

FOREST INVENTORY AND MONITORING GUIDELINES

A Guidebook for NCF Members

Updated 2014

Prepared by Northwest Natural Resource Group
& Stewardship Forestry



Conservation

Conservation is a state of harmony between men and land. By land is meant all of the things on, over, or in the earth. Harmony with land is like harmony with a friend; you cannot cherish his right hand and chop off his left. That is to say, you cannot love game and hate predators; you cannot conserve the waters and waste the ranges; you cannot build the forest and mine the farm. The land is one organism. Its parts, like our own parts, compete with each other and co-operate with each other. The competitions are as much a part of the inner workings as the co-operations. You can regulate them—cautiously—but not abolish them.

The outstanding scientific discovery of the twentieth century is not television, or radio, but rather the complexity of the land organism. Only those who know the most about it can appreciate how little we know about it. The last word in ignorance is the man who says of an animal or plant: "What good is it?" If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.

-Aldo Leopold in *Round River*

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Northwest Certified Forestry is a non-profit membership and services program developed by NNRG to assist small forest landowners in Oregon and Washington with optimizing the economic and ecological potential of their forestlands. Visit www.nnrg.org for more information.

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Introduction

Pacific Northwest forests are a study in contrasts. Peering through their overt beauty one finds a covert mystery that only reveals itself through studied observation. Understanding this mystery leads to a more intimate participation with the forest, and allows forest managers to make better decisions about desired future conditions. Monitoring forest ecosystems has many valid applications, ranging from simple ocular assessments to more complex systematic statistical sampling of ecosystem attributes. This guidebook weaves together a range of monitoring options that allows forest managers to develop a monitoring program that is appropriate for their interest and skill level and meets the management objectives of their forest.

For forest managers who are managing to the standards of the Forest Stewardship Council™ (FSC®), a monitoring program is required and is one of the ten principles of the FSC certification standards. *Principle 8: Monitoring and Assessment* in the FSC-US Forest Management Standard (v1.0) states that:

“The frequency and intensity of monitoring should be determined by the scale and intensity of forest management operations as well as the relative complexity and fragility of the affected environment. Monitoring procedures should be consistent and replicable over time to allow comparison of results and assessment of change.”

The goal of this guidebook is to provide a practical, simple inventory and monitoring system for landowners who own less than 2,500 acres. By using these guidelines, you will collect information that can be used to improve forest management and meet FSC certification requirements. Instructions for various monitoring strategies, datasheets to record field information and other tools are provided here to assist you with developing a site specific monitoring plan. The methods suggested in this guidebook are but one approach for collecting inventory and monitoring data. They are not a rigid set of requirements, but instead a set of guidelines and tools that you can adapt to you specific ownership, skill sets, and management approach. Landowners with no existing monitoring system may choose to adopt this system as-is, while others who have existing systems will likely use it as a reference to ensure they are meeting FSC requirements.

This guidebook is designed for landowners who possess only basic forestry skills. It does assume that you have a forest stewardship plan that includes maps, outlines primary management objectives, and is capable of being updated as new information becomes available. You should find that the datasheets offered as a supplement to this guidebook (available at nnrg.org/ecosystem-services) can be easily integrated into your existing forest management plan. **Most important, this guidebook should provide you with a simple system to collect, organize, and interpret key information to help you steward your forestland.**

Structure of Guidebook

This guidebook uses a specific structure for presenting information on how to inventory and monitor forestland. The guidebook is organized into four sections:

- Techniques
- Office preparation
- Field instructions
- Office analysis

This sequential manner introduces concepts and techniques, helps you prepare for fieldwork, gives instruction for collecting field data, then provides guidance on how to organize field data and update forest management plans.

Required Skills

You will need the following basic forestry skills to use this guidebook. These skills can be gained through training workshops provided by Northwest Certified Forestry or coached stewardship planning classes offered by state forestry extension services.

General Skills

1. Pacing distances along roads and through forest
2. Following a bearing on a compass
3. Use of a clinometer or other device to measure % slope, tree height and height-to live crown
4. Basic familiarity with Microsoft Excel (for timber stand inventory)

Forest Structure

1. Using a diameter tape & measuring a tree's diameter at breast height
2. Identifying trees that have high wildlife habitat value.
3. Tree & shrub species identification
4. Noxious weed identification
5. Estimating percent shrub cover
6. Coring trees

Forest Roads

1. Assessing general road conditions and severity of any problems
2. Evaluating culverts for fish passage, appropriate sizing, and condition

Streams and Wetlands

Note: If you are doing more intensive stream surveys you may need additional skills.

1. Classifying streams (fish bearing, non-fish bearing, etc)
2. Measuring bankfull width and bankfull depth
3. Measuring stream temperature and canopy cover with a thermometer and densiometer

Overview of FSC Inventory and Monitoring Guidelines

FSC certification requires participating landowners to implement a monitoring strategy that is appropriate to the scale of their operation. FSC monitoring requirements are addressed in *Principle 8. Monitoring and Assessment* of the [FSC-US Forest Management Standard \(v1.0\)](#). The basic monitoring requirements are summarized below:

1. Monitoring shall be conducted appropriate to scale

The frequency and intensity of monitoring should be determined by the scale and intensity of forest management operations as well as the relative complexity and fragility of the affected environment. Monitoring procedures should be consistent and replicable over time to allow comparison of results and assessment of change.”

2. Forest management should monitor the following indicators

- Yield of all forest products harvested
- Growth rates, regeneration and condition of the forest
- Composition and observed changes in the flora and fauna
- Environmental and social impacts of harvesting and other operations
- Costs, productivity, and efficiency of forest management

3. Results of monitoring should be incorporated into the implementation and revision of the management plan

- Discrepancies between outcomes (i.e. yields, growth, ecological changes) and desired future conditions (i.e. plans, projects, anticipated impacts) are appraised.
- Management plans and actions are revised to better achieve the desired future conditions.

Overview of NCF Monitoring Guidelines

These guidelines include the following five components:

1. A quantitative methodology for inventorying forest resources
2. A qualitative methodology for assessing general ecosystem conditions across the ownership
3. A qualitative methodology for site specific monitoring of management activities and sites of special concern
4. A system for organizing data collected from the first three steps above
5. Recommendations for incorporating data into a forest management plan

1. Inventorying Forest Resources

The forest inventory component of these guidelines consists of a stand level inventory system that quantifies forest structure, volume, and growth over time. The guidelines provide instructions for creating simple fixed plots to collect forest data as well as a spreadsheet program to record and calculate results. Beginning with a baseline inventory of your forest, the inventory should be updated

every 10 years, or coincident with the harvest frequency of the forest. However, a comprehensive inventory is not necessary on small ownerships that are not managed intensively or that have multiple stands of the same type (i.e. stands similar in age, species composition, site quality, and/or tree density).

2. Assessing Ecosystem Conditions Across Ownership

This component provides instructions for how to systematically walk each stand in an ownership to get a general idea of species composition, density, and forest structure, as well as identifying and monitoring such attributes as: forest health, natural disturbances, invasive species, wildlife habitat, and wildlife presence. These stand assessments are repeated every 10 years and can be in conjunction with a stand inventory. In addition, roads, streams and wetlands are evaluated for significant changes, degradation, or maintenance needs at different time intervals that are outlined in Table 1. The presence of wildlife species is also tracked through time.

3. Site Specific Monitoring

The site specific monitoring component of these guidelines consists of pre- and post-activity visual assessments of the sites where major management activities occur, such as timber harvesting, road construction or decommissioning, chemical use, etc. Sites are monitored for environmental impacts such as soil compaction, sediment delivery, or non-native, invasive species intrusion, and whether objectives such as live tree or snag retention targets are met. Assessments occur annually until either re-planting goals have been met following a timber harvest and/or any adverse impacts are resolved. Harvest volumes, costs, revenues, and public or outside review of activities are also recorded. Also, specific sites with rare, threatened or endangered species; major forest health or invasive weed problems should be monitored annually.

4. Data Organization

The data organization component of these guidelines consists of a series of datasheets for recording information collected from inventories and assessments. These datasheets come in the form of interactive Microsoft Excel spreadsheets that are provided both on Northwest Certified Forestry's website and provided with this guidebook. The datasheets include instructions for recording all forest data and assessment records, income and expenses, public use of the property, wildlife and plant species observed on the ownership and other useful information. *You are welcome to customize these sheets in Microsoft Excel or develop your own if you wish.*

It is recommended that every 10 years, or at the time of a timber harvest, a summary of the monitoring information be prepared and incorporated into the forest management plan, thereby informing adaptive changes to the plan. This summary can include growth and yield calculations; a report on any forest health issues; observations of rare, threatened or endangered species and their habitat; significant ecological changes; a list of major management activities; and totals for management costs, revenues, and local economic inputs.

5. Integrating Existing Information into a Management Plan

It is likely that you may have already collected part or much of the information described in this protocol. If you already have some form of monitoring system, this system can be used as a reference to ensure your system meets FSC requirements. If you have already collected inventory or monitoring information, existing records can be used as a baseline and data can be transferred to the datasheets provided in this plan. Be sure to check whether your existing records contain all the information described in these guidelines, and whether your collection methods are compatible with those described herein. If you have anecdotal monitoring information in your head, the datasheets provided in these guidelines can be used to capture this information. You may want to verify their observations through another field visit, depending on how detailed the information is and how confident you are of your memory.

Monitoring Intensity

The intensity and frequency of monitoring should vary with size and management intensity, or according to the following landowner classes and [Table 1](#).

Large landowners (over 100 acres) who manage intensively

Landowners who manage more than 100 acres or have a harvest frequency (average time between major commercial harvests) of 20 years or less should use all 4 components of the NCF monitoring system, or their own comparable system. This class of landowners is referred to as “large landowners” in the remainder of the document.

Small landowners (under 100 acres) or larger landowners who harvest infrequently

Landowners in this class may choose to develop a less intensive monitoring system. They may leave out component #1, the forest inventory, and do less intensive monitoring on the other components by following guidelines for “small landowners” that are highlighted in the relevant sections in this document.

Creating a Monitoring System

To help with organizing the data collected during the monitoring process, you should follow these steps:

1. Print out several copies of the Overview Datasheet #0 to use as a basis for creating and organizing the monitoring system.
2. Examine Table 1 below and determine which components are required for your ownership.
3. Read the instructions for each component and establish a schedule for monitoring the various attributes of your ownership. Record this schedule on the Overview Datasheet #0.
4. Note which parts of the system you understand and feel comfortable implementing, and which parts you will need training for. During an FSC audit, you can discuss your monitoring system and training needs with a representative of Northwest Certified Forestry and determine an implementation plan that meets your needs.

