

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 will provide important ecological data that will be used in learning scenario development for the IFPA's Sustainable Forest Management Plans.

Development of Carbon Curves for Addressing CSA Certification



Fraser Lake Sawmills

Introduction

With Canada's recent ratification of the Kyoto Protocol and the increasing global awareness of climate change issues, forest companies are under mounting pressure both nationally and internationally to account for the effects of their activities on terrestrial carbon (C) stocks and greenhouse gas emissions (GHGs). The capacity of forest ecosystems to sequester C has been increasingly recognized as an environmental value and thus a significant component of sustainable forest management plans. Moreover, several certification schemes, including the Canadian Standards Association (CSA), have identified the effects of management on global C cycles as a criterion for sustainable forest management. To successfully implement such a criterion within a certification system, it is necessary to utilize scientifically credible indicators and associated measures that can be evaluated as part of a sustainable forest management plan. Indicators based on correlations with volume and mean annual increment are insufficient.

This project was undertaken to provide support for the Morice and Lakes IFPA certification (CSA) initiative with respect to meeting the requirements around measuring the impacts of forest management activities on global C cycles.

Objectives

- 1) To prepare carbon analysis units (CAUs) and transition pathways for both the Morice and Lakes Timber Supply Areas (TSAs)
- 2) To use the FORECAST model to generate a database of carbon curves for the defined CAUs
- 3) To prepare a report describing the development and use of the curves to assess C indicators as part of the landscape-scale Tesera modelling for the Morice and Lakes TSAs.

Employing C indicators in the Morice and Lakes TSAs

Acceptable indicators for directly assessing the impacts of forest management on carbon cycles include stock change and average annual sequestration rate (defined on page 4). The use of these C indicators in the context of the forest planning modelling being conducted by Tesera Systems for the Morice and Lakes Timber Supply Areas (TSAs) requires a calculation of total ecosystem C content for each forest cover polygon in each time period of the planning horizon. This, in turn, requires the capability to project the impacts of forest management and disturbance on C content.



Methods

Model description

FORECAST is a management-oriented, stand-level forest growth simulator that has been federally and provincially approved for use in forest carbon modelling. The model was designed to accommodate a wide variety of harvesting and silvicultural systems in order to compare and contrast their effect upon forest productivity, stand dynamics and a series of biophysical indicators of selected non-timber values including ecosystem carbon dynamics (e.g. Seely et al. 2002). The model uses a hybrid approach whereby local growth and yield data (often from TASS/TIPSY) are utilized to derive estimates of the rates of key ecosystem processes related to the productivity and resource requirements of selected species. This information is combined with data describing rates of decomposition, nutrient cycling, light competition, and other ecosystem properties to simulate forest growth under changing management conditions as well as the storage of ecosystem carbon in above- and below-ground biomass, dead organic matter and soil pools. Further details of FORECAST calibration and its potential applications are provided in Kimmins et al. (1999), and Seely et al. (1999).

Development of Carbon Analysis Units for the Morice and Lakes TSAs

Given the fact that carbon accounting must be summarized at the landscape scale and the fact that the forest inventory data consists of hundreds of thousands of discrete polygons it was necessary to employ a modelling and accounting approach using carbon analysis units (CAUs) as the primary modelling unit. This method is consistent with that employed by the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) (see Kurz et al. (2002). A series of analysis units were defined for both the Morice and Lakes TSAs that would allow the landscape forest planning model used by Tesera to estimate the impacts of various modelled harvesting and disturbance scenarios on long-term patterns of ecosystem carbon storage and sequestration rates.

A set of CAUs were developed based on the Timber Supply Review (TSR) analysis units (for both the Morice and Lakes TSAs)

to represent existing natural stands, existing managed and future managed stands based on species composition, site quality and regeneration assumptions. A detailed description of the CAUs is provided in the full report (Seely 2004). FORECAST was subsequently used to generate ecosystem C storage curves for each of the defined CAUs. Because ecosystem carbon storage is a continuous variable (i.e. it cannot easily be reset like merchantable volume following harvest), it was necessary to carefully consider transition pathways when preparing the carbon curves. The stand management transition pathways determined for specific forest polygons within the forest planning scenarios prepared by Tesera were summarized and used to guide this process. The objective was to create a relatively smooth transition, in terms of ecosystem C storage, from a natural stand to a managed stand following harvest. This was achieved by estimating an average harvest age for each of the existing stand types and using this harvest age to generate the starting condition for each of subsequent managed stand-curves. Using this approach each managed stand CAU was limited to a single predecessor. Despite using this method, there will still be some errors generated during the transition process but they should be relatively small compared to changes in total ecosystem C storage due to growth and harvest.

