The PractiSFM multi-resource inventory protocol and Decision Support System
A model to address the private forest resource information gap in Ireland

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Abstract
During the last 20 years, the size of the forest estate in Ireland has increased dramatically. Inventory and management information on the (FSC-certified) publicly-owned forest is widely available, however details on the rapidly expanding private estate, both in terms of inventory data and management objectives, are missing. The PractiSFM inventory protocol and Decision Support System (DSS) comprises Microsoft Excel™ based modules that allow forest managers to analyse multi-resource inventory data and to project the development of a forest under a range of management alternatives. After each simulation, reports in tabular, graphic and map format are produced on a wide range of variables. Visual tools (i.e. an interactive map interface and a goal analysis module) have been incorporated into the program to refine alternatives and to facilitate choice amongst alternatives. It is suggested that use of the PractiSFM inventory and decision support model will allow for the reporting of essential information on the state, development and management of the private forest estate to the State forest authorities. These standardised data can then form the basis for a multi-resource forest inventory and timber (and non-timber) production forecast for the private forests, complementing the already available information on the publicly-owned forest and the results of the low-resolution national forest inventory (NFI) that has recently been completed.

Keywords
Multi-resource forest inventory, forest planning, decision support, inventory reporting, sustainable forest management

Introduction

As a result of the introduction of government and EU incentives, private afforestation as a proportion of total afforestation in Ireland has increased significantly in recent years. Large areas of the private woodlands planted in the 1980s and early 1990s are now approaching the age of first thinning and as the forest estate matures it is estimated that the timber supply from private owners will rise steadily from 0.24 million m^3 at present (Knaggs and O'Driscoll 2008) to over 1 million m^3 by the year 2015, representing some 20% of the total potential national roundwood supply (Gallagher and O'Carroll 2001). However, much of the information concerning private forest holdings is at present either non-existent, confidential or scattered amongst various organisations (Ní Dhubháin and Wall 1998, Gallagher and O'Carroll 2001). In contrast, timber or non-timber inventory information on the publicly owned FSC-

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certified forest, managed by the State Forest Board, Coillte Teoranta, is maintained as an up-to-date, stand-level forest inventory database (Quinn 1996).

While national forest inventory and monitoring initiatives have been ongoing in Ireland for a number of years (Purcell 1979, Fogarty et al. 2000), several authors have drawn attention to the problems of the reliability and correctness of the data that has been collected in these programs (Department of Agriculture Food and Forestry 1996, Gallagher and O'Carroll 2001, Bacon and Associates 2004). The National Forest Inventory (NFI), recently completed by the Forest Service, is a detailed forest inventory using systematic sampling based on a 2 x 2 km grid covering the entire country, with approximately 1800 inventory plots to be assessed on a 5-year cycle (Forest Service 2007a). The inventory produced forest resource information for national policy and international reporting purposes and will go some way to address the lack of current, relevant forest inventory data at a national level. However, the data collected will not serve the data needs of private woodland owners and managers in the implementation, assessment and monitoring of sustainable forest management at a local forest or stand level. The need for further information on economic, silvicultural, environmental and social aspects of private forest holdings, projected timber and non-timber forecasts and management planning in the private sector will also not be addressed by the NFI alone (Figure 1).

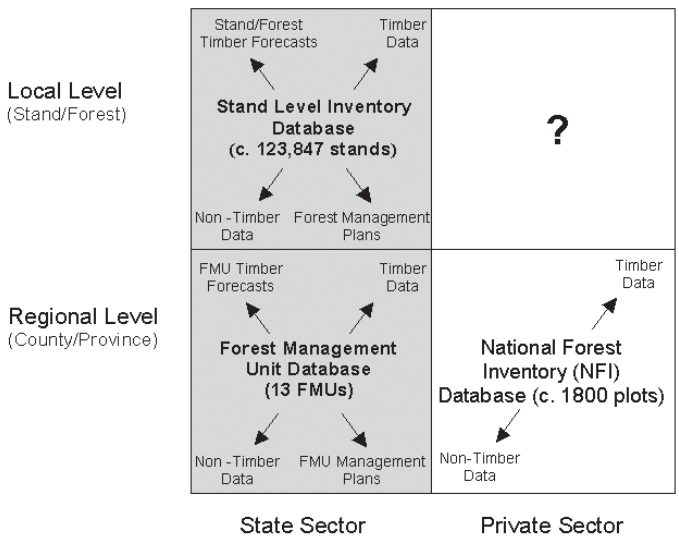

Figure 1: *State and private sector forest inventory, management planning and forecasting protocols, at local and regional levels.*

