

# PROJECT SUMMARY

### Ecosystem Management

### Forest Productivity

### Public Involvement

### Adaptive Management

The ecosystem management component of the Morice & Lakes IFPA has embarked on several projects that assess biodiversity, ecological attributes, and fish and wildlife habitat. These projects provide important ecological data used in learning scenario development for the IFPA.

## Accuracy Assessment of Predictive Ecosystem Mapping in the Morice and Lakes TSAs



Fraser Lake Sawmills



### Introduction and Purpose

Predictive Ecosystem Mapping (PEM) was completed for the Morice Timber Supply Area (TSA) in 2003 and the Lakes TSA in 2004 using the Ministry of Forests' PEM model "EcoGen" (Meidinger et al. 2000). Many of the indicators in the Morice and Lakes Sustainable Forest Management plans and other IFPA activities rely on site series level data from the PEMs as an input variable. Site series level data is also integral for refining forest productivity assumptions in timber supply forecasts used for AAC recommendations. In order for PEM to be considered in timber supply analysis, an accuracy assessment must be conducted to evaluate whether the output meets the minimum reliability goal of 65%. The purpose of this project was to conduct a formal accuracy assessment of the Morice and Lakes PEM.

### Study Area and Methods

PEM was conducted over all of the original Morice and Lakes Forest Districts; however, our accuracy assessment excluded small portions from each area. In the Morice we excluded the CWHws2 and the MHmm2 biogeoclimatic variants (Banner et al. 1993) and in the Lakes we excluded Tweedsmuir Provincial Park. Excluding these peripheral areas substantially reduced the overall sampling requirements and cost of the project.

This accuracy assessment followed the provincial standard - *Protocol for Accuracy Assessment of Ecosystem Maps* (Meidinger 2003). This procedure involved selection of a random sample of PEM polygons, field surveys within those polygons to determine the site series that occurred there, and comparison of the field survey results to the PEM predictions.

To meet the specified minimum confidence level of 0.80 with a maximum error value of 0.07 we determined *a priori* sample size requirements to be 108 for the Morice and 86 for the Lakes using calculations outlined by Meidinger (2003). A key requirement of accuracy assessment is obtaining a random field sample. To reduce travel costs, and maximize sampling efficiency, we used a clustered random approach where three sample polygons were randomly located within a maximum (but also random) distance of two kilometers of each other. To address potential positional accuracy issues associated with very small polygons we excluded polygons less than one hectare in size from the samples.

Polygon assessment was a 'blind' process. That is, neither the person selecting the polygons nor the field crews knew what the PEM classifications were for the polygons that they assessed. Within each polygon transects were established to provide appropriate coverage to assess the range of variation within each polygon. Typically this involved a traverse along the

longest axis of the polygon with a second (or more) transects perpendicular to the first. Field crews assessed forest cover characteristics and mesoslope position from ortho/TRIM field maps to ensure representative portions of the polygon were covered. Transects were measured using hip chains and the composition of ecosystem units were recorded relative to the distance along the traverse.

To assess the accuracy of mapping entities a set of graphs and several scoring methods were calculated and summarized. These include:

1. A graph of map entity proportions determined from map predictions compared to proportions determined from field sampling. (overall % overlap)
2. Proportion of the area where the dominant entity mapped is the same as the leading ecosystem unit observed by field sampling. (dominant correct)
3. Percent overlap in the entities mapped versus those determined by field sampling (% overlap; e.g. for a PEM polygon classed as 01<sub>100</sub> and with a field observation of 01<sub>70</sub>06<sub>30</sub> the % overlap = 70%)
4. Percent acceptable overlap, where partial credit is added to the % overlap scores for predicted ecosystem units that were “close” to those observed in the field. Acceptable ecosystem units were scored at 50% of the value of correct units. (% acceptable overlap; e.g. where 06 is an acceptable unit for 01 - for a PEM polygon classed as 01<sub>100</sub> and with a field observation of 01<sub>70</sub>06<sub>30</sub> the % acceptable overlap = 85%)

Scoring methods 2 though 4 were calculated in two ways: a) with each sample weighted equally, and b) weighted by the area of each of the polygons that were sampled. The area-weighted scores are the primary scores of interest.