Table 1: Inventory and Monitoring Guidelines¹

Component & Recording Method	Recommended Measurement Frequency	
	Small landowners (<100 acres), or low-intensity management	Large landowners (>100 acres), or higher intensity management
1. Timber Inventory		
- Data sheets #1 & 2 - NCF Inventory Program	Recommended	Every 10 years or at time of harvest
2. Assessing Ecosystem Conditions Across Ownership		
Forest Stand -Data sheet #3	Every 10 years or after major disturbance (forest fire, windstorm,	Every 10 years or after major disturbance (forest fire, windstorm,
Roads -Data sheet #4	Every 2-5 years depending on road conditions or after major storm.	Every 2-5 years depending on road conditions or after major storm.
Biodiversity - Biodiversity Field Assessment Form	Every 2-5 years or after major disturbance or management activity	Every 2-5 years or after major disturbance or management activity
Stream & Wetland - Data sheets #5 & 6	Every 5 years or after major storm.	Every 5 years or after major storm.
3. Site Specific Monitoring		
Management Activities: - Data sheet #7 - Data sheets #3-6	Prior to major management activity in affected roads, stands, streams, wetlands, or other sites. After activity, monitored annually until site has met re-vegetation goals and/or any adverse impacts are fully	Prior to major management activity in affected roads, stands, streams, wetlands, or other sites. After activity, monitored annually until site has met re-vegetation goals and/or any adverse impacts are fully
- Management Plan	Annually until issue is resolved or change in RTE status	Annually until issue is resolved or change in RTE status
4. Data Organization & Summaries		
Overview - Overview Sheet #0	Updated as activities occur	Updated as activities occur
Chain of custody -NCF Invoice	Files updated as sales occur	Files updated as sales occur
Species Presence - Data sheet #9	Required only for RTE ₂ species. Recommended for other	Required only for RTE ₂ species. Recommended for other
Public use - Management Plan	Not required.	Maintain annual records of public use.
Summaries for management plan update - Management Plan	Every 5 years or at time of harvest	Every 5 years or at time of harvest
¹ Forest Health issues include noxious weeds, or pathogens, insect outbreaks, or other disturbances that affect major portion of ownership. ² RTE: Rare, threatened or endangered species		

¹ Forest inventory and monitoring data sheets are available at www.nnrg.org/ecosystem-services

Equipment List

The following items are recommended for conducting forest inventory and monitoring exercises.

Items needed for all field inventory or assessments

Field assessment datasheets (current and previous)

Field vest

Plastic flagging (at least three different colors)

Mechanical pencils

Sharpie permanent ink pen

Compass

Calculator

Small Ruler (metric & English)

75' or 100' Spencer tape w/dbh tape

Clinometer

Clipboard or datum

Stand map w/plots mapped out

Small pocket sized notebook

Digital camera

Plant ID book

Sample plastic bags for unknown plants

18" Increment borer (if aging trees is needed)

Items for Permanent Plots

Heavy duty stapler & staples

Hatchet or hammer

Numbered tree tags (check for numbers that have not been used)

Unmarked bearing tree tags for scribing

Nails

Zip ties

Rebar & plastic pipes (for replacement if missing)

Tree paint (spray can): orange or other bright color

Optional Items

Aerial Photo or contour map of stand

18" re-bar works great for holding Spencer tapes

Binoculars

First-aid kit

Machete for heavy brush

Stream thermometer

Snacks

Water

Cell phone or radio phone

Component 1: Inventorying Forest Resources

A forest inventory is the backbone of any monitoring system. As it is impractical to measure every tree in a stand, a statistical sample of a stand is preferred. Inventory plots of a specific dimension are randomly located throughout a stand using a systematic sampling technique. Variables such as tree diameter, shrub cover, number of snags, etc, are then measured on each plot. Values from each plot are averaged together to generate an average value per acre for each variable measured (e.g. tree diameter). Values for each variable in the entire stand (e.g. total timber volume) can then be calculated by multiplying the average by the number of acres in the stand. Values from each stand in the ownership are then added together to provide ownership level values.

Confidence Intervals

When collecting plot and stand data, it is important to determine how closely the sample reflects what is actually on the ground (e.g. trees per acre, volume, etc). This is done by calculating a *confidence interval*, or a range that we can be 95% certain the true average falls within. For example, if a stand has an average volume of 30mbf/acre and a 95% confidence interval of 5mbf/acre, we would state that we can be 95% certain that the true average is between 25 and 35mbf/acre. If the stand is 100 acres, we are 95% certain it has 2,500 – 3,500mbf. The 95% level can be raised or lowered, but 95% is common in forest sampling.

Confidence intervals also allow us to determine if changes through time are statistically significant. For example if we re-inventory the stand in 10 years and it has a volume of 40mbf/ acre +/- 6mbf (34-46mbf/acre), we cannot say that there has been a statistically significant change in the volume as the confidence intervals overlap. If the average is instead 40mbf +/- 3mbf/acre (37-43mbf/acre), there would be a statistically significant difference. While forest management is always based on imperfect information, it is critical to know how imperfect it is. The NCF inventory software program provided with these guidelines automatically calculates the confidence interval for plot and stand data you enter in the program.

To lower confidence intervals and provide more accurate inventory information, you can either increase the size of plots, which lowers the variability between them, or you can increase the number of plots. As resources are always limited, a major goal of forest inventory is to install the minimum number of plots possible to achieve the desired level of accuracy or size of confidence interval. In most baseline and monitoring inventories that are done for planning purposes, foresters often do a “stand exam” in which a lower level of accuracy and fewer plots are sufficient. When you are preparing for a timber harvest, however, a higher level of accuracy is typically desired and a “cruise” with more plots is conducted. The inventory methodology provided in these guidelines is designed for stand exams, but can be used for more intensive cruises by simply adding more plots.

1.1 Inventory Techniques

The following guidelines provide an overview of a forest inventory strategy:

Temporary vs. Permanent Plots

When conducting a forest inventory, most landowners install temporary plots. When the stand is re-inventoried in the future, plot locations are different. This is the simplest inventory method and is recommended for landowners who have minimal time to devote to forest inventory or who rely on multiple consultants.

Permanent inventory plots are often used on large ownerships and are the most precise method of monitoring forest change over time. To establish “permanent” plots, plot centers are marked with a stake or other marker and the variables of the forest stand within the plot are re-measured through time.

If you are conducting a forest carbon inventory you will want to establish permanent plots that can easily be re-measured.

Fixed Area vs. Variable Radius Plots

Fixed area plots consist of a predetermined and unchanging area on the ground and are the most simple to work with. Variable radius plots involve the use of special tools, such as a prism or Relascope, and take some time to understand and master. Only landowners who are familiar with variable radius plots and have their own inventory software should use them. Therefore, variable radius plots will not be discussed in this monitoring guidebook. Permanent plots should generally be fixed area plots. Landowners can decide to use fixed area plots in some stands and variable radius plots in others, but the methods should be kept consistent when re-measurements are conducted in the same plot. The field instructions and inventory program discussed later in this handbook use fixed area plots.

Inventory Frequency

A baseline inventory of an entire ownership should be completed when a management plan is written. It is difficult to develop a plan without knowing what resources exist on the property, especially if the owner intends to harvest timber in the near future. Likewise, the entire ownership should be re-inventoried at least every 10 years or at the time of timber harvest. However, a full inventory is not necessary for low intensity managed forests or forests that have multiple stands in a similar stand type (stands similar in age, species composition, site quality, tree density, etc.). Instead, a sample of stands from each stand type can be selected for the baseline inventory and re-measured every 10 years in order to provide information for updating the management plan. Average per acre values for such variables as volume, trees per acre, etc, should be calculated for each stand type and extrapolated to the stands that are not inventoried. In general, at least 50 percent of the stands in each stand type should be inventoried. The other 50 percent should receive qualitative assessments of ecosystem

functions (described later in this guidebook and field data sheets are available at www.nnrg.org/ecosystem-services).

For stands where harvesting occurs more frequently than every 10 years, pre-harvest cruises and post harvest monitoring can be used in lieu of inventorying the stand during regular property-wide re-inventories. Finally, the entire ownership does not have to be inventoried or re-inventoried at one time as individual stands can be inventoried over several years.

1.2 Office Preparation

Once the basic framework of the inventory system has been decided upon, the following steps should be followed to inventory an individual stand. These steps are best done at home, prior to the field portion of the inventory.

1. Determine type of plot (temporary or permanent)

Decide whether plots will be temporary or permanent. Again, you may choose to put permanent plots in a few select stands that will receive specific treatments you wish to monitor and temporary plots in stands you only want to collect short-term data from.

If you are conducting a forest carbon inventory you will want to establish permanent plots that can easily be re-measured.

2. Determine plot size

Each plot should contain an average of 8-15 overstory trees. If you know the approximate density (trees per acre) use the table below to select the appropriate plot size. The plot size must be kept the same on all plots in a stand, but can vary between stands. If you don't know the density of the stand, you will need to visit the stand and measure the trees per acre.

Table 2: Recommended Plot Size

Trees per Acre	Recommended Plot Size	Plot Radius
800+	1/100 th acre	11.8'
400-800	1/50 th acre	16.7'
150-400	1/20 th acre	26.3'
75-150	1/10 th acre	37.2'
75 or less	1/5 th acre	52.7'

How to Determine Trees Per Acre

1. Select an area that is representative of the stand and locate and flag a plot center.
2. Measure out 26.3' in four directions from plot center and flag the circumference of the plot.
3. Count the number of overstory trees in this plot and multiple by 20 to get trees per acre for that stand.
4. Locate 2-3 plots in the stand to get an average tree per acre value.

3. Determine target number of plots

Using the table below, determine the number of plots necessary to achieve a thorough representation of the forest. For stands with highly variable species composition, install more plots. For homogenous stands, reduce the number of plots. If you are conducting a cruise prior to a timber harvest and desire a higher level of accuracy, increase the number of plots.

If you are conducting a forest carbon inventory you will want to establish a minimum of 1 plot per 5-10 acres.

Table 3: Recommended number of plots for different stand sizes.

