

SUSTAINABLE **FOREST**  
MANAGEMENT NETWORK



RÉSEAU DE GESTION  
DURABLE DES **FORÊTS**



Networks of Centres  
of Excellence  
Réseaux de centres  
d'excellence

**A Compendium of Sustainable  
Forest Management Network  
Computer Simulation Modeling  
(1995-2003)**

*By Robin Duchesneau*

## **THE SUSTAINABLE FOREST MANAGEMENT NETWORK**

Established in 1995, the Sustainable Forest Management Network (SFM Network) is an incorporated, non-profit research organization based at the University of Alberta in Edmonton, Alberta, Canada.

The SFM Network's mission is to:

- Deliver an internationally-recognized, interdisciplinary program that undertakes relevant university-based research;
- Develop networks of researchers, industry, government, Aboriginal, and non-government organization partners;
- Offer innovative approaches to knowledge transfer; and
- Train scientists and advanced practitioners to meet the challenges of natural resource management.

The SFM Network receives about 60% of its \$7 million annual budget from the Networks of Centres of Excellence (NCE) Program, a Canadian initiative sponsored by the NSERC, SSHRC, and CIHR research granting councils. Other funding partners include the University of Alberta, governments, forest industries, Aboriginal groups, non-governmental organizations, and the BIOCAP Canada Foundation (through the Sustainable Forest Management Network/BIOCAP Canada Foundation Joint Venture Agreement).

## **KNOWLEDGE EXCHANGE AND TECHNOLOGY EXTENSION PROGRAM**

The SFM Network completed approximately 300 research projects from 1995 – 2004. These projects enhanced the knowledge and understanding of many aspects of the boreal forest ecosystem, provided unique training opportunities for both graduate and undergraduate students and established a network of partnerships across Canada between researchers, government, forest companies and Aboriginal communities.

The SFM Network's research program was designed to contribute to the transition of the forestry sector from sustained yield forestry to sustainable forest management. Two key elements in this transition include:

- Development of strategies and tools to promote ecological, economic and social sustainability, and
- Transfer of knowledge and technology to inform policy makers and affect forest management practices.

In order to accomplish this transfer of knowledge, the research completed by the Network must be provided to the Network Partners in a variety of forms. The KETE Program is developing a series of tools to facilitate knowledge transfer to their Partners. The Partners' needs are highly variable, ranging from differences in institutional arrangements or corporate philosophies to the capacity to interpret and implement highly technical information. An assortment of strategies and tools is required to facilitate the exchange of information across scales and to a variety of audiences.

The KETE documents represent one element of the knowledge transfer process, and attempt to synthesize research results, from research conducted by the Network and elsewhere in Canada, into a SFM systems approach to assist foresters, planners and biologists with the development of alternative approaches to forest management planning and operational practices.



Knowledge Exchange and Technology Extension Program (KETE)  
Sustainable Forest Management Network

# **A Compendium of Sustainable Forest Management Network Computer Simulation Modeling (1995-2003)**

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## ABSTRACT

This document is a compendium of computer simulation modeling funded by the Sustainable Forest Management Network (SFMN) between 1995 and 2003, inclusive. The intent behind this research project was to accelerate the exchange of research results internally and externally, to maximize the use and potential impact of SFMN-generated knowledge for economic growth, public policy development, and social innovation.

This compendium was assembled by reviewing 383 SFMN publications for references to computer simulation modeling, classifying and collating the applicable research projects into eleven categories, adding labels such as author (s), title, year and location, and a short summary of the modeling method, intent, and area of application. The compendium contains 104 entries classified by category, province, year, as well as a function of the following descriptors: fire, light, water, wind, carbon, habitat, biodiversity and wildlife, forest and landscape, regeneration, visualization, growth and yield, peatland, economic, wood pulp mill, social, and policy.

Integrated Resource Management, Innovative Zoning, and Carbon Forest Management were the most prevalent modeling categories. According to the key descriptors the major modeling efforts are within the areas of forest and landscapes, economic, and habitat, biodiversity, and wildlife. Visualization, wind and peatland had the least modeling efforts. Fire and regeneration issues were strong secondary considerations in multidisciplinary modeling projects.

This SFMN compendium of computer simulation modeling is a valuable extension tool since it consolidates and disseminates knowledge in a research domain that often lacks integration and transparency. Besides serving as a reference document for SFMN members, partners, affiliates and the general public, it also provides a basis for determining whether modeling efforts are in agreement with the overall objectives and expectations of the SFMN.

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## INTRODUCTION

The number of computer simulation modeling publications in the literature is steadily increasing. Modeling applications now span a wide range of topics such as watersheds, wildlife and habitats, growth and yield, fire, forest and landscape, insect epidemics, and predicting silvicultural outcomes on ecological, economic and social criteria and indicators. Yet, there has been very little effort into cataloging, analyzing, comparing, and resolving other logistical and ethical issues surrounding ‘proper’ model application, or ‘good modeling practices’.

The main objective of this research project was to retrieve, classify, and provide a brief description of the modeling efforts invested by SFMN researchers. This compendium is in partial fulfillment of the SFMN research project entitled ‘Sustainable Forest Management Network Forest Models: Past, Present, and Future Directions’, which is a project within the SFMN Knowledge Exchange and Technology Extension (KETE) program.

## METHODOLOGY

SFMN modeling literature used in the development of this compendium was collected from SFMN Publications, Project Reports, Working Papers, Research Program Guides, Synthesis Reports, books, and other SFMN documents found on the SFMN web site (<http://sfm-1.biology.ualberta.ca>). The compendium covers documents produced between 1995 and 2003, inclusive. Each document found in the sources listed above was searched for text referring to computer simulation modeling that led to, or would eventually produce, quantitative predictions and forecasts of future ecological states. When such references were found, the content was classified and summarized, and the information subsequently entered in the compendium. Empirically driven statistical models such as principle component analysis and regressions, and conceptual models (e.g. flowcharts) were not included in the analysis.

Although great efforts were made to keep the information collated in this compendium as accurate as possible, it is important to mention that source documents were, at times, incomplete or incomprehensible. In these cases, the content reflects a personal understanding of the authors’ modeling intent. Additionally, the research content encountered in the SFMN ‘Working Papers’ and ‘Research Program’ might be subject to change as the research project proceeds towards completion.

Projects were classified primarily into research subjects consistent with 9 SFMN research subject areas: Natural Disturbance Management, Innovative Zoning, Policy and Institutional Analysis, Value Added/Alternative Products, Ecological Criteria and Indicators, Water and Wetlands, Sustainable Aboriginal Communities, Social and Economic Criteria and Indicators, Pulp and Paper Technologies/Solid Waste Management, and Carbon and Forest Management. Due to overlap among subject areas, some projects can be found under one or more subject categories. These particular circumstances are indicated in parenthesis following the ‘research subject’ in the compendium.



An alternative classification scheme was added to enhance the SFMN’s research subject classification system, and to better describe the modeling projects. One or two key word ‘descriptors’ were added to each project: a primary descriptor which establishes the modeling effort according to its main objective, and, when necessary, a secondary descriptor to capture the breadth of the modeling project. These descriptors are: fire, light, water, wind, carbon, habitat, biodiversity and wildlife, forest and landscape, regeneration, visualization, growth and yield, peatland, economic, wood pulp mill, social, and policy.

Each entry in the compendium contains the following labels: ‘author(s) and year’, ‘research subject’, ‘source’, ‘descriptors’, ‘location’, ‘title’ and a brief ‘description’ of the modeling effort. Wherever ‘Research Program’ is encountered beside a ‘source’ label, this indicates that the source document came from a current SFMN project that was still ongoing at the time of the development of this report. These cases are problematic since they indicate what is being done, rather than what may have actually been documented in a publication. It is virtually impossible to determine the exact status of these special cases. These cases are treated separately in the results section, whenever needed.

## RESULTS & DISCUSSION

To consolidate the computer simulation modeling research efforts within the SFMN, 383 source documents as currently published on the SFMN web site were reviewed. 85 SFMN modeling projects were found that contained reference to computer simulation modeling between 1995 and 2003. These projects were entered in the compendium according the SFMN research subject classification scheme. Due to the difficulty of classifying multidisciplinary research projects nineteen entries were placed in more than one research subject. Thus, there are presently 104 entries in the compendium.

Table 1: Labels (A-K) used throughout this report to represent the compendium’s research subjects used to classify modeling efforts.

CATEGORIES (SFMN ‘PUBLICATIONS’ SUBJECT)	LABEL
Natural Disturbance Management	A
Innovative Zoning	B
Integrated Resource Management (IRM)	C
Policy and Institutional Analysis	D
Value-Added/Alternative Products	E
Ecological Criteria and Indicators (C&I)	F
Water and Wetlands	G
Sustainable Aboriginal Communities	H
Social and Economic Criteria and Indicators (C&I)	I
Pulp and Paper Technologies/Solid Waste Management	J
Carbon Forest Management	K





Based on labels provided in Table 1, Table 2 depicts the efforts of the SFMN, by province, given the various SFMN publication categories. Fifteen research projects spanned their modeling efforts to more than one province. Five of these projects concerned themselves with four different provinces, one project covered three provinces, and nine covered two provinces. The remaining 82 entries dealt with one province only. Of these, Alberta contained the highest number of projects, followed by British Columbia, and Quebec with 49, 13 and 10 entries, respectively. Other provinces had four or less modeling projects. Nova Scotia, Newfoundland and Labrador, Prince Edward Island, Yukon, and Nunavut had no modeling representation.

Table 2: Number of SFMN ‘Publications’ and ‘Research Program’ entries with a component of computer modeling per province according to the various categories. Note: N.A. indicates a theoretical modeling exercise that is not related to a specific location.

Province	CATEGORY											Total
	A	B	C	D	E	F	G	H	I	J	K	
British Columbia (BC)	0	0	3	2	0	0	0	2	1	3	2	13
Alberta (AB)	12	1	18	3	0	4	5	0	2	4	0	49
Saskatchewan (SK)	2	0	1	0	0	0	0	0	0	0	0	3
Manitoba (MN)	0	0	1	0	0	0	0	0	0	0	0	1
Ontario (ON)	1	1	0	0	0	1	1	0	0	0	0	4
Quebec (QC)	4	0	2	0	0	0	4	0	0	0	0	10
New Brunswick (NB)	0	0	0	0	0	1	0	0	0	0	0	1
North West Territories (NWT)	0	0	0	0	0	0	0	1	0	0	0	1
BC, AB	0	1	0	0	1	0	0	0	0	0	2	4
BC, ON	0	0	0	0	0	0	0	1	0	0	0	1
BC, QC	2	0	0	0	0	0	0	0	0	0	0	2
AB, ON	1	0	0	0	0	0	0	0	0	0	0	1
AB, MN	0	0	0	0	0	0	0	0	0	0	1	1
AB, SK, MN	0	0	0	0	0	0	1	0	0	0	0	1
BC, AB, ON, QC	1	0	0	0	0	0	0	0	0	0	0	1
AB, ON, QC, NB	2	0	1	0	0	0	0	0	0	0	0	3
SK, MN, ON, QC	1	0	0	0	0	0	0	0	0	0	0	1
N.A.	0	1	1	2	1	1	0	0	1	0	0	7
<b>Total</b>	<b>26</b>	<b>4</b>	<b>27</b>	<b>7</b>	<b>2</b>	<b>7</b>	<b>11</b>	<b>4</b>	<b>4</b>	<b>7</b>	<b>5</b>	<b>104</b>

Figure 1 depicts the modeling efforts within the SFMN for both ‘Publications’ and ‘Research Program’ categories by research subject. For example, 14 of the 23 SFMN ‘Publications’ (~60%) in the Integrated Resource Management (C) category contained modeling efforts, and 13 of the 16 (~81%) ‘Research Program’ listings in the same category contained modeling efforts.

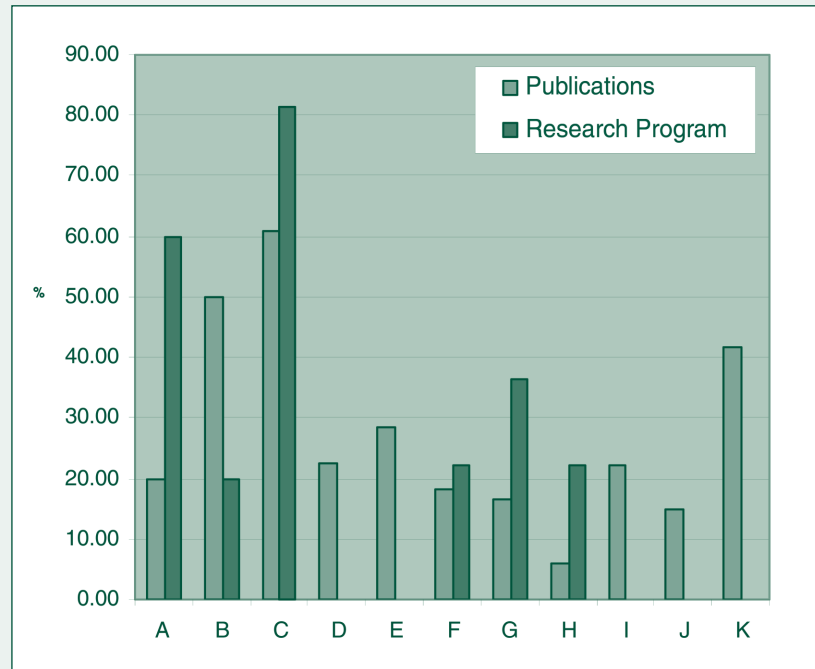


Figure 1: Proportion of SFMN projects containing computer simulation modeling by research subject within existing ‘Publications’ and on-going ‘Research Program’ projects.

As seen in Figure 1, only three research subjects had more than 40% of the projects contain computer simulation modeling for the ‘Publications’ entries, and two for the ‘Research Program’ entries: Integrated Resource Management (C), Innovative Zoning (B), and Carbon Forest Management (K); and Innovative Zoning (B) and Natural Disturbance Management (A), respectively. Other research subjects are similar and average 18% for ‘Publications’, and 5% for ‘Research Program’ entries. Several research subjects contained no on-going modeling efforts within the ‘Research Program’.

Figure 2 depicts the modeling efforts by research subject as a function of the total projects containing modeling within the SFMN. Again this is broken down by ‘Publications’ and ‘Research Program’ entries. As seen in Figure 2, Innovative Zoning (B) and Natural Disturbance Management (A) research subjects contained the most modeling projects with approximately 23% and 18% for ‘Publications’, and 38% and 33% for ‘Research Program’, respectively.