Results and Discussion

Ecosystem C Storage and Average Sequestration Rates

Ecosystem C storage provides an estimate of the total amount of carbon stored in a given analysis unit for a specific stand age and is used to measure stock change (see Section 3.2 in full report). In contrast, the calculated average annual sequestration rate represents an estimate of the rate of change in ecosystem C storage with time. It incorporates C losses via decomposition of dead organic matter and C gains via photosynthesis and biomass growth. As such it may be positive or negative.

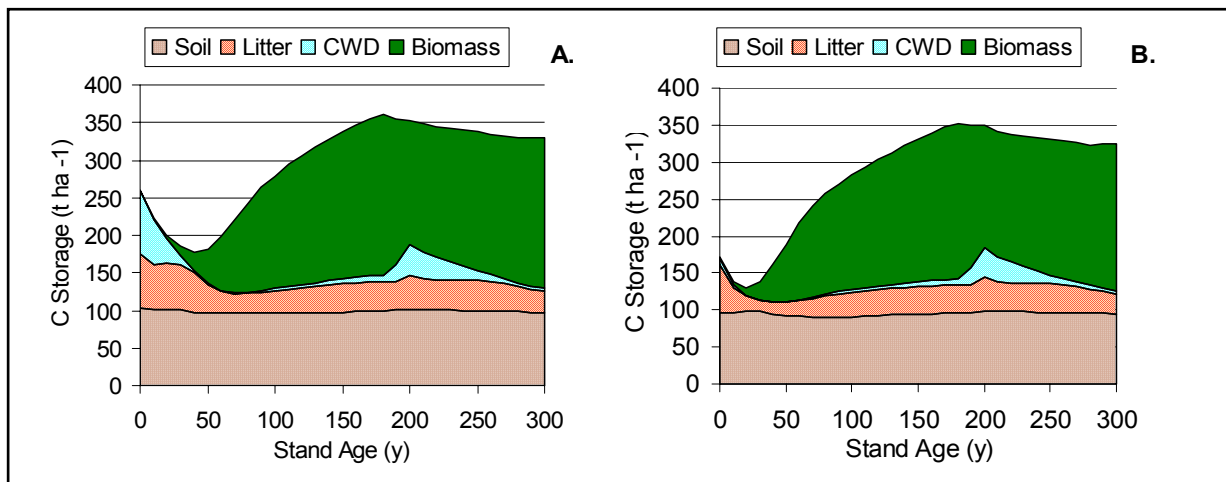


Figure 1. An example of the long-term changes in ecosystem carbon storage within the major ecosystem pools for an A.) natural and B.) managed stand type.