Upon completion of the four scoring methods described above it was evident that the PEMs did not meet the minimum 65% accuracy level for it to be used for timber supply analysis. Ultimately, this deficiency may require revision of the PEM model (knowledge tables, polygon derivations, or both). However, there was one major issue related to ecosystem unit specificity that could be examined and provided a basis for rescoring the PEMs without the immediate requirement of revising the actual PEM model. We identified three cases where two similar ecosystems were classified as separate units in the PEMs and where there were frequent misclassifications between them. These included the 01 and 01c in the SBSmc2, 01 and 04 in the ESSFmc (Morice only) and, to a lesser degree, between 05 and 01 in the SBSdk. For rescoring purposes we lumped these three pairs of ecosystem units and considered them equivalent when scoring them.

## Results

### Morice

The accuracy assessment scores (and rescores) for the Morice PEM based on 109 random samples are provided below in Table 1. All of the original scores except *Overall % Overlap* were lower than the 65% target. Lumping the three pairs of similar ecosystem units (01 and 01c in the SBSmc2, 01 and 04 in the ESSFmc, and 01 and 05 in the SBSdk) resulted in 3-29% higher accuracy scores (Table 1). The *Overall % Overlap* scores broken down for the three dominant BEC variants are provided in Table 2. Without lumping units, PEM accuracy was highest in the SBSmc2 and lowest in the SBSdk. For site series within variants the PEM showed a consistent pattern of underestimating the amount of zonal ecosystems and overestimating the amount of wetter and richer ecosystems (Figure 1).

Table 1. Accuracy assessment scores for the Morice PEM based on 109 random samples. Rescores allowed for the following ecosystem unit equivalencies: 01 and 01c in the SBSmc2, 01 and 04 in the ESSFmc, and 01 and 05 in the SBSdk.

Method	Original Scores	Rescore with lumped units
Overall % Overlap	74	77
Dominant Correct	43	72
% Overlap	38	58
% Acceptable overlap	59	72

Table 2. Overall % Overlap scores broken down for the 3 dominant BEC variants for the Morice PEM based on 109 random samples. Rescores allowed for the following ecosystem unit equivalencies: 01 and 01c in the SBSmc2, 01 and 04 in the ESSFmc, and 01 and 05 in the SBSdk.

BEC Variant	Original Scores	Rescore with lumped units
SBSmc2	79	79
SBSdk	60	74
ESSFmc	63	71