Following the publication of the Irish National Forest Standard in 2000 (Forest Service 2000), private forest owners are encouraged to evaluate and manage forests for sustainability through the quantification and qualification of multiple forest resources. The preparation of forest management plans is now a prerequisite for the grant payments made in support of afforestation in Ireland (Forest Service 2003). Currently, the two mandatory, paper-based plans, spanning the years 4-10 and 10-20 respectively, include only very basic statements on the management objectives, environmental objectives, and work plans during the planning period. While accurate information is available regarding the area and location of new plantations as a result of the afforestation approval process, these management plans do not provide detailed information on the silvicultural and management practices, nor on the resulting timber and non-timber production potential of the afforested area. A number of reports and submissions to government have emphasised the need for management and database software to support management planning and decision making for private growers and to allow standardised reporting of inventory data to the forest authorities (Ní Dhubháin and Wall 1998, Hennessy and Lawlor 2000, Gallagher and O'Carroll 2001, Whelan 2004, Phillips 2008).

Integrated multi-resource inventory and decision support systems (DSS) for sustainable forest management offer forest owners and managers new and more robust methods for conducting inventories and simulating, analysing and evaluating forest management activities, resulting in a practically attractive, more transparent and higher quality planning process (Rauscher et al. 2000, Reynolds 2005). The development of 'user-friendly' decision support tools, does not seek to replace the need for expert assessment, rather it facilitates the non-specialist or small business users constrained by resources, by integrating and resolving multiple, and often conflicting issues (Ray et al. 2003). In addition, through the use of a DSS, the way the decision maker arrived at the decision is automatically documented and, thus, the process facilitates decisions that are reproducible and as rational as possible (Vacik and Lexer 2001). As a result, these systems have become increasingly important in gaining support from the public for forest related management activities, in attaining planning approval from forest regulatory authorities and in achieving accreditation from forest certification bodies for sustainable forest management (Johnson et al. 2007).

While DSSs for forest management have been used extensively internationally in recent years (Schuster et al. 1993, Akabua et al. 2000, Pyatt et al. 2001, Reynolds 2001, Ray et al. 2003), their use in Ireland has mostly been limited to Coillte Teoranta (Williamson and Nieuwenhuis1991, Tiernan and Nieuwenhuis 2005) or in academic research (Nieuwenhuis and Nugent 1999, Nieuwenhuis and Tiernan 2005). It is only relatively recently that the power of computers has been brought to bare in decision making in areas such as yield modelling (GROWFOR (COFORD 2007a)) and windthrow (Irish Windthrow Risk Model (COFORD 2007b)). This paper describes the development and application of the PractiSFM DSS, designed to function as a user-friendly, integrated multi-resource inventory data management and stand-level based forest planning tool. The development, design and structure of the DSS are described briefly. The inventory, management planning and forecast outputs produced by the DSS are also described. The paper identifies and highlights the importance of

the three outputs provided by the PractiSFM DSS: 1) multi-resource inventory data; 2) forest management plans and; 3) timber and non-timber forecasts. The potential for the spatially explicit, high resolution inventory and management planning data outputs from the system to supplement existing Forest Service management information requirements and to complement low resolution information from the recently completed national forest inventory (NFI) is discussed.