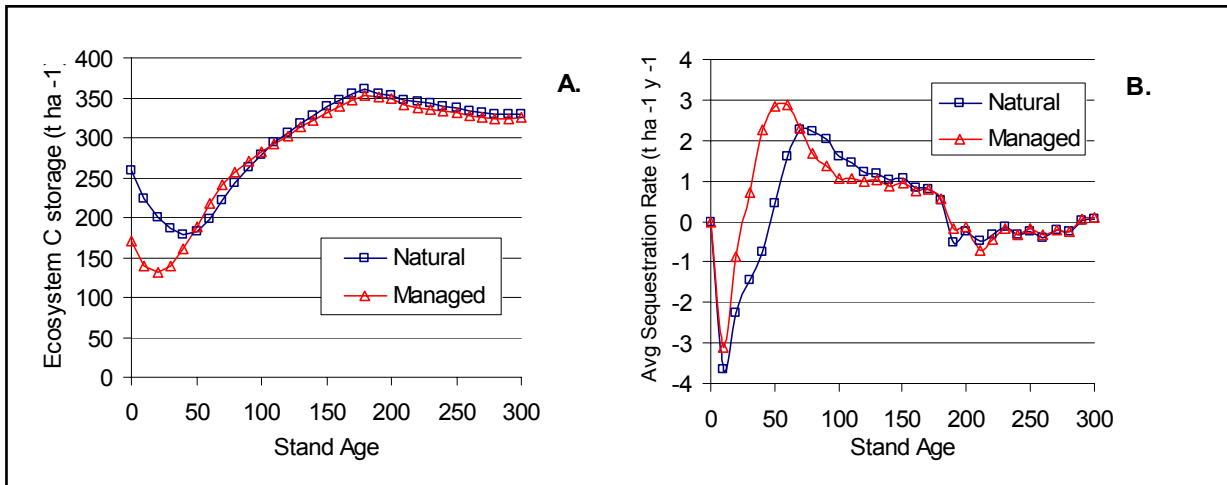


Figure 2. A comparison of A.) total ecosystem C storage and B.) average annual C sequestration rates for example natural and managed Sw/PI stand types.

Examples of the long-term dynamics of carbon storage within the major ecosystem pools are shown for a natural stand Sw/PI stand (Fig. 1A) and an associated managed stand type (Fig. 1B). A direct comparison total ecosystem C storage for the natural and managed stand examples is shown in Figure 2A. The relatively larger ecosystem C storage observed early in stand development for the natural stand is the result of the larger quantity of dead organic matter, primarily snags and coarse woody debris (CWD), following the fire which initiated the natural stand (Fig. 1A). In contrast, the managed stand has a smaller initial pool of C in dead organic matter resulting from the removal of harvested material (Fig. 1B). The pronounced increase in CWD around year 200 in both examples is the result of a simulated break-up of pine component of the stand at this age. The differences in dead organic matter pools following disturbance also has an effect on the average annual sequestration rates of natural and managed stands (Fig. 2b). In both cases there is a negative carbon balance for several decades following the disturbance. This is the result of the release of C (as CO₂) to the atmosphere following the decomposition of the various pools of dead organic matter resulting from the disturbances. Since the managed stand type has much smaller residual pools of CWD and relatively fast growth rates, its average sequestration rate climbs much more quickly than that for the natural stand types. However, from the perspective of total ecosystem stock change and assuming that both stands started with a similar quantity of ecosystem C prior to disturbance, the managed stand represents the greatest loss of carbon until around 50 years following disturbance when its total carbon content recovers to the level observed for a similarly aged natural stand. Ultimately, carbon accounting must be conducted at the landscape or operational scale (e.g. Kurz et al. 2002).

The Application of C Indicators for Landscape-Scale Analyses

By incorporating the stand-level C curves into the Tesera forest planning model, the effects of landscape-scale harvesting activities on the global C cycle were estimated for alternative scenarios based on the indicators described above. The carbon curves generated using FORECAST were used for the calculation of the landscape-level C indicators described below:

Indicator: Total Ecosystem C Storage

- **Definition:** The calculation of total ecosystem C storage within a timber supply area allows for a long-term evaluation of effects of management activities and/or natural disturbance on forest C stocks. Stock change is the current method accepted for C accounting under the Kyoto Protocol. It assumes that C stored in harvested materials is returned to the atmosphere immediately following harvesting.
- **Spatial Extent:** Timber Supply Area
- **Units:** Mt (10⁶ tonnes) C

Indicator: Average C Sequestration Rates

- **Definition:** The calculation of average C sequestration rates within a timber supply area allows for a long-term evaluation of effects of management activities and/or natural disturbance on the rate at which the forested landscape is sequestering C. Unlike the stock change method, average sequestration rates are based on changes in ecosystem carbon storage over time without accounting for C removed in harvested biomass. The rationale is that much of the carbon in harvested materials will be stored in wood products following harvest. An assessment of the sequestration rate provides a measure of the rate and direction of carbon exchange between the forest ecosystem and the atmosphere.
- **Spatial Extent:** Timber supply area
- **Units:** Tonnes C yr⁻¹

References

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For More
Information...



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