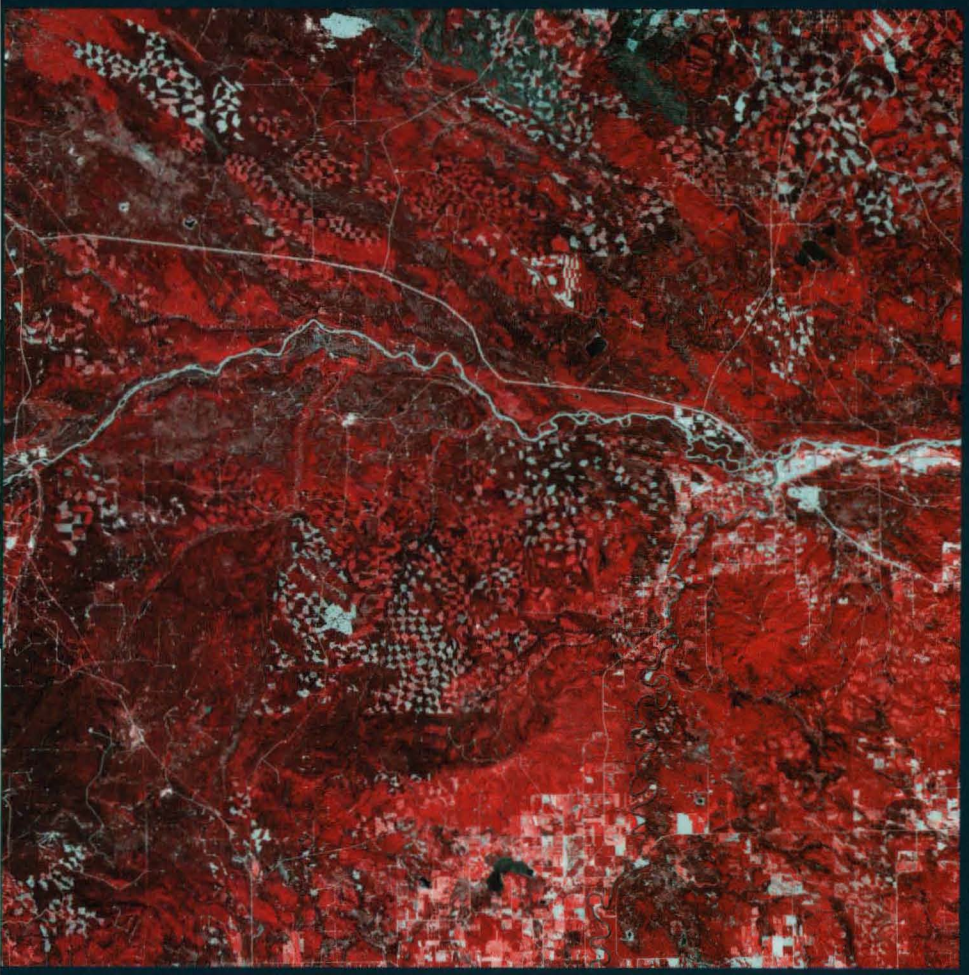
Geographic Information Systems and Remote Sensing for Sustainable Forest Management:

CHALLENGE AND INNOVATION IN THE 21ST CENTURY



R.J. Hall, A.L. Storrier, G.A. Sanchez-Azofeifa, B.A. Rivard, R.W. Wein, J.L. Henry, C.J. Brodie, and B.L. Laishley, editors

Abstracts and Workshop Program

Natural Resources Canada
Canadian Forest Service
Ressources naturelles Canada
Service canadien des forêts
Canada

Geographic Information Systems and Remote Sensing for Sustainable Forest Management: Challenge and Innovation in the 21st Century

ABSTRACTS AND WORKSHOP PROGRAM

R.J. Hall, A.L. Storrier, G.A. Sanchez-Azofeifa, B.A. Rivard, R.W. Wein, J.L. Henry, C.J. Brodie, and B.L. Laishley, editors

Workshop held
February 23–25, 2000
Edmonton, Alberta, Canada

Canadian Forestry Service
Northern Forestry Centre

The Canadian Forest Service's Northern Forestry Centre is responsible for fulfilling the federal role in forestry research and technology transfer in Alberta, Saskatchewan, Manitoba, and the Northwest Territories. The main objectives are research in support of improved forest management for the economic, social, and environmental benefit of all Canadians.

