PLYRS plantation management system

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Abstract

This paper discusses PLYRS - a new plantation management system jointly developed by ForestrySA, Auspine Limited, Green Triangle Forest Products (GTFP) and The University of Melbourne. The system uses an heuristic simulation approach to enable rapid evaluation of the effect of silvicultural treatments and harvesting plans on a selected area of plantation in terms of wood and cash flows. PLYRS represents an advance over previous plantation management systems in use in Australia in terms of its functionality, ease of use and maintenance, integration and flexibility. While the current system is based on the management of *Pinus radiata*, it forms the basis of a system for the management of other plantation species.

Introduction

A cooperative of major plantation growers based in the Green Triangle Region of South Eastern Australia, and The University of Melbourne has developed a new plantation management system - the *"Plantation Yield Regulation System (PLYRS)"*. PLYRS is a modern, integrated plantation management and yield regulation system that assists users to manage their plantation estate. Its primary function is to aid in the preparation of detailed harvesting plans that are consistent with an organisation's long term management goals and commitments.

PLYRS allows plantation managers to rapidly evaluate the effect of applying various silvicultural treatments and harvesting plans on the wood and cash flows from a selected area of plantation. Harvesting plans can be fine-tuned to meet market demands for specific products and/or specific periods of time and identify potential short falls or surplus product volumes. Thus the system can be used to minimise risk and to maximise the returns from a plantation within the constraints of commitments and resource availability.

Typical uses of the PLYRS plantation management system include:

- Examining the consequences of a range of silvicultural and management alternatives.
- Scheduling wood flows to meet commitments over both short and long term planning horizons.
- Performing detailed operations planning and management using "current day" estimates of expected yields on a stand by stand basis.
- Simulating available wood and cash flows for land purchase proposals.
- Carrying out forest valuation and/or land expectation value analysis.

PLYRS has been designed to form the basis of a system that can be adapted to the management of a range of plantation species through the implementation of appropriate biometric functions. The system has been developed in a Microsoft Visual Basic – Access environment and runs on standard Personal Computers running Windows 95/98, Windows 2000 or NT.

The initiative to develop PLYRS came from ForestrySA, Auspine Limited and Green Triangle Forest Products (GTFP), who each recognised the need to update their existing systems with one that would better address modern plantation management practises. To this end and to gain economies of scale, the Cooperative was formed which in turn contracted the Information Technology for Forest Management Group of the University of Melbourne to develop and maintain the new plantation management system. This development was aided by funding from the Forest and Wood Products Research and Development Corporation (FWPRDC).

This paper outlines the basic structure and functions of the PLYRS system.

Design Considerations

Development of PLYRS as a new system enabled the developers to improve on existing systems used by plantation growers in Australia. PLYRS meets the requirements of current day plantation management and takes advantage of new software and hardware technology. Specific design considerations were:

- **Reduced overall process time.** PLYRS allows rapid evaluation of the effect of changes to simulated management alternatives, allowing more management alternatives to be evaluated in a given time, or quick refinement of a selected option.
- **Ease of use.** PLYRS ease of use allows plantation management staff to rapidly commence using it productively. Historically, many plantation management systems have required a considerable length of time to learn to use.
- **Flexibility.** Basic PLYRS functionality is fully under user control.
- **Improved reporting/export of results.** PLYRS is a very open system in that all data can be printed and/or exported either directly through PLYRS or using the reporting facilities in Microsoft Access.
- **Integration.** All components of PLYRS are seamlessly integrated into the one system. Changes made in one part of PLYRS are reflected throughout the system.
- **Future development.** PLYRS has been designed to form the foundation for further development for other plantation species.
- **Maintainability.** PLYRS has been implemented using a mainstream business application development language and database to ensure future maintainability

Concepts

The important concepts that must be addressed by a plantation management system are:

- Spatial entities
- Past and future plantation management (Management Strategy)
- Growth and plantation events (Biometry)

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- Products, Costs and Revenues.

They are implemented in PLYRS as follows:

Spatial Entities

The basic entity used to describe a plantation within PLYRS is the *Resource Area*. Resource Areas are user-defined and homogeneous in terms of administrative boundaries, site characteristics (Site Quality, soil type, etc) and operational history.