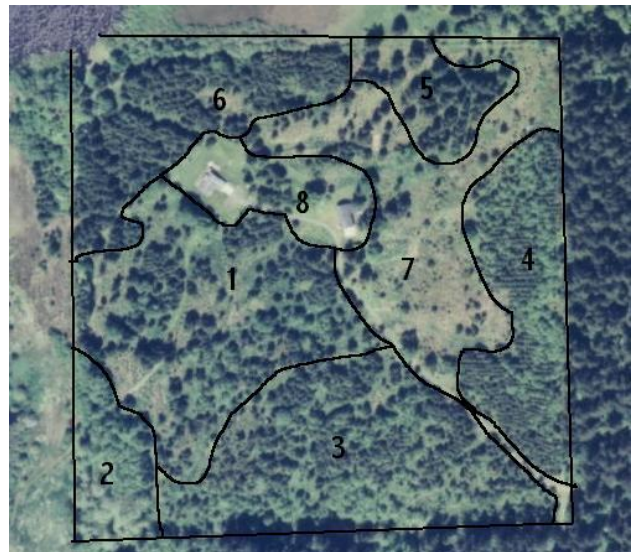
Plot Size	Stand Size			
	5-20 Ac	21-40 Ac	41-80 Ac	80+ Ac
1/100th	10	15	20	25
1/50th	10	15	20	25
1/20th	8	10	12	15
1/10th	6	8	10	15
1/5th	5	8	10	12

4. Create a stand map

You will need to create a scaled map of the forest stands on your property using an 8.5 x 11 sheet of paper (or larger) that can easily be carried during field work. The scale of the map must be large enough to draw in all the plots so you can see them. You will need to know the scale and indicate it on the map.

Maps can be created from any of the following sources:

- Aerial photos
- Topographic maps
- Orthophotos printed from GIS or web-based mapping programs
- Hand drawing (must be to scale)

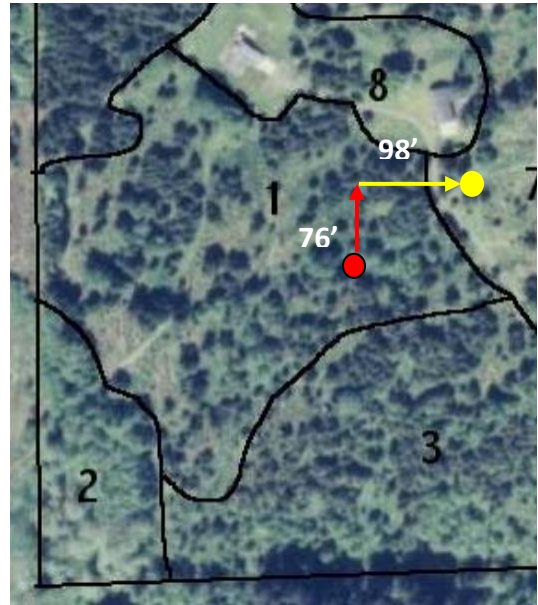


Stand map for a 40 acre parcel.

5. Layout first plot on map

Once you have created your map, you need to locate and draw in the first plot within the first stand (see Figure 1 below). The location of this plot *must be randomized*. Use the following steps:

- Select a corner of the stand that is easy to locate in the field. This will be your control point.
- Use a random [number generator](http://www.random.org/) (www.random.org/) on a calculator or computer and generate two random numbers between 0 – 100.
- Multiply the first random number by 0.66, add 66, and round up. For example, if your random number is 48, you will multiply 48 by 0.66, then add 66 to arrive at 98 feet. *If you are operating in a stand that is smaller than 20 acres and the plot size is 1/10 acre or less, use 0.33 and 33 instead of 0.66 and 66.*
- Do this for the second random number. If your random number is 15, then multiply 15 by .66, then add 66 to arrive at 76 feet. *If you are operating in a stand that is smaller than 20 acres and the plot size is 1/10 acre or less, use 0.33 and 33 instead of 0.66 and 66 for both random numbers.*
- From the control point, measure into the stand on the east/west axis the number of feet calculated from your first random number. In this case 98 feet. Mark a light dot on the map in pencil.
- From this dot, measure into the stand on the north/south axis, the number of feet calculated from your second random number. In this case 76 feet. Mark this spot on your map. This is your first plot.
- Write both distances on the map.
- Write the plot number on the map, and the plot size that will be used for the stand.



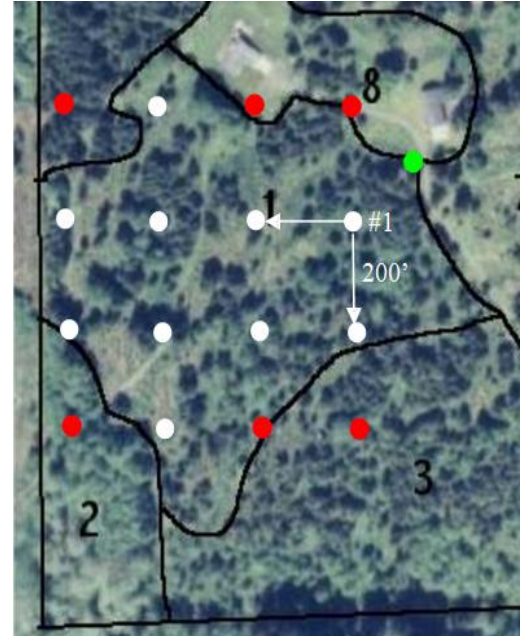
Establishing control point and first plot in an 11-acre stand.

6. Layout remaining plots

Layout and number the remaining plots on a grid by measuring out from the first plot. In stands that are roughly the same average length and width (square or circular), the north-south distance between plots will be the same as the east west distance.

To calculate the distance between plots, multiply the number of acres of the stand by 43,560, then divide by the target number of plots, take the square root, and round down to the nearest 50'. For example, for an 11 acre stand with a target of 10 plots: $11 * 43,560 = 479,160$. $479,160 / 10 = 47,916$. $\sqrt{47,916} = 218$. By rounding to the nearest 50', the distance between the remaining plots will then be 200'.

To lay out the remaining plots, use a ruler and the scale bar to measure out 200' along the east-west axis and 200' along the north-south axis to the second plot, and so forth until you have filled up the stand (see Figure 1 below). *Do not include plots that are within one plot radius of the stand boundary.* You may fall short of your target number by a few plots due to the shape of the stand - this is normal. If you fall very short (less than 20% of the target), you will need to shorten the grid distance and try again. Be sure to use a penciled, as you may need to erase plots and start over. Be sure to write the grid distance on the map.

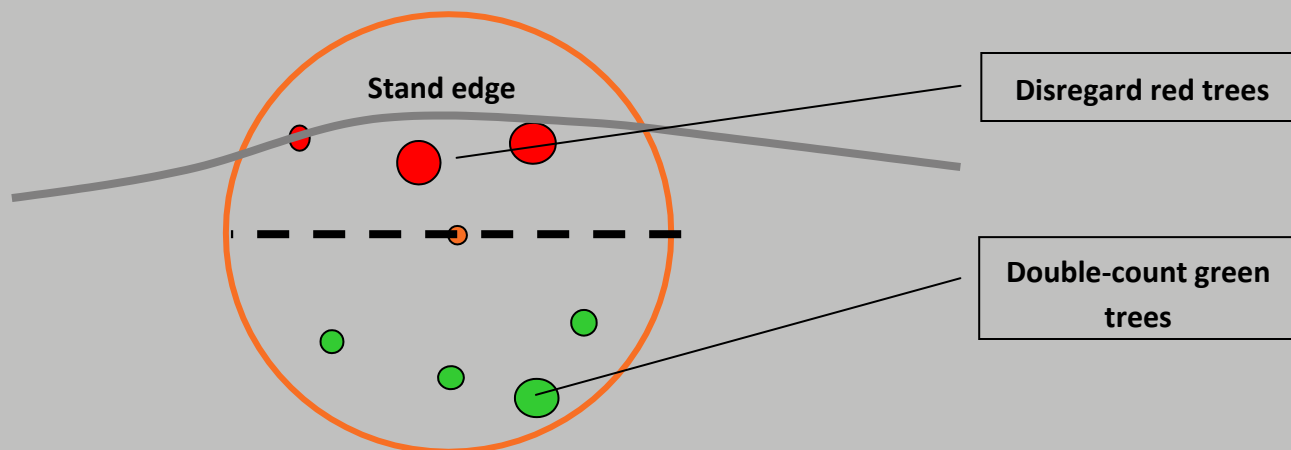


Lay out remaining plots

Partial Plots at the Edge of a Stand

In cases where a plot's center falls near the edge of the stand and part of the tree plot is outside the stand, use the following half-plot method:

1. Draw an imaginary line through plot center that is roughly parallel to the stand boundary to divide the plot into two halves.
2. Disregard all the trees, shrub, and saplings in the half of the plot that falls partially outside of the stand.
3. Double count all the trees and saplings in the half plot that is entirely in the stand by recording each tree twice on the datasheets. Estimate percent cover of shrubs only for the half plot.



7. Prepare datasheets and inventory tools

You are now ready to head into the field and conduct the Inventory!

Be sure you have the following:

- a. The stand map with the plots you prepared.
- b. An aerial photo of the stand or contour map (these aren't essential, but one or the other is recommended).
- c. For every two plots you intend to install, bring one copy of Inventory Datasheets #1 & #2. If you use handheld data collectors or PDA's, download each datasheet into the device.
- d. One copy of the Stand Assessment Datasheet.
- e. One copy of the five- page field instructions.
- f. If you are re-measuring permanent plots, include a copy of the stand map from the last inventory, plus the old datasheets (or a print out of the data) for reference.
- g. The required field equipment listed in the Equipment List.



Basic forest inventory tools.

1.3. Field Instructions

Use these instructions in conjunction with Inventory Datasheets #1, #2, and #3. Datasheets are available at nnrg.org/ecosystem-services under the Field Forms section, look for Forest Inventory Forms.

1. Locate first plot

- a. For the first plot, start at the control point and locate the first plot using your compass and hip chain or measuring tape. It is good practice to calculate your pace during these measurements to calibrate it for the forest conditions you will be in.
- b. For subsequent plots, use your compass and measure (or pace off) the distance between plots. If the brush is very thick and your pacing is questionable, measure the distance between each plot with a tape. If a plot falls near the stand edge and part of the plot is outside of the stand, use the instructions on page 12 to establish this plot. If a plot center falls outside of the stand, eliminate this plot from your inventory.

2. Mark plot center

Temporary plots:

On your last pace, dig into the ground with your foot and place a piece of flagging in the hole or use a small stick with flagging to mark plot center. If you are working alone, inserting an 18" piece of re-bar in the ground at plot center can be helpful to hold the measuring tape while measuring out distances from plot center (remove rebar and re-use on every plot). Hang flagging nearby so it is visible and write the plot number and date on the flagging.

