Evaluating DFC Worksheet stand inventory and site attribute data from approved Forest Practices Applications: a Study Plan

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Introduction

Purpose

In this document we present a study plan to verify the accuracy of the data used in an analysis of DFC Model outputs (McConnell et al., in prep “a”). This earlier study used DFC worksheet data from randomly selected Forest Practices Applications (FPAs) with inner zone harvest along westside Type F streams. The primary outcome analyzed was DFC Model projected future stand conditions under different prescription options.

The field data we propose to collect will be used to evaluate whether the input data supplied on the DFC worksheets accurately reflect initial stand conditions used by the DFC Model to project future conditions.

This project is the fourth part of an investigation exploring the effects of westside Type F riparian forest prescription options on timber harvest and current and future residual stand conditions. This suite of projects focuses on the silviculture used in operational forest management and the performance of the DFC model in projecting future stand conditions. The prescriptions analyzed are: a) no-cut, b) thin from below – Option 1, and c) leave trees closest to the stream – Option 2.

The purpose of the first part of this investigation (McConnell et al., in prep "a") is to estimate the future basal area per acre (BAPA) in the core and inner zones, given rule-specified timber harvest prescription constraints such as minimum leave tree requirements and minimum "floor" widths. The first part of the investigation used data from randomly selected FPAs to determine the effect of harvest prescriptions including the no-cut option on projected BAPA at a stand age of 140 years.

The purpose of the second phase of the investigation is to determine if DFC Model results obtained are in "reasonable agreement" with the outputs of other commonly used tools for predicting stand growth. In the second phase, DFC model outputs are compared against results of other growth and yield models, namely ORGANON and the Forest Vegetation Simulator (FVS) (McConnell et al., in prep "b").

The third phase of the investigation is a sensitivity analysis of the DFC Model to determine its response to possible errors in input variables as well as determine its accuracy, limitations or sensitivity. This is an important analysis with respect to the DFC Model because, unlike many other public domain growth and yield models, the DFC Model has not yet had a robust systematic investigation of its behavior under a range of conditions. This analysis is currently underway (Roorbach et al, in prep).

Finally, the focus of this study is to determine if the stand and site input data used by landowners to run the DFC Model were accurate. The other common public domain forest growth and yield models used in western Washington require stand data that is typically collected by trained crews that are experienced in appropriate procedures for sampling forest vegetation and collecting site attribute data. The DFC Model, in contrast, was designed to use less complicated data collection methodologies that would enable forest landowners with or no little formal forestry training to be able to collect the required data, use the DFC Model, and determine what timber harvest treatments, if any, were permissible for their riparian stands. In this study we will systematically evaluate the accuracy of stand and site input data used to run the DFC Model from a sample of the FPAs used in the other parts of this 4-phase analysis.

Objectives:
The objectives of this study are to:

1) Validate the accuracy of DFC Model input data by collecting stand inventory data and the other field attributes required as inputs to run the DFC Model from a sub-sample of the FPAs used in the analysis of DFC Model outputs (McConnell, in prep "a").

2) Quantify the differences in DFC Model outputs for conifer basal area per acre (CBAPA) and trees per acre (TPA) using the data collected in this field exercise and compare these to DFC Model outputs using the original data submitted in each FPA.

3) Assess and qualitatively describe stand structure at each site, compare the accuracy of the different methods used to determine stand age, and discuss

potential problems, if any, with determining the stand age used as a DFC Model input.

4) Assess and qualitatively describe RMZ length at each site and discuss potential problems, if any, with determining an accurate RMZ length.

Parameters:
Input data that drives the DFC Model includes both site attributes and stand inventory data. Some of the data required to run the DFC Model directs model prescriptions that are shown as outputs and do not directly influence the growth algorithms. For example, stream size is required because it influences inner and outer zone widths and, on Site Class III, stream size determines whether or not Option 2 can be used (not allowed on large streams). All required attributes therefore can affect model results through their effect on prescriptions or through their effect on different growth rates the model uses for different user reported site productivity (site class) inputs or tree density (TPA).

Stand inventory input data consists of: a) stand age, b) number of conifer and hardwood trees by 2” diameter class, c) the number of tree diameter classes, and d) major tree species (Douglas-fir or western hemlock). Site attribute data is comprised of: a) site class, b) stream size, and c) RMZ length (Table 1).