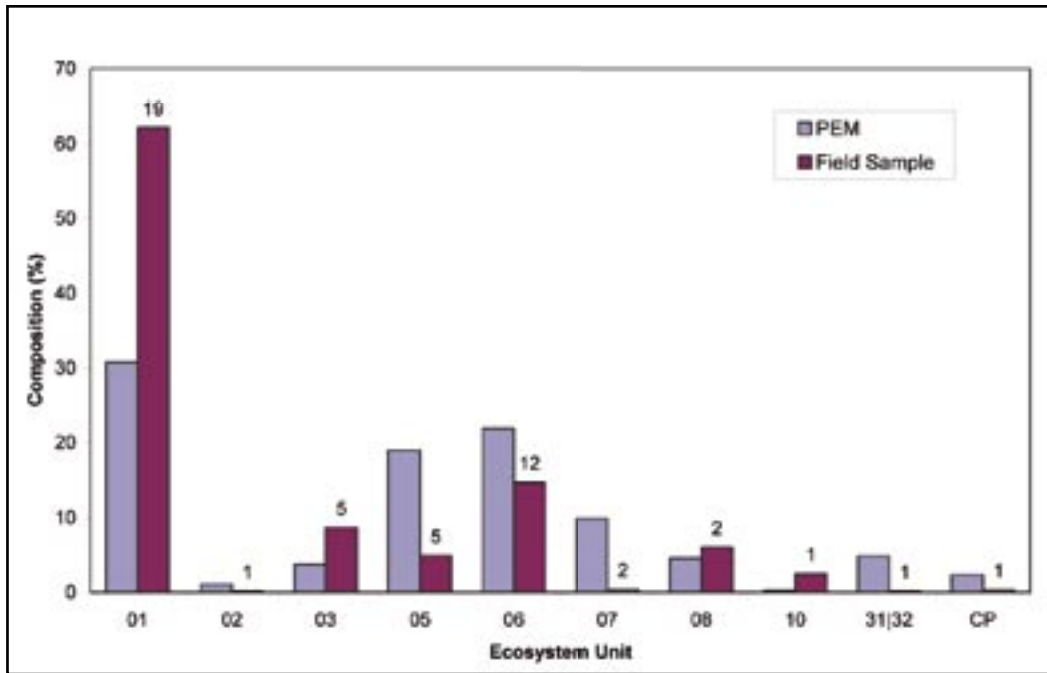


Figure 1. Relative composition of ecosystem units in the SBSdk based on the Morice PEM and a field sample of 22 polygons. Numbers above the field sample bars indicate the number of polygons that ecosystem unit was detected in. The pattern of the PEM underestimating the amount of zonal (01) ecosystems and over estimating the amount of wetter/ richer ecosystems was similar in the other dominant BEC variants in the project.

### Lakes

The accuracy assessment scores (and rescores) for the Lakes PEM based on 90 random samples are provided below in Table 3. All of the original scores except *Overall % Overlap* were lower than the 65% target. Lumping the two pairs of similar ecosystem units (01 and 01c in the SBSmc2, and 01 and 05|03 in the SBSdk) resulted in 4-19% higher accuracy (Table 3). The *Overall % Overlap* scores broken down for the three dominant BEC variants are provided in Table 4. Without lumping units PEM accuracy was highest in the SBSdk and lowest in the SBSmc2. For site series within variants the Lakes PEM also showed a consistent pattern of underestimating the amount of zonal ecosystems and overestimating the amount of wetter and richer ecosystems. Of particular significance the PEM predicted <4% of the area should be SBSmc2-01c compared to our field observation of 29%.

Table 3. Accuracy assessment scores for the Lakes PEM based on 90 random samples. Rescores allowed for the following ecosystem unit equivalencies: 01 and 01c in the SBSmc2, and 01 and 05|03 in the SBSdk.

Method	Original Scores	Rescore with lumped units
Overall % Overlap	67	71
Dominant Correct	56	75
% Overlap	45	62
% Acceptable overlap	63	72

Table 4. Overall % Overlap scores broken down for the 3 dominant BEC variants for the Morice PEM based on 109 random samples. Rescores allowed for the following ecosystem unit equivalencies: 01 and 01c in the SBSmc2, and 01 and 05|03 in the SBSdk.

BEC Variant	Original Scores	Rescore with lumped units
SBSmc2	62	62
SBSdk	71	83
ESSFmc	68	68

## Discussion and Management

### Limitations of PEM Accuracy at the BEC Variant and Ecosystem Unit Level

It is important to emphasize that the statistical confidence of this assessment is limited to the overall TSA areas. Sampling was insufficient to quantify the accuracy of individual BEC variants or ecosystem units. Comparisons of *Overall % Overlap* scores between the PEM and field samples (Tables 2 and 4, Figure 1) can provide useful information about general patterns of misclassification, but they cannot be used to infer pass or fail of any units at the variant or ecosystem scale. For all but the most common units the accuracy and precision of the field sample will be quite low at the ecosystem unit level.

### Discrepancy Between Overall % Overlap and Polygon-based % Overlap Scores

There was a large difference between polygon-based % *overlap* scores (e.g. 38% in the Morice) and the *overall % overlap* scores (e.g. 74% Morice). This disparity is due to the scale of assessment and to issues with positional accuracy. Positional accuracy refers to the accuracy of an entity relative to a specific location at a specified scale. Positional accuracy constitutes a variable proportion of the total PEM accuracy depending on the scale being examined. The *overall % overlap* score compares PEM and field results at the TSA level and is effectively aspatial. At the polygon level there is a strong spatial accuracy component to the assessment and our results indicate the ability of the PEM to predict the correct ecosystem at the polygon scale is quite low. This pattern is consistent with virtually any type of analysis at multiple scales; the broader the scale, the lower the constraint of spatial accuracy. If we had used an alternative accuracy assessment methodology proposed by Moon (2004) the accuracy score would have been higher simply because of the coarser spatial resolution of that methodology.