Permanent plots:

- i. Place a PVC pipe over a two foot piece of rebar that has been driven into the ground to mark plot center. Label PVC pipe with the appropriate plot identification number.
- ii. In order to more easily find the plot center in the future, identify and mark bearing trees using the following steps:
 - a. Locate two vigorous, dominant trees (no alder or willow if possible) that are roughly perpendicular to plot center.
 - b. Paint a ring or spot of bright tree paint as high as possible on each tree.
 - c. Scrape off moss at base of tree facing plot center. Paint with spot of paint.
 - d. Scratch the following information onto aluminum tags and record the same information in Inventory Datasheets #1 & #2: plot #, distance to plot center, azimuth from tree to plot center, tag # from tree plot (in notes only).
 - e. Staple tags to trees.



Marking plot center with a PVC pipe and flagging.

Correcting for Slope

If you encounter a slope that is greater than 45 percent, you will need to correct any up or downhill measurements for slope. Do this by dividing your desired distance between plots by the cosine of the angle (in degrees) of the slope. If your plot distance is 300' and the slope angle is 30 degrees (58% slope), then the distance you would measure on the ground is $300/\cosine(30) = 346'$.

3. Photo points (optional)

Take the following digital photos at every plot for permanent plots and every other plot for temporary. Use the widest zoom possible.

- A photo of the plot number on the hanging flagging at plot center. Make sure the plot number is identifiable in the photograph.
- One photo in each of the four cardinal directions. Standing at plot center and starting with due north, proceed clockwise east, south, and west.
- Sky & canopy. Facing north, standing at plot center, aim the camera directly up.
- Ground: Take two steps north of plot center and photograph directly down (feet are ok!).

4. Topographic information

Record percent of slope, aspect, and topographic position (e.g. valley bottom, midslope, ridge, bench, terrace, flat, depression, etc).

5. Tree and shrub measurements

Tree plot:

i. Plot dimensions:

Record plot size and radius on data sheet. *If there's a question about whether a tree is in or out of the plot, measure to the center of the tree with tape. If the majority of the tree's diameter is within the plot, include the tree.*

ii. Measurements:

Measure all live trees over 5.0" dbh. However, if you are inventorying a young stand where the average dbh is less than 6", include all trees in the tree plot. If your stand has an average dbh between 5-10" dbh and an understory tree layer is present, include trees above 3" dbh in the tree plot.



Measuring plot radius with a Spencer tape.

- **Species:** Use species codes from code sheet. If you find a species not on this list, assign it a two letter code and add it to the code sheet. Count Cascara, Willow, and Hawthorne as trees/saplings if they have stems over 3" dbh, otherwise record as shrub.
- **Strata (optional):** This is not essential if you are not familiar with how to classify. Otherwise, use the following classifications:
 - O: Overstory: Trees in the upper third of the canopy. Their height should be at least 2/3rds of the average height of the largest trees in the stand.
 - M: Mid-Story: Trees in the middle 2/3rs of the canopy. Their height should be between 1/3 and 2/3rds of the avg height of the largest trees in the stand.
 - U: Understory: Trees in the bottom third of the canopy.
- **Dbh:** Measure to 0.1 inch.
- **Wildlife tree identification:**

Record "1" if tree contains the following:

 - Indications of wildlife use such as woodpecker activities, nests, heavy browse or rubbing, bark or cambium scraping, etc.
 - Features attractive to wildlife such as significant rot, large branch platforms, cavities, broken tops, damaged or deformed stems, exposed bole areas with decay, significant mistletoe infection, or conks on bark.
 - Record further description and cause of damage in notes column if desired.
- **Percent Defect (optional):** Estimate in 10 % classes in terms of merchantable volume deduction. Only do this if you wish to record defect and know how to do it.
- **Tag trees (permanent plots only):** Each tree or a selection of diameters and species. Tag with pre-numbered tag facing plot center. First tree tagged should be the first tree east of due north (from plot center); proceed in a clockwise direction marking all remaining trees. Place nail or thin line of paint at height where dbh is measured.

iii. Intensive Measurement Trees:

Select 2-8 trees per plot for these **additional** measurements. If measuring tree volume is an important part of the inventory, you will need to ensure that at least 20 intensive measurement trees are measured over all the plots for each species. Thus if your inventory only has eight plots, you should measure three trees per plot for each species. For these species, choose the largest tree and 1-2 trees closest to plot center that are over 5" dbh. If the largest tree is the closest tree to plot center, choose the next 1-2 closest trees. For species where precise volume estimates are not as important, choose one average size tree per plot. On all intensive measurement trees, record the following:

- a. Height to nearest foot
- b. Height to live crown (optional): Locate live crown on conifers at point where 3-quadrants of crown have live branches. For irregular crowns, average quadrants together.
- c. Age (if stand age or site index is not known): core tree with an increment bore for age and also to assess recent annual growth rates if desired.
- d. Tag trees (permanent plots only): Intensive measurement trees should be tagged

Sapling Plot:

Definition: Saplings are trees under 5" dbh and over 4.5 feet in height. Ignore seedlings that are less than 4.5 feet in height. If you are inventorying a young stand where the average dbh is less than 5", do not do the sapling plot and include all your trees in the main tree plot. If your stand has an average dbh between 5-10" dbh and an understory tree layer is present, only measure trees in the 0.1 – 3" dbh class and include the 3-5" in the main tree plot.

i. Plot Dimensions:

Determine appropriate plot size for saplings:

- If there are less than 20 saplings in the regular tree plot, use same plot size as tree plot.
- If there are more than 20 saplings, use a smaller shrub plot size.
- Choice of plot size must be the same for all plots throughout the stand.
- Record plot size on datasheet.

ii. Measurements:

- Record number of trees by species in 0.1-3" dbh classes.
- Record number of trees by species in 3-5" dbh classes.
- Count Cascara, Willow, and Hawthorne as trees/saplings if they have stems over 3" dbh, otherwise record as shrub.
- Tag selected saplings (permanent plots only): a selection of species and sizes of saplings should be tagged. Number each tag and record the species, diameter 6" above the ground, and height for each sapling in the Inventory Datasheet # 1.

Shrub Plot:

i. Plot Dimensions: 1/50th of an acre, 16.7' radius. Use same plot center as tree plot.

ii. Measurements for each major shrub species:

Note: Minor species do not need to be recorded on every plot.

- **Species:** Use species codes from Table 4 below. If you find a species not on this list, assign it a two letter code and add it to the code sheet.
- **Percent cover by species:** Estimate to the nearest 10%. An easy way to estimate percent cover is to divide circular plot into 4 quarters, estimate how much of surface area is covered by that shrub one quarter at a time, and add up at the end. A 3'x3' square is approximately 1 percent cover in a 1/50th acre plot.
- Record average height to the nearest 0.5 ft.
- Count Cascara, Willow, and Hawthorne as trees/saplings if they have stems over 3" dbh, otherwise record as shrub.

6. General Stand Assessment

At each plot (or every other plot if you are installing more than 10 plots in a stand), assess general ecological conditions and record observations using Stand Assessment Datasheet #3. Use only one datasheet per stand. Since you have already measured tree and shrub variables, leave the tree and shrub section blank in Stand Assessment Datasheet #3.

Table 4: Vegetation Codes

Tree Species

Conifers		Hardwoods		Others	
YC	Alaska Yellow Cedar	AS	Aspen	UN	Unknown
DF	Douglas-fir	BM	Bigleaf Maple		
ES	Engelmann Spruce	BC	Black Cottonwood		
GF	Grand fir	CA	Cascara		
LP	Lodgepole pine	CH	Bitter Cherry		
NF	Noble fir	GA	Garry Oak		
SF	Pacific Silver fir	OA	Oregon Ash		
PP	Ponderosa Pine	DG	Pacific Dogwood		
SS	Sitka Spruce	MD	Pacific Madrone		
RC	Western Hemlock	PY	Pacific Yew		
WP	Western White Pine	BR	Paper Birch		
		RA	Red Alder		
		WO	Willow		

Shrub Species

BB	Bog Blueberry	HZ	Hazelnut	SB	Salmonberry
BC	Blackcap Raspberry	IV	English Ivy	SCB	Scot's Broom
BD	Hedge Bindweed	IP	Indian Plum	SCR	Stink Currant
BF	Bracken Fern	LCF	Licorice Fern	SL	Salal
BL	Bog Laurel	LF	Lady Fern	SN	Snowberry
BR	Bog Birch	LG	Leathery Grease-Fern	SV	Serviceberry
CA	Cascara	LT	Labrador Tea	SW	Sword Fern
CB	Wild Crabapple	MA	Mountain Ash	TBB	Trailing Blackberry
CH	Cherry	MF	Maidenhair Fern	THS	Thistle
CR	Cranberry	ML	Milfoil	TH	Thimbleberry
DC	Devil's Club	NB	Ninebark	TR	Tansy ragwort
DR	Deer Fern	NR	Nutka Rose	TT	Trapper's Tea
EB	Evergreen Blackberry	NT	Nettle	TW	Twinberry
EH	Evergreen Huckleberry	OG	Oregon Grape	VM	Vine Maple
FA	False Azalea	OS	Oceanspray	WF	Water Fern
FB	False Bamboo	PL	Purple Loosestrife	WDF	Woodfern
GB	Gooseberry	RC	Red Currant	WO	Willow
HBB	Himalayan Blackberry	RD	Red-osier Dogwood	YI	Yellow-flag Iris
HH	Hardhack	RE	Red Elderberry	UN	Unknown
HT	Horsetail	RG	Reed Canary Grass		
HW	English Hawthorn	RH	Red Huckleberry		
HY	Holly	RH	Rhododendron		

1.4 Office Analysis

Once you complete the field portion of the inventory, you are ready to use the NCF Inventory Program to calculate the results. The Inventory Program is available at nnrg.org/ecosystem-services. The program can be used on any computer that has Microsoft Excel '98 or a more recent version. The program is a relatively basic inventory program that will provide most of the functionality needed for inventory and monitoring purposes.

Note: On older computers, the program may take some time to calculate results. Although the program can calculate timber volumes, it is not a full cruising program and therefore cannot organize timber volumes into different sorts.