Site Class is the only site attribute input required. Stream size is used by the DFC Model only to calculate rule-specified treatment areas (inner and outer zone widths) or determine prescription options allowed on site class III, where Option 2 is allowed only on small streams. RMZ length is used to determine the area of the core and inner zones and from these calculate basal area and number of trees per acre.

Table 1 – Stand inventory data and site attribute data used to run the DFC Model and their units or the method used to determine these.

Stand Inventory Data	**Site Attribute Data**
1. Stand age (years)	1. Site class (from maps)
2. Number of conifer trees by 2” dbh class by core and inner zone	2. Stream size (small: ≤ 10’) or large, > 10’) bankfull channel width)
3. Number of hardwood trees by 2” dbh class by core and inner zone	3. RMZ length (feet)
4. Number of dbh classes by core and inner zone	
5. Major species (Douglas-fir or western hemlock) (by majority of basal area)	

Sampling Methodology

Selecting FPAs to Evaluate:
Fifteen of the FPAs used in the office analysis (Phase 1, McConnell, in prep “a”) were selected randomly for field sampling. Because we do not have variability estimates for

the attributes to be analyzed, we opted to sample 10% of the stands used in the phase one analysis. We anticipate that this sample size will be large enough to determine trends and small enough that a dedicated two-person field crew can sample it in a reasonable amount of time.

Pre-Sampling Office Assessments:

The following information will be collected in the office prior to initiation of field work.

Site class:
Prior to visiting each stand, site class will be verified using DNR site class maps that are available online at the DNR website using FPARS
http://www3.wadnr.gov/dnrapp4/fparsweb/public/Default.aspx

RMZ length:
We will ask landowners how they determined RMZ Length. There are no Board Manual specified procedures for determining stream length. Possible approaches used to determine RMZ length include measuring it in the field, from an aerial photograph, a map or GIS data.

Stand age:
We will ask landowners what method they used to determine stand age. Two methods are permitted according to the Board Manual (Section 7, Appendix C. "Determining Stand Age"). These are: 1) using inventory data or stand history information, if available, or, 2) "increment boring of an average of the dominant conifer trees within the riparian zone."

Stream size:
There are Board Manual specified procedures for measuring stream size (Section 2, Part 2, "Measuring Bankfull Width and Depth") and we anticipate that most streams will be clearly either large or small. Only a small percentage of streams would require measurement to determine its appropriate size class. Thus, we will ask landowners how stream size was determined only if we have questions after we have visited the site and made this determination ourselves.

Field Data Collection

Logistical considerations:
The stands selected for sampling are an average length of 1278' but vary in length from 290" to 3320". The amount of time available for fieldwork for this study will allow for an average of three days per site. Sub-sampling units is not an option because the outputs reported in the FPAs are based on the entire RMZ length. Analyses of RMZ data (Mosman, personal communication) showed that there was high variability in stand data from RMZs. No appropriate plot sampling method for collecting DFC data was found to be feasible. Riparian stand data from less than the entire RMZ reach length would be insufficient for evaluating the DFC data collected for an FPA, so it is critical to get data from the full extent of each site sampled. To ensure that this occurs, we will test our

methodology on a stand near Olympia to ensure that our protocols are feasible and efficient and then make adjustments as needed before sampling the remaining stands to ensure the timely completion of this work.

Given that we are sampling in the winter, we may encounter problems such as snow, road washouts and nearby timber harvest operations, all of which could block access to some sites. In general we will visit stands in a logical order based on their location and proximity to other stands. Weather conditions across western Washington may also be a factor that determines the order in which stands will be sampled.

Should stands prove to be inaccessible or impractical to sample for any of these reasons or other reasons that may develop, we will select replacement sites moving to the next site in order from the randomized list of sites. We will report progress and challenges encountered (if any) to RSAG and CMER and get guidance on their resolution as needed.

Field protocols:
The stand attributes to be collected listed below are presented in the order in which data collection would occur.

<u>Plot location:</u>
At each site, the physical location of each stand will be checked to ensure that it accords with the maps submitted with each FPA. If stand locations are not accurately recorded on the maps this will be noted, the correct location of timber harvest recorded, and, when back in the office, site class for the correct location determined.

<u>Stream size (width):</u>
Stream size will be the first DFC Model input attribute considered (after location). This is because stream width is one of the determinants (along with site class) of the width of the inner zone. If stream size is not accurate, this would change our protocol for collecting stand inventory data. For all streams on which stream size is not obvious (either clearly large or clearly small), stream widths will be measured at systematic intervals using the methods described inn Board Manual, Section 2, Part 2, “Measuring Bankfull Width and Depth”. These measurements will be collected systematically along the stream width with a minimum of 10 measurements and no less than one measurement every 200’.