The development of the PractiSFM system

The PractiSFM DSS was designed as a low/no cost, flexible, user-friendly decision support tool to aid forest owners and managers in the implementation of SFM. A review process coupled with feedback from forest managers, forest management consultancy companies and the Forest Service, facilitated the design and implementation of an effective and efficient multi-resource inventory protocol (Barrett and Nieuwenhuis 2006) and permitted the identification of the following key functionality requirements in the PractiSFM DSS:

- the capability for the processing, analysis, storage and reporting of stand-level multi-resource (timber and non-timber) forest inventory data;
- the facilitation of stand-level timber and non-timber forecasting for the planning horizon;
- the generation of a range of forest management scenarios over the planning horizon to determine the effects of stand management decisions on a range of timber and non-timber (environmental, economic, social) parameters of relevance in SFM;
- the production of appropriate user-friendly interactive, tabular, graphic and map based tools and outputs to facilitate decision-making;
- the compatibility with the needs of the Forest Service for multi-resource inventory and planning data to complement the National Forest Inventory, assist in the monitoring of SFM and facilitate strategic planning of the forest sector.

PractiSFM was developed in incremental stages within Microsoft Excel using the Visual Basic for Applications (VBA) integrated development environment (IDE). VBA offers the advantages of fast performance, tight integration with the host application, and the ability to build solutions without the use of additional programming tools. Microsoft Excel's familiarity to the end user group (Hennessy and Lawlor 2000), its widespread availability, its user-friendliness and its relatively low cost compared with other proprietary systems were also considered advantages. The PractiSFM DSS comprises three main program modules (Figure 2), which control the functionality of the application, including the production of inventory data entry forms, validation of inventory data, production of stand timber and non-timber forecasts, generation of reports and control of interactive mapping and goal analysis functions. Data requirements for the program are provided in the form of keyboard input through forms and dialogs, and data stored in lookup tables as part of the application. Figure 2 also illustrates the potential linkages of the outputs from PractiSFM with the NFI.

Inventory reporting

The primary source of input data for the PractiSFM DSS is the PractiSFM multi-resource inventory, developed in conjunction with the PractiSFM DSS as a standard set of procedures for observing, assessing and recording multi-resource forest inventory data at a stand-level scale (Barrett and Nieuwenhuis 2006). The multi-resource inventory has been developed in accordance with the criteria and indicators (C&I) as identified in the Irish National Forest Standard (Forest Service 2000) and comprises a total of 27 different timber (e.g. dbh, top height) and non-timber (e.g. vegetation class, landscape sensitivity, soils type etc.) components, with each component comprising one or more variables (Barrett et al. 2007). The multi-resource procedures adopted were incorporated in a field sheet, including key information (e.g. description of types of evidence demonstrating specific wildlife activity, descriptions of tree canopy density classes/foliage discolouration classes), and field sheet guidance notes for each of the components. In addition, documentation listing the steps taken to arrive at the final set of methodologies was created. This was provided to explain the reasoning behind and justification for the various multi-resource inventory procedures and to show the relevance and importance of each of the parameters measured against C&I in the National Standard. The PractiSFM field sheet has been set up on a hand-held data logger.