1. Specifications

- a. The program uses the Tarif system to calculate volumes. Tarif equations are from Bell & Dilworth (1996). The advantage of this system is that heights are not required for every tree.
- b. Volumes presented are Scribner board foot volumes to a 6" top, using 32' logs, unless otherwise noted.
- c. The program can manage up to 10 stands, 35 plots per stand, and 3,500 tree records. If you have more data than this, contact NCF for a version with more capacity.
- d. The program can manage data from either fixed or variable radius plots.
- e. All the data sheets are set to print. However, make sure you only print the page numbers you wish.
- f. For those who wish to change the program, unprotect the worksheets and "unhide" all columns. The tariff equations are in a hidden worksheet.

2. Inputting Data

- a. When you first open the program, a dialogue box will likely open that asks you whether to allow "macros", click "yes" or "ok". If the program won't open, you must click on the "tools" drop down menu, and select "options". Look for the "security tab. At the bottom you will see "Macro security". Click on that button and then set your Macro security rating to "medium". Close, and then re-open the NCF inventory program and select yes to accept the macros and open the program.
- b. In the same "tools" menu, select "options". Click on the "calculation". Make sure it is set to "manual" in the first box, and NOT automatic.
- c. Once you have the program open and the settings set, the first step is to input the overall stand data. You will see numerous worksheet tabs on the bottom of the page. Click on the first worksheet labeled "stand". For each stand, enter the stand type (age class and dominant species), inventory date, acres, and the sapling plot size (i.e. 0.1 for 1/10 acre). Change the shrub plot size if you used a different size than 1/50th of an acre (16.7' radius). If you used fixed area plots, leave the last two blue columns blank. If you used variable radius plots, enter the Basal Area Factor and Plot Radius Factor, and leave the fixed area plot column blank.
- d. Next enter the tree records from Inventory Datasheet #1 using the "Tree" worksheet. The "tag #" column is for permanent plots only. Leave all columns you do not have data for

blank and only enter data in the white cells with grid lines. The green cells of the sheet are summary statistics and you cannot enter any data in these cells. The last column, "Net SV 32' 6", is the Scribner board foot volume for that tree.

- e. Next click on the "Sapling" worksheet tab and enter your sapling data from Inventory Datasheet #3.
- f. Finally click on the "Shrub" worksheet tab and enter your shrub data from Inventory Datasheet #3.
- g. If you have used different two letter codes for any of the tree or shrub species that are shown on the field instructions, or found a species that was not listed and added a code for it, go to the "Tr code" sheet or the "Sh_code" sheet. Change or add codes so they match your records.
- h. If you use an electronic data recorder, cut and paste the information into the appropriate columns.
- i. **Keep your field datasheets!** You may need to refer to these in the future and there is some data (bearing trees, topographical information, etc.) that does not get entered into the program.

3. **Reports**

- a. Once you have entered the data, save the file under a specific name. The computer may take 5-10 minutes to calculate all the results.
- b. The program is set to only calculate results when the program is saved or when you **press F9**. If you enter new data or change any of the data entered, press F9 to update the calculated results.
- c. The worksheets with "_rpt" after their name provide various types of reports. You can only enter data in the green cells on these reports.
- d. The reports should be formatted and are ready to print.
- e. **Plots Report:** This report shows all the plots for each stand. For a description of the metrics, see the "terms" worksheet with the red tab. Use the filter button in cell C1 to sort the list. Click on the filter button and scroll down to "non-blanks". This will show only the plots that have inventory data. If you add more data, you must use the filter to show "all" and then go back and use the filter to show only "non-blanks". The "dbh cut off" green box allows you to set a lower diameter for the columns in gray. The 6" value is set so the metrics in the gray columns are calculated for all trees 6" dbh and greater. This allows you to see the summary information with and without trees under whatever diameter threshold they wish to set. *Saplings are not included in these totals, even if the diameter limit is set below 6".* This dbh cut off can be used to separate out understory trees or saplings from the overstory in the summary metrics. Remember to hit F9 once you change the number so the computer re-calculates the values.
- f. **Individual Stand Report:** This shows all the plots and stand totals for an individual stand. Enter the stand number in the green box and hit F9 to re- calculate the data. You use the filter button in cell B1 in the same manner as the Plots Report, but be sure to reset it by filtering for "all" and then filtering for "non-blanks" each time you enter a new stand number. You can set the dbh cut off as well.

- g. Stand Report: This provides totals for all the stands. The filter can be used in the same manner as above. This report uses the dbh cut-off from the Plots Report worksheet. The numbers in () are 95% confidence intervals.
- h. Species Report: This provides a breakdown of trees per acre, quadratic mean diameter, and basal area for the six most abundant species by basal area. All other species are combined into other or "OT". Use the filter if desired.
- i. Volume Report: This report shows volumes by species on a per acre basis and total volume (multiplying the volume per acre by the number of acres in each stand). It lists the six most abundant species and lumps the rest into other or "OT". This report summarizes the total ownership volume and calculates 95% confidence intervals and percent error. The filter can be used in the same fashion as above.
- j. Stand Table: This bar graph shows the distribution of species by 3" diameter class for a specified stand. To change stands, enter the stand number in the green cell and hit F9. To alter the ranges on the x and y axes, click on the graph. Below the graph you will see the range for the graph in a blue outlined box on the numbers. Adjust this blue box to set the range you wish.
- k. Shrub Report: This report shows the top four shrubs species in each stand by percent cover.

Component 2: Assessing Forest Ecosystems

The qualitative assessment protocol for forest ecosystems described in this guidebook provides guidelines for you to conduct periodic, systematic surveys of your ownership to track important ecological and physical attributes through time. These attributes include forest health issues, natural disturbances, invasive species, major habitat features, RTE species (rare, threatened or endangered), wildlife presence, and illegal trespass problems. In addition, roads, streams, and wetlands are periodically evaluated for significant changes, degradation, or maintenance needs.

Unlike the forest inventory process, the following assessments are not quantitative, and therefore are designed to be consistent and replicable over time. The datasheets provided with these guidelines present a simple method for recording information that many landowners already collect, but don't necessarily write down. You may wish to expand these datasheets and *will likely need to use the back of each sheet for additional notes*.

You may choose to modify the datasheets provided with these guidelines, or develop your own system for collecting and recording information. When it is time to update the management plan, you can refer to the datasheets and include a summary of your observations in your plan. There are four separate parts to the general qualitative assessments: stand, road, stream, and wetland.

2.1 Stand Assessment Instructions

General Guidelines

The goal of stand assessments is to systematically walk each stand on your ownership in a manner that allows you to observe at least 75 percent of the area in the stand. After the initial baseline assessment of each stand has been made, stands should be reassessed on the following frequencies:

1. Every 10 years
- or -
2. Shortly after a major management activity (i.e. timber harvest, road building) or a natural disturbance that significantly alters the vegetation in the majority of the stand (i.e. fire, wind or ice storm, major beetle mortality, etc). After such an event, the assessment cycle restarts and the next assessment should be 10 years later.

For larger ownerships, it may be more practical to conduct assessments of individual stands over a period of several years.

Office Preparation

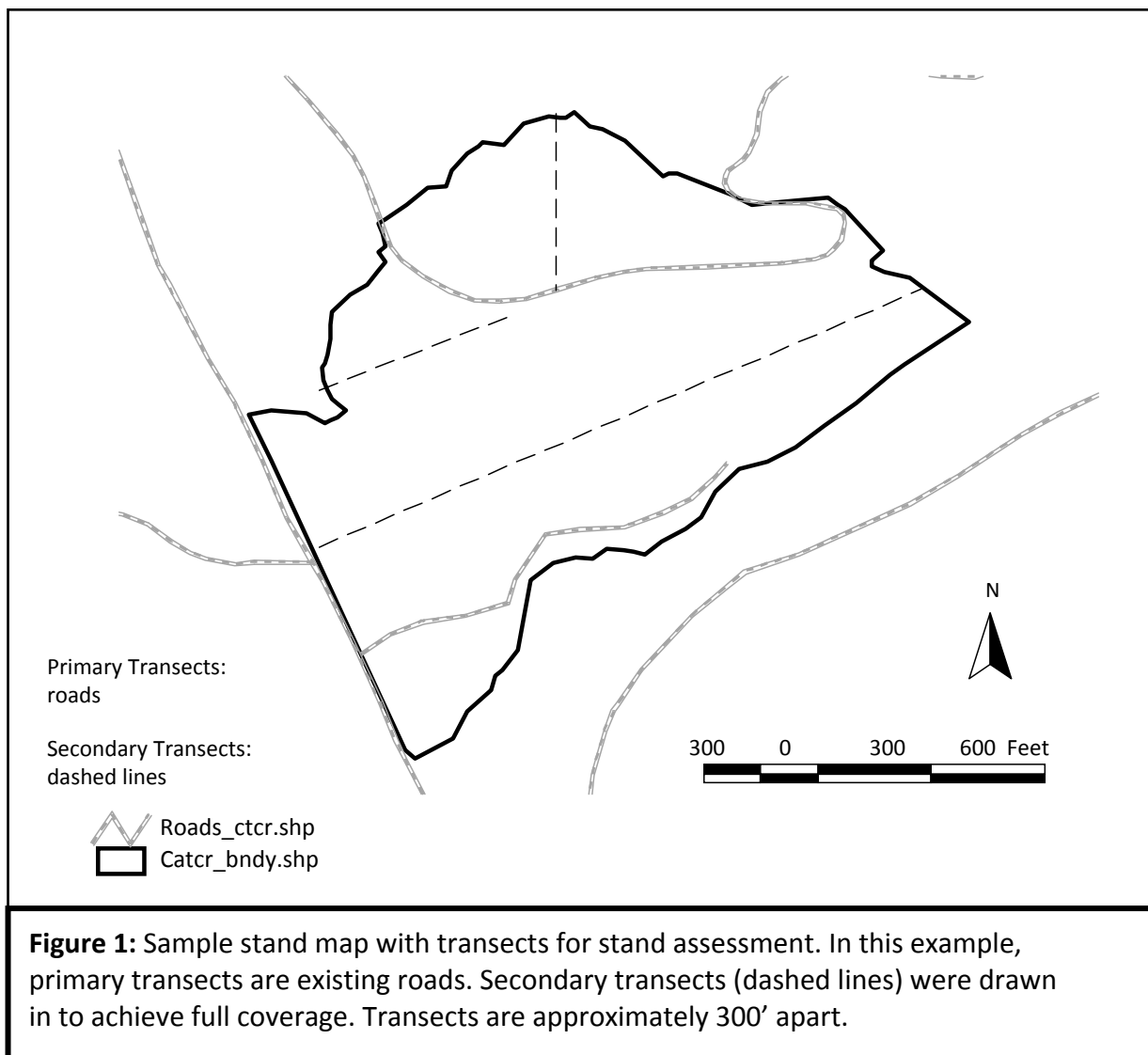
1. Establishing transects

To set up a systematic design sufficient to cover the stand, you will need to define a set of transects (lines through the stand) that you will walk. *The easiest way to do this is to use the plot grid from the inventory you recently completed.* Simply take your plot map, Stand Assessment Datasheet #3 and these instructions with you during the inventory and record observations at each inventory plot (or every other plot if you are installing more than 10 plots).

