DOUG FIR	.920	DF	.83	C	C	DF--EQUA--050	5	1	40	1.0	0	0	E	S	5700 C
6	WH	WHEMLOC	.944	WH	.84	C	C	WH--EQUA--050	5	1	40	1.0	0	0	E	S	6400 C
8	GF	GR FIR	.940	SS	.86	C	C	WH--EQUA--050	5	1	40	1.0	0	0	E	S	5730 C
10	SS	S SPRUCE	.962	SS	.85	C	C	WH--EQUA--050	5	1	40	1.0	0	0	E	S	5200 C
12	RC	WR CEDAR	.951	SS	.78	C	C	WH--EQUA--050	5	1	40	1.0	0	0	E	S	4700 C
14	WP	W PINE	.950	PP	.85	C	C	DF--EQUA--050	5	1	40	1.0	0	0	E	S	4800 C
16	NF	NOB FIR	.924	NF	.89	C	C	DF--EQUA--050	5	1	40	1.0	0	0	E	S	4800 C
18	AF	ALP FIR	.940	SS	.86	C	C	WH--EQUA--050	5	1	40	1.0	0	0	E	S	5000 C
20	YC	AY CEDAR	.940	SS	RC	C	C	DF--EQUA--050	6	1	40	1.0	0	0	E	S	4700 C
22	MH	MHEMLOC	.944	WH	.87	C	C	WH--EQUA--050	6	1	40	1.0	0	0	E	S	6350 C
24	PP	P PINE	.870	PP	.86	C	C	PP--REF --050	6	1	40	1.0	0	0	E	S	4800 C
26	LP	LP PINE	.960	LP	.85	C	C	LP--EQUA--100	5	1	40	1.0	0	0	E	S	4800 C
28	ES	E SPRUCE	.962	SS	.86	C	C	WH--EQUA--050	5	1	99	1.0	0	0	E	S	5200 C
30	WL	W LARCH	.900	DF	.87	C	C	PP--EQUA--100	5	1	40	1.0	0	0	E	S	4800 C
32	BM	BL MAPLE	.953	BM	.81	H	H	RA--EQUA--050	6	1	32	1.0	0	0	E	S	5300 C
34	CW	COTWOOD	.940	RA	.82	H	H	WH--EQUA--050	6	1	32	1.0	0	0	E	S	4900 C
36	RA	R ALDER	.953	RA	.73	H	H	RA--EQUA--050	6	1	32	1.0	0	0	E	S	5500 C
38	BR	BIRCH	.940	RA	RA	H	H	RA--EQUA--050	6	1	32	1.0	0	0	E	S	5500 C
40	AS	ASPEN	.940	RA	RA	C	C	RA--EQUA--050	6	1	32	1.0	0	0	E	S	4300 C
42	WB	WB PINE	.870	DF	LP	C	C	LP--EQUA--100	6	1	32	1.0	0	0	E	S	4800 C
44	CH	CHERRY	.940	RA	RA	H	H	RA--EQUA--050	6	1	32	1.0	0	0	E	S	5000 C
46	OK	OR W OAK	.953	RA	RA	H	H	RA--EQUA--050	6	1	32	0.5	0	0	E	S	6900 C
48	OA	OR ASH	.953	RA	RA	H	H	RA--EQUA--050	6	1	20	0.5	0	0	E	S	5800 C
50	WF	W FIR	.940	SS	.89	C	C	WH--EQUA--050	5	1	20	0.5	0	0	E	S	4400 C
53	YEW	PAC YEW	.940	SS	SS	C	C	WH--EQUA--050	6	1	20	0.5	0	0	E	S	5000 C
54	MA	MADRONE	.940	RA	RA	H	H	RA--EQUA--050	6	1	20	0.5	0	0	E	S	5000 C
57	DGW	DOGWOOD	.940	RA	RA	H	H	PP--EQUA--100	6	1	20	0.5	0	0	E	S	5000 C
61	CAS	CASCARA	.940	RA	RA	H	H	RA--EQUA--050	6	1	20	0.5	0	0	E	S	5500 C
62	WIL	WILLOW	.953	RA	RA	H	H	RA--EQUA--050	6	1	20	0.5	0	0	E	S	5500 C
96	LC	LOGCAB	.944	WL	.87	C	C	WH--EQUA--050	4	1	99	1.0	0	0	E	S	4700 C
97	OH	OTH HDWD	.940	RA	RA	C	C	RA--EQUA--050	6	1	20	0.5	0	0	E	S	5500 C

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Table 15 - Westside Sort Grade Table