The Northern Forestry Centre is one of five centers of the Canadian Forest Service, which has its headquarters in Ottawa, Ontario.

Le Service canadien des forêts, Centre de foresterie du Nord, représente le gouvernement fédéral en Alberta, en Saskatchewan, au Manitoba et dans les Territoires du Nord-Ouest en ce qui a trait aux recherches forestières, et au transfert de technologie. Cet organisme s'intéresse surtout à la recherche en vue d'améliorer l'aménagement forestier afin que tous les Canadiens puissent en profiter aux points de vue économique, social et environnemental.

Le Centre de foresterie du Nord constitue l'un des cinq établissements du Service canadien des forêts, dont l'administration centrale est à Ottawa (Ontario).

Cover:
August 29, 1998 Landsat 5 Thematic Mapper false color composite near Whitecourt, Alberta depicting forested areas, harvested areas in varying stages of regrowth, and extensive geophysical activity.

Catalogue no. Fo42-305/2000E
ISBN 0-662-28586-7

This publication is available at no charge from:

Natural Resources Canada
Canadian Forest Service
Northern Forestry Centre
5320 – 122 Street
Edmonton, Alberta
T6H 3S5

CANADIAN CATALOGUING IN PUBLICATION DATA

Geographic Information Systems and Remote Sensing for Sustainable Forest Management (1st : 2000 : Edmonton, Alberta, Canada)

Geographic information systems and remote sensing for sustainable forest management : challenge and innovation in the 21st century : abstracts and workshop program

"Workshop held February 23–25, 2000, Edmonton, Alberta, Canada"
ISBN 0-662-28586-7
Catalogue no. Fo42-305/2000E

1. Forests and forestry — Remote sensing — Congresses.
2. Geographic information systems — Congresses.
3. Remote sensing — Congresses.
4. Forest management — Congresses.
5. Sustainable forestry — Congresses.
I. Hall, R.J.
II. Northern Forestry Centre (Canada).
III. Title.

SD387.R4G46 2000 634.9'2 C00-980085-9

This report has been printed on Canadian recycled paper.

Hall, R.J.; Storrier, A.L.; Sanchez-Azofeifa, G.A.; Rivard, B.A.; Wein, R.W.; Henry, J.L. Brodie, C.J.; Laishley, B.L., editors. *Geographic information systems and remote sensing for sustainable forest management: challenge and innovation in the 21st century.* Abstracts and workshop program of a workshop held February 23–25, in Edmonton, Alberta. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, Alberta.

ABSTRACT

A workshop entitled, *Geographic Information Systems and Remote Sensing for Sustainable Forest Management: Challenge and Innovation in the 21st Century* was held February 23 to 25, 2000, in Edmonton, Alberta, with participants from seven countries. Over 50 papers and posters were presented on the application of geographic information systems and remote sensing technologies to the study of land use and cover change, biodiversity monitoring, spatial data integration and management, as well as on the advances of technological tools for supporting forest management decisions, and forest management.

RÉSUMÉ

Un atelier intitulé « Geographic Information Systems and Remote Sensing for Sustainable Forest Management: Challenge and Innovation in the 21st Century » (Systèmes d'information géographique et télédétection au service de la gestion des forêts: défis et innovations pour le 21e siècle) s'est tenu du 23 au 25 février 2000 à Edmonton (Alberta). Les participants venaient de sept pays différents et plus de 50 présentations et posters ont été présentés d'une part sur l'application des systèmes d'information géographique et des techniques de télédétection à l'étude des changements affectant l'utilisation des terres et la couverture végétale, à la surveillance de la biodiversité, à l'intégration et à la gestion de données spatiales et d'autre part sur les progrés accomplis dans le domaine des outils technologiques utilisés pour la prise de décisions en matière de gestion forestière.