For stands that have not yet been inventoried, you will need to establish a set of transects. *If existing trails and roads provide a thorough coverage of the property, they may be used in lieu of new transects.* However, establishing transects ensures all areas in a stand are able to be observed. If you have assessed the stand in the past and established transect lines, you can use the transect lines from the prior assessment.

To establish a new set of transects, follow these steps (refer to Figure 1 below for an example).

1. Print a scaled stand map.
2. Draw roads, trails, or streams that pass through or border the stand.
3. Use the latter features as the primary transects and determine if the coverage is sufficient (e.g. able to see 75 percent of the stand). In a typical dense stand (250+ tpa), you can see trees 100' away. In a more open stand, you can typically see trees 200' away.
4. Establish a set of secondary transects if necessary to ensure complete coverage of the stand. *The distance between transects should be double the farthest distance you can see dominant trees in the stand.* Typically, it's easiest to pick a primary transect feature (road, trail, stream etc), and make the secondary transects parallel or perpendicular to it. Also, transects that head on a north-south or east-west axis are simpler.
5. Measure and note on the map the bearing and starting point of each secondary transect. Use a ruler to measure distances, and a protractor or compass for bearings. If you do not know how to measure bearings, stick with transects on 45 degree increments: N, NE, E, SE, S, SW, W, NW.
6. If you will not be using the plots you established during your forest inventory, then add up the approximate total distance of *all your transects* and divide by 10. This is your "stop distance", or the points at which you will stop while walking each transect in order to observe and record information. Note the stop distance range on the map.



2. Prepare datasheets and field tools

You are now ready to head into the field and conduct the stand assessment. Be sure to take the following with you:

1. The stand map with transects (or plots) drawn in.
2. A Stand Assessment Datasheet #3 for each stand (or plot).
3. Copies of old stand assessment sheets and stand maps if a prior stand assessment has been conducted.
4. The required field equipment listed in the Equipment List.

Field Instructions

Use these instructions in conjunction with the Stand Assessment Datasheet #3. As you walk your transects, make approximately 10 stops in the stand by using your stopping distance range as a guide (total length of the transects divided by 10). For example, if the total length of all of the transects in a stand is 5,500', then you would stop approximately every 550'. Choose one distance and keep it the same through the stand. You may not end up with exactly 10 stops and may want to add more, especially in large stands. While walking each transect, look both directions and record your observations using Stand Assessment Datasheet #3. If you are assessing a stand that has been assessed in the past, look at the old assessment sheet and note any significant changes from previous assessments. Take photos of any notable issues or features if desired. Finally, if you need to leave the transect to investigate an area, leave a piece of flagging on the transect so you can return to the same spot to continue. Record the following items:

1. Forest Health & Ecological Hotspots

If you notice one of the features listed on the datasheet while walking the transect or at a stop, place a tick mark in the appropriate box and provide a brief description of it in the box or on the back of the datasheet.

- a) Note its location on the stand map. Also note if you will need to return to the site to further investigate any forest health issues, conduct a future management activity (i.e. remove an invasive species), or do site specific monitoring (i.e. major root rot pocket).
- b) Taking along a book on forest diseases can be helpful in identifying particular tree diseases that you may encounter.

2. Wildlife

Follow instructions for Forest Health and Ecological Hotspots.

3. Trees & Shrubs

Note: Leave this section blank if you are doing a stand inventory in conjunction with the assessment.

At the first stop, write in the tree and shrub species you see beginning with the most prevalent

and ending with the least. At subsequent stops, use the same boxes for each species. If you have more than 5 species, note the presence of the minor species on the back of the sheet, but do not worry about collecting all of the measurements for these species. At each stop visually estimate the following for each tree and shrub species and record in the appropriate box. These are meant to be approximate estimates, you do not need to be exact. If greater accuracy is desired, you can install full inventory plots at a few stops during the stand assessment using the NCF inventory system. At the end of the stand assessment, you can average the values together to get a stand average for each species and all species.

Trees

- a. Strata: overstory, midstory, or understory. Some species may be in more than 1 strata. If a species is heavily represented in more than one strata, you may want to put each strata in a separate box.
- b. Trees per Acre: For dense stands, project an imaginary 17' radius circle from where you are standing and count all the trees of each species in it and multiply by 50 to get trees per acre. For more open stands, use a 26' radius circle and multiply by 20 to get trees per acre. You may need to measure out and flag the radius a few times to train your eye. At the end of the stand assessment, you can average the tpa values together to get a stand average for each species and all species.
- c. Average DBH. Record this to the nearest 2" diameter class. You may need to measure a few trees to train your eye.

Shrubs

- a. % Cover: Use a 17' radius circle to visually estimate the percent cover of each shrub species. The total % cover may add up to more than 100% if some species overlap.
- b. Average Height: record this to the nearest foot, or 0.5 for low shrubs.

Snags

At each stop, record the following:

- a. Count the number of directions (N, S, E, W) you see snags over 6" dbh in. Do not double count snags. Place a tick mark in the appropriate "directions observed" box.
- b. Estimate the percent of the snags you see in all four directions that are in each "DBH class" and record the number in each box. Visually estimate dbh and approximate to the nearest 10 percent.
- c. Repeat for "Height Class". A medium height class is defined as snags that are close to ½ of the average overstory tree height in the stand.
- d. Repeat for "species" by using the appropriate species codes (e.g. "DF, RC" for Douglas-fir or western red cedar. Use "Unk" (unknown) for any snags whose species you cannot identify.
- e. Example: if at your first stop you see snags in four directions, place a mark in the abundant (4) box. If the snags are 80 percent small and 20 percent medium, write "80" in the small box and "20" in the medium box. If the snags are 60% short and 40% medium in height, write "60" in the short box and "40" in the medium box. Do the same for percent of species.

Downed Logs

Use the same approach as for snags at each stop.

- a. If shrub cover is high in a stand, it may be hard to see the ground and any downed logs. In this case, walk out approximately 50' in each compass direction and look for logs in the brush.
- b. Judge decay status by the presence or absence of the majority of the bark, in addition to whether any areas of the downed log are without bark or are hard to the touch or soft and punky.
- c. Midpoint diameter is the diameter at the halfway point in the log. Estimate diameter visually.

After you have completed the stand assessment, add up the tick marks in each box. Use the back of the datasheet or an additional sheet to write a brief summary of the conditions for each of the boxes on the datasheet.

Digital photos should be promptly downloaded and clearly labeled with the date and location where they were taken. Finally, update the Monitoring **Overview Datasheet #0** by writing in the date of your assessment and the major issues found.

2.2 Road Assessment Instructions

General Guidelines

While forest roads are essential to managing forestland, they typically have a high level of environmental impact and require ongoing maintenance. The overall goal of monitoring roads is to detect any road deterioration, maintenance needs, or negative environmental impacts so any issues can be addressed before they become significant problems. It is assumed that the road system is mapped and described in the management plan and you have a basic road maintenance plan.

For landowners who harvest over 2 million board feet a year and have a WA DNR approved RMAP, their RMAP can be used in place of, or in conjunction with, the monitoring system described here. All roads are not equal in their impact, and thus assessments should be done in the following timeframes.

Applicability Note

For forest owners in Washington State, the Washington State Department of Natural Resources requires all small forest landowners to submit a *Road Maintenance and Abandonment Plan Checklist* prior to conducting timber harvesting activities. This checklist is available on-line at: <http://www.dnr.wa.gov/sflo/rmap/>, or by contacting the Small Forest Landowner Office at: 360-902-1415.

The information collected during the road assessment process outlined in these guidelines will allow you to easily fill out the Roads Checklist required by the DNR.

NCF has developed a road monitoring workbook available upon request.

1. Low gradient roads on flat topography with few stream crossings should be assessed every 5 years.
2. High gradient roads on side slopes and/or with multiple stream crossings should be assessed every 2 years.
3. Assessments should also be done after a major storm event or prior to a management activity on the specific roads that will be used. A major storm event is one with enough precipitation to potentially wash out culverts, cause road related landslides, or major sedimentation of streams. After a major storm event or management activity, the next assessment should 2-5 years later, unless another major storm occurs.

Design & Office Preparation

Using a map of the road system, roads should be broken down into segments that are based on natural or historical divisions in the road system. Individual segments should be small enough for effective management planning, on the order of 0.5-5 miles. The larger the landowner's ownership, the larger the segments are likely to be. Landowners with few road miles may only need to create 1 segment for their entire road system. Roads with lots of stream crossings and potential maintenance issues should have shorter segments. Segments may include dead end spurs or short loops. There are numerous methods of labeling road segments so information on the road system can be systematically tracked. In general, main system roads should be given numbers or names, and any spurs off these main roads given a dashed intermediate number. Segments can then be labeled with another dashed letter. All of these labels should be clearly identified on a map.

On large ownerships with lots of roads, the location, condition, and maintenance needs for stream crossings culverts and cross drain culverts should be systematically tracked by developing a simple list or spreadsheet. Culverts should be identified on the road map and given a label that corresponds to the road segment they are located in. If the approximate location of these is not known, the first assessment can be used to locate them with a GPS unit or by mileage location on each road segment. Or, if mapping all culverts is too difficult, culverts on each road segment can simply be counted and recorded on the data sheet provided. Ideally, small landowners should also record the location of all culverts on their road map, but this is not essential.

On small ownerships, the whole road system should be assessed in one field outing, while on larger ownerships it may take several outings staggered over a two-year assessment period. In addition, if a road is used as a transect in a stand assessment, you may do the road assessment at the same time the stand assessment is conducted. Whatever the case, you will need the following items before conducting a road assessment.

Note: Datasheets may need to be printed on write-in-the rain paper!

1. Two copies of a map showing all the road segments that will be assessed. Ideally, maps should have locations of stream crossings and culverts.
2. One blank copy of the Roads Assessment Datasheet #4 for each segment. For long segments with many issues, 2-3 sheets per segment may be necessary.
3. A copy the most recent road assessment for each segment, and any information on culverts that you may have.
4. The appropriate field gear from the Equipment List.