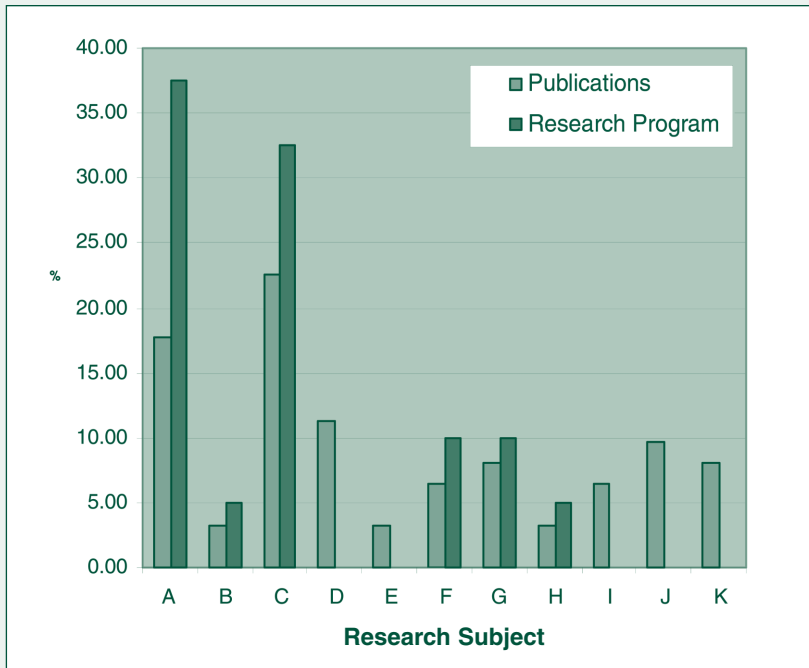


Figure 2: Distribution of computer simulation modeling efforts among SFMN research subjects by 'Publications' and in on-going 'Research Program' projects.

Figure 3 shows how the efforts have been invested through time (annually), and the distribution of these efforts throughout the research subjects. The year 2001 was by far the most productive with 39 entries (pie chart), which represents approximately 38% of all entries in the compendium. These 39 entries were very well distributed amongst all the categories (stacked columns), with an average of approximately 3 research projects for every research subject.

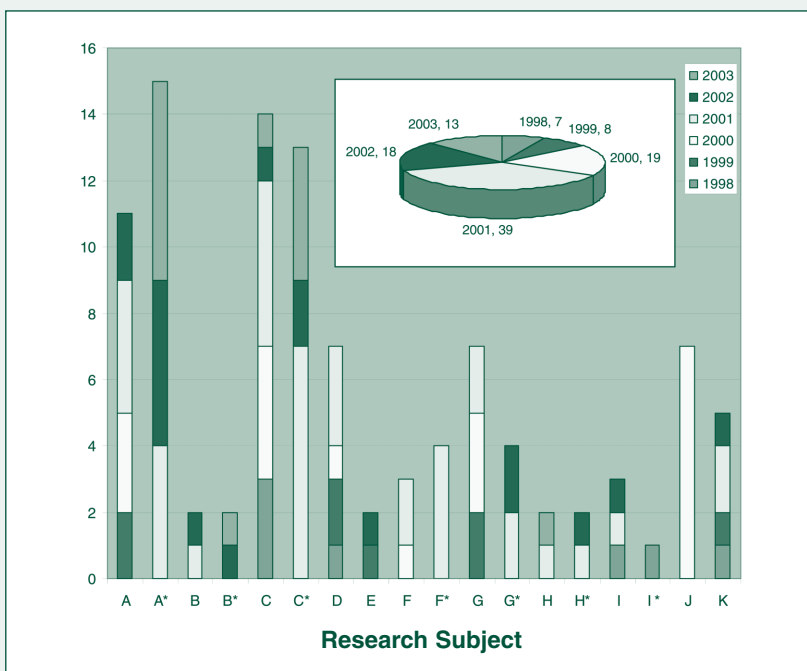


Figure 3: Number of 'Publications' and 'Research Program' projects by research subject and year (note: \* beside a letter indicates 'Research Program' entries).

Figure 3 shows that the years with the least number of modeling projects were 1998 and 1999, with only 7 and 8 projects respectively. Further analysis reveals in 1998 approximately 5% of the 'Publications' entries (of the total 85) contained modeling efforts, while in 2003 13% of the 'Research Program' entries contained modeling efforts, indicating an increasing trend over time in modeling efforts within the SFMN.

As previously mentioned a second classification scheme was added to augment the SFMN's 'Publication Subject' classification. For each entry, two key descriptors were added; a primary that expressed the main objective of the modeling effort, and a secondary to account for the multidisciplinary nature of some of the modeling projects. Figure 4 depicts the representation of the modeling efforts by primary descriptor.

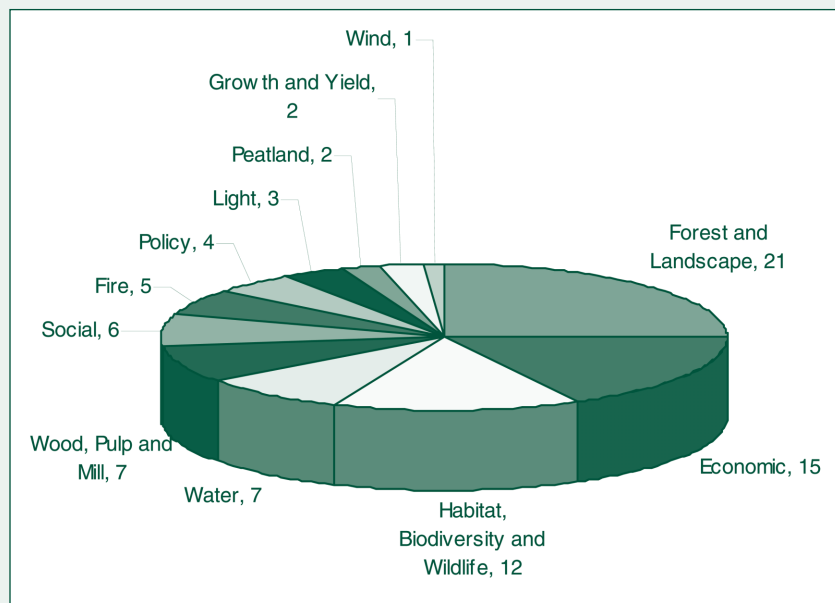


Figure 4: Number of SFMN projects containing simulation modeling classified by primary descriptor.

Figure 4 indicates that most of the SFMN modeling research projects involved forest and landscape issues (21 of the 85 entries ~25%). Economic (15/85) and habitat, biodiversity, and wildlife (12/85) topics were also well represented. Combined, these three topics account for ~56% (48/85) of the SFMN modeling efforts. Since the primary descriptor only accounts for the main modeling objective, it can be useful to break these results down further (Table 3).



Table 3: Number of SFMN ‘Publications’ and ‘Research Program’ projects involving computer modeling by primary and secondary descriptor.

<b>PRIMARY + SECONDARY ALTERNATIVE CLASSIFICATION</b>	<b>NUMBER</b>
Economic + Policy	6
Economic + Fire	3
Economic + Carbon	1
Economic + Social	2
Economic + Forest and Landscape	3
Fire + Forest and Landscape	3
Fire + Growth and Yield	1
Fire + Policy	1
Forest and Landscape	2
Forest and Landscape + Policy	2
Forest and Landscape + Fire	4
Forest and Landscape + Growth and Yield	3
Forest and Landscape + Regeneration	6
Forest and Landscape + Habitat, Biodiversity and Wildlife	4
Growth and Yield + Fire	2
Habitat, Biodiversity and Wildlife + Fire	3
Habitat, Biodiversity and Wildlife + Forest and Landscape	8
Habitat, Biodiversity and Wildlife + Water	1
Light + Growth and Yield	3
Peatland + Fire	1
Peatland + Carbon	1
Policy + Carbon	1
Policy + Economic	1
Policy + Fire	1
Policy + Forest and Landscape	1
Social + Forest and Landscape	2
Social + Visualization	1
Social + Economic	2
Social + Carbon	1
Water + Fire	3
Water + Peatland	1
Water + Forest and Landscape	2
Water + Habitat, Biodiversity and Wildlife	1
Wind + Forest and Landscape	1
Wood, Pulp and Mill + Water	2
Wood, Pulp and Mill	5
<b>TOTAL</b>	<b>85</b>

Table 3 provides a more complete picture of the multidisciplinary aspect of SFMN modeling efforts. Table 3 demonstrates that habitat, biodiversity, and wildlife at the forest and landscape level, along with policy coupled with economic considerations, and forest and landscape with regeneration issues, constitute important combinations in the SFMN modeling work.

This can also be seen by amalgamating both primary and secondary descriptors to provide a more holistic view of the modeling efforts. Figure 5 indicates that while forest and landscape topics are still the major focus of SFMN modeling, fire and policy issues are also considerable.

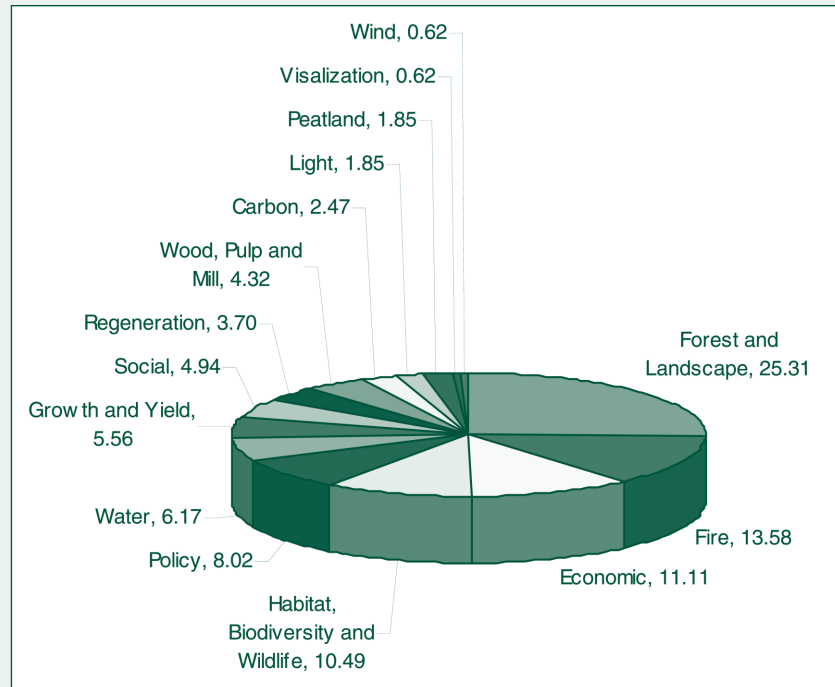


Figure 5: Proportion of total SFMN modeling efforts considering both the primary and secondary descriptors combined.

## SUMMARY

This compendium was developed in partial fulfillment of the SFMN research project entitled ‘Sustainable Forest Management Network Forest Models: Past, Present, and Future Directions’. Here, 383 SFMN source documents were reviewed and 85 modeling projects were found to contained references to computer simulation modeling. Much of the SFMN simulation modeling research was based in Alberta with approximately 47 percent of all efforts, compared to a provincial average (i.e. calculated from all provinces that had modeling projects) of approximately 6 percent. Nova Scotia, Newfoundland and Labrador, Prince Edward Island, Yukon, and Nunavut had no modeling representation.

Most modeling efforts appeared to be contained within three main research subjects for the ‘Publications’ entries, and two for the ‘Research Program’ entries, with: Integrated Resource Management (60%), Innovative Zoning (50%), and Carbon Forest Management (41%); and Innovative Zoning (33%) and Natural Disturbance Management (38%), respectively. 2001 was by far the most productive year, contributing 38% of all entries in the compendium. Other years averaged 13 percent, with the least productive years being 1998 and 1999.



According to key descriptors the main modeling topics within the SFMN are forest and landscapes (21%), economic (15%), and habitat, biodiversity, and wildlife (12%). The remaining topics averaged approximately 5%, with wind-related issues being the least represented. When considering the multidisciplinary facet of the modeling projects (i.e. taking into consideration both the main and secondary modeling objectives), fire issues become more apparent, as well as carbon and regeneration concerns.

This SFMN compendium of computer simulation modeling is a valuable extension tool, and particularly within the arena of simulation modeling since it consolidates and disseminates knowledge in a research domain that often lacks integration and transparency. Besides serving as a reference document for SFMN members, their industrial partners, and the general public, it also provides a basis for determining whether modeling efforts are in agreement with the overall objectives and expectations of the SFMN.

It is strongly recommended that this compendium be upgraded annually. Consolidating future SFMN modeling efforts could be facilitated through an internal model registry program, and a sorting algorithm to assist in the compilation process. Not only would this make the task simpler, it would serve as a quality control instrument by which authors would be assured of the integrity in the representation their modeling work.







# SFMN MODELING COMPENDIUM

## (1995-2003)

### KEY TO LABELS USED IN THE SFMN MODELING COMPENDIUM

- Author(s) and year:** primary author is listed by last name and initials followed by the year of the document. In the case of dual authorship, second authors are also listed. In the case of > 3 authors, only the first author is listed followed by “*et al.*”
- Research subject:** refers to one of nine research subject areas used by the SFMN.
- Source:** the SFMN document type, available on the SFMN website, that was used to gather the information for the compendium. In cases of on-going projects where no published document exists, the annual SFMN Research Program document where the project is described is provided.
- Descriptors:** additional key-word topic descriptors
- Location:** province where the majority of work was (is) performed
- Title:** project title taken directly from the SFMN publication (e.g., project reports), or the research program document project title.
- Description:** a brief description of the modeling efforts



## Research subject: Natural Disturbance Management

1. Author(s) and year: Adamowicz, W.L. *et al.* 2000  
Research subject: Natural Disturbance Management (also in Policy and Institutional Analysis)  
Source: final project report available on SFMN website  
Descriptors: economic, policy  
Location: Alberta  
Title: **Assessing the Economic Impacts of Natural Disturbance Forest Management.**  
Description: The objective of this project was to construct tools to assess the economic impact of a transition from sustained yield to natural disturbance management. An Input-Output (I-O) analysis, a Computable General Equilibrium (CGE) model, Social Accounting Matrix SAM model types were used to determine regional economic impacts and a Monte Carlo simulation optimization model was constructed with STELLA for addressing non-timber impacts.
2. Author(s) and year: Armstrong, G., and S.G. Cumming. 2002  
Research subject: Natural Disturbance Management (also in Social and Economic Criteria & Indicators)  
Source: working paper available on SFMN website  
Descriptors: economic, fire  
Location: Alberta  
Title: **Shadow Prices as Estimates of the Cost of Forest Fires.**  
Description: The shadow prices output variable from a linear programming based timber harvest scheduling model (LP\_TSM) was used, in conjunction with output from a fire model (FEENIX) to approximate the costs of potential fires for a boreal mixedwood forest of northeastern Alberta.
3. Author(s) and year: Coates, K.D., *et al.* 2001  
Research subject: Natural Disturbance Management  
Source: working paper available on SFMN website  
Descriptors: forest and landscape, growth and yield  
Location: British Columbia, Quebec  
Title: **SORTIE: A Resource Mediated Spatially-Explicit and Individual-Tree Model that Simulates Stand Dynamics in both Natural and Managed Forest Ecosystems.**  
Description: The model SORTIE is described and used to provide three examples of how management of the spatial arrangement or size of residual trees affects future forest development: 1) stand development analysis in temperate forests of northwestern BC, 2) impact of light environment on understory survivorship of stems in deciduous dominated temperate forests of southern Quebec, and 3) Impact of strip cutting in aspen-spruce stands of the boreal forest of BC.

