Ecosystem Mapping Accuracy and Timber Supply Applications

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Over the past few years, there has been a shift from Terrestrial Ecosystem Mapping (TEM) to Predictive Ecosystem Mapping (PEM), where ecosystem mapping is considered important to meet the needs of licensees for timber supply analysis, certification requirements, and biodiversity management. About two years ago, the Chief Forester posed the following questions (among others):

> "How accurately does PEM identify site series for large management units such as TSAs? Is there a body of PEM work that has been ground-truthed that can be used to demonstrate the validity of the approach? Is PEM accuracy adequate for use in base case analysis as part of the Timber Supply review and habitat supply analysis?"

At that time, we addressed the PEM accuracy issues by setting some guidelines for acceptance of PEM for the timber supply review. Over the past two years (2001 – 2002), there have been several successful PEM projects; that is, they have met the minimum accuracy requirements for use in timber supply modeling.

However, PEM is still a developing inventory and it is difficult to predict at the outset which projects will meet the minimum accuracy requirements for TSR. There are many PEM methods, procedures are evolving, and the input data for PEM is not of equal quality and accuracy throughout B.C. Therefore, accuracy assessments must continue to be required for PEM if they are to be used in base case analysis. The principle employed for TSR base cases is to incorporate the best available information and knowledge; hence acceptance for use of PEM in a base case means that it should provide superior information to any alternatives.

An ecosystem mapping accuracy assessment protocol was developed in 1999, finalized in 2000, and recently revised based on reviews and experience over the past few years. The *Protocol for Accuracy Assessment of Ecosystem Maps* (http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr011.htm) is designed to be a flexible procedure that outlines the principles of accuracy assessment for PEM and TEM and presents a standard set of scores. Implementation of the accuracy assessment requires a sampling plan. It is the intent of this paper to outline the minimum requirements for accuracy assessments of PEM or TEM that are to be used in timber supply modeling.

In both PEM and TEM, site series are sometimes grouped and mapped as a combined entity, if it is felt that the site series could not be mapped at the scale and resolution of the data (air photos or digital map input data). The assignment of site index to these site series groups is of some concern in timber supply modeling, however, if they are very similar ecologically, which is often the case, then the site index may be the same (or nearly so).

An issue of greater concern to timber supply modeling is that PEMs often have "tied" site series results for polygons. This can be because of limited input map data or a failure of the PEM model to distinguish site series. A small percentage of polygons with "tied" site series (or other map entities) is likely not too great a concern in modeling and will not significantly impact the accuracy scoring. However, a high proportion of polygons with imprecise site series allocation will likely reduce the accuracy score (see Protocol section on "scoring ties"). In any case, the assignment of site index to polygons with tied site series must be addressed in the timber analysis report.

PEMs that have very few site series groups and few, if any, tied map entities mapped in polygons are truly "site series PEMs" and they can be used in a fairly straight-forward manner in conjunction with SIBEC estimates in timber supply modeling. PEMs with several to many site series groups (more than 1

pair per subzone/variant) or many tied site series mapped (greater than 10% of polygons with ties) are "generalized PEMs" and cannot as a rule be used in timber supply modeling. If, however, the assignment of site index estimates to grouped and tied map units in a generalized PEM is reasonable, understandable and sensible, then the analysis may be acceptable to the Forest Analysis Branch of the BCFS.

Some map areas contain a high proportion of non-forested ecosystems, e.g., alpine, wetlands, avalanche tracks. In these cases, the map accuracy assessment must adequately address accuracy of mapping on the forest land area.

Accuracy Assessment Requirements for Use of Ecosystem Mapping in Timber Supply Modeling

For use in base-case analysis:

1. An independent accuracy assessment must be conducted following the *Protocol for Accuracy Assessment of Ecosystem Maps;*

2. For PEM, other ecosystem maps, and TEM Level 5 and R survey intensity[1], the accuracy assessment must be at a minimum of a Level 4 sampling level (see Table 1 in Protocol); for TEM Level 4 survey intensity, the accuracy assessment must be at a minimum of a Level 2 sampling level;

3. The BCFS Regional Ecologist or Provincial Ecologist must approve the sampling plan;

4. The 'percent dominant correct' and 'percent overlap' scores for polygons must be greater than or equal to 65% (focus is on the Forest Area);

5. Sample size (number of polygons or small areas sampled) must be large enough so that:

    a) the estimate of percent dominant correct has a maximum error of 7% with a confidence of 0.8;
    b) the estimate of percent overlap has a maximum error of 5% with a confidence of 0.9; and,
    c) it is at least two times the number of forested series.

6. The minimum score for 'percent overlap' for the entire map is 65%;

7. The ecosystem map must be a "site series PEM" or TEM.

The minimum accuracy statistics outlined above are based on an evaluation of scores obtained from TEM and PEM accuracy assessments and a consideration of what level of accuracy is necessary to ensure that an ecosystem map used in conjunction with SIBEC estimates will provide the Chief Forester with better data on site productivity than the present forest cover data.

Although 65% may seem a low accuracy to some people, most strategic-level resource mapping does not meet this level of accuracy for the majority of map attributes. Also, for most site productivity applications, two or more site series may have the same site index estimate for a particular regeneration species. Therefore, site series accuracy is likely to be a lower score than 'site index reliability'. Unfortunately, we do not have statistics for the reliability of site index assignment using PEM and SIBEC. However, when conducting TEM or PEM accuracy assessments, the 'percent acceptable overlap' score is also calculated, where site series adjacent to the 'correct' site series on the edatopic grid, and meeting certain other similarity criteria, are given 'half marks'. These scores are obviously higher than the percent dominant correct or percent overlap, but probably better represent the true reliability of the map for site productivity

[1] see Table 6.3 in *Standard for Terrestrial Ecosystem Mapping in British Columbia*

application. However, due to the subjective nature of determining acceptable site series to the ‘correct’ one, the minimum statistics are only presented for the ‘correct’ and ‘overlap’ scores above.

Where an accuracy assessment is not conducted using the protocol or the resulting statistics do not meet the levels indicated above, then the ecosystem map can only be accepted as part of a sensitivity analysis in the timber supply review. A PEM map must still follow the PEM inventory standard, which requires a minimum of a Level 1 sampling level accuracy assessment.