Field Instructions

Each segment should be covered by foot, horse, bicycle, or vehicle. The best time to do an assessment is immediately after a heavy rainstorm in the winter or early spring as any road problems will be most evident at these times. While covering each segment, carefully examine all stream crossings and cross drain culverts, and any areas with significant roadbed issues. If doing the assessment by car, make sure to get out of the car to do this. Look for any issues listed on the bottom of the Roads Assessment Datasheet #4. If you find any issues:

1. Record the approximate location or mileage along the segment. For issues that involve culverts, note the culvert label or number if you have labeled your culverts.
2. Record the issue number from the list at the bottom of the sheet. Provide a briefly description if necessary.
3. Note the severity of the issue and any maintenance that is needed and when. Use the back of the sheet if necessary for additional notes.
4. Culverts on fish bearing streams should be evaluated as to whether they are passable by fish. All stream culverts should be checked to see if they large enough for the size of the stream if this has not been done in the last 10 years.
5. If desired, write in the approximate location of the issue on your road map.
6. Take photos of any notable issues or features if desired. Writing the date and location of a photo on a piece of paper and photographing it before taking a photo can help prevent forgetting where the picture was taken. Digital photos should be promptly downloaded and clearly labeled with the date and location where they were taken.

Once you have completed the assessment, update your road maintenance plan and update the **Overview Datasheet #0** by writing in the date of your assessment and any major issues found.

2.3 Stream Assessment Instructions

General Guidelines

Streams and their associated riparian forests are highly dynamic systems that are hotspots of biodiversity and play critical roles in watershed health. While many protocols for stream monitoring have been developed, it is often difficult to attribute changes to a particular ownership or management activity as streams typically cut through multiple ownerships. The

limited metrics selected for assessment in this guidebook are designed to provide a general picture of stream conditions and detect any detrimental impacts resulting from management activities at the stand or ownership level. It is assumed that all major streams have been identified in the management plan and baseline conditions assessed.

Stream segments should be assessed according to the following frequency:

1. For small landowners, every 5 years for fish bearing streams. Other streams are recommended but not essential.
2. For large landowners, every 5 years for perennial streams. Intermittent streams are recommended but not essential.
3. Additionally, assessments should also be done after a major storm event or prior to a management activity that is within 200' of a specific stream. A major storm event is one with enough precipitation to dramatically alter stream channel characteristics or cause significant road related impacts to streams. After a major storm event or management activity, the next assessment should be 5 years later, unless another major storm occurs.

Design & Office Preparation

Similar to the road system, the stream network on an ownership should be broken into segments and each segment given an identifying number or name. Segmentation should be based on natural breaks in stream networks (e.g. stream junctions, road crossings) or landmarks that are easily identifiable. Individual segments should be small enough to be assessed in one day. The larger the landowner's holdings, the larger the segments are likely to be. Segments may include small tributaries.

On small ownerships, the whole stream network should be assessed in one field outing, while on larger ownerships it may take several outings staggered over time. In addition, if a stream is used as a transect in a stand assessment, you may conduct the stream assessment at the same time as the stand assessment. Whatever the case, you will need the following items before conducting a stream assessment.

Note: Datasheets may need to be printed on write-in-the-rain paper!

1. Two copies of a scaled map showing all the stream segments that will be assessed.
2. An aerial photo is also helpful. Measure the total distance of the stream and decide on a stopping distance to achieve 10-12 stops per segment.
3. One copy of the Stream Assessment datasheet #5 for each segment.
4. A copy of the last stream assessment for each segment (if a stream assessment was previously conducted).
5. The appropriate field gear from the Equipment List. You will need foot wear that you can walk in the water with.
6. Datasheets and gear for installing stand inventory plots if quantitative data will be collected from riparian forests (e.g. to prepare for harvesting within the riparian zone,

or applying for an Alternate Plan).

Field Instructions

Each segment should be walked either in the stream channel (if the stream is shallow and low velocity) or next to it. The best time to do an assessment is in the mid-fall when stream flows are at their lowest. If you are assessing a stream that has been assessed in the past, look at the old assessment sheet and note any observed changes. Items shaded in gray on the Stream Assessment Datasheet #5 are for more intensive stream assessments and are optional for small landowners.

First, note in the upper right box of the Stream Assessment Datasheet #5 whether the stream is a fish bearing stream (F), non-fish bearing perennial (Np), or non-fish bearing seasonal (Ns). Water type maps can be downloaded from the Washington Department of Natural Resources website.

Next, as you walk along the stream, look for the attributes described in the first box of the sheet. Describe any attributes you find, or other important features such as fish passage barriers, blocked culverts, etc., and note their location on the map. If a fish bearing stream goes through a culvert, determine whether the culvert is passable by fish.

At each segment, record the following attributes on the Stream Assessment Datasheet #5:

Channel Characteristics

1. Bankfull width (BFW) of the stream

This is the width of the scoured stream channel at peak flow, not necessarily where the water level currently is. Measure from where signs of channel scour exist on each side of the stream bank. To do this, place a staff or piece of rebar on one side of the BFW to anchor your Spencer tape. For streams with multiple channels, measure each channel and add up the total.

2. Bankfull depth (BFD) of the stream

Divide the BFW into 10 evenly spaced increments and measure the depth of the stream at each increment. Average the increments together to obtain BFD. A formal dipstick can be used, or one can be improvised.

Measuring Bankfull width, bankfull depth, and channel migration zones

For additional directions on how to measure stream channel characteristics, the Washington DNR's Forest Practices Board manual provides excellent guidance: <http://dnr.wa.gov/forestpractices/board/manual/section2.pdf>

Actual measurement is recommended and may be necessary for DNR permits or alternate plans. However, landowners may visually estimate distances or depths, especially on large, high volume streams.

3. Channel Migration Zone (CMZ)

If you are planning to harvest with the a riparian area, and the stream has an unconfined channel that migrates over time across a floodplain, measure and record the total width of the CMZ and record on the back of the sheet. Measuring a CMZ can be complex. The Washington Department of Natural Resources provides guidelines for this process (see box above).

4. Stream Gradient

Hang flagging at an equal distance above the water at each end of the stream segment and estimate the gradient of the stream by sighting along the line between the flagging. By using a clinometer, more accurate gradient readings can be achieved. Place a tick in the appropriate box.

5. Substrate

Draw an imaginary line across the stream at the stop point and examine the stream substrate. Mark the dominant substrate type in the datasheet. Do this same process 10' above the stop point and 10' below it. You should mark 3 ticks for every stop.

6. Pool/Riffle Ratio

Estimate the percentage of stream distance that is in pools vs. riffles.

7. Residual pool depth

Note: For more intensive stream surveys only.

In the nearest pool downstream of the stopping point, estimate the water level of the pool at zero stream flow and measure the deepest part of the pool. These depths can be visually estimated or measured, depending on the intensity of the monitoring desired. For more guidance see: <http://www.fs.fed.us/psw/rsl/projects/water/Lisle87.pdf>.

Water Quality

1. Note whether the water in the stream is clear, muddy, gray, reddish, green, or any other color.
2. If you choose to measure temperature or any other stream chemistry metrics, record them here. You may need to take samples. While measuring stream temperature is not

required for small landowners, it provides useful information and will likely be necessary if you plan to apply for an Alternate Plan.

Vegetation

1. Forest Type

Describe the general forest type and condition of the forest (i.e. mature hardwood dominated forest with lots of dying alder; young, dense conifer stand with lots of self thinning).

2. Large Conifers

From the stopping point, look in the four directions and note whether you see a living or dead conifer greater than 18" dbh within 100' of the stream. Do not double count in adjacent directions. Mark a tick in the appropriate box.

3. Overstory Canopy Cover

Look directly above and estimate the percent of the sky that is covered by overstory trees. Place a tick in the appropriate box on the datasheet. Do not count tall shrubs, but "look through" them if you can. Do not try to estimate the small flecks of light that come through tree canopies, but instead count the entire area occupied by an individual tree canopy as occupied canopy cover. Count only the gaps between the trees as open sky. Mature forests with full tree stocking typically have 75-100% canopy cover, while recently thinned forests or forests with lots of mortality have 40-75% canopy cover. Only young or heavily harvested stands typically have canopy cover below 40 percent.

4. Overhanging Vegetation

At the stopping point, look up and down the stream and estimate the percent of the stream bank that has overhanging vegetation (small trees, or shrubs). Place a tick in the appropriate box on the datasheet.

If you are planning to harvest within the Riparian Management Zone or apply for an Alternate Plan, installing an inventory plot from the NCF stand inventory system at every other stop along the stream assessment is recommended. Use the stopping point at plot center. These plots should be considered a riparian stand and inputted into the NCF inventory program together to provide quantitative data on riparian forest structure.

Organisms

1. Examine two to three pools within each stream segment for any fish or amphibians and record observations in the datasheet to describe their abundance. Record a "0" if you see none. Record the species or species group (salmonids, sculpin, etc) you observe if you can identify them. Use the back of the sheet if you need more space.

2. Within each stream segment pick up four to six large rocks that are embedded in the stream channel and exposed to the stream current. Examine the rocks for any signs of aquatic insects. Put a tick in the box that describes their abundance. List the species groups you find if you know how to identify them.

Large Woody Debris

1. For each 300' of stream length, count both the number of large and small pieces of woody debris in the stream channel. Large pieces must be 18" or greater in their midpoint diameter, and small pieces must be between 6-18" midpoint diameter. Visual estimation of midpoint diameter is sufficient. Only count pieces that are at least as long as the average bank full width of the creek. For example, if a stream is 10' bank full width, then pieces must be at least 10' in length to count. For log jams with a multitude of smaller pieces, estimate the number of pieces in the jam.
2. Next, estimate the percent of the pieces that are conifer, hardwood, or unknown in 10 percent classes and record in the appropriate boxes.
3. Take photos of any notable issues or features. After you have completed the stream assessment, add up the tick marks or average the numbers in each box. Use the back of the datasheet or an additional sheet to write a brief summary of the stream conditions and any important observations. Digital photos should be promptly downloaded and clearly labeled with the date and location where they were taken. Finally, update your monitoring **Overview Datasheet #0** by writing in the date of your assessment and the major issues found.