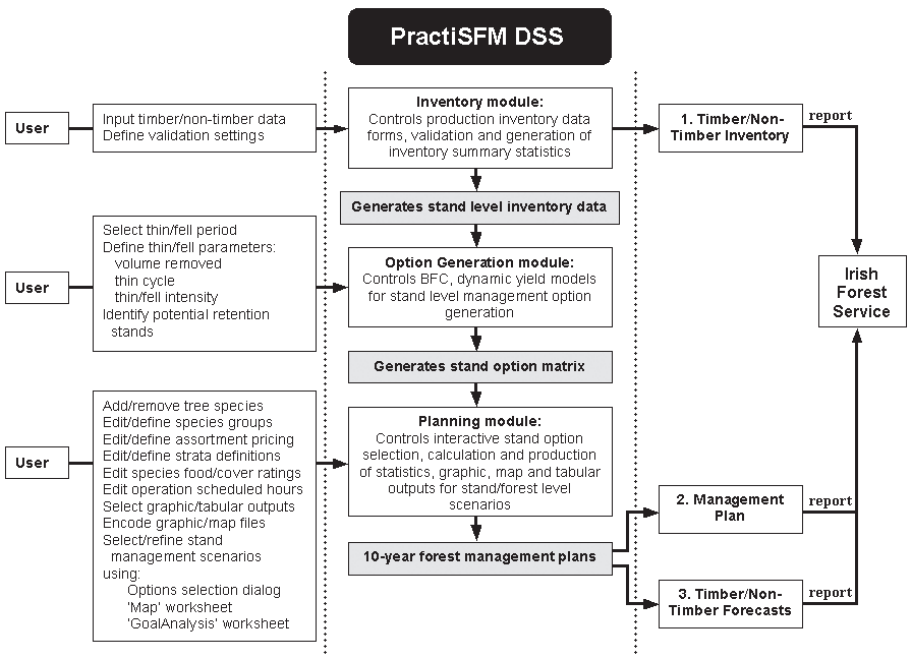

Figure 2: *Structure of the PractiSFM DSS showing the relationship between user inputs, the DSS application modules and output linkages to the NFI.*

Quantitative continuous data (e.g. length of hedgerows, adjacency to streams), quantitative categorical data (e.g. deadwood, natural regeneration) and qualitative categorical data (e.g. internal and external landscape sensitivity) are stored, processed and summarised by the PractiSFM DSS. These data allow the forest owner to form a more holistic picture of the current state of the forest ecosystem, establish a sound knowledge base upon which to make more informed forest planning and management decisions and, thorough monitoring using additional data from future inventories, will assist in the assessment of the progress towards or away from SFM (Barrett et al. 2007). Summary statistics and estimates of timber and non-timber parameters are generated on an aggregated plot, per species, per hectare and stand level. Inventory plot data are checked and validated when the program is initiated to ensure they are in the correct domain and user defined ranges. Timber and non-timber inventory statistics (e.g. amenity, landscape sensitivity, vegetation classification, terrain classification) describing the current state of the forest are outputted from the program in a standard format, grouped by stand and species (Table 1).

Validation of the multi-resource inventory

Subsequent testing and validation of the PractiSFM inventory protocol was carried out by an independent assessor on eight sites in addition to the main test site at Ballycurry, Co. Wicklow. The additional test sites were selected so as to be typical of the physical, environmental and characteristics of privately owned forests in Ireland. This further testing permitted the: 1) analysis of whether the results of the inventory were representative of the different sites; 2) assessment of the time and resources required; 3) evaluation of the effectiveness and completeness of the documented protocol; and 4) correction and revision of the assessment protocols and associated documentation where problems occurred in the interpretation of the methodology. A plot-based, timber inventory and the PractiSFM multi-resource inventory were carried out for each of the stands at eight test sites. Where forest mapping data were not available, stand boundaries and other physical and environmental features were mapped using a GPS.

Completeness and representativeness of multi-resource inventory

The multi-resource inventory protocol was capable of accommodating the wide array of biological, physical, cultural and social characteristics encountered. The testing and validation process permitted the revision of the protocol where inadequacies had been identified. These revisions included: a methodology for recording and mapping within-stand open spaces (excluding roads); a revision of deadwood volume classes; a record of forest wind-zone (Miller 1985); a record of the forest soil type (Horgan et al. 2003); and a record of any proposed statutory or non statutory designations within and/or adjacent to the forest being assessed. Assessment of landscape sensitivity proved most difficult to finalise and apply in practice. A combination of expert knowledge and additional information describing landscape quality and type, sourced from county landscape character maps (Department of the Environment and Local Government 2000) and/or county development plans facilitated the allocation of internal and external landscape sensitivity scores.