4. Author(s) and year: Cumming, S.G., *et al.* 1999  
Research subject: Natural Disturbance Management  
Source: working paper available on SFMN website  
Descriptors: forest and landscape, fire  
Location: Alberta  
Title: **Gap Dynamics in Boreal Aspen Stands: Is the Forest Older Than We Think?**  
Description: A simple cellular automata model was created to examine the consistency between rates of harvest coupled with fire suppression with projected natural rates of disturbance by fire. The simulated trajectories of canopy stem density and age structure of aspen stands permitted to conclude that gap dynamics can maintain near-pure deciduous stands in the absence of shade tolerant competitors; vast tracts of boreal forest are being managed on the basis of an incorrectly estimated age structure and misconception of their dynamics.
  
5. Author(s) and year: Dickson, M.B., and E.A. Johnson. 2000.  
Research subject: Natural Disturbance Management  
Source: working paper available on SFMN website  
Descriptors: fire, forest and landscape  
Location: Saskatchewan  
Title: **Fire-Caused Mortality in Trees.**  
Description: A mechanistic model was created to provide managers with a tool to predict vascular-cambium necrosis and tree death from bark thickness and fire residence time, and variables that are readily estimated in the field or from models. The model consists of a surface-fire extinction model coupled to a heat-transfer and biophysical cell-survivorship model.
  
6. Author(s) and year: Dufour, B., and R. Gagnon. 1999  
Research subject: Natural Disturbance Management  
Source: project report available on SFMN website  
Descriptors: forest and landscape, regeneration  
Location: Quebec  
Title: **Prédiction de la Régénération Naturelle Après Coupe dans la Forêt Boréale du Saguenay-Lac Saint Jean.**  
Description: A model was constructed to predict the stocking density of natural regeneration for five commercial tree species, three to five years post-logging. The model uses stand composition, reproduction strategies, and effects of logging to determine a residual coefficient of distribution of regenerating stems of *Picea mariana*, *Abies balsamea*, *Pinus banksiana*, *Betula papyrifera* and *Populus tremuloides*.



7. Author(s) and year: Greene, D.F., *et al.* 2001  
Research subject: Natural Disturbance Management (also in Integrated Resource Management)  
Source: working paper available on SFMN website  
Descriptors: forest and landscape, regeneration  
Location: Alberta, Quebec, New Brunswick, Ontario  
Title: **A Biological and Economical Analysis of Silvicultural Alternatives to the Conventional Clearcut/plantation Prescription in Boreal Mixedwood Stands (aspen/white spruce/balsam fir).**  
Description: A series of mathematical equations were coupled to create a mechanistic model of seedling recruitment. This model was used to determine the impact of four prescriptions that serve as alternatives to conventional clearcutting followed by planting: (1) reliance on advance regeneration with or without augmentation by fill-planting; (2) understory scarification during a mast year; (3) direct seeding either aerially or with a scarifier-seeder; and (4) underplanting.
8. Author(s) and year: Johnson, E.A., *et al.* 2000  
Research subject: Natural Disturbance Management  
Source: final project report available on SFMN website  
Descriptors: forest and landscape, fire  
Location: Saskatchewan  
Title: **Understanding How Fire Behavior Characteristics Shape Tree Population Dynamics, Diversity, and Forest Patterns.**  
Description: Findings of four distinct research projects are reported. Two projects necessitated modeling efforts: (1) a spatially explicit wetness model (TOPMODEL) for the project called "A Spatially Realistic Distributed Model of Fragmentation Resulting from Human Disturbance in the Mixedwood Boreal Forest of Saskatchewan", and (2) a mechanistic recruitment model for the project called "Recruitment Curves of Trees into Burns."
9. Author(s) and year: Pennanen, J.K., *et al.* 2001  
Research subject: Natural Disturbance Management  
Source: working paper available on SFMN website  
Descriptors: forest and landscape, regeneration  
Location: Quebec  
Title: **Development of Q-LAND, a Spatial Model of Forest Landscape Dynamics Incorporating Prediction of Tree Volume and Seedling Recruitment.**  
Description: A spatially explicit simulation model of long-term dynamics of forest landscapes is being developed to investigate how different actual or potential disturbance regimes determine the structure and dynamics of forest landscapes. Q-LAND consists of modifying LANDIS and

FIN-LANDIS to incorporate (1) prediction of basal area and tree volume at the cell level and, (2) seed dispersal and sexual and asexual regeneration. A preliminary test of the model is presented for one stand-type in Abitibi, Quebec.

10. Author(s) and year: Stadt, K.J., *et al.* 2002  
Research subject: Natural Disturbance Management  
Source: project report available on SFMN website  
Descriptors: light, growth and yield  
Location: Alberta  
Title: **A Comparison of Non-Spatial and Spatial, Empirical and Resource-Based Competition Indices for Predicting the Diameter Growth of Trees in Maturing Boreal Mixedwood Stands.**  
Description: MIXLIGHT, a forest light simulator which mechanistically estimates the light resource to the top of the subject tree over the growing season, was used to produce individual tree spatial competition indices. These indices were then used to predict the diameter growth of subject trees in mixed species stands. Comparisons were made between non-spatial and spatial, empirical and resource-based competition indices.
11. Author(s) and year: Stadt, K.J., *et al.* 2001  
Research subject: Natural Disturbance Management  
Source: final project report available on SFMN website  
Descriptors: light, growth and yield  
Location: Alberta  
Title: **Modeling Light Dynamics in Boreal Mixedwood Forests.**  
Description: Light competition between aspen and spruce was examined using MIXLIGHT in order to address management and regulatory implications such as the efficiency of Alberta's free-to-grow (FTG) standards. This paper also reports on the development, refinement, and testing of MIXLIGHT.
12. Author(s) and year: Johnson, E. 2001  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: fire, forest and landscape  
Location: Ontario  
Title: **Interaction of forest management and wildfire on the landscape mosaic.**  
Description: Using spatial data on fire, logging and settlement a model is being developed for estimating both the naturally-caused and forest-operations-caused variation in age mosaic of the landscape. This will allow evaluation of Ontario's forest management practices of the mimicking natural disturbance hypothesis.



13. Author(s) and year: Bergeron, Y. 2001  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: forest and landscape, fire  
Location: Quebec  
Title: **Development of a forest management strategy based on natural disturbance for the western Québec and eastern Ontario black spruce ecosystem.**  
Description: An empirical succession model is being developed using an analysis of permanent plots and ecological survey data from the Ministère des Ressources Naturelles du Québec, together with detailed dendroecological field data. This model will predict vegetation composition in relation to fire regime both at the stand and landscape levels, and contribute to the development of a new approach to designing strategic plans that will allow forest managers to plan interventions that emulate forest mosaics that are similar to the ones created by natural disturbances. Possible consequences on allowable cut and operational costs will be assessed.
14. Author(s) and year: Drapeau, P. 2002  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: habitat, biodiversity and wildlife, forest and landscape  
Location: Quebec  
Title: **Spatial Configuration of Forest Remnants that Maintain Biodiversity in Highly Managed Forest Landscapes: A Multiscale Approach.**  
Description: This research will assist in determining spatial configurations of harvesting that will minimize the impact of fragmentation on biodiversity. The specific objectives are to predict the response of biodiversity indicators (vascular plants, non-vascular plants and songbirds) to the spatial pattern of remnant forests for different levels of fragmentation, with emphasis on highly fragmented managed landscapes; and develop management guidelines for the spatial configuration of remnant forests that are functionally meaningful from an organism's perspective at multiple spatial scales (from local to regional scales).
15. Author(s) and year: Flannigan, M. 2001  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: fire, forest and landscape  
Location: Saskatchewan, Manitoba, Ontario, Quebec  
Title: **Climate and Fire Relationships in the Central and Eastern Boreal Forest.**  
Description: By using general circulation models and regional climate models, the relationships among fire, climate

and vegetation will be used to estimate the impact of changes in the boreal forest in the 21st century, including the effect of the anticipated future warming on the fire regime. The results from this research will be incorporated into a fire succession model.

16. Author(s) and year: Ruel, J.-C. 2003  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: wind, forest and landscape  
Location: British Columbia, Quebec  
Title: **Windthrow Risk Modeling.**  
Description: Both empirical and mechanistic models are being developed, validated, and refined in order to provide a set of stand and forest level management strategies for the boreal and cool temperate forests of Canada. The UK FOREST GALES model will serve as a conceptual modeling template, adapted, and then used to validate model predictions for a few specific case studies: the MacGregor Model Forest in British Columbia and the Montmorency Forest in Quebec.
17. Author(s) and year: Comeau, P. 2002  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: forest and landscape, regeneration  
Location: Alberta  
Title: **Spatial Aspects of Boreal Mixedwood Succession and Stand Dynamics.**  
Description: This research ties into and provides data for validation and further development of spatial stand- and landscape-level models such as TASS, SORTIE, and FEENIX. The main objectives are to provide a quantitative analysis to address questions such as:
1. After the initial regeneration phase, do aspen patches expand over time? What is the relationship between this and initial aspen density and spatial pattern?
  2. After initial post-disturbance white spruce establishment, do established patches of white spruce increase in size and density over time? Are there subsequent episodes of white spruce recruitment in stands older than 40 years old? What is the relationship between this and initial white spruce densities and spatial patterns?
  3. In stands older than 20 years, what initial threshold densities and configurations of aspen preclude subsequent white spruce infill?
  4. Do patches of white spruce preclude future aspen regeneration? Under what spatial configurations (aerial extent and density within the patches) would





white spruce understory protection result in poor regeneration of aspen and conversion of a mixedwood stand to a spruce stand?

5. What processes control growth of white spruce into an aspen canopy, with respect to spruce-aspen spatial relationships (i.e., do spatial factors such as whipping act to keep spruce in the understory)?

**18.** Author(s) and year: Greene, D. 2002

Research subject: Natural Disturbance Management

Source: SFMN 2002/2003 Research Program document

Descriptors: forest and landscape, regeneration

Location: Alberta

Title: **Modeling the Spatial Dynamics of White Spruce and Aspen in the Boreal Mixedwood.**

Description: The first objective of this study is to encapsulate presently available knowledge, and results of ongoing research on white spruce, into an existing spatial dynamic (landscape) model of the mixedwood region. We will then evaluate alternate hypotheses regarding the importance of the two recruitment mechanisms, to determine if either is consistent with the known patterns of present and historical abundance of white spruce. The second objective is to develop models of the more important silviculture systems in use or being studied, and to evaluate their consequences on the landscape over meaningful time, relative to natural processes. The third objective is to improve the physical and biological realism of the underlying models, by refining the models of potential recruitment in post-fire stands, incorporating the influence of large canopy spruce trees within aspen stands, and accounting for some of the effects of climatic and site variability within the region.

**19.** Author(s) and year: Lieffers, V. 2003

Research subject: Natural Disturbance Management

Source: SFMN 2002/2003 Research Program document

Descriptors: light, growth and yield

Location: Alberta

Title: **Crown Density and Crown Closure in Relation to Stand Characteristics.**

Description: "Crown shyness" from stand characteristics will be determined using photographs or light instrumentation (LAI-2000) or remote air photos to predict changes in growth and yield using the models GYPSIE or SORTIE, and to refine models that predict light transmission through canopies (MIXLIGHT and SORTIE).

20. Author(s) and year: Macdonald, E. 2002  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: forest and landscape, regeneration  
Location: Alberta  
Title: **Impacts of Post-Burn Salvage Logging on Plant Biodiversity and Tree Regeneration of the Mixedwood Boreal Forest.**  
Description: This study will examine the effect of coarse woody material removal (salvage logging) in burns on regeneration of the dominant tree species, understory plant biodiversity and community composition, and successional development in the western boreal mixedwood forest. We will determine the roles of changes in above-ground (microclimate, microsite availability) vs. below-ground (soil temperature, moisture, carbon and nutrients) effects in this process. The data produced by this study will be incorporated into stand- and landscape-level models of boreal forest regeneration and succession and provide information relevant to modeling of socio-economic trade-offs under the TRIAD paradigm.
21. Author(s) and year: Messier, C. 2001  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: forest and landscape, regeneration  
Location: Alberta, Manitoba, Ontario, Quebec  
Title: **Developing Better Probability Function and Field Indicators of Seedling Mortality of Important Boreal Species across the Canadian Boreal Forest.**  
Description: This project is validating and improving the current mortality functions for regeneration in different stand dynamics models, but specifically for SORTIE/boreal. The modeling effort will provide a pan-Canadian comparison of the early dynamics of important boreal species, and provide the template for the development of a comprehensive stand dynamics model that works across the entire boreal forest through a more complete understanding of the factors driving inter-regional differences.
22. Author(s) and year: Messier, C. 2002  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: forest and landscape, regeneration  
Location: British Columbia, Alberta, Ontario, Quebec



Title: **Implementation of Stand- and Landscape-Level Models of Forest Regeneration and Stand Dynamics to Investigate Various Management Scenarios of SFM in Northern BC, Northern Alberta and the Clay Belt Region of Central Canada.**

Description: In order to predict future forest conditions at different scales, SORTIE/boreal (stand-level model) and SELES/boreal (landscape-level model) are being calibrated and tested for 3 different areas of the boreal forest (northern BC, northern Alberta and the mixed-wood and black spruce forests of the Claybelt zone). The SORTIE model is also being modified to provide a more flexible architecture so that it can be used and easily modified (including the addition of new submodels).