2.4 Wetland Assessment Instructions

General Guidelines

The wetland assessment is similar to the stream assessment process in most respects. A limited set of metrics has been selected to provide a general picture of wetland conditions and measure changes over time. Wetlands should be assessed every 5 years, prior to a management activity that is within 200' of them, or after a major storm event, whichever is sooner. A major storm event is one with enough precipitation to potentially alter the wetland. It is assumed that all major wetlands have been identified in the management plan and baseline conditions have been assessed.

Design & Office Preparation

Each wetland or wetland complex should receive a separate assessment. Wetland assessments should be done in the mid to late winter or early spring when the water table is high. If a past assessment has been done, a copy of the prior datasheet and map should be carried and referenced to note changes in conditions. Landowners will need the following items for the assessment:

Note: Datasheets may need to be printed on write in the rain paper!

1. A copy of a scaled map showing the wetland.
2. One copy of the Wetland Assessment Datasheet #6.
3. A copy the previous wetland assessment for that wetland (if one was conducted)
4. The appropriate field gear from the Equipment List. You will need foot wear that can get wet.

Field Instructions

The wetland assessment consists of walking around the wetland, accessing numerous points where the water can be seen, and locating any inlet or outlet channels. As you walk around the wetland, take photos of any notable issues or features and record the following:

1. General characteristics

Observe and estimate the characteristics listed on the datasheet to the best of your ability. Note any major features on the map. Signs of water level fluctuation include exposed mud, waterlines, unvegetated beach, floated leaves on vegetation, or moss line on trees.

2. Vegetation

Mark whether the vegetative cover of the wetland is uniform and of a single type (i.e. just grasses and sedges), or patchy with multiple types (i.e. grasses, shrubs, and trees). Next, estimate the percent of the wetland covered by the listed cover types to the nearest 10 percent.

Describe the general forest type and condition of the forest in or surrounding the wetland (i.e. mature cottonwood forest). If the wetland is primarily forested, estimate the percent canopy closure from several points within the wetland. Look directly above and estimate the percent of the sky that is covered by overstory trees. Do not count tall shrubs, but “look through” them if you can. Do not try to estimate the small flecks of light that come through tree canopies, but instead count the entire area occupied by an individual tree canopy as occupied canopy cover.

Count only the gaps between the trees as open sky. Mature forests with full tree stocking typically have 75-100% canopy cover, while recently thinned forests or forests with lots of mortality have 40-75% canopy cover. Only young or heavily harvested stands typically have canopy cover below 40 percent. A densitometer can also be used for this if you have one. Finally, record presence and percent cover of any invasive species you detect in the wetland.

3. Wildlife

Place a tick mark in the appropriate box on the datasheet if you see any evidence of wildlife. Record any species sighted during the assessment. After you have completed the wetland assessment, use the back of the datasheet or an additional sheet to write a brief summary of the conditions in the wetland. If you plan to harvest in or near the wetland, classify the wetland according to the Washington State Department of Natural Resources wetland typing system (WAC 222-30). Digital photos should be promptly downloaded and clearly labeled with the date and location where they were taken. Finally, update your monitoring **Overview Datasheet #0** by writing in the date of your assessment and the major issues found.

Component 3: Site Specific Monitoring

3.1 Overview & Guidelines

In addition to maintaining a forest inventory and general qualitative monitoring, the FSC standards state clearly that the ecological, social, and economic impacts of management activities should be monitored. As a general guideline, any management activity that significantly alters forest structure *and* has the potential to impact other ecological functions (hydrology, wildlife habitat, etc) should be assessed to establish baseline conditions before it takes place and then monitored after it is completed. Such activities include: timber harvest or salvage over 5 mbf; major non-timber forest products harvests; any harvest in a sensitive area such as habitat for a rare, threatened or endangered species or riparian area; any road construction or decommissioning; aerial application of herbicides, or any prescribed burning.

Activities that may not require formal monitoring include pre-commercial thinning, minor harvest of non-timber forest products, manual removal or selective spraying of competing vegetation or invasive species, routine road maintenance, tree or shrub planting, or other minor activities. Informal monitoring of these items is encouraged, however.

Pre-activity assessment can often be done by combining it with regular inventory or general stand assessments. For example, prior to a timber harvest, an inventory, stand assessment and road assessment for the affected area is recommended. A harvest that will likely affect a stream or wetland should include a stream or wetland assessment to establish pre-activity conditions. If this is not practical, an informal assessment of the site before the activity is sufficient.

After the activity is completed, the site should be monitored annually until the site has met tree seedling survival goals or any adverse impacts are resolved. Ideally the same person who conducted the pre-activity monitoring should do the post-activity monitoring. The Management Activity Datasheet #7 was designed to make this monitoring as simple as possible. Landowners may wish to customize this datasheet and may need to use the back of each sheet for additional notes. After the field work is completed, the data should be filed in a safe place. When it is time for a management plan update, key information can be summarized and included. You are also welcome to develop your own system of tracking this information if the datasheets do not work for you.

You may also have sites on your ownership with specific issues that need to be assessed and tracked such as rare wildlife habitat, high conservation value sites, major invasive weed infestations, or major forest health concerns. Tracking of these issues can be done informally, but should be recorded in some fashion. Monitoring should happen annually until the issue is resolved or the site is no longer rare habitat or a high conservation value site.

3.2 Management Activity Monitoring Instructions

Before getting out into the field, landowners will need to gather the following items.

1. One copy of the Management Activity Datasheet #7.
2. A map or copy of an aerial photo of the area.
3. Copies of previous monitoring sheets or pre-activity assessment sheets for reference.
4. The appropriate field gear from the Equipment List.

The monitoring should consist of walking the site, taking photos of any notable issues or features, if desired, and recording the following on the datasheet. The datasheet is designed for harvest of timber or non-timber forest products, but can be used for other activities. Leave items that do not apply blank.

1. Activity(s) & Date(s)

Describe the major activity and the date, plus any follow-up activities related to it (i.e. harvest followed by planting).

2. Implementation

List the main objectives of the activity and the extent to which they were met. Include any major lessons learned.

3. Soil Impacts

Estimate the total surface area of soil that was significantly compacted or displaced (3+ machine passes). For ground based yarding, pace out the total length of the major skid trails and multiply it by the average width. For troughs (soil displacement) created by cable yarding corridors, estimate the total distance of the corridors and multiply by the average width. For landings, calculate the area by measuring the diameter if it is circular or the length and width if it is rectangular. If this is a road related activity, estimate the area affected.

4. Aquatics/Soils

Note if you see any of the listed items and their severity. Try to determine the trigger point and source of the item (i.e. where is the sediment coming from and what caused it?). Describe on the back of the sheet if there are any significant issues and note the location on the map.

5. Sensitive Sites

Note if the activity took place near a site and if any impacts are observed. Refer to pre-activity stream, wetland, or other assessments to determine if any changes or impacts have occurred. Note location of any major impacts on the map.

6. Roads

Evaluate roads impacted during the activity by referencing to the pre-activity road assessment sheet and noting any changes or new issues.

7. Post Activity Conditions

As they apply, note the target densities of the items listed *by species* and estimate the actual densities you see. Estimating post-harvest trees per acre by species, snags retained, non-timber forest products retention, or re-vegetation/regeneration can be done by installing a few informal inventory plots in representative areas of the stands. Finally, list any noxious invasive species, their approximate percent cover, and note their location on the map.

8. Economics and Social

After the activity has been completed, summarize your harvest volumes, expenses, revenues, and local economic input. Most of this information will be needed when you pay your timber taxes. If you do have exact records for some of these items, estimate them to the best of your ability. If desired, more specific information used to generate these summaries can be included on the back of the sheet or on a separate sheet (or computer spreadsheet). This may include: number of truckloads shipped with dates, ticket number, destination, scale, payments, and totals; predicted volumes and payments vs. actual; breakdown of management costs: logging design and permitting, road construction and maintenance, logging, reforestation, PCT, restoration, etc. Large landowners will likely need to develop a more detailed system to track this information.

After you have completed the monitoring, use the back of the datasheet or an additional sheet to write a brief summary of the conditions and any follow-up activities needed. Note if no further monitoring is required (i.e. regeneration is free to grow, non-timber forest products have recovered, new road is stabilized, etc). Digital photos should be promptly downloaded and clearly labeled with the date and location where they were taken. Finally, update your monitoring **Overview Datasheet #0** by writing in the date of your monitoring visit and the major issues found.

Component 4: Organization & Summaries

In order to make the monitoring activities described in the above sections worthwhile, it is critical that the information gathered be organized, stored, and summarized into useful information. You can develop a system that provides the following functions:

Monitoring System Overview

To organize and track the multiple monitoring activities described in the components above, you can use the **Overview Datasheet #0** to record when inventory and assessments have been completed and when they are needed next. This sheet, or some version of it, is very helpful during FSC audits. *This sheet should be customized and filled out when you first set up your monitoring system.*

Data Storage

A safe and secure filing system is necessary to store all datasheets, maps, inventory reports, records of sales to different producers (chain of custody), financial records, and other documents. A clear system of storing and labeling photographs, either digitally or in print, is also needed.

Tracking Species Presence

When conducting forest inventories, activity monitoring, or stand, stream, road, or wetland assessments, or during any other activity on your property, you should keep a list of the plant and animal species that have been observed on the ownership.

The Species List Datasheet #9 (available on nnrg.org/ecosystem-services) can be used for this. Whenever a new species is found or a rare, threatened or endangered species is sighted, the list should be updated. Tracking species is only required for Rare, Threatened, or Endangered Species (RTE). Maintaining a list of other species is recommended, however, and is a fun way to get to know your land. You will likely need to refer to plant and animal identification books.

Public Involvement

Keep a record of any major public or educational use of the property, as well as any press articles relevant to the ownership's social impact.

Summaries

As part of updating your management plan, you should summarize the information gathered in the monitoring activities in between the last management plan update and the current update.

Management plan updates and re-inventories are required every 10 years or after extensive management activities, whichever is longer. The summary should include:

- *Growth calculations.* This can be done by comparing the volume totals for each stand between the two most recent inventories. Total standing volume for the ownership

should be calculated and compared to the last inventory.

- *Yield calculations.* The total harvest volumes by species, both timber and non- timber forest products, should be calculated for the time period.
- A brief report on general assessments that summarizes significant changes in stand conditions for each stand or each forest type, roads, streams, wetlands, rare wildlife habitat, forest health issues, etc.
- A brief report listing and summarizing all major management activities. A summary of total management costs, revenues, and local economic inputs should also be included.
- A brief summary of major lessons learned and any changes in management approaches.