Table 1: *A sample of inventory statistics produced by the PractiSFM DSS.*

Timber parameters	Non timber parameters
Timber Plot Area (ha)	Great soil group
Species Present	Severity of soil damage
Age of Species (yr)	Soil damage as a prop. of stand area
Avg. No. stems per plot > 7 cm	Adjacency of stand to major rivers (m)
Avg. No. stems per plot < 7 cm	Adjacency of stand to minor rivers (m)
Total No. stems per plot	Stems (per ha) of natural regeneration
Basal Area per plot (m^2)	Invasive species as a prop. of stand area
Volume in the per plot (m^3)	Presence/absence of feeding by wildlife
Mean diameter breast height (cm)	Deadwood volume class
Mean Basal Area per tree (m^2)	Internal landscape sensitivity class
Mean Volume per tree (m^3)	External landscape sensitivity class
Mean Top Height	Amenity sensitivity class
General Yield Class	Stand terrain classification

Precision and accuracy of multi-resource methodologies

Multiple resource inventories and associated variables and measurement techniques should match individual informational needs, resources, budgets, data-processing capabilities, forms of analysis to be employed, and tabulations to be reported (Whyte 1999). In the PractiSFM multi-resource inventory protocols, a trade-off is achieved between the investment in sampling and the level of accuracy and precision obtained. The system was designed to facilitate collection of timber data according to point, line and plot sampling strategies typically used in Irish forestry (Purser 2000), facilitating statistical analysis and error estimation. The timber inventory provides an opportunity for reconnaissance and a rapid visual assessment of various non-timber (multi-resource) attributes of the stand. Where appropriate, additional time is spent gathering more detailed information on specific multi-resource stand attributes.

Quantitative continuous data, quantitative categorical data and qualitative categorical data are collected as part of the protocols. The quantitative continuous data provide an opportunity for statistical analysis and trend analysis. The quantitative categorical data allow trend analysis as the classes are clearly defined (Lund 1998). However, appropriate training should be given in the measurement of these categorical data. For example, a tendency exists to assess smaller vegetation coverages as larger (e.g. percentage cover grass/herb, lichen, shrub) and larger coverages as smaller than they are in reality (Jukola-Solunen and Salemaa 1985). Further research is needed to try to quantify and objectify the (subjective) qualitative categorical landscape sensitivity data.

Planning and forecasting

The objectives of Irish private forest owners for their forests are typically multiple-use rather than singular; however almost all owners consider the production of timber for sale as a prime objective (Ní Dhubháin and Wall 1998). Thus, to achieve the owner's objectives, active management occurs primarily through decisions to thin, fell, regenerate, underplant, restock or retain stands beyond the normal financial rotation age. The harvest simulation or timber forecasting tools built into the PractiSFM option generation module (Figure 2) are based on the Forestry Commission Yield Class system (Edwards and Christie 1981) and the Irish Dynamic Yield Models developed for Sitka spruce, Douglas fir and Norway spruce (Broad and Lynch 2006). Estimated thinning and felled timber harvest volumes associated with particular silvicultural treatments may also be entered manually into the DSS, in cases where (Irish) forest growth projection models have yet to be developed (e.g. for Continuous Cover Forest systems (CCF) and for broadleaf species). The option generation module is used to create an option matrix, which represents a series of 10-year harvest (thin, clearfell, CCF felling, retention) schedules and replanting/underplanting treatments for each stand in the forest. The option generation module incorporates interactive dialogs and uses stand stocking, basal area, yield class, average growing stock, user defined thinning parameters and other calculated stand summary statistics as inputs to guide the creation of realistic stand management option sets. Non-timber data for each option is also included in the option matrix.

The planning module (Figure 2) uses the values in the option matrix generated by the option generation module to create: 1) alternative forest management planning scenarios (management plans); 2) forecasts of timber (e.g. future species age, composition, diversity statistics, log volume assortments); and 3) non-timber variables (e.g. deer habitat suitability ratings, retention area, ending deadwood volume) for the 10-year planning horizon. The planning module generates a series of interactive dialogs, a map-based interface and a goal analysis worksheet to assist the user in selecting specific stand management options from the option matrix. The capabilities for scenario visualisation and the creation of maps incorporated into the PractiSFM DSS mean that the important consequences of proposed management alternatives, in both time and space, can be effectively communicated in a visually intuitive graphic form. For example, the PractiSFM DSS allows the comparison of alternative landscape designs or harvest strategies relative to the other parameters of interest such as the revenue from timber sales, landscape sensitivity, amenity sensitivity, stands adjacent to water bodies, terrain classification, stonewall length, and forest safety or hazard indices.