23. Author(s) and year: Adamowicz, W.L. 2003

Research subject: Natural Disturbance Management

Source: SFMN 2002/2003 Research Program document

Descriptors: economic, fire

Location: Alberta

Title: **Economic Analysis of the Effect of Wildfire and Wildfire Management on Air Quality.**

Description: This project will investigate the relationship between forest fire management and the economic benefits of air quality improvements. The project has two components. The first component will develop an information base and set of tools that can be used to construct measures of the return on investment (ROI) of fire management activities as they pertain to changes in human health risks and air quality. This is only one piece of the ROI puzzle and it must be assessed along with information on the returns in other categories (property, timber, etc.) as well as the unintended consequences (or negative returns) arising from fire management activities (wildlife habitat, biodiversity, increased future fire impacts, etc.). The second component of the project is to include air quality and human health considerations in a zoning scheme or values-at-risk map (VARM). This will involve linkages between models of fire behavior, air emissions, human health and economics.

24. Author(s) and year: Armstrong, G. 2003

Research subject: Natural Disturbance Management

Source: SFMN 2002/2003 Research Program document

Descriptors: economic, fire

Location: Alberta

Title: **Approximating Values at Risk from Wildfire Using Shadow Prices.**

Description: The management plans for many forest management areas are developed with the aid of linear programming (LP) based forest activity scheduling models. A standard output of these models is the marginal contribution of each hectare of each forest type to the management objective specified for the forest. These marginal contributions are known as shadow prices. These shadow prices can be viewed as the cost of losing a hectare of a forest type to wildfire. By definition these shadow prices are applicable to small changes in area for a single timber type. A major element of this research project will involve the linkage of cost estimates developed to a GIS-based values at risk map (VARM). This VARM will provide information to a fire management agency which will help guide fire fighting and land management decisions.

25. Author(s) and year: Boxall, P. 2003  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: fire, policy  
Location: Alberta  
Title: **A Static and Dynamic Analysis of Forest Recreation Values at Risk.**  
Description: This effort is focusing on the incorporation of models of public participation in forest recreation and their economic values of recreation into a provincial zoning scheme or values-at-risk map (VARM). This will allow fire managers to use the VARM to project fire effects on recreation into the future and thus incorporate fire and recreation dynamics into the allocation of fire management resources, and examine returns on investments in some selected fire management activities (e.g. fire-smart forest management strategies).
26. Author(s) and year: Martell, D. 2003  
Research subject: Natural Disturbance Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: fire, forest and landscape  
Location: Alberta, Ontario  
Title: **Decision Support Systems for Flammable Wildland Urban Interface Landscapes.**  
Description: A spatially explicit fire occurrence prediction model is being developed and coupled with a mechanistic fire spread model to predict how fires will ignite and spread on a hypothetical wildland urban interface landscape that contains forest stands, fuel breaks, lakes, rivers, roads, communities, remote cabins and other features that are characteristic of the boreal forest region of



Canada. Following, a decision support system will be designed to specify integrated fire management strategies (e.g., prevention, fuel treatment and building code impacts on structures) to predict the probability or risk that designated areas or structures will be burned during designated time intervals. This work is being accomplished in conjunction with fire management agencies in Alberta and Ontario and a diverse group of ecologists, economists, sociologists and psychologists.

## Research Subject: Innovative Zoning

27. Author(s) and year: Saddler, J.N. 2002  
Research subject: Innovative Zoning (also in Value Added/Alternative Products, and Carbon Forest Management)  
Source: final project report available on SFMN website  
Descriptors: policy, carbon  
Location: British Columbia, Alberta  
Title: **The Potential of Short Rotation Forestry on Marginal Farmland in BC and Alberta to Provide a Feedstock for Energy Generation and to Reduce Greenhouse Gas Emissions**  
Description: Delucchi's full fuel cycle greenhouse gas (GHG) model was used to calculate the amount of GHG emissions from production and combustion of wood-derived ethanol under three land-use scenarios: (1) short rotation forestry on a land previously covered by pasture (70%), agricultural fields (15%) and forest (15%); (2) short rotation forestry on a previous forested land (100%), and (3) using sawmill wood residues with no energy-dedicated wood plantation. The model developed by Delucchi takes a cradle-to-grave approach in estimating the amount of emissions over the entire life cycle of a fuel. Emissions are calculated as a weighted sum of carbon dioxide, methane and nitrous oxide, and are reported as gram equivalent CO<sub>2</sub>.
28. Author(s) and year: Weber, M.L. 2001  
Research subject: Innovative Zoning (also in Integrated Resource Management, and Policy and Institutional Analysis)  
Source: working paper available on SFMN website  
Descriptors: economic, forest and landscape  
Location: not applicable  
Title: **Decentralized Reserve Design Strategies: A Framework for Analysis.**

Description: A simple model is used to simulate the effect of 'tradable landuse rights (TLRs) on the selection of a natural reserve network (protected area) on a hypothetical landscape. TLRs are useful market instruments that explicitly consider the economic constraints associated with implementation of the network. TLRs themselves are defined in terms of multiple parameters which are at the discretion of the regulator. The landscape matrix is assumed initially to be comprised of 1 ha units of uniform habitat value, with three distinct economic sectors. Finally, this the methodology is compared to other conventional optimization techniques.

29. Author(s) and year: Hauer, G. 2002  
Research subject: Innovative Zoning  
Source: SFMN 2002/2003 Research Program document  
Descriptors: economic, policy  
Location: Alberta  
Title: **Integrated Assessment of Intensive Forest Management under the TRIAD Approach to Land Use Design.**

Description: The landscape level model called Dualplan, which is ideally suited for economic analysis of forest landscape design, is being used to analyze the impact of potential TRIAD approaches on economic timber supply, non-timber benefits (in particular wildlife habitat), non-timber human users of the forest, and to provide an economic assessment of intensive forest management under TRIAD approaches.

30. Author(s) and year: Thompson, I. 2003  
Research subject: Innovative Zoning  
Source: SFMN 2002/2003 Research Program document  
Descriptors: habitat, biodiversity and wildlife  
Location: Ontario  
Title: **Predicting Effects of Intensive Forest Management on Aspects of Biodiversity.**

Description: The impact of post-harvest silvicultural activities are being examined with an aspatial model to determine various wildlife responses, including studies of habitat associations of moose, snowshoe hare, a group of mid-to late-successional forest birds (including e.g., Cape May warbler, three-toed woodpeckers, Tennessee warbler, yellow-bellied flycatcher), and salamanders (yellow-spotted and blue-spotted). A summary of the studies would predict population changes (if any) through time over large landscapes as a result of IFM (intensive forest management) for the selected species. The research effort is an indirect consequence of the Lands for Life process and the Ontario Forest Accord.



## Research Subject: Integrated Resource Management

31. Author(s) and year: Greene, D.F., *et al.* 2001  
Research subject: Integrated Resource Management (also found in Natural Disturbance Management)  
Source: working paper available on SFMN website  
Descriptors: forest and landscape, regeneration  
Location: Alberta, Quebec, New Brunswick, Ontario  
Title: **A Biological and Economical Analysis of Silvicultural Alternatives to the Conventional Clearcut/plantation Prescription in Boreal Mixedwood Stands (aspen/white spruce/balsam fir).**  
Description: A series of mathematical equations were coupled to create a mechanistic model of seedling recruitment. This model was used to determine the impact of four prescriptions that serve as alternatives to conventional clearcutting followed by planting: (1) reliance on advance regeneration with or without augmentation by fill-planting; (2) understory scarification during a mast year; (3) direct seeding either aerially or with a scarifier-seeder; and (4) underplanting.
32. Author(s) and year: Weber, M.L. 2001  
Research subject: Integrated Resource Management (also in Policy and Institutional Analysis)  
Source: working paper available on SFMN website  
Descriptors: economic, policy  
Location: not applicable  
Title: **Decentralized Reserve Design Strategies: A Framework for Analysis.**  
Description: A simple model is used to simulate the effect of 'tradable landuse rights (TLRs) on the selection of a natural reserve network (protected area) on a hypothetical landscape. TLRs are useful market instruments that explicitly consider the economic constraints associated with implementation of the network. TLRs themselves are defined in terms of multiple parameters which are at the discretion of the regulator. The landscape matrix is assumed initially to be comprised of 1 ha units of uniform habitat value, with three distinct economic sectors. Finally, this the methodology is compared to other conventional optimization techniques.
33. Author(s) and year: Armstrong, G.W. 2000  
Research subject: Integrated Resource Management  
Source: working paper available on SFMN website  
Descriptors: growth and yield, fire  
Location: Alberta  
Title: **Probabilistic Sustainability of Timber Supply Considering the Risk of Wildfire.**

Description: A Monte Carlo simulation model which incorporates timber harvesting, forest fires, and replanning was developed as an alternative to conventional timber supply models. The output of the model consists of projected distributions of sustainable harvest levels generated by a timber supply model, in response to specified harvest volumes and randomly generated burn areas. The random variable in the Monte Carlo simulation is the annual area burned and results are presented as probability distributions of calculated AACs presented over a 100 year-simulation horizon. An alternative definition of sustainability incorporating probabilities and finite time was developed.

34. Author(s) and year: Armstrong, G., *et al.* 2000  
Research subject: Integrated Resource Management  
Source: working paper available on SFMN website  
Descriptors: habitat, biodiversity and wildlife, fire  
Location: Alberta  
Title: **Integrated Resource Management in the Context of the Range of Natural Variability.**

Description: A modeling system comprised of an aspatial Monte Carlo simulation and a linear programming based forest activity scheduling model was developed. The simulation model is used to develop 100-year forecasts of probability distributions for habitat area of five vertebrate species under a stochastic wildfire regime. The model is used to identify the trade-offs between forest harvesting, wildfire habitat, and the degree of similarity between the managed forest structure and the distribution of structures that could be generated by natural disturbance.

35. Author(s) and year: Armstrong, G., *et al.* 1998  
Research subject: Integrated Resource Management  
Source: working paper available on SFMN website  
Descriptors: growth and yield, fire  
Location: Alberta  
Title: **Natural Disturbance Management: Timber Supply Implications.**

Description: The model developed here is a straightforward representation of forest growth and disturbance. The initial forest is represented as a matrix of productive area indexed by age and conifer content. Each year, a proportion of the area is disturbed and regenerates according to regeneration assumptions. The portion of the area that is not disturbed increases in age by one year. A proportion of the area in each conifer content class moves to the next highest conifer content class. This sequence is repeated for each year in the specified





simulation period. The inputs to the model used here consist of a set of forest inventory data, timber yield tables, succession and regeneration assumptions, and annual disturbance probabilities.

36. Author(s) and year: Bunnell, F.L., *et al.* 2000  
Research subject: Integrated Resource Management (also in Ecological Criteria and Indicators)  
Source: project report available on SFMN website  
Descriptors: forest and landscape, habitat, biodiversity and wildlife  
Location: Alberta  
Title: **Statistical Methods and Tools for Cross-scale Modeling.**  
Description: This project contains four research components. The first component was the development of FEEnix, a spatial simulation tool that can be used to evaluate the ecological and economic consequences of alternative forest management practices at large spatial and temporal scales. FEEnix comprises four main submodels including a harvest scheduler and road builder, a wildfire ignition and spread submodel, a mixedwood stand dynamics submodel, and a set of habitat models predicting the distribution and abundance of forest birds. In the fourth research component FEEnix is linked to newly developed habitat models to explore interactions between alternative harvesting scenarios, fire regimes and stand dynamics on bird species abundances and community structure.
37. Author(s) and year: Cumming, S., *et al.* 1998  
Research subject: Integrated Resource Management  
Source: working paper available on SFMN website  
Descriptors: forest and landscape, habitat, biodiversity and wildlife  
Location: Alberta  
Title: **A Grid-based Spatial Model of Forest Dynamics Applied to the Boreal Mixedwood Region.**  
Description: A landscape simulation model was developed for applications to forest management and habitat conservation problems in the boreal mixedwood forest. The regionally-specific model elements are fire, mixedwood stand dynamics, hierarchical harvest scheduling, and habitat modeling. The model consists of an individual-based population dynamics model which is linked to a detailed spatial simulation of forest harvesting to represent as accurately as possible the forest landscape changes that a particular species of wildlife will face. The model reads and operates on raster-based map files, such as can be generated from GIS data. In this project, ARC/INFO coverages of AVI (Alberta Vegetation Inventory) data from part of the Alberta-Pacific Forest Management Area (FMA) were used as the primary data source.

38. Author(s) and year: Hauer, G.K., *et al.* 2001  
Research subject: Integrated Resource Management  
Source: project report available on SFMN website  
Descriptors: policy, economic  
Location: Alberta  
Title: **Modeling Overlapping Tenures in Alberta: A Case Study.**  
Description: The model developed in this study uses a dual decomposition technique based on the interpretation of the dual side of a linear or non-linear programming formulation of a Model II forest-management scheduling model. The original programming formulation can be viewed as a series of individual stand level decision problems. The stand level decisions include harvest timing for initial and subsequent harvests, mill destination for each timber type, and regeneration options. All the possible stand-level decisions are evaluated with a stand level objective function that is linked to the forest level objectives via shadow prices on the forest wide constraints. The solution to the stand level problem amounts to a stand level benefit-cost analysis.
39. Author(s) and year: Kessler, W., *et al.* 2001  
Research subject: Integrated Resource Management (also in Sustainable Aboriginal Communities)  
Source: project report available on SFMN website  
Descriptors: social, forest and landscape  
Location: British Columbia  
Title: **Evaluation of the “ECHO” System and Scenario Planning for Sustainable Forest Management.**  
Description: The purpose of this research was to document the process of integrating Aboriginal values into a model-based scenario planning approach and to assess whether advanced analytical planning approaches could facilitate Aboriginal community participation in resource management decision making. This was accomplished in collaboration with Tl’azt’en Nation using the co-managed John Prince Research Forest (JPRF) in central interior British Columbia as a case study. This project, as originally proposed, was comprised of three research objectives: (1) Evaluation of the “Echo” planning system, a product of the collaborative research conducted between the MacGregor Model Forest Association (MMFA) and UNBC, based largely upon technical criteria, (2) Application of the “Echo” system to the integration of Tl’azt’en values and perspectives into sustainable forest management planning for the JPRF, and (3) Evaluation of the effectiveness of the Echo-assisted scenario planning approach to achieving meaningful participation of Tl’azt’en community members in sustainable forest management.