Preface

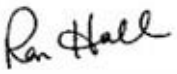
On behalf of the University of Alberta Earth Observation Systems Lab (Drs. G. Arturo Sanchez-Azofeifa and Benoit Rivard), the Department of Earth and Atmospheric Sciences, the Network of Centres of Excellence – Sustainable Forest Management, Canadian Forest Service, and our sponsors we would like to welcome you to the Geographic Information Systems (GIS) and Remote Sensing for Sustainable Forest Management: Challenge and Innovation in the 21st Century workshop. Over the next century, our challenge is to identify innovative approaches to the integration of GIS and remote sensing for sustainable forest management. There is a need to identify how these technologies may be best utilized in managing our forest resources, and how to close the gap between system developers, researchers, and users.

This workshop will promote the exchange of ideas about, and present information on, applications of GIS and remote sensing as tools for supporting sustainable forest management decisions. The workshop will be conducted over 2.5 days with the first two days dedicated to user applications followed by a half day on vendor workshops. A keynote presentation will be given in each morning followed by concurrent sessions for all paper presentations. Concurrent sessions will be held in the areas of land use and land cover change, biodiversity, spatial data integration and management, technical tools to support forest management decisions, and applications of GIS and remote sensing to forestry. An exciting program has been assembled from over 50 papers and posters that have been received from authors in Canada, United States of America, India, Costa Rica, Belgium, and Japan.

This workshop was initiated through funding from the Sustainable Forest Management Network (SFMN) at the University of Alberta along with corporate sponsorship from those listed in the workshop sponsor page. The contributions from these organizations were key in bringing the workshop idea to fruition, and their support is gratefully acknowledged.

This workshop would not be possible without the assistance of many individuals. Staff and graduate students from the Sustainable Forest Management Network and the University of Alberta are acknowledged for their contributions prior to and during the workshop. Ms. Elaine Schiewe and Deborah Klita of the Canadian Forest Service are also gratefully acknowledged for their assistance in production of this booklet.

We thank you for your participation and wish you the very best for a successful workshop.



R.J. Hall

Workshop Sponsors

The following sponsors are gratefully acknowledged for their contributions and support to this workshop.

Alberta Environment
http://www.gov.ab.ca/
Ken Dutchak/Bob Sleep
12th floor, 9820 – 106 Street
Edmonton, Alberta T5K 2J6
780-422-0218

Brydun Geomatics
Jack Henry
Box 1920
Whitecourt, Alberta T7S 1P6
780-778-3730

Canadian Forest Service
http://www.nofc.forestry.ca/
Ron Hall
Northern Forestry Centre
5320 – 122 Street
Edmonton, Alberta T6H 3S5
780-435-7209

Natural Resources Canada / Ressources naturelles Canada
Canadian Forest Service / Service canadien des forêts

Ducks Unlimited Canada
http://www.ducks.ca/
Al Richard
202, 10720 – 178 Street
Edmonton, Alberta T5S 1J3
780-489-2002

Ducks Unlimited Canada

Earth Observation Systems Laboratory (EOSL)
http://www.ualberta.ca/~gis1/
G. Arturo Sanchez-Azofeifa
Department of Earth and Atmospheric Sciences
University of Alberta
Edmonton, Alberta T6G 2E3
780-492-8051

Earth Resource (ER) Mapper
http://www.ermapper.com/
Stephanie Prior
Suite 1200, 421 – 7 Avenue SW
Calgary, Alberta T2P 4K9
403-508-1772

ER Mapper

Environmental Systems Research Institute (ESRI) Canada Limited
http://www.esricanada.com/
David Parry
Suite 200, 9940 – 106 Street
Edmonton, Alberta T5K 2N2
780-424-3774

ESRI Canada
www.esricanada.com

Intergraph Canada Ltd.
http://www.intergraph.com/
Terry Grant
#700, 10123 – 99 Street
Edmonton, Alberta T5J 3H1
780-424-7431