<u>RMZ Length:</u>
The primary purpose of measuring RMZ length is to reliably estimate riparian forest area in order to calculate the number of TPA and tree BAPA for each DFC Worksheet. There are no Board Manual specified procedures for determining RMZ length and some methods used to determine stream length, for, for example, estimating the number of redds per unit of stream may not serve well for estimating RMZ length appropriate to forest management applications. This is especially the case with sinuous streams.

For our terrestrially oriented objective we will use a valley-centered methodology that rounds stream corners and with this approach, attempt to account for the length of riparian forest a stream passes through. We will use laser range finders to measure stream length, taking sitings as frequently as needed to work efficiently (no specified distance for each stream segment is required). When we learn more about how this attribute was determined, we may develop additional sampling protocols and/or better define the approach used.

<u>Stand inventory data:</u>
We will collect stand inventory data from the core and inner zone. In the first pass through the RMZ the core zone will be sampled and the inner zone will be sampled on a return trip.

Working in pairs, we will record tree species and 2" diameter class with one person walking close to the waters' edge (core zone) or ribbon line demarcating the core and inner zone break (inner zone). Tree diameters will be measured using a Biltmore stick or similar tool. One person will mark location and measure trees, the other will record tree species and diameter class. Tree species rather than tree species group (conifer vs. hardwood) will be collected so that the assigned "major species" can be verified. Where timber harvest has occurred in the inner zone, an effort will be made to locate stumps and estimate tree diameters from these. Both individuals will use laser range finders to determine core zone width and determine if trees are in or out. Ribbon will be hung to mark the 50' core zone boundary. Coming back the other way, measurements will be made from the ribbon line established on the first pass demarcating the core zone/inner zone boundary to the outer edge of the inner zone.

We do not expect complete similarity between our data and the data used in the FPA as both inner zone timber harvest and continued growth of trees and changes to stands since the initial measurements will have occurred. Where inner zone timber harvest has occurred, comparison to pre-treatment data may be less accurate because some of it will be based on estimated diameters, extrapolating from tree stumps. While core zones will not have been harvested, some trees will have grown and moved to a higher diameter class, other trees will have blown down or died standing. We will record the current status of trees that have recently fallen that we believe were likely to have been standing when the original data were collected and will include these in the tree tally for each stand.

<u>Stand age:</u>
The age of trees in stands will be collected in the last pass through the stand. At least ten dominant or co-dominant trees per stand will be cored. We will sample from the stand cohort that has a plurality of basal area; scattered relict trees from previous stands wil not be used to determine stand age. Ages from tree cores will counted while in the field and cores reinserted into the core holes; we will not bring cores into the office for further analysis.

Sample trees will be spaced such that at least one is measured in every 300' segment along the stream. Where trees have been cut, stand age will be counted from at least ten stumps, with the stumps also collected from along the entire length of the RMZ. Where possible ages will be gathered from Douglas-fir trees as a first choice, western hemlock as the second choice and red alder the third choice.

Analyses:

This section discusses how the data will be analyzed to achieve the four study objectives.

Objective 1, “Validate the accuracy of DFC Model input data by collecting stand inventory data and other field attributes used to run the DFC Model from a sub-sample of the FPAs used in the analysis of DFC Model outputs (McConnell, in prep “a”).”

We will accomplish objective 1 by comparing the field data we collect with the input data used in the original DFC Worksheets for each FPA. Data will be evaluated primarily by graphical analyses. For stand input data we will graphically compare frequency distributions of number of trees by size class and species type. For quantitative comparisons, differences in the number of trees by group will be expressed as a percent of the data used in the original FPA. Frequency distributions will also be used to compare binomial data such as major tree species and stream size. If differences in data attributes collected are found, the attributes that are most commonly misclassified or recorded inaccurately will be identified.

Objective 2, “Quantify the differences in DFC Model outputs for conifer BAPA (CBAPA) and trees per acre (TPA) using the data collected in this field exercise and compare these to DFC Model outputs using the original data submitted in each FPA.”