Understanding the issues related to scale and positional accuracy has important implications for refining the PEM. Positional accuracy is greatly affected by the methods and criteria used to derive the PEM polygons. Therefore model revisions may need to include review/revision of the actual PEM polygons in addition to revisions to the ecological knowledge tables.

### Types of Repeating PEM Misclassifications

At the polygon level it was difficult to identify consistent patterns for PEM misclassifications. For example, for a given PEM ecosystem unit with classification errors the field samples frequently included observed units that were drier/poorer and wetter/richer than the predicted unit. Notwithstanding this high degree of variation, the following three types of misclassification errors were consistent in both PEM projects.

1. There was consistent under prediction of zonal sites and over prediction of wetter/richer ecosystems in all of the major BEC variants.
2. There were frequent misclassifications between similar ecosystem units such as the 01 and 01c in the SBSmc2. We assessed the significance of this issue through our rescoring exercise, and those results were 11-29% higher for all polygon-based scoring methods.
3. At least part of the problem with the high commission errors for wetter/richer ecosystem units appears to be related to appropriate polygon delineation. In many cases the predicted ecosystems did occur in the sample polygons, but they were only a minor component associated with a specific mesoslope position or adjacent water feature. If those areas were broken out as separate polygons the accuracy would be improved.

# Implications of PEM Accuracy for Timber Supply Analysis and Other Projects

## Timber Supply Analysis

Meidinger (2003) states that the % *dominant correct*, % *overlap* (for polygons), and *overall % overlap* must be greater than or equal to 65% in order for a PEM to be used in timber supply analysis. Even with lumping similar ecosystems at least one polygon-based rescores is below the 65% level. The Ministry of Forests has reviewed the results of our accuracy assessment and the Morice and Lakes PEMs were not approved for use in Timber Supply Analysis (D. Meidinger, pers. comm.).

## Other Projects

The implications of the PEM accuracy on other projects that use it will be quite project specific. Users of the PEMs should consider the following factors to evaluate the potential accuracy implications.

Scale - The accuracy of these PEMs, and presumably other projects that use them, depends on the scale they are used at. At the TSA scale the PEMs were quite accurate even without lumping the pairs of similar ecosystems. However, the accuracy was quite low at the polygon scale, especially without lumping the pairs of similar ecosystems. The finer the scale the PEM is used at, the lower the accuracy will be.

Bias - The PEMs are biased toward over predicting the amounts of wet/rich ecosystems and under predicting the amounts of zonal ecosystems. Projects using the PEMs should assess the implications of this misclassification bias. For example, habitat suitability models for some wildlife species, such as grizzly bears, have higher ratings for wetter/richer sites. As a result of the PEM bias the habitat models may overestimate the amount of high value habitat.

Trade-offs to Lumping Similar Ecosystems - Although lumping the pairs of similar ecosystems resulted in higher accuracy scores, that benefit may be offset by the reduced ecosystem specificity for some projects. For example, terrestrial lichen forage for caribou is much higher in the SBSmc2-01c than in the 01. By lumping the 01 and the 01c the habitat model may lose significant resolution and predictive ability.

The IFPA technical committee is currently reviewing its options for revising or redoing PEM in the Morice and Lakes TSAs.

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## Literature Cited

- Banner, A., W. MacKenzie, S. Haeussler, S. Thompson, J. Pojar and R. Trowbridge. 1993. A field guide to site identification and interpretation for the Prince Rupert Forest Region. Ministry of Forests, Research Branch, Victoria, B.C.
- Meidinger, D. 2003. Protocol for accuracy assessment of ecosystem maps. BC Tech. Rep. 011. Res. Br. BC Min. Forests. Victoria, BC.
- Meidinger, D., B. Enns, A. Banner, C. Jones and S. Reed. 2000. EcoGen – A Model for Predictive Ecosystem Mapping. Econote 2000-1. BC Min. Forests. Victoria, BC.
- Moon, D. 2004. A protocol for assessing thematic map accuracy using small area sampling. Unpubl. Rep. submitted to the Cariboo Site Productivity Adjustment Working Group.

## Notes

## For More Information...



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