The goal analysis worksheet produced by the planning module allows the decision maker to set satisfactory levels of achievement for specific parameters or indicators of SFM (e.g. volume harvested, discounted revenue). The interactive dialogs initiated by the goal analysis worksheet facilitate the decision maker in the selection of management options which direct or move the simulation towards these desirable goals or aspirations. The goal analysis worksheet slider bars are used to visualise the minimum, current and maximum possible values of a range of timber and non-timber variables, including harvest volume, discounted revenue, area of retention, amenity

sensitivity, average deadwood per hectare, area of broadleaf restocking, deer food/cover habitat weightings.

Tabular and graphic output produced by the PractiSFM DSS 10-year plans or simulations include, among others, timber volume assortments forecasts and associated revenues, species composition, age class distributions, landscape sensitivity statistics, estimated deadwood volume production and estimates of scheduled operation hours (Table 2). The starting condition of the output variables (at the start of the 10-year planning horizon, based on the multi-resource inventory data) is produced with each of the scenario outputs, which allows the decision maker to compare whether any of the alternative scenarios improved on the current condition of the variables being assessed. This body of information may then be used to select an alternative for implementation or refine an existing scenario. Multiple scenarios or alternatives can also be retained for comparison.

Table 2: *Summary management planning outputs produce by the PractiSFM DSS*

Harvest (thinning/clearfell) volume (m^3) per period[1] per species group or by stand[2]
Harvest (thinning/clearfell) value (€) per period per species group
Harvest volume/value/discounted value per period
Starting/ending/normal conifer age class strata area and species
Starting/ending/normal broadleaf age class strata area and species
Starting/ending species/mixture totals (ha)
Starting/ending species stand types (ha)
Aquatic area/adjacency outputs for minor and major streams
Cumulative retention area (ha) per stand type
Internal landscape sensitivity of stands (ha) scheduled for harvesting operations
External landscape sensitivity of stands (ha) scheduled for harvesting operations
Terrain classification for stands (ha) scheduled for harvesting
Terrain classification for stands (ha) scheduled for clearfell/thinning
Starting/ending deadwood by conifer/broadleaf strata (m^3)/by stand
Scheduled hours for planting/thinning/clearfell operations/by stand/forest
Starting/ending deer habitat – food
Starting/ending deer habitat – cover
Amenity/aquatic/forest safety/landscape sensitivity map-based outputs

[1] The 10-year simulated planning horizon is divided into five 2-year periods.
[2] Outputs are also generated by species by stand.

The PractiSFM system, the NFI and stand level multi-resource information

Current, accurate and reliable multi-resource data form the basis for a (sustainable) forest management decision-making process. An understanding and application of the

relevant multi-resource, management planning and forecast data can help forest owners and managers to evaluate the current status of forest resources, identify objectives that are sustainable, evaluate the effects of proposed management strategies and reconcile competing objectives and values. The paucity of standardised inventory, management planning and forecast data for privately owned forests in Ireland makes it very difficult for the State forest authority to comprehensively evaluate the extent, type, distribution and use of potential resource outputs from privately owned forests. Basic silvicultural management information and data regarding the owners' intentions for their forests are also missing. These information deficits also cause potential difficulties when formulating relevant and focused national policies and new forest schemes directed towards encouraging active management of the private estate.

The Private Stand Level Inventory proposed by the Forest Service in 2007 will go some way towards addressing the lack of inventory data for the private estate (Forest Service 2007b). However, the inventory will be confined to a sub-set of the private forest estate established during the 1980s and will be directed towards the collection of data for timber related parameters only (stand area, top height, basal area, stand age etc.), with no attention given to either the owners objectives or the collection of data for non-timber parameters such as visual amenity, wildlife or biodiversity. Furthermore, unlike the NFI, there are no plans to periodically update the stand level inventory, resulting in an inability to monitor change and leading to potential information deficits in future years, if no other inventory standards or provisions for the collection of timber and non-timber parameters for the private estate are put in place.