We will accomplish objective 2 by evaluating the potential effect of differences in input data to DFC Model BAPA projections and RMZ widths by running the DFC Model for each site with the data collected in this sampling exercise, recording the results and comparing these against the outputs obtained using the original data. Both the outcomes obtained and percentage difference will be evaluated graphically. The differences found, if any, and interpretation of these differences will be considered in context of the sensitivity analyses done by Roorbach et al. (in prep).

Objective 3 , “Assess and qualitatively describe stand structure at each site, compare the accuracy of the different methods used to determine stand age, and discuss potential problems, if any, with determining the stand age used as a DFC Model input.”

We will accomplish objective 3 by comparing the accuracy of the different methods used to determine stand age (stand inventory vs. coring trees). There is no appropriate statistical test to be made at the stand level as there is only one data point for an age derived from stand inventory data so we will compare inventory age vs an average of stand age obtained by coring trees graphically. We will not compare stand inventory or coring trees against counting tree rings as counting tree rings is a post-hoc approach not suitable for pre-harvest decision-making. In addition, a narrative description of stand structure will be provided to report on the extent to which riparian stands appear to have a structure that lends itself to the simple attributes used in the DFC Model or, if, in fact, stands are often uneven-aged, tree species differ throughout the riparian area making a "major species" call difficult, tree diameters are uniformly larger in one part of the stand vs. another and etc.

Objective 4, "Assess and qualitatively describe RMZ length at each site and discuss potential problems, if any, with determining an accurate RMZ length."

We will accomplish objective 4 by reporting the length we measured using the "valley-centered" approach discussed in methods and comparing this to the length reported in the FPAs evaluated. We will also prepare a narrative describing and evaluating the different methods used to determine RMZ length. The analysis for this objective will be developed more fully developed once we hear back from landowners on what methodology they used when they submitted FPAs.

Deliverables:

1) A database containing the data collected from each of the riparian management zones sampled. Data will be checked for accuracy and provided in an electronic file using either Microsoft Excel or Access.

2) The DFC worksheet files for: a) data collected in the field and b) the data as submitted in the FPA evaluated in this study.

3) A report to CMER that will include:
    a. Graphical comparisons of the data collected in this study and the data that was submitted in the randomly selected FPA used in this study,
    b. Graphical comparisons of the DFC Model outputs of the data collected in the field and the data that was submitted in the randomly selected FPA used in this study,
    c. A narrative assessment of the relative accuracy of and problems associated with (if any) of getting reliable estimates of: i) stand age and ii) RMZ length, and
    d. A narrative assessment of stand structure with particular attention to whether riparian stands are even or uneven-aged. Discussion will address whether stands can be characterized adequately by assigning them a single age or are uneven-aged and therefore may not meet some of the attributes assumed for riparian stands under the DFC management concept.

The report will be submitted first to RSAG and then, once approved by RSAG to CMER. Required changes will be implemented until the report gains final approval. This report is not expected to require independent scientific review. It remains entirely in CMER and FFR Policy's purview to direct that it be submitted to scientific review with the understanding that this may alter the timeline for completion proposed in the next section.

Timeline:

1) Field data collection will be completed by January 31. Data entry and checking will be completed and provided to the RSAG/CMER/DNR by February 15.
2) The first draft of the report will be submitted to RSAG in time for the March RSAG meeting (RSAG typically holds their monthly meeting in the second week of each month).
3) A DRAFT final report will be will be sent to CMER no later than one week before the April CMER meeting.

References:

McConnell, S., D. Schuett-Hames and A. Roorbach. In prep, a. An analysis of Forest Practice Applications: stand characteristics, current and projected to age 140. Report to RSAG.

McConnell, S., D. Schuett-Hames and A. Roorbach. In prep, b. Comparison of DFC Model stand basal area predictions at stand age 140 to outputs obtained from the Forest Vegetation Simulator and the ORGANON model. Report to RSAG.

Roorbach, A., S. McConnell and D. Schuett-Hames. In prep. DFC Model Sensitivity Analysis. RSAG Review draft dated Nov. 8, 2005.

Appendix A – Abbreviations and Acronyms Used:

BAPA – Basal Area Per Acre
CMER – Cooperative Monitoring, Evaluation and Research
DFC – Desired Future Condition
DNR – Washington Department of Natural Resources
FPA – Forest Practices Applications
FPARS – The Forest Practices Application Review System
FVS – Forest Vegetation Simulator
ORGANON – **OR**egon **G**rowth **AN**alysis and projectio**N**
RMZ – Riparian Management Zone
RSAG – Riparian Scientific Advisory Group
TPA – Trees Per Acre