Integrated Mapping Technologies
Ian Grady
#1800, 1188 West Georgia Street
Vancouver, British Columbia V6E 4A2
604-682-7376

International Geosphere-Biosphere Programme – Land Use and Cover Change (IGBP-LUCC)
http://www.icc.es/lucc/
G. Arturo Sanchez-Azofeifa
Department of Earth and Atmospheric Sciences
University of Alberta
Edmonton, Alberta T6G 2E3
780-492-8051

Network of Centres of Excellence – Sustainable Forest Management Network
http://www.biology.ualberta.ca/sfm
Christine Brodie
University of Alberta
Edmonton, Alberta T6G 2E9
780-492-9834

PCI Geomatics
http://www.pcigeomatics.com/
Allison Malis
480 B. Tennyson Place
Victoria, British Columbia V8Z 6S8
250-382-5800

Silicon Graphics Inc. (SGI)
http://www.sgi.com/global/canada/
Marc Nolte
Suite 1430, 335 – 8 Avenue SW
Calgary, Alberta T2P 1C9
403-269-5844

Space Imaging
http://www.spaceimaging.com/
David Ward
317 Cave Avenue
Bainbridge Island, Washington 98110
206-780-4281

Spatial Geo-Link Limited [ERDAS products]
http://www.spatialgeolink.com
Toni Sani
Suite 224, 3075 – 14 Avenue
Markham, Ontario L3R 0G9
905-470-5990

Preliminary Workshop Program

Feb 23/00	Salon B	Feb 23/00	Salon C
Time	Event	Time	Event
7:30 to 8:30	Registration - Coffee (Foyer)		
8:30 to 9:30	**Welcome:** Dr. Vic Adamowicz, Network of Centres of Excellence - Sustainable Forest Management; Dr. Dick Peters, Dean of Science, University of Alberta; and the Honorable Gary Mar, Alberta Minister of Environment **Keynote:** Dr. **Peter Murtha**, Faculty of Forestry, University of British Columbia *Monitoring the Effectiveness of Sustainable Forest Management with Remote Sensing and GIS Technologies: A Vision*		
9:30 to 10:00	Coffee Break		
	Session 1: Land Use and Cover Change (LUCC) 1		**Session 2: Technical Tools to Support Forest Management Decisions**
10:00 to 10:25	Remotely Sensed Thematic Data - K. Dutchak	10:00 to 10:25	Fire Monitoring, Mapping, and Modeling Using Satellite and GIS Technology - B.S. Lee, R. Landry, and Z. Li
10:25 to 10:50	Monitoring Land Use and Land Cover Change in Boreal Regions: Implementation of a Provincial Protocol Using Remote Sensing Techniques: A Case Study in Alberta, Canada - G.A. Sanchez-Azofeifa, T. Polzin, G. Hamilton, K. Dutchak, B. Sleep, A. Richards, and R. Bennet	10:25 to 10:50	Satellite Forest Fire Scar Mapping as a Tool for Salvage Logging Planning - R. Landry, D. Raymond, H. MacLeod, R.J. Hall, A. Robertson, and J. Russell
10:50 to 11:15	Land Use/Land Cover Mapping Using Integrated Remote Sensing and GIS - J.S. Paterson and U. Nielsen	10:50 to 11:15	Digital Remote Sensing Imagery for Forest Management: Hype or Panacea? The 10-year Experience of Blue Ridge Lumber (1981) Ltd. - A. Robertson
11:15 to 11:40	Cutblock Update with India IRS-1C Imagery - R.J. Hall, N. Walsworth, M. Gartrell, T. Balce, and K. Dutchak	11:15 to 11:40	GIS Applications in Oregon's Western Forests: Contributions and Limitations of GIS Technology to Forest Research - M. Wing
11:40 to 12:05	Landscape Fragmentation in Alberta through Remote Sensing - S. Shukla, G.A. Sanchez-Azofeifa, and S. Hannon	11:40 to 12:05	Classifying Herbaceous and Shrubby Vegetation for Ecosystem Management Using Modeled Physical Gradients - C.C. Dymond and E.A. Johnson
12:05 to 13:30	**Lunch**		
	Session 3: Applications of Remote Sensing and GIS to Forestry 1		**Session 4: Applications of Remote Sensing and GIS to Forestry 2**
13:30 to 13:55	Mapping Conifer Understory from Satellite Imagery - R.J. Hall, D.R. Peddle, and D.L. Klita	13:30 to 13:55	Integrating Orthorectified RADARSAT Data and GIS Data for Forest Management - J.S. Paterson and U. Nielsen
13:55 to 14:20	Deriving Physical Forest Stand Information from Remotely Sensed Imagery Using Canopy Reflectance Models - D.R. Peddle	13:55 to 14:20	Modeling Ecosystem Productivity Using Modern Statistical Techniques - R.C. Yang, Y. Wang, and I.G.W. Corns
14:20 to 14:45	Modeling Stand Volume from Landsat Thematic Mapper and GIS Data in Fort Simpson, NWT - G. Gerylo, R.J. Hall, and S.E. Franklin	14:20 to 14:45	Assessments of Very Dense Stands in Old Burns with Data from the Compact Airborne Multispectral Imager (casi) - D.S. Davison, S. Achal, R. Gauvin, S. Lamille, and G. Newsome
14:45 to 15:10	Ecological Base Mapping and Wildlife Habitat Suitability Interpretations: A Sustainable Forest Management Tool - A. Saxena and K. Gazey	14:45 to 15:10	Estimating Tree Heights of the Boreal Forest Using Airborne Laser Altimetry - B.A. St-Onge
15:10 to 15:30	Coffee Break		
15:30 to 16:30	**Poster Sessions - Time with Authors**		