Operations Units are user-defined groupings of Resource Areas for the purposes of applying a common schedule of events and/or management regime. Operations Units may or may not be contiguous and must consist of 1 or more whole Resource Areas. Examples include a collection of compartments all planted in the same year or simply a single compartment. Note that Resource Areas forming an Operations Unit do not necessarily share the same operational history.

Resource Areas and Operations Units in PLYRS can be linked back to their spatial equivalents in an organisation's Geographic Information System (GIS) for spatial display and analysis.

Management Strategy

A management strategy expresses how an area of plantation is to be managed to meet organisational objectives. PLYRS allows plantation managers to tailor individual management strategies for each Operations Unit, apply generic management strategies to groups of Operations Units, or use a combination of these approaches. Management strategies have been implemented in PLYRS using user-defined *schedules* and *regimes* (described below), each of which consists of a series of *events*.

Events

Events are defined as any operation or activity that may occur within or to a plantation that has an impact on its stocking and structure, growth, yields and financial returns. Events can be categorised into four groups:

- Area – events that alter the area available for commercial timber production – i.e. land purchase.
- Stocking – events that affect the stocking – i.e. planting, harvesting, mortality.
- Productivity – events that alter a stand's productivity or Site Quality – i.e. weedicide, fertilising.
- Managerial – events that, from a PLYRS perspective, only affect the economics of commercial timber production – i.e. fire protection, assessment.

The effect of an event during a simulation is determined by the date the event ocurrs and its attributes. Examples of event attributes include residual stocking and extraction row frequency for thinning events.

Operational History, Schedules and Regimes

PLYRS groups events into Operational History (past events), Schedules (scheduled events) and Regimes (schedule templates). Central to the operation of PLYRS is the ability to dynamically link operational history, a schedule and a management regime during the simulation of an Operations Unit or group of Operations Units.

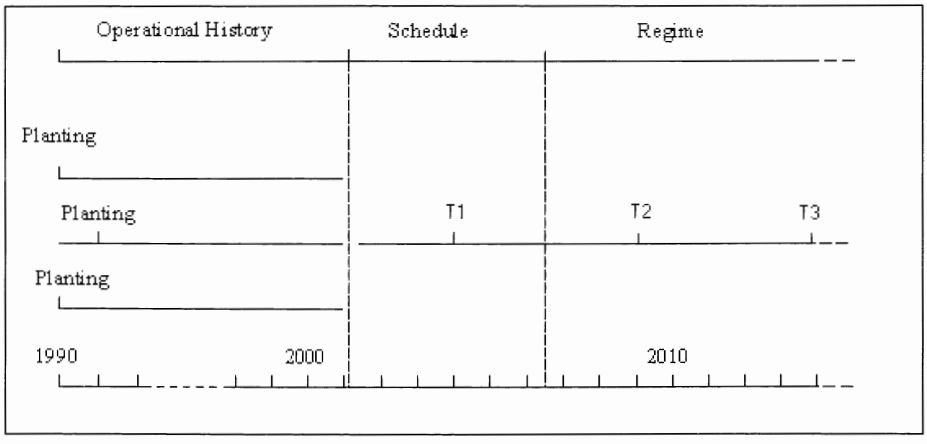
1. Operational History - is defined as a sequence of events that have already occurred. Each event is defined by its attributes and the date that it occurred. Operational history is recorded against Resource Areas.
2. Schedules - are defined as a sequence of events that are scheduled to occur in the future. Each event is defined by its attributes and the date that it is planned to occur. A schedule can be either approved or proposed:
   - Approved schedules basically form the organisation's approved operations plan (including the cutting schedule). Events will occur when nominated unless management actively brings for ward or postpones the event.
   - Proposed schedules are a sequence of events used to test a management option.
3. Regimes - are defined as a sequence of events whose timing is set relative to previous events (i.e. at an age rather than a date).

Regimes are used by PLYRS as a template to generate schedules. Regimes are "linked" to the last scheduled event, or last operational history event if there are no scheduled events, i.e. the last scheduled/historical event is matched to the equivalent regime event. Subsequent regime events are used to generate new scheduled events. Figure 1 demonstrates the relationship between Operational History, Schedules and Regimes. In the example, three Resource Areas (two planted in 1990, one in 1991) have been combined into the one Operations Unit. The Operations Unit has a first thinning scheduled in 2004. The assigned regime has linked on the scheduled first thinning and created second and third thinning events.