40. Author(s) and year: Patriquin, M.N, *et al.* 2001  
Research subject: Integrated Resource Management (also in Social Economic Criteria and Indicators)  
Source: working paper available on SFMN website  
Descriptors: economic, policy  
Location: Alberta  
Title: **Environmentally Extended Regional Economic Impact Modeling.**  
Description: Computable general equilibrium (CGE) modeling is emerging as the most prolific tool for economy-wide impact analysis. This study investigates environmentally extended economic impact estimation on a regional scale using a case study region in the province of Alberta known as the Foothills Model Forest (FMF). The modeling objectives are to demonstrate that variation exists in the impact estimates derived from I-O based and CGE impact models, show the efficacy of CGE models in estimating economic impacts at a regional scale, and to present an integrated economic and environmental model based on the CGE approach. The environmentally extended CGE framework is used to evaluate the effect the inclusion of the environment has on policy evaluation. The types of impact examined include: changes to land use allocation, the phase-out of an existing mining operation, and increased visitor activity. These economic changes will have impacts on output, household income, and environmental quality. The results of the research contribute to the methodology of regionalizing economic data, economic impact assessment, and integrated economic and environmental CGE modeling.
41. Author(s) and year: Schneider, R.R., *et al.* 2002  
Research subject: Integrated Resource Management  
Source: working paper available on SFMN website  
Descriptors: economic, policy  
Location: Alberta  
Title: **The Management of Cumulative Impacts of Land-uses in the Western Canadian Sedimentary Basin: A Case Study.**  
Description: This modeling effort demonstrates a fundamentally different approach to forest management in which stakeholders weigh management options in terms of their long-term effects on the forest in order to balance conservation and economic objectives. The model ALCES®, a landscape-scale simulation model, was used to quantify the effects of the current regulatory framework and typical industrial practices on a suite of ecological and economic indicators over the next 100

years. Simulations involving a suite of “best practices” demonstrated that substantial improvements in ecological outcome measures can be achieved, while maintaining a sustainable flow of economic benefits, through alternative management scenarios.

42. Author(s) and year: Sheppard, S.R.J., *et al.* 2003  
Research subject: Integrated Resource Management (also in Sustainable Aboriginal Communities)  
Source: special publication available from SFMN office  
Descriptors: social, visualization  
Location: British Columbia  
Title: **Landscape Visualization for First Nations: An Extension Guide for First Nations, planners and educators.**  
Description: The Cheam First Nation and the Shuswap Nation Tribal Council have teamed up with Dr. Stephen Sheppard and John Lewis of the University of B.C.'s Collaborative for Advanced Landscape Planning (CALP) to develop methods of computer-based landscape visualization to assist their communities in communications and planning on land/resource management issues. Visualization software such as the 3D Analyst extension to ArcView GIS and World Construction Set (WCS), allow alternative forest management actions and consequences to be illustrated in three dimensions (3D) and with photographic realism, in a form that non-experts can easily understand and relate to their own environment.
43. Author(s) and year: Thompson, W.A., *et al.* 1998  
Research subject: Integrated Resource Management  
Source: working paper available on SFMN website  
Descriptors: policy, fire  
Location: British Columbia  
Title: **Using Forest Fire Hazard Modeling in Multiple Use Forest Management Planning.**  
Description: Using a forest modeling system these authors examine several alternative operational interpretations of the accommodation and emulation of fire. The modeling system consists of a forest fire hazard model which estimates the potential for forest fire based upon forest attributes, forest utilization and topography. Three forest management plans based upon the fire accommodation and emulation principles were compared with five more traditional management plans. The comparisons involved the net present values of timber harvests, timber harvest volumes, degrees of fire hazard, impacts on forest biodiversity, and the number of violations of two common regulatory constraints — even flow maintenance and green-up and adjacency restrictions.



44. Author(s) and year: Waaub, J.-P., *et al.* 2000  
Research subject: Integrated Resource Management  
Source: project report available on SFMN website  
Descriptors: forest and landscape, growth and yield  
Location: Quebec  
Title: **Integrated Tools for Decision Aid in Sustainable Forest Management**  
Description: The general objective of this project is to create an integrated decision support tool for forest managers concerned by harvesting or inhabited forest projects in the context of sustainable management. First, a general purpose multi-stakeholder modeling tool using SYLVA I was developed to investigate landscape planning scenarios determined according to a multicriteria decision support system that relied, among other things, on an ecological framework. Second, a spatial information management system integrating GIS and remote sensing data was developed to serve the purpose of managing, processing, and analyzing spatial data. Finally, the tools were assembled together to create a decision support system for addressing sustainable forest management issues.
45. Author(s) and year: Boutin, S. 2003  
Research subject: Integrated Resource Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: forest and landscape, policy  
Location: Alberta  
Title: **Vegetation Succession on Linear Features Undergoing Cumulative Disturbances in the Boreal Forest.**  
Description: The potential impacts of anthropogenic linear features (e.g. seismic lines) on vegetation succession, wood supply, carbon budgets, and selected species of wildlife can be significant. The size, duration, and intensity of these features will be studied with the goal of creating vegetation and carbon succession curves so as to help in understanding how these curves change when multiple disturbances interact. This series of vegetation and carbon succession curves will also serve as inputs into modeling projects to further enhance current landuse projection tools. Results from this study will provide background for producing guidelines as to how practices might be altered to regenerate seismic lines under a variety of circumstances.
46. Author(s) and year: Boyce, M. 2003  
Research subject: Integrated Resource Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: habitat, biodiversity and wildlife, forest and landscape

Location: Alberta

Title: **Effect of Linear Features and Access on the Behaviour and Demographics of Black Bears.**

Description: The production of a simulation modeling framework capable of evaluating alternative access management scenarios is be accomplished by integrating knowledge from several related studies addressing the effects of linear features. Data such as (1) bear behaviour and avoidance of high human-use areas, (2) cub mortality, (3) sex- and age-specific habitat selection, (4) female nutritional condition, and (5) reproductive rates are being collected to support simulation models that predict the effects of access and hunting on bear populations.

47. Author(s) and year: Kurz, W. 2003

Research subject: Integrated Resource Management

Source: SFMN 2002/2003 Research Program document

Descriptors: forest and landscape, policy

Location: Alberta

Title: **Linear Feature and Access Management Modeling and Scenario Analysis.**

Description: This project relates to development of modeling tools integral to an adaptive management program that will evaluate effects of linear disturbances and access in north-eastern Alberta. Further development of existing modeling platforms is an efficient alternative to development of new platforms, and four existing models will be utilized by this research: TELSA, ALCES, FEENIX, and TARDIS. They will be combined in a hierarchical framework and used to evaluate future effects of linear feature and human access management strategies. Where modeling needs are not satisfied, development will add capabilities to appropriate models. Following model validation, the framework will be used to identify best practices for linear feature and access management in north-eastern Alberta.

48. Author(s) and year: Duinker, P. 2001

Research subject: Integrated Resource Management

Source: SFMN 2002/2003 Research Program document

Descriptors: habitat, biodiversity and wildlife, forest and landscape

Location: Alberta

Title: **Validation of Wildlife Habitat Models of the Biodiversity Assessment Project — Alberta.**

Description: Four vertebrate-species habitat-supply models (HSMs) are being empirically strengthened through targeted field-data collection on specific habitat characteristics



and degrees of animal use of the habitats. As such, sensitivity analyses are being performed to aid in the replacement of hypothesized model relationships. These quantitative models will aid in predicting possible biodiversity-related impacts of a range of alternative forest-management strategies and provide new forecasts and advice to Millar Western Forest Products Ltd.

49. Author(s) and year: Adamowicz, W.L. 2001  
Research subject: Integrated Resource Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: economic, social  
Location: Alberta  
Title: **Modeling Spatial and Temporal Economic Activity in Forested Landscapes: Forest Management, Non-Timber Values, Habitat, Wildlife, Access, Cumulative Effects, Disturbance, Recreational Use, Subsistence Use and Human Dynamics.**  
Description: The modeling platform FEENIX is being used to develop a spatially explicit model of human resource use including recreational and subsistence uses of wildlife resources, disturbance and the interaction between human disturbance and fish/wildlife resources. Additionally, relationships between access, resource use and spatial economic behaviour will be developed, as well as the human use sector. This modeling effort will improve the understanding of spatial economic behaviour for three sectors: forestry, fish and wildlife resource users, and the energy sector.
50. Author(s) and year: Armstrong, G. 2001  
Research subject: Integrated Resource Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: habitat, biodiversity and wildlife, forest and landscape.  
Location: Alberta  
Title: **A Forest Management Planning System Incorporating A Stochastic Model of Disturbance Regimes: Planning for Timber Production, Wildlife Habitat and Risk Management in a Wildfire-Dominated Ecosystem.**  
Description: A computer-based modeling system incorporating a model of the disturbance regime operating on a forest management agreement area or similar forest-planning unit will be developed. It will be used to address a number of questions:  
1. Given a desired sustained harvest level and a model of the disturbance regime, what is the probability of successfully achieving the desired harvest level in each year of the planning horizon?

2. What are the financial, timber supply and habitat diversity implications of alternative post-fire salvage policies?
3. What are the financial, timber supply, and habitat diversity implications of landscape level manipulations? Are they likely to have any significant effect on the probability of the occurrence of large fire events?

51. Author(s) and year: Bunnell, F. 2001

Research subject: Integrated Resource Management

Source: SFMN 2002/2003 Research Program document

Descriptors: habitat, biodiversity and wildlife, fire

Location: Alberta

Title: **Landscape Issues in Sustainable Forest Management: Statistical Methods and Tools for Projecting Consequences of Management Actions.**

Description: Two modeling platforms — FEENIX and TARDIS — are being parameterized to examine harvesting/fire interactions, validation and generalization of existing habitat-based wildlife models, estimation of movement parameters for individual-based models of forest birds, and integration with existing GIS tools. With these landscape simulation tools it will be possible to quantify the effect of forest age on fire spread probabilities, and develop models of the influence of harvesting patterns on fire ignition and spread. Validation will be accomplished using existing habitat-based, bird species models with local data sets from other areas of Alberta, British Columbia and Manitoba with data from the model-directed sampling initiative.

52. Author(s) and year: Foote, L. 2002

Research subject: Integrated Resource Management

Source: SFMN 2002/2003 Research Program document

Descriptors: water, habitat, biodiversity and wildlife

Location: Alberta

Title: **Measuring and Modeling Wetland Disturbances in Western Boreal Mixedwood Ecosystems.**

Description: The spatially explicit model (FEENIX) is being parameterized from empirical field studies to derive projections of wetted area, timber losses, wetland species populations, and habitat components altered over a 200-year planning horizon. This will allow simulations of forest and wetland responses to various inputs of road development, beaver control, and amounts of streamside timber left in buffer strips. Outputs from this research are expected to be beneficial to forest and petroleum industries, wildlife managers, and policy makers.





53. Author(s) and year: Schmiegelow, F. 2001  
Research subject: Integrated Resource Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: habitat, biodiversity and wildlife, fire  
Location: Alberta  
Title: **Large-Scale Issues of Sustainable Forestry: Wildlife Habitat Modeling and Biomonitoring.**  
Description: Habitat models based on remotely sensed data such as forest inventories or satellite imagery, as well as demographic wildlife models are being developed and validated. These models will be linked to landscape simulation models to evaluate the consequences of alternative management activities and policies over large spatial and temporal scales. Wildlife modeling efforts will include caribou and taxa other than birds.
54. Author(s) and year: Bayley, S. 2001  
Research subject: Integrated Resource Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: water, forest and landscape  
Location: Manitoba  
Title: **The Management of Boreal Riparian Areas: Development of Base-Line Data; Regionalization of Parameters and Integrated Watershed Management Protocols.**  
Description: An ecosite model (grounded in an inventory-based ecosite classification system) is being developed to forecast impacts and rank buffering capacity of wetland ecosite types. This will allow industry to assess the impact that future disturbance will have on an individual wetland or wetland complex and the ability that wetland may have to buffer downstream impacts based on its ecosite type, size, and landscape position. Variables of interest include plant identification, physical and spatial setting, soil type, chemical parameters and concentrations (e.g., pH, conductivity, Ca, Mg, K, Na, nitrate, nitrite, ammonium, total phosphorus, total dissolved phosphorous, and soluble reactive phosphorus). Linking with other digital layers available at Louisiana Pacific will generate additional spatial data.
55. Author(s) and year: Rempel, R. 2001  
Research subject: Integrated Resource Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: habitat, biodiversity and wildlife, forest and landscape  
Location: Manitoba  
Title: **Multiple Landscape Indicators of Forest Bird Diversity and Community Structure.**  
Description: To provide reasonable assurance that forest management practices will not put this vertebrate community in danger, managers need to determine the thresholds at which changes in landscape structure and overstory

composition will affect the bird community. Such information can then also be used to develop predictive models of how bird communities will respond to future forest conditions. The main objectives are to:

1. Relate forest bird community structure to landscape pattern and composition, and test for changes;
2. For individual species, determine thresholds at which landscape pattern and composition are associated with a change in habitat occupancy; and
3. For individual species, create spatially explicit abundance (and variance) maps of bird distribution to describe and test for spatial relationships with landscape structure, landform patterns, and topography.

56. Author(s) and year: Kneeshaw, D. 2002  
Research subject: Integrated Resource Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: social, economic  
Location: Quebec  
Title: **Integration of Public Participation and Bio-Physical and Socio-Economic Modeling for Sustainable Forest Management.**

Description: This multi-objective research effort will, among others, integrate previously developed biophysical indicators (biodiversity, water quality, soils, and productivity) with social and economic indicators in a spatially explicit landscape level model (SELES/Mauricie) to facilitate the process of integrated resource management decision-making by allowing an examination of trade-offs. Results will permit the development of a framework for adaptive ecosystem management guided by public participation (including the evaluation and development of C&I by community, First Nations, researchers, and Industry stakeholders), and initiate a process of social learning and public participation for responsible decision-making in a test region in central Québec.