A number of COFORD and IRCSET (Irish Research Council for Science, Engineering and Technology) funded research projects also focus on providing resource information related to the private forest estate (e.g. CLUSTER, FORECAST, FORESTSCAN, REMOTEINV). However, these research programs are not yet fully operational and face the same short-term project duration, funding and institutional/ government support issues as all research programmes not operated on a permanent footing. In addition, their scope and scale all vary, some projects addressing only specific forests or regions or taking a top down approach to forest resource analysis and forecasting. A bottom-up approach has been identified as the "ideal situation" in terms of the private estate information question (Phillips 2008). Such a bottom-up approach should consider the owners' preferences and management regimes, which should be collected together with reliable stocking and growth information. This information would then form the basis of forecasts using reliable and flexible growth models. The forest owner centric approach to the resource question would also facilitate more realistic national and catchment based forecasting, as well as scenario modelling.

Although the PractiSFM system was primarily developed to assist forest owners and managers to develop, present and compare alternative forest management regimes and ultimately to manage a range of forest values in a more sustainable and holistic manner, the system could potentially function as a model to facilitate automated, standardised reporting of detailed, spatially explicit, stand and forest level multi-resource inventory data. Many of the data types collected and summarised using the PractiSFM multi-resource inventory and DSS are similar to those collected in the

National Forest Inventory (NFI) recently completed (Barrett et al. 2007, Forest Service 2007a). The compatibility of PractiSFM with the NFI could facilitate local, regional and national analysis and reporting of timber and non-timber resource data when the datasets are combined. However, the issues of standards, objectivity and transparency in the data collection procedures initiated by forest owners and their agents will need to be considered carefully and resolved before inventory and management information can be incorporated into any Forest Service data base.

The Forest Service is currently developing a complete online version of the corporate iFORIS, (integrated Forest Information System) which supports the administration of state supported afforestation and premium schemes. Such an online system would strongly benefit from the capacity to receive electronically the inventory and management planning information currently required by applicants in receipt of afforestation premium payments. Provided that the information can be sent in a standardised electronic form, PractiSFM DSS outputs could be modified as required to serve this niche. The 1946 Forestry Act, currently being reviewed for submission to the Irish Government later this year, will potentially include new provisions related to the requirement for forest management planning documentation in support of felling activities on privately owned forest lands. The new Forest Act also represents an opportunity to incorporate, from a regulatory control point of view, the same bottom-up approach to the collection of multi-resource inventory and other information as incorporated into the PractiSFM system.

Timber production forecasting

The management plan information produced by the PractiSFM DSS can provide the Forest Service with a detailed record of forest operations and work plans for the planning period. A standardised, digital work plan produced by PractiSFM could facilitate forest owners and forest managers in receiving pre-approval for forest operations. To date, such management planning is submitted in hard copy or paper format. The current lack of timber and non-timber (amenity value, recreation, wildlife habitat value) inventories and forecasts for many private forest properties undermines significantly the technical and scientific credibility of forest resource management plans, and stymies strategic planning for the forest industry chain at the regional and national level. Successful planning for the future development of the processing sector cannot occur without accurate spatial and temporal information on future supply. It is of critical importance that the processing industry is provided with reliable supply forecasts so that the processing capacity can be installed at the right time and in the right locations to handle the increasing amount of roundwood coming from private forests (Gallagher and O'Carroll 2001).

Information derived from the PractiSFM DSS inventory, management and forecast output could also be used to facilitate policy makers and researchers in assessing the existing and future needs of the sector for financial support, planning, training and education. The results from the test sites showed that the owners' objectives had a significant effect on timber and non-timber production, so that when viewed in isolation from the owners' objectives, the multi-resource inventory alone is not sufficient to determine the future output of products and services. Full consideration

of the relevant multi-resource inventory, management and forecast data can help to improve the forestry sector's decision and policy making processes by providing an understanding of the natural and human systems and their interactions. For example, a more complete picture of woodland owners' intentions with regard to thinning and felling would allow the sustainable development of policies or support mechanisms to ensure that harvest operations are occurring at optimal stages of the forest rotation or are planned at a landscape or regional level to facilitate the development of industry, and to ensure that the productive, amenity, habitat, carbon sequestration, environmental, landscape and aesthetic potential of particular regions are maintained or enhanced (Hummel 2005, Pajuoja et al. 2005).