Biometry

Biometric functions are tables and equations used by PLYRS to simulate growth and the effect of events on Operations Units. The selection of biometric functions to be applied to specific locations is entirely under user control in PLYRS.

Figure1: Example of the relationship between Operational History, Schedules and Regimes.



Sets of biometric functions applied to locations are stored in biometric libraries. Each library can then be applied to one or more Operations Units to allow testing and re-use of different combinations of biometric functions.

The biometry currently implemented in PLYRS has been developed for the *Pinus radiata* plantations located in the southeast of South Australia and is largely derived from that documented in the Woods and Forests Department Bulletin No. 23 (Lewis et al, 1976) and further developed by Leech (1978). The implementation of the biometry is modular and allows the inclusion of biometry for other locations and or species providing it is of the same form, that is, dependant on Site Quality mapping and volume growth rather than basal area and height growth.

Products, Costs and Revenues

The biometric functions in PLYRS predict total stem volume to a small end diameter of 10 cm. The user can elect how this volume is to be apportioned to user-defined products. Similarly, revenues and costs can be assigned to products in terms of dollars per cubic metre. Costs can also be defined in terms of dollars per hectare, primarily for non-harvesting events.

Depending on the availability of suitable biometry, future PLYRS development could incorporate product mixes determined from a range of inventory methods and/or estimates made by comparisons between actual and previously predicted harvest volumes.

Components of PLYRS

This section describes the major functional components of PLYRS.

Stand Information System

The Stand Information System manages the addition, editing, deletion and reporting of Resource Areas, Operations Units, operational history, and schedules. Users can work with individual records or, where appropriate, groups of records.

Data can be directly entered into PLYRS or imported via intermediate dBase files from a variety of sources, including GIS, databases and portable data loggers.

Inventory

The inventory component provides the means to enter, validate, verify and store inventory plot data in PLYRS. Inventory data can be directly entered into PLYRS, or imported from external files. PLYRS requires users to establish the links between inventory data and the Resource Areas it represents. This allows Resource Areas too small to warrant establishing plots in to be assigned appropriate inventory plots.

PLYRS uses inventory data to update the standing volume and stems per hectare figures and optionally to nominate stems to be removed in the next harvesting event or to nominate the next scheduled harvesting event.

Selection/Filtering Tools

The initial step in performing most actions in PLYRS is to locate and select the required record(s). PLYRS provides a comprehensive set of selection and filtering tools for this purpose:

- Sorting. Columns can be sorted in ascending or descending order.
- Extended selection. PLYRS supports Windows standard record selection using the Shift and Control keys.
- Simple filtering. Records can be selected based on the data in any one column. This mechanism also allows a list from another source eg a document, to be "cut and paste" into PLYRS as the selection criteria.
- Advanced filtering. Records can be selected based on the data in one or more columns. Selected records are those that meet all specified criteria.
- Excel/Access. The selection and filtering tools available in Microsoft Excel and Microsoft Access can be used to select desired records in PLYRS.
- Filtering within results. The results of a previous filtering operation can be further filtered to drill down to the desired records.

Yield Simulation

The Yield Simulation component is used to evaluate management alternatives on selected Operations Units in terms of wood and cash flows and through an heuristic simulation process select and refine the better alternative(s).

The minimum requirements to set up a yield simulation run are:

- The area to be simulated (one or more Operations Units).
- The schedule to be manipulated.
- The biometric functions to be applied.
- The regime to be applied.

For each Operations Unit to be simulated, PLYRS processes historical events, scheduled events then regime events. The regime is "linked" to the last scheduled event i.e. the last scheduled event is matched to the equivalent regime event.

PLYRS uses the assigned biometric functions to simulate growth responses and event behaviour on each Resource Area making up an Operations Unit. The results for each Resource Area are then aggregated up to get Operations Unit level results. This approach improves the precision of estimates over the existing systems' approach of using Operations Unit averages, particularly when there is a deal of variability within an Operations Unit.

PLYRS provides feedback of the results of a Yield Simulation run to allow verification of the results of selected options and to guide further refinement of the management strategy. The simulation results can be viewed on the screen, printed, or exported to an external file. PLYRS can also be used to simulate the management of a single Operations Unit and hence generate yield tables for selected stand types.