TblSortGrade		Sort/Grade Table																				
Table Name: WEST SIDE																		Date: 5/5/2014				
Sort	Grd	Abr	Desc	Fbr	Min Dia	Max Dia	Max B Butt	Min I Len	Max Len	Defect	Min Vol	Vol Type	Min Rings	Knot S Size	Knot Freq	Str	Sap	Min Age	Lbs	Lbs Type	Cords	Cords Type
0		CU	CULL		0	0	0	0	0	0	0		0	0	0			0	0	0	0	0
1		1P	1PEELER		30	0	0	17	0	0	0		8	0	0			0	0	0	0	0
2		2P	2PEELER		30	0	0	17	0	0	0		8	0	0			0	0	0	0	0
3		3P	3PEELER		24	0	0	17	0	0	0		6	0	0			0	0	0	0	0
4		S	SPECMILL		16	0	0	17	0	0	0		6	0	0			0	0	0	0	0
5		1S	1 SAW		24	0	0	16	0	0	0		0	0	0			0	0	0	0	0
6		2S	2 SAW		12	0	0	12	0	0	60 M		0	0	0			0	0	0	0	0
7		3S	3 SAW		6	0	0	12	0	0	50 M		0	0	0			0	0	0	0	0
8		4S	4 SAW		5	0	0	8	0	0	10 M		0	0	0			0	0	0	0	0
9		UT	UTILITY		2	0	0	8	0	0	0		0	0	0			0	0	0	0	0
A		C1	CLASS 1		9	12	0	0	0	0	0		0	0	0			0	0	0	0	0
B		C2	CLASS 2		9	12	0	0	0	0	0		0	0	0			0	0	0	0	0
C		C3	CLASS 3		8	11	0	0	0	0	0		0	0	0			0	0	0	0	0
D		C4	CLASS 4		8	10	0	0	0	0	0		0	0	0			0	0	0	0	0
E		C5	CLASS 5		7	9	0	0	0	0	0		0	0	0			0	0	0	0	0
H		H1	HEAVY 1		10	13	0	0	0	0	0		0	0	0			0	0	0	0	0
0		CU	CULL		0	0	0	0	0	0	0		0	0	0			0	0	0	0	0
D		D	DOMESTI		0	0	0	0	40	0	0		0	0	0			0	0	0	0	0
H		H	HIGHQUA		12	0	0	12	40	0	60		0	0	0			0	0	0	0	0
M		M	MINIPEEL		8	0	0	17	40	0	0		0	0	0			0	0	0	0	0
R		RO	ROUGH		12	0	0	12	40	0	60		0	0	0			0	0	0	0	0

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Table 16 - East Side / White Salmon Sort Grade Table

Sort/Grade Table																						
TblSortGrade																						
Table Name: NEWEAST																		Date: 5/5/2014				
Sort	Grd	Abr	Desc	Fbr	Min Dia	Max Dia	Max E Butt	Min I Len	Max Len	Defect	Min Vol	Vol Type	Min Rings	Knot S Size	Knot Freq	Str	Sap	Min Age	Lbs	Lbs Type	Cords	Cords Type
0	CU		CULL		0	0	0	0	0	0	0		0	0	0			0	0	0	0	0
1	1S	1	SAW		24	0	0	16	40	0	0		0	0	0			0	0	0	0	0
2	2S	2	SAW		12	0	0	12	40	0	0		0	0	0			0	0	0	0	0
3	3S	3	SAW		6	0	0	12	40	0	0		0	0	0			0	0	0	0	0
4	4S	4	SAW		5	0	0	0	40	0	10		0	0	0			0	0	0	0	0
5	5S	5	SAW		6	0	0	12	40	0	0		0	0	0			0	0	0	0	0
6	6S	6	SAW		5	0	0	0	40	0	10		0	0	0			0	0	0	0	0
9	UT		UTILITY		2	0	0	0	40	0	10		0	0	0			0	0	0	0	0
N	N		NO GRAD		4	0	0	0	32	0	0		0	0	0			0	0	0	0	0
P	P		PEELER		24	0	0	17	32	0	0		0	0	0			0	0	0	0	0
S	S		SP MILL		16	0	0	17	32	0	0		0	0	0			0	0	0	0	0
0	0		CULL LO		0	0	0	0	0	0	0		0	0	0			0	0	0	0	0
D	D		DOMESTI		0	0	0	0	0	0	0		0	0	0			0	0	0	0	0
H	H		HEW SAW		4	0	0	12	0	0	0		0	0	0			0	0	0	0	0
M	M		MINIPEEL		8	15	0	17	0	0	0		0	0	0			0	0	0	0	0
P	PO		POLE		0	0	0	0	0	0	0		0	0	0			0	0	0	0	0

Sort/Grade Table																						
TblSortGrade																						
Table Name: WSALMON																		Date: 5/5/2014				
Sort	Grd	Abr	Desc	Fbr	Min Dia	Max Dia	Max E Butt	Min I Len	Max Len	Defect	Min Vol	Vol Type	Min Rings	Knot S Size	Knot Freq	Str	Sap	Min Age	Lbs	Lbs Type	Cords	Cords Type
0	CU		CULL		0	0	0	0	0	0	0		0	0	0			0	0	0	0	0
1	1P		PEELER		30	0	0	17	0	0	0		8	0	0			0	0	0	0	0
2	2P		PEELER		30	0	0	17	0	0	0		8	0	0			0	0	0	0	0
3	3P		3 PEEL		24	0	0	17	0	0	0		6	0	0			0	0	0	0	0
4	S		SP MILL		16	0	0	17	0	0	0		6	0	0			0	0	0	0	0
5	5S		5 SAW		5	0	0	16	0	0	0		0	0	0			0	0	0	0	0
6	2S		2 SAW		12	0	0	12	0	0	60	M	0	0	0			0	0	0	0	0
7	3S		3 SAW		6	11	0	12	0	0	50	M	0	0	0			0	0	0	0	0
8	4S		4 SAW		5	0	0	8	0	0	10	M	0	0	0			0	0	0	0	0
9	UT		UTILITY		2	0	0	8	0	0	0		0	0	0			0	0	0	0	0
0	CU		CULL		0	0	0	0	0	0	0		0	0	0			0	0	0	0	0
D	D		DOMESTI		2	0	0	0	40	0	0		0	0	0			0	0	0	0	0
H	H		HIGHQUA		12	30	0	16	40	0	0		6	2	0			0	0	0	0	0
M	M		MINIPEEL		8	15	0	17	32	0	0		6	1	0			0	0	0	0	0

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APPENDIX E – TIMBER CRUISING REFERENCES

Books and Publications:

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Websites:

Atterbury Consultants, Inc. <http://www.atterbury.com/>

John Bell and Associates. <http://www.proaxis.com/~johnbell/>

Kim Iles and Associates. <http://www.island.net/~kiles/>

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