57. Author(s) and year: Sauchyn, D. 2003  
Research subject: Integrated Resource Management  
Source: SFMN 2002/2003 Research Program document  
Descriptors: policy, forest and landscape  
Location: Saskatchewan  
Title: **Climate Change Impacts on the Southern Boreal Forest: Past and Future Distribution and Productivity.**

Description: This project addresses the impacts of climate change on forest productivity and the adaptation to practices and policies that will be required to sustain the forest industry with changes in climate and the distribution of the boreal forest. A model of forest productivity over the past millennium will be calibrated using data on past climate and verifying the results using data on past



vegetation. This will require a history of the response of boreal forest ecosystems to the climate change and variability of the past 1000 years. The source of this information will be tree rings, the pollen and plant macrofossils in lake sediments, and isotopes of carbon and oxygen in the sediments and trees. The research results will be transferred to an industrial partner during the project for planning the annual allowable cut for a selected area in central Saskatchewan.

## Research Subject: Policy and Institutional Analysis

58. Author(s) and year: Adamowicz, W.L., *et al.* 2000  
Research subject: Policy and Institutional Analysis (also in Natural Disturbance Management)  
Source: final project report available on SFMN website  
Descriptors: economic, policy  
Location: Alberta  
Title: **Assessing the Economic Impacts of Natural Disturbance Forest Management.**  
Description: The objective of this project was to construct tools to assess the economic impact of a transition from sustained yield to natural disturbance management. An Input-Output (I-O) analysis, a Computable General Equilibrium (CGE) model, Social Accounting Matrix SAM model types were used to determine regional economic impacts, and a Monte Carlo simulation optimization model was constructed with STELLA for addressing non-timber impacts.
59. Author(s) and year: Weber, M.L. 2001  
Research subject: Policy and Institutional Analysis (also in Integrated Resource Management and Innovative Zoning)  
Source: working paper available on SFMN website  
Descriptors: economy, policy  
Location: not applicable  
Title: **Decentralized Reserve Design Strategies: A Framework for Analysis.**  
Description: A simple model is used to simulate the effect of 'tradable landuse rights (TLRs) on the selection of a natural reserve network (protected area) on a hypothetical landscape. TLRs are useful market instruments that explicitly consider the economic constraints associated with implementation of the network. TLRs themselves are defined in terms of multiple parameters which are at the discretion of the regulator. The landscape matrix is assumed initially to be comprised of 1 ha units of uniform habitat value, with three distinct economic sectors. Finally, this the methodology is compared to other conventional optimization techniques.

60. Author(s) and year: Hegan, R.L., and M.K. Luckert. 1999  
Research subject: Policy and Institutional Analysis  
Source: working paper available on SFMN website  
Descriptors: economic, policy  
Location: Alberta  
Title: **An Economic Assessment of Using the Allowable Cut Effect (ACE) for Enhanced Forest Management (EFM) Policies: An Alberta Case Study.**  
Description: A timber supply model was used to simulate the returns to EFM investment to assess whether the ACE is likely to be a good basis for an EFM policy. More precisely, the Woodstock Forest Modeling System (Version 2.0) and the LP-solver C-WHIZ (Version 2.0) were joined to simulate various constrained flows of timber over a planning horizon according to a linear programming solution. The planning horizon consisted of 200 periods, with each period representing a year. NPV's (net present value) were calculated using stumpage rates of 5\$/m<sup>3</sup> for aspen and 15\$/m<sup>3</sup> for spruce and a discount factor of 2 percent. These estimates of NPVs: 1) indicate whether the ACE may provide tenure holders with incentives to undertake investment activities, and 2) provide indications of financial returns to alternative sustained yield/ACE policies. In addition the effects of green-up constraints were also included, in a final set of simulations.
61. Author(s) and year: van Kooten, G.C., and E.H. Bulte. 1998  
Research subject: Policy and Institutional Analysis (also in Social and Economic Criteria and Indicators and Carbon Forest Management)  
Source: working paper available on SFMN website  
Descriptors: social, carbon  
Location: British Columbia  
Title: **How Much Ancient Forest Should Society Retain? Carbon Uptake, Recreation, and Other Values?**  
Description: A deterministic optimal control model is used to compute socially optimal stocks of old growth. The model employed is reminiscent of Ehui and Hertel's model where opportunity costs of preservation and conversion (logging benefits, C-flux costs/benefits, changes in amenity values) are calculated, rather than agricultural related values. The main modeling question is: Given information on non-timber benefits, how much old-growth forest should society keep in order to maximize the discounted flow of present and all future net benefits?



62. Author(s) and year: van Kooten, G.C., and E. Krcmar. 2001  
Research subject: Policy and Institutional Analysis (also in Carbon and Forest Management)  
Source: project report available on SFMN website  
Descriptors: economic, carbon  
Location: British Columbia  
Title: **Climate Change, Canadian Policy and Terrestrial Ecosystems: Economic Considerations.**  
Description: The TECAB model (a multiple objective model) was used to examine tradeoffs among economic, carbon uptake and biodiversity objectives. TECAB uses compromise programming to find a balanced strategy. The model consists of tree-growth, agricultural activities and land-allocation components, and is used to examine the costs of carbon uptake. The model also addresses uncertainty using fuzzy logic. Five modeling objectives are defined for land management: 1) maximization of net discounted returns from forest and agricultural activities; 2) maximization of cumulative timber volume; 3) maximization of cumulative discounted carbon stored (uptake minus emissions); 4) maintenance of a stable flow of timber to the mills; and 5) attainment of a desired forest structure.
63. Author(s) and year: Veeman, T.S., and M.K. Luckert. 2001  
Research subject: Policy and Institutional Analysis  
Source: project report available on SFMN website  
Descriptors: economic, policy  
Location: Alberta  
Title: **Economic Issues in Assessing Sustainable Development in Forestry.**  
Description: To test the effectiveness of ACE (allowable cut effect) in changing harvest volumes, a set of timber supply models were constructed. Each model went through 200 time periods, representing years, under varying constraints. These constraints included the age distribution of the initial forest inventory (juvenile, mature); the species composition of the annual allowable cut (coniferous/deciduous); the type of effective forest management investment (intensive/extensive), and the harvesting flexibility around the annual allowable cut.
64. Author(s) and year: Vertinsky, I., and D. Zhou. 1999  
Research subject: Policy and Institutional Analysis (also in Value Added/Alternative Products)  
Source: working paper available on SFMN website  
Descriptors: economic, social  
Location: not applicable  
Title: **The Economics of Certifying the Environmental Friendliness of Products.**

Description: This modeling effort examines the welfare consequences of offering a voluntary environmental quality certification program in addition to requiring products to meet a minimum quality standard. The basic model assumes duopolistic competition with prices and qualities being the decision variables. There are basically two primary types of multi-attribute utility functions: additive and multiplicative.

## Research Subject: Value Added / Alternative Products

65. Author(s) and year: Saddler, J.N. 2002  
Research subject: Value Added/Alternative Products (also in Innovative Zoning and Carbon Forest Management)  
Source: final project report available on SFMN website  
Descriptors: policy and carbon  
Location: British Columbia, Alberta  
Title: **The Potential of Short Rotation Forestry on Marginal Farmland in BC and Alberta to Provide a Feedstock for Energy Generation and to Reduce Greenhouse Gas Emissions.**  
Description: Delucchi's full fuel cycle greenhouse gas (GHG) model was used to calculate the amount of GHG emissions from production and combustion of wood-derived ethanol under three land-use scenarios: (1) short rotation forestry on a land previously covered by pasture (70%), agricultural fields (15%) and forest (15%); (2) short rotation forestry on a previous forested land (100%), and (3) using sawmill wood residues with no energy-dedicated wood plantation. The model developed by Delucchi takes a cradle-to-grave approach in estimating the amount of emissions over the entire life cycle of a fuel. Emissions are calculated as a weighted sum of carbon dioxide, methane and nitrous oxide, and are reported as gram equivalent CO<sub>2</sub>.
66. Author(s) and year: Vertinsky, I., and D. Zhou. 1999  
Research subject: Value Added/Alternative Products (also in Policy and Institutional Analysis)  
Source: working paper available on SFMN website  
Descriptors: economic, social  
Location: not applicable  
Title: **The Economics of Certifying the Environmental Friendliness of Products.**  
Description: This modeling effort examines the welfare consequences of offering a voluntary environmental quality certification program in addition to requiring products to meet a minimum quality standard. The basic model



assumes duopolistic competition with prices and qualities being the decision variables. There are basically two primary types of multi-attribute utility functions: additive and multiplicative.

## Research Subject: Ecological Criteria and Indicators

67. Author(s) and year: Bunnell, F.L., *et al.* 2000  
Research subject: Ecological Criteria and Indicators (also in Integrated Resource Management)  
Source: project report available on SFMN website  
Descriptors: forest and landscape, habitat, biodiversity and wildlife  
Location: Alberta  
Title: **Statistical Methods and Tools for Cross-scale Modeling.**  
Description: This project contains four research components. The first component was the development of FEEnix, a spatial simulation tool that can be used to evaluate the ecological and economic consequences of alternative forest management practices at large spatial and temporal scales. FEEnix comprises four main submodels including a harvest scheduler and road builder, a wildfire ignition and spread submodel, a mixedwood stand dynamics submodel, and a set of habitat models predicting the distribution and abundance of forest birds. In the fourth research component FEEnix is linked to newly developed habitat models to explore interactions between alternative harvesting scenarios, fire regimes and stand dynamics on bird species abundances and community structure.
68. Author(s) and year: de-Camino-Beck, T., and A. Sanchez-Azofeifa. 2001  
Research subject: Ecological Criteria and Indicators  
Source: working paper available on SFMN website  
Descriptors: forest and landscape  
Location: not applicable  
Title: **Percolation in Neutral Landscapes: Landscape Metric Sensitivity to Critical Thresholds and a New Class Division Index.**  
Description: Five types of neutral landscapes (random, ortho, anneal, block, and patches) derived from cellular automata (CA) were created to analyze the sensitivity of landscape metrics to characterize landscape structure under different tree densities. These neutral landscapes were then used to find the percolation thresholds of patterned landscapes. Measures of landscape structure were determined by calculating some of the common measures of landscape structure, such as number of patches, total edge, mean patch size, weighted mean patch size, contagion, adjacency, mean fractal

dimension, lacunarity, spatial block entropy, mass entropy and landscape division. The dynamics of the landscape were modeled using a transition function. The transition function provides specific rules for all of the state transitions (class changes).

69. Author(s) and year: Sanchez-Azofeifa, A., *et al.* 2001  
Research subject: Ecological Criteria and Indicators  
Source: project report available on SFMN website  
Descriptors: forest and landscape, habitat, biodiversity and wildlife  
Location: Alberta  
Title: **Quantifying Landscape Pattern and Fragmentation: A Transect Analysis Approach in Alberta.**  
Description: A new class division index and percolation model has been developed to study Land Use and Land Cover Change impacts on forested and agricultural landscapes. The model is useful for understanding the cumulative effects of oil and gas exploration, as well as providing an alternative method for quantifying landscape metrics and image classification. Additionally, the model is a potential tool for linking to current biodiversity data bases, and looking at the relationship between biodiversity richness and landscape structure.
70. Author(s) and year: Schmiegelow, F. 2001  
Research subject: Ecological Criteria and Indicators  
Source: SFMN 2002/2003 Research Program document  
Descriptors: habitat, biodiversity and wildlife, forest and landscape  
Location: Alberta  
Title: **Directed Sampling of Avian Indicators of Forest Change: Refining Models and Sampling Methods and Identifying Species at Risk.**  
Description: Existing predictive models of bird-habitat relationships, and of the parameter estimates used in assessment of effective sample designs, are being tested from a model-directed retrospective field study. This research effort will aid Alberta's biodiversity monitoring program by determining appropriate indicators for the boreal mixedwood forest, permit the identification of those bird species most at risk, while evaluating activities at levels at which forest management planning takes place.
71. Author(s) and year: Thompson, I. 2001  
Research subject: Ecological Criteria and Indicators  
Source: SFMN 2002/2003 Research Program document  
Descriptors: habitat, biodiversity and wildlife, forest and landscape  
Location: Ontario  
Title: **Analysis of Wildlife Harvest Statistics at Multiple Scales to Assess Impacts of Boreal Forest Management.**





Description: Following an analysis of Ontario's databases, predictive models will be developed to assess and compare the effects of forest management to those of natural disturbances on wildlife species at multiple scales. These models will aid to understand changes in various wildlife populations, and determine thresholds of changes for future biomonitoring of indicators.

72. Author(s) and year: MacLean, D. 2001

Research subject: Ecological Criteria and Indicators

Source: SFMN 2002/2003 Research Program document

Descriptors: forest and landscape

Location: New Brunswick

Title: **Spatial and Temporal Patterns of Natural and Human-Caused Forest Disturbance on the J.D. Irving Ltd. Black Brook District: Past, Present and Future.**

Description: Scenario planning tools are being developed to quantitatively analyze forest landscape patterns under managed and natural disturbance conditions from the J.D. Irving Ltd. Black Brook District forest in New Brunswick. Modeling procedures will project the current and simulated potential forests under alternative scenarios that can be applied broadly to sustainable forest management in Canada. Natural distribution of vegetation types by eco-district will set objectives for minimum areas to be maintained, and natural disturbance regimes for each vegetation community (disturbance agent, cycle length, and resulting stand and forest characteristics) will define guidelines for stand- and forest-level treatments consistent with natural stand structures and disturbance regimes.

73. Author(s) and year: Spence, J. 2001

Research subject: Ecological Criteria and Indicators

Source: SFMN 2002/2003 Research Program document

Descriptors: forest and landscape, habitat, biodiversity and wildlife

Location: Alberta

Title: **Integrating the "Ecosystem Management Emulating Natural Disturbance" (EMEND) Experiment.**

Description: The overall objectives of this project are to: (1) determine how forest harvest and regeneration can maintain biotic communities, spatial patterns of forest structure and functional ecosystem integrity comparable to mixedwood landscapes that have arisen through wildfire and other inherent natural disturbances; and (2) evaluate these practices in terms of economics, sustainability and social acceptability. Analytical and predictive modeling will be developed and generalized in collaboration with researchers across Canada.

Through the EMEND experiment, sound guidance will be provided about building biodiversity considerations into forest management, and how biodiversity can best be valued in relation to economic factors and socio-political desirables.