Yield Regulation tools

PLYRS can be used to develop schedules of events that produce "regulated" wood flows of one or more products. Regulation involves fine-tuning of scheduled operation attributes and occurrence dates to produce desired wood flows over specified periods of time eg 20,000 m3 per annum of sawlog for the next 10 years. The key element in this fine-tuning is a suite of PLYRS tools that enable changes to be made to event

occurrence dates and event attributes on groups of events. For example, the occurrence dates of a user-selected group of events can be moved forward or backward by a user-specified number of years.

Financial Analysis

The Financial Analysis component computes the financial consequences of a schedule of events using user-defined products, costs and revenues. Outputs are cash flows, Net Present Value at user-defined interest rates and base date, and Internal Rate of Return. This component provides the basic information necessary for forest analysts to carry out sensitivity analyses to test economic parameters as well as undertake forest asset valuation exercises.

Data Export and Reporting

All information displayed in PLYRS is available for export and a number of utilities are available throughout the system to assist the user in filtering and selecting the information of interest. Resources data, management information and the results of simulation and financial analysis may be readily extracted and passed into standard presentation packages, (eg. Microsoft Word, Microsoft Excel) or into other management information systems such as GIS. This enables the user to invoke the power of those packages for reporting and further analysis.

Summary

PLYRS is an easy to use, open and flexible plantation management system that allows plantation managers to rapidly evaluate the effect of applying various silvicultural treatments and harvesting plans on the wood and cash flows from a selected area of plantation. Its principle use is to assist plantation managers in the preparation of detailed harvesting plans that are consistent with an organisation's long term management goals and commitments.

Although the current version of PLYRS is based on the biometry used in the South East of South Australia, PLYRS forms the basis of a system that can be readily adapted to the management of other plantation species.

PLYRS was developed as a new system, which allowed the developers to address the deficiencies inherent in many plantation management systems in use in Australia. In particular, PLYRS is a seamlessly integrated single system, is easy to use and was designed for ease of maintenance and further development.

References

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Decision support software tools for pine plantations

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Abstract

Software tools that link silviculture, wood quality and grading of structural timber are being developed to support the managers of Queensland's commercial pine estate. The tools allow the evaluation of alternative silvicultural scenarios, in terms of internal rate of return and net present value. This paper describes the decision support project that will bring together software tools that grade sawn timber outputs from a conversion model, assign revenues, link to costs associated with a specific silvicultural scenario, and finally generate internal rates of return and net present values. These software tools provide a powerful decision support system that will pass on significant benefits to plantation managers. They will capture several decades of research to maximise the benefits to forest growers and processors by linking silviculture, wood quality and grading of structural timber.

Introduction

Efficient and appropriate management of commercial plantations is a primary goal for forestry organisations. Recently, this goal has become focused on the production of total volume at shortened rotation lengths, however an equally important issue is the impact of reduced rotation lengths on the quality of the timber produced.

A decision support system (DSS) that would allow the managers of commercial plantations to test a range of silvicultural scenarios and evaluate changes in internal rate of return, as well as taking into account impacts on wood properties, would be a valuable tool. The Cooperative Research Centre for Sustainable Production Forestry, the Queensland Department of Primary Industries (QDPI) – Forestry and the Queensland Forestry Research Institute (QFRI) are involved in a DSS project to achieve these aims.

The project is focussed on slash pine (*Pinus elliottii* var. *elliottii)*, Caribbean pine (*P. caribaea* var. *hondurensis*), their F_1 interspecific hybrid, as well as hoop pine (*Araucaria cunninghamii*). These are the main plantation taxa grown in Queensland, with the F_1 hybrid now deployed across the main plantation estate in south-east Queensland. The grower of these plantations, QDPI – Forestry, will be the primary user of the DSS (Catchpoole *et al.* 2001).

The purpose of the DSS is to allow forestry managers to evaluate alternative plantation scenarios in terms of internal rate of return prior to implementation. This could include altering the stocking, average site index and rotation length, as well as evaluating changes in graded timber recovery by overlaying wood property and branch models. In addition, the DSS can be used to evaluate the performance of clones, in terms of branch

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