A feature of the privately owned forest estate in Ireland is that a relatively small number of forest management companies (approximately five) have established (and in some cases still manage) the majority of the privately owned forests. Thus, the inventory, management planning and reporting linkages provided by PractiSFM could be implemented easily and efficiently, representing a potentially large proportion of forest owners, if only a small number of forest management companies adopted such a system to facilitate management of the recently established private estate. Several of the forest management companies involved in this study have acknowledged the potential benefits of PractiSFM as an inventory and management planning tool and have also seen the usefulness of this type of software for reporting to the Forest Service and facilitating their day-to-day business in areas such as grant applications, felling licence approval and record keeping. A new research project, PractiSFM II, has recently been initiated in cooperation with COFORD and three forest management companies, to investigate the potential of the PractiSFM DSS to: 1) facilitate the standardisation of management plan reporting by private forest owners/managers to the Forest Service; 2) investigate the synergies between the multi-resource inventory data derived from PractiSFM DSS outputs and data recorded in the National Forest Inventory and the Integrated Forest Information System (iFORIS); and 3) determine the role of PractiSFM DSS outputs in facilitating regional and national timber forecasting and strategic planning for the forest industry. The project will involve the implementation and testing of PractiSFM in an operational environment within the three companies, and the development of an optimisation module to facilitate owners/managers in the proper weighing of the objectives and in obtaining optimal solutions.

Conclusions

Until relatively recently, forest management practices in private forests in the Republic of Ireland have been directed solely towards timber production. Little, if any, consideration was given to the physical, social and biological forest resources, their status and condition, as well as their significance in developing sustainable forest management plans. The PractiSFM multi-resource inventory and decision support software offers a practical, user-focused approach to stand-level, multi-resource forest inventory and decision support for private forest owners and managers, using Criteria and Indicators identified in the Irish National Forest Standard. The system has the potential to facilitate the exchange of inventory, management planning and

forecast information between forest owners/managers and the Forest Service in a standardised format. Thus, the PractiSFM system can provide the missing link in the forest information chain between the forest owner and the Forest Service and, in combination with National Forest Inventory data and information from the State managed forests, complete the picture of the current and future state of the national forest estate (Figure 3).

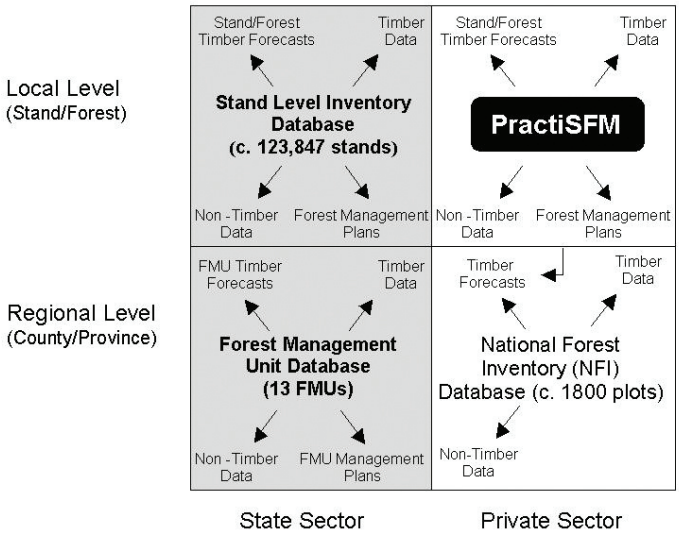

Figure 3: *The place of PractiSFM in state and private sector forest inventory, management planning and forecasting protocols.*

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