## Research Subject: Water and Wetlands

74. Author(s) and year: McEachern, P., *et al.* 2001  
Research subject: Water and Wetlands  
Source: project report available on SFMN website  
Descriptors: peatland, fire  
Location: Alberta  
Title: **Forest Fire-Induced Impacts on Lake Water Chemistry, Basin Hydrology and Pelagic Algae in Boreal Sub-Arctic Lakes of Northern Alberta.**  
Description: A simple predictive model was constructed to relate percent of watershed disturbance and time since disturbance to patterns in lake water chemistry. More precisely, the aim of the research was to examine the impacts of fire damage to peatlands on lake water chemistry and pelagic algae in the Caribou Mountains of Alberta with partners from the High Level Lumber Division (HLLD), Daishowa-Marubeni International (DMI), and the Little Red River Tall Cree First Nation (LRRTC).
75. Author(s) and year: McEachern, P., *et al.* 1999  
Research subject: Water and Wetlands  
Source: working paper available on SFMN website  
Descriptors: water, fire  
Location: Alberta  
Title: **The Forest Fire Induced Impacts on Phosphorus, Nitrogen and Chlorophyll a concentrations in Boreal Sub-Arctic Lakes of Northern Alberta.**  
Description: General models that explain the dependence of water chemistry on watershed characteristics were explored. Over a range of catchment-to-lake area ratios, Caribou Mountain lake chemistry was related to fraction of total catchment areas. Catchments were subsequently reduced in size to effective areas (EA) and a method for predicting the mean size of an EA was contrived using an isotope mass-balance model for  $^{18}\text{O}$  and sodium.
76. Author(s) and year: Prairie, Y. 1999  
Research subject: Water and Wetlands  
Source: project report available on SFMN website  
Descriptors: water, fire  
Location: Quebec



Title: **Paleolimnological Reconstruction of Forest Fire Induced Changes in Lake Biogeochemistry.**

Description: This study was designed to assess the impact of a natural catchment perturbation (forest fire) on the chemistry of the lakes in which they drain. Predictive models to describe and predict pH, total phosphorus and dissolved organic carbon as a function of diatom assemblages were constructed using WA-PLS algorithms. These relationships can be used to infer past change in the chemistry of lakes from changes in the specific composition of the diatom assemblages through time. Using this approach it was shown that forest fires produce a marked increase in lake nutrient phosphorus, and that lake nutrient concentrations seems to be greatest when the lake is oligotrophic and lessens as the lake progressively becomes richer. Scientific and management implications are discussed.

77. Author(s) and year: Putz, G., *et al.* 2000

Research subject: Water and Wetlands (also in Pulp and Paper Technologies and Solid Waste Management)

Source: project report available on SFMN website

Descriptors: wood pulp mill, water

Location: Alberta

Title: **Two-Dimensional Modeling of Effluent Mixing in the Athabasca River Downstream of Alberta Pacific Forest Industries, Inc.**

Description: The overall purpose of the research project is to further verify and develop a two-dimensional, unsteady effluent input river mixing and transport model. Adaptations to this mixing model can provide the capability to simulate environmental reaction of water quality parameters, within a river, in combination with the river mixing and transport. A unique feature of the model is that unsteady input conditions can be accounted for, and that the resulting time-varying concentrations across a stream and in the downstream direction can be predicted. A calibrated model at a particular mill site can serve as a valuable management tool for efficient planning of receiving stream water quality monitoring programs, i.e. the model will indicate where samples should be taken to document potential maximum concentrations. The model can also be used to assess the environmental impact of abnormal conditions such as spills and/or low river flow conditions on the receiving stream water quality, or to investigate the implications of alternative discharge locations on the receiving stream water quality.

78. Author(s) and year: Putz, G., and D.W. Smith. 2000  
Research subject: Water and Wetlands (also in Pulp and Paper Technologies and Solid Waste Management)  
Source: project report available on SFMN website  
Descriptors: wood pulp and mill, water  
Location: Alberta  
Title: **River Mixing and Mass Balance of Several Water Quality Parameters in the Wapiti River Downstream of Weyerhaeuser Canada, Ltd.**  
Description: The overall purpose of this research project is to further verify and develop a two-dimensional, unsteady effluent input, river mixing and transport model to simulate environmental reaction of water quality parameters, within a river, in combination with the river mixing and transport. A unique feature of the model is that unsteady effluent input conditions can be accounted for, and that the resulting time-varying, effluent substance concentrations across a stream and in the downstream direction can be predicted. The first objective of the overall project involved the verification of the river mixing and transport portion of the model using tracer tests conducted at several Canadian mill discharge locations. The second objective is to adapt the model to predict the fate of selected mill effluent substances (e.g. color, COD, AOX and toxic compounds) within the Wapiti River near Grande Prairie downstream of a Weyerhaeuser Canada Ltd. mill site.
79. Author(s) and year: Putz, G., and D.W. Smith. 2000  
Research subject: Water and Wetlands (also in Pulp and Paper Technologies and Solid Waste Management)  
Source: project report available on SFMN website  
Descriptors: wood pulp mill, water  
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Title: **Two-Dimensional Modeling of Effluent Mixing in the Athabasca River Downstream of Alberta Pacific Forest Industries, Inc.**  
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the model will indicate where samples should be taken to document potential maximum concentrations. The model can also be used to assess the environmental impact of abnormal conditions such as spills and/or low river flow conditions on the receiving stream water quality, or to investigate the implications of alternative discharge locations on the receiving stream water quality.

- 80.** Author(s) and year: Vitt, D.H. 2001  
Research subject: Water and Wetlands (also in Pulp Carbon Forest Management)  
Source: project report available on SFMN website  
Descriptors: peatland, carbon  
Location: Alberta, Saskatchewan, Manitoba  
Title: **Modeling Impacts of Climate on Peatland Carbon Stores and Fluxes.**  
Description: A simple peat-accumulation process model was used to investigate regional patterns of carbon sequestration under climate change conditions. As such, the two-layer, Clymo-type conceptual model was adopted and parameterized for three generalized peatland types with available data from continental western Canada. The model was used to explore how different peatlands may respond to climate changes, particularly potential changes in peatland water table, and how this variability is patterned regionally. Parameter estimates for the catotelm from sites in continental western Canada were determined using a single exponential decay model. Peat accumulation rates were corrected for the influence of specific-specific maximum peat depth on catotelm volumes (long-term peat decomposition losses). Hundred-year simulations were run for each peatland type for each specific, and point-model values were extrapolated to known coverages of peatland type. A sensitivity analysis was also conducted.
- 81.** Author(s) and year: Carignan, R. 2001  
Research subject: Water and Wetlands  
Source: SFMN 2002/2003 Research Program document  
Descriptors: water, fire  
Location: Quebec  
Title: **Attenuation of impacts by forest harvesting in boreal shield lakes**  
Description: Quantitative impact models linking mercury and methylmercury contamination to watershed disturbance are being refined and validated for 30 headwater lakes

of Haute-Mauricie logged in 2001-2002. Research is focusing on the impact of logging and fire on abiotic conditions of lakes (water quality), and biotic effect on game fish. The models created from this study will provide practical management tools.

82. Author(s) and year: Lean, D. 2002  
Research subject: Water and Wetlands  
Source: SFMN 2002/2003 Research Program document  
Descriptors: water, peatland  
Location: Quebec  
Title: **Factors Which Influence Methylmercury (MeHg) Concentrations in Boreal Shield Ecosystems.**  
Description: This project examines the influence of logging and fire disturbances on forest ecosystems that could alter methylmercury (MeHg) production and persistence. The focus is on changes in natural bogs, fens and other wetlands within the control research area. This will also include aspects of changes in seasonal hydrology. Specifically, research will determine where the MeHg comes from and the critical factors that influence its persistence. Following logging activities, DOC (dissolved organic carbon) will be examined to determine the rates of photodegradation as to provide the appropriate variable so that this process can be included in overall fate models of mercury in forest/lake ecosystems. In addition, rates of degradation by bacteria will be examined to determine if the activity of these organisms is adversely altered by fire or logging.
83. Author(s) and year: Magnan, P. 2001  
Research subject: Water and Wetlands  
Source: SFMN 2002/2003 Research Program document  
Descriptors: habitat, biodiversity and wildlife, water  
Location: Quebec  
Title: **Models for Sustainable Fisheries in Boreal Shield Lakes Impacted by Forest Harvesting.**  
Description: Simple empirical models are being built to predict the amplitude of changes in fish populations (e.g. small yellow perch, white sucker, northern pike and walleye) following different levels of deforestation. These predictive models will enable managers to propose cutting and fish exploitation regimes that will allow both forest harvesting and sustainable fisheries for lakes located in the Haute-Mauricie (Reservoir Gouin area, Québec).



84. Author(s) and year: Sibley, P. 2002  
Research subject: Water and Wetlands  
Source: SFMN 2002/2003 Research Program document  
Descriptors: water, forest and landscape  
Location: Ontario  
Title: **The Effect of Harvesting Practices and Buffer Strip Width in Boreal Riparian Forests on Water Quality and Ecological Integrity of the Nearshore Zone of Lakes.**  
Description: This project asks how disturbance regimes and/or buffer width in riparian forests affects the structural and functional integrity of nearshore areas and the energetic and biotic linkages that exist between the nearshore zone and adjacent riparian areas. Information derived from this research will be used to develop practical models to facilitate improved predictions of the consequences of forest harvesting practices, and buffer strip width, on the ecological integrity of boreal lakes in Ontario, including implications for potential effects on fish habitat and lake fish populations. This information will enable forest resource managers to make more informed decisions within the framework of sustainable forest management.

### Research Subject: Sustainable Aboriginal Communities

85. Author(s) and year: Kessler, W., *et al.* 2001  
Research subject: Sustainable Aboriginal Communities (also in Integrated Resource Management)  
Source: project report available on SFMN website  
Descriptors: social  
Location: British Columbia  
Title: **Evaluation of the “Echo” System and Scenario Planning for Sustainable Forest Management.**  
Description: The objective of this project was to evaluate a particular suite of analytical forest planning models, combined with scenario planning techniques, applied in a unique University/Aboriginal co-management environment. In the course of this research, the investigators developed local-level Criteria and Indicators (C&I) of sustainability, based upon the values and needs of the members of the Tl’azt’en Nation. The Echo planning system was calibrated using the John Prince Research Forest (JPRF) landscape. In addition to technically evaluating the models, this permitted the investigators to prepare and refine GIS and other necessary input data. In both the Strategic planning and Tactical planning models, non-preemptive linear goal programming techniques are combined with mathematical simulation to find optimal policies for achieving multiple simultaneous management objectives over space and time.

86. Author(s) and year: Sheppard, S.R.J., *et al.* 2003  
Research subject: Sustainable Aboriginal Communities (also in Integrated Resource Management)  
Source: special publication available from SFMN office  
Descriptors: social, visualization  
Location: British Columbia  
Title: **Landscape Visualization for First Nations: An Extension Guide for First Nations, planners and educators.**  
Description: The Cheam First Nation and the Shuswap Nation Tribal Council have teamed up with Dr. Stephen Sheppard and John Lewis of the University of B.C.'s Collaborative for Advanced Landscape Planning (CALP) to develop methods of computer-based landscape visualization to assist their communities in communications and planning on land/resource management issues. Visualization software such as the 3D Analyst extension to ArcView GIS and World Construction Set (WCS), allow alternative forest management actions and consequences to be illustrated in three dimensions (3D) and with photographic realism, in a form that non-experts can easily understand and relate to their own environment.
87. Author(s) and year: Vertinsky, I. 2001  
Research subject: Sustainable Aboriginal Communities  
Source: SFMN 2002/2003 Research Program document  
Descriptors: social, forest and landscape  
Location: British Columbia, Ontario  
Title: **First Nation's Strategy for Sustainable Forest Management.**  
Description: A set of system dynamic models are be developed to assess the capacity of the forest base and other natural and environmental resources to provide for the needs of the Little Red River/Tall Cree Nation (LRR/TC) under various uses, and alternative management practices. These researcher-developed models will be translated into a framework that can be used by the LRR/TC and other First Nations.
88. Author(s) and year: Wein, R. 2002.  
Research subject: Sustainable Aboriginal Communities  
Source: SFMN 2002/2003 Research Program document  
Descriptors: social, economic  
Location: Northwest Territories  
Title: **A Dynamic Model of Driftwood Flow Along the Lower Mackenzie River: An Alternative Timber Supply for Remote Northern Communities?**





Description: The general objective of this research is to quantify the temporal budget and to test hypotheses for production, movement, decomposition and use of driftwood logs along the major rivers in the Gwich'in Settlement area. To meet this objective, community elders will be surveyed to understand how driftwood is harvested and how many logs were harvested historically and at present. Remote sensing techniques will be used to quantify the inventory of riverside trees, the rates of bank erosion and the inventory of logs on the riverbanks. Rates of log movements will be estimated using river hydrology data and mark-recapture approaches, and rates of decomposition of the logs by field sampling. All of the above data will be used to build a dynamic model of driftwood changes over time and space. This model will predict the economic value of small-scale harvesting to communities, and provide a budget for the use of driftwood logs.

## Research Subject: Social and Economic Criteria and Indicators

89. Author(s) and year: Armstrong, G., and S.G. Cumming. 2002  
Research subject: Social and Economic Criteria and Indicators (also in Natural Disturbance Management)  
Source: working paper available on SFMN website  
Descriptors: fire  
Location: Alberta  
Title: **Shadow Prices as Estimates of the Cost of Forest Fires.**  
Description: The shadow prices output variable from a linear programming based timber harvest scheduling model (LP\_TSM) was used, in conjunction with output from a fire model (FEENIX) to approximate the costs of potential fires for a boreal mixedwood forest of northeastern Alberta.
90. Author(s) and year: Hailu, A., and T.S. Veeman. 1998  
Research subject: Social and Economic Criteria and Indicators  
Source: working paper available on SFMN website  
Descriptors: wood, pulp and mill, social  
Location: not applicable  
Title: **Environmentally Sensitive Productivity Analysis of the Canadian Pulp and Paper Industry, 1959-1994: An Input Distance Function Approach.**  
Description: This study attempted to analyze productivity trends in the Canadian pulp and paper industry in a way that is sensitive to the environmental effects of the industry's production activity. This was done by estimating a parametric input distance function frontier that incorporates both desirable and undesirable outputs. The parameters of the function were estimated using

mathematical programming. Four desirable outputs, two major water pollutant outputs (BOD and TSS) and seven inputs were identified for the estimation of the input distance function. The main conclusion of this study is that productivity improvement, from the social viewpoint, has been stronger than conventional measures would suggest. The shadow price estimates, however, indicate that the cost to producers of pollution control has been rising.

91. Author(s) and year: Patriquin, M.N, *et al.* 2001  
Research subject: Social and Economic Criteria and Indicators (also in Integrated Resource Management)  
Source: working paper available on SFMN website  
Descriptors: economic  
Location: Alberta  
Title: **Environmentally Extended Regional Economic Impact Modeling.**  
Description: Computable general equilibrium (CGE) modeling is emerging as the most prolific tool for economy-wide impact analysis. This study investigates environmentally extended economic impact estimation on a regional scale using a case study region in the province of Alberta known as the Foothills Model Forest (FMF). The modeling objectives are to demonstrate that variation exists in the impact estimates derived from I-O based and CGE impact models, show the efficacy of CGE models in estimating economic impacts at a regional scale, and to present an integrated economic and environmental model based on the CGE approach. The environmentally extended CGE framework is used to evaluate the effect the inclusion of the environment has on policy evaluation. The types of impact examined include: changes to land use allocation, the phase-out of an existing mining operation, and increased visitor activity. These economic changes will have impacts on output, household income, and environmental quality. The results of the research contribute to the methodology of regionalizing economic data, economic impact assessment, and integrated economic and environmental CGE modeling.
92. Author(s) and year: van Kooten, G.C., and E.H. Bulte. 1998  
Research subject: Social and Economic Criteria and Indicators (also in Policy and Institutional Analysis, and Carbon Forest Management)  
Source: working paper available on SFMN website  
Descriptors: economic, carbon  
Location: British Columbia  
Title: **How Much Ancient Forest Should Society Retain? Carbon Uptake, Recreation, and Other Values?**



Description: A deterministic optimal control model is used to compute socially optimal stocks of old growth. The model employed is reminiscent of Ehui and Hertel's model where opportunity costs of preservation and conversion (logging benefits, C-flux costs/benefits, changes in amenity values) are calculated, rather than agricultural related values. The main modeling question is: Given information on non-timber benefits, how much old-growth forest should society keep in order to maximize the discounted flow of present and all future net benefits?

## Research Subject: Pulp and Paper Technologies / Solid Waste Management

93. Author(s) and year: Berube, P.R., and E.R. Hall. 2000  
Research subject: Pulp and Paper Technologies/Solid Waste Management  
Source: project report available on SFMN website  
Descriptors: wood, pulp and mill  
Location: British Columbia  
Title: **High Temperature Biological Treatment of Foul Evaporator Condensate for Re-use.**  
Description: This study assesses, amongst others, the possibility of biologically removing methanol (primary contaminant of concern from kraft pulp mills) from synthetic condensate using a high temperature membrane bioreactor (MBR), over the entire expected range of temperatures for evaporator condensate. Based on kinetic information, a model was developed to simulate the effect of elevated operating temperatures on a biological treatment system. The model was used to optimize the operation of a high temperature MBR for the treatment of evaporator condensate for reuse. Based on the model, the optimal operating temperature for the treatment of evaporator condensate for reuse was determined to be 60°C.
94. Author(s) and year: El-Din, M.G., and D.W. Smith. 2000  
Research subject: Pulp and Paper Technologies/Solid Waste Management  
Source: interim project report available on SFMN website  
Descriptors: wood, pulp and mill  
Location: Alberta  
Title: **Maximizing Enhanced Ozone Oxidation of Pulp Mill Effluents.**  
Description: Three analytical models have been derived for modeling the hydrodynamic behavior of the bubble column, and six additional models have been derived for modeling the overall performance of oxygen and ozone bubble columns for clean water and for pulp mill effluent treatment. Those models have been initially tested against experimental data obtained in the past in a fine-

diffuser bubble column that had been operated at the Environmental Engineering Laboratory of the University of Alberta. Those models have shown an excellent agreement with the experimental data. Those models are being tested against the experimental data for the water treatment conditions in the jet-bubble column. Finally, two experimental studies including the ozone mass transfer and color and chlorinated organic compounds reduction in pulp mill effluents and bubble size determination in pulp mill effluents using the Laser Doppler Anemometer (LDA) are currently in progress.

95. Author(s) and year: Jenkinson, R.W., *et al.* 2000  
Research subject: Pulp and Paper Technologies/Solid Waste Management  
Source: project report available on SFMN website  
Descriptors: wood, pulp and mill  
Location: British Columbia  
Title: **Computational Fluid Dynamics Modeling of Aerated Stabilization Basins.**  
Description: A two-dimensional computational fluid dynamics (CFD) model was employed to model the fluid flow within the basin without aeration using a commercial package, FLUENT. The modeling results were compared with depth-averaged ADV velocity measurements taken within the basin. Many CFD modeling parameters were varied, including grid size and structure, turbulence modeling and boundary condition modeling. The solute transport modeling only examined the transport equations with uniform dispersion over the basin and, although it was the original intent, no attempts were made to model aeration at this stage. The overall shape of the modeled tracer curves compared favorably to the tracer study data obtained in the lab.
96. Author(s) and year: Putz, G., *et al.* 2000  
Research subject: Pulp and Paper Technologies/Solid Waste Management (also in Water and Wetlands)  
Source: project report available on SFMN website  
Descriptors: wood, pulp and mill technology, water  
Location: Alberta  
Title: **Two-Dimensional Modeling of Effluent Mixing in the Athabasca River Downstream of Alberta Pacific Forest Industries, Inc.**  
Description: The overall purpose of the research project is to further verify and develop a two-dimensional, unsteady effluent input river mixing and transport model. Adaptations to this mixing model can provide the capability to simulate environmental reaction of water quality parameters, within a river, in combination with the river mixing and transport. A unique feature of the model is that unsteady



input conditions can be accounted for, and that the resulting time-varying concentrations across a stream and in the downstream direction can be predicted. A calibrated model at a particular mill site can serve as a valuable management tool for efficient planning of receiving stream water quality monitoring programs, i.e. the model will indicate where samples should be taken to document potential maximum concentrations. The model can also be used to assess the environmental impact of abnormal conditions such as spills and/or low river flow conditions on the receiving stream water quality, or to investigate the implications of alternative discharge locations on the receiving stream water quality.

97. Author(s) and year: Putz, G., and D.W. Smith. 2000  
Research subject: Pulp and Paper Technologies/Solid Waste Management (also in Water and Wetlands)  
Source: project report available on SFMN website  
Descriptors: wood, pulp and mill, water  
Location: Alberta  
Title: **River Mixing and Mass Balance of Several Water Quality Parameters in the Wapiti River Downstream of Weyerhaeuser Canada, Ltd.**  
Description: The overall purpose of this research project is to further verify and develop a two-dimensional, unsteady effluent input, river mixing and transport model to simulate environmental reaction of water quality parameters, within a river, in combination with the river mixing and transport. A unique feature of the model is that unsteady effluent input conditions can be accounted for, and that the resulting time-varying, effluent substance concentrations across a stream and in the downstream direction can be predicted. The first objective of the overall project involved the verification of the river mixing and transport portion of the model using tracer tests conducted at several Canadian mill discharge locations. The second objective is to adapt the model to predict the fate of selected mill effluent substances (e.g. color, COD, AOX and toxic compounds) within the Wapiti River near Grande Prairie downstream of a Weyerhaeuser Canada Ltd. mill site.
98. Author(s) and year: Putz, G., and D.W. Smith. 2000  
Research subject: Pulp and Paper Technologies/Solid Waste Management (also in Water and Wetlands)  
Source: project report available on SFMN website  
Descriptors: wood, pulp and mill technology, water  
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99. Author(s) and year: Sreckovic, G., and E.R. Hall. 2000  
Research subject: Pulp and Paper Technologies/Solid Waste Management  
Source: project report available on SFMN website  
Descriptors: wood, pulp and mill  
Location: British Columbia  
Title: **Computer Simulation of Activated Sludge Clarifiers in the Pulp and Paper Sector.**  
Description: The overall research aim was to establish a framework for a comprehensive dynamic model to predict the long term dynamic behavior of an activated sludge plant treating pulp and paper wastewater. This report summarizes the first step in the overall project — the construction and verification of a dynamic model for a pulp and paper primary clarifier. The model was calibrated and verified against multiple multi-annual and multi-monthly full scale facility data sets. In order to further improve the model response, the mechanistic model was connected to a neural network to form a hybrid model. The mechanistic model error function was used to train the neural network. The neural network outputs were added to the mechanistic model outputs to make the final, hybrid model outputs. In this way, the hybrid model could be used to introduce variables not included in the mechanistic model, but affecting the process, to quantify the impact of additional variables, and to improve the accuracy of the mechanistic model.



## Research Subject: Carbon Forest Management

- 100.** Author(s) and year: Saddler, J.N. 2002  
Research subject: Carbon Forest Management (also in Innovative Zoning and Value Added/Alternative Products)  
Source: final project report available on SFMN website  
Descriptors: policy and carbon  
Location: British Columbia, Alberta  
Title: **The Potential of Short Rotation Forestry on Marginal Farmland in BC and Alberta to Provide a Feedstock for Energy Generation and to Reduce Greenhouse Gas Emissions.**  
Description: Delucchi's full fuel cycle greenhouse gas (GHG) model was used to calculate the amount of GHG emissions from production and combustion of wood-derived ethanol under three land-use scenarios: (1) short rotation forestry on a land previously covered by pasture (70%), agricultural fields (15%) and forest (15%); (2) short rotation forestry on a previous forested land (100%), and (3) using sawmill wood residues with no energy-dedicated wood plantation. The model developed by Delucchi takes a cradle-to-grave approach in estimating the amount of emissions over the entire life cycle of a fuel. Emissions are calculated as a weighted sum of carbon dioxide, methane and nitrous oxide, and are reported as gram equivalent CO<sub>2</sub>.
- 101.** Author(s) and year: van Kooten, G.C. 1999  
Research subject: Carbon Forest Management  
Source: working paper available on SFMN website  
Descriptors: economic, policy  
Location: British Columbia, Alberta  
Title: **Economic Dynamics of Tree Planting for Carbon Uptake on Marginal Agricultural Lands.**  
Description: The specific purpose here is to investigate the claims of foresters that afforestation of marginal lands in (mainly western) Canada can make a significant contribution to Canada's international commitments. To do so, a dynamic optimization model was used to determine optimal levels of land conversion and, thus, the potential contribution that afforestation of marginal agricultural land can make to Canada's Kyoto commitment. The study area encompasses the Peace River region of British Columbia and all of Alberta. Here the model is fully described and a sensitivity analysis was performed.

- 102.** Author(s) and year: van Kooten, G.C., and E.H. Bulte. 1998  
Research subject: Carbon Forest Management (also in Policy and Institutional Analysis, and Social and Economic Criteria and Indicators)  
Source: working paper available on SFMN website  
Descriptors: social, carbon  
Location: British Columbia  
Title: **How Much Ancient Forest Should Society Retain? Carbon Uptake, Recreation, and Other Values?**  
Description: A deterministic optimal control model is used to compute socially optimal stocks of old growth. The model employed is reminiscent of Ehui and Hertel's model where opportunity costs of preservation and conversion (logging benefits, C-flux costs/benefits, changes in amenity values) are calculated, rather than agricultural related values. The main modeling question is: Given information on non-timber benefits, how much old-growth forest should society keep in order to maximize the discounted flow of present and all future net benefits?
- 103.** Author(s) and year: van Kooten, G.C., and E. Krcmar. 2001  
Research subject: Carbon Forest Management (also in Policy and Institutional Analysis)  
Source: project report available on SFMN website  
Descriptors: economic, carbon  
Location: British Columbia  
Title: **Climate Change, Canadian Policy and Terrestrial Ecosystems: Economic Considerations.**  
Description: The TECAB model (a multiple objective model) was used to examine tradeoffs among economic, carbon uptake and biodiversity objectives. TECAB uses compromise programming to find a balance strategy. The model consists of tree-growth, agricultural activities and land-allocation components, and is used to examine the costs of carbon uptake. The model also addresses uncertainty using fuzzy logic. Five modeling objectives are defined for land management: 1) maximization of net discounted returns from forest and agricultural activities; 2) maximization of cumulative timber volume; 3) maximization of cumulative discounted carbon stored (uptake minus emissions); 4) maintenance of a stable flow of timber to the mills; and 5) attainment of a desired forest structure.
- 104.** Author(s) and year: Vitt, D.H. 2001  
Research subject: Carbon Forest Management (also in Water and Wetlands)  
Source: project report available on SFMN website  
Descriptors: peatland, carbon  
Location: Alberta, Saskatchewan, Manitoba





Title: **Modeling Impacts of Climate on Peatland Carbon Stores and Fluxes.**

Description: A simple peat-accumulation process model was used to investigate regional patterns of carbon sequestration under climate change conditions. As such, the two-layer, Clymo-type conceptual model was adopted and parameterized for three generalized peatland types with available data from continental western Canada. The model was used to explore how different peatlands may respond to climate changes, particularly potential changes in peatland water table, and how this variability is patterned regionally. Parameter estimates for the catotelm from sites in continental western Canada were determined using a single exponential decay.





# SFMN PARTNERS AND AFFILIATES NOVEMBER 2004

## GRANTING COUNCILS

- Networks of Centres of Excellence (NCE) Program
  - Natural Sciences and Engineering Research Council of Canada (NSERC)
  - Social Sciences and Humanities Research Council of Canada (SSHRC)

## SPECIAL FUNDING AGREEMENTS

- Sustainable Forest Management Network/BIOCAP  
Canada Foundation Joint Venture Agreement

## FUNDING PARTNERS

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- Canadian Forest Service
- Environment Canada
- Parks Canada
  - Ecological Integrity Branch
- Government of Alberta
  - Alberta Sustainable Resource Development
- Government of British Columbia
  - Ministry of Forests
- Government of Manitoba
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- Gouvernement du Québec
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- Bowater Inc.
- Canadian Forest Products Ltd.
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- LP Canada Ltd.
- Millar Western Forest Products Ltd.
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- Tembec Inc.
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### ABORIGINAL GROUPS

- Gwich'in Renewable Resource Board
- Heart Lake First Nation
- Kaska Tribal Council
- Little Red River/Tall Cree Nation
- Moose Cree First Nation

### NON-GOVERNMENTAL ORGANIZATIONS (NGOs)

- Ducks Unlimited Canada

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- Canadian Institute of Forestry
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- Forest Engineering Research Institute of Canada
- Lake Abitibi Model Forest
- Manitoba Model Forest
- National Aboriginal Forestry Association



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