Feb 24/00	Salon B	Feb 24/00	Salon C
Time	Event	Time	Event
7:30 to 8:30	Coffee		
8:30 to 9:30	Introduction and **Keynote:** Dr. Alex **Pfaff**, School of International and Public Affairs, Dept. of Economics and Center for Environmental Research and Conservation, Columbia University *Carbon Sequestration Policies and the Sustainability of Forest Resources: A Vision Using Remote Sensing and GIS*		
9:30 to 10:00	Coffee Break		
	Session 5: Biodiversity		**Session 6: Spatial Data Integration and Management**
10:00 to 10:25	Spatial Dimensions of Conservation: Concepts Supporting Conservation - R.W. Weis, A.K. Franke, and N.L. Salamon	10:00 to 10:25	Information Models: A Tool for Optimizing Spatial Data for Forest Management - A.G. Levinsohn
10:25 to 10:50	Remote Sensing and Forest Biodiversity Monitoring in Alberta - E.E. Dickson, L.M. Moskal, S.E. Franklin, R.J. Hall, and D. Farr	10:25 to 10:50	GIS-based Heritage Potential Modelling and Heritage Management in the Forest Industry - T.H. Gibson and J. Finnigan
10:50 to 11:15	Land Cover Mapping and Landscape Fragmentation Analysis in Support of Grizzly Bear Habitat Management - J. Dechka, S. Franklin, D. Peddle, and G. Stenhouse	10:50 to 11:15	Geodatabase Data Model – Its Impact on Data Management in Forest Information Systems, an ESRI Canada Perspective - D. Parry and L. Dmitruk
11:15 to 11:40	Anthropogenic Factors Shaping the Structure of a Tropical Forest: A Study at Biligiri Rangaswamy Temple Sanctuary, Western Ghats, India - M.C. Kiran, N. Barve, J. Poulsen, R.U. Shaanker, K.N. Ganeshaiah	11:15 to 11:40	The Transition from Timber Supply to Resource Supply Analysis - D.R. Webb
11:40 to 13:30	**Lunch**		
	Session 7: Land Use and Cover Change (LUCC) 2		**Session 8: Applications of Remote Sensing and GIS to Forestry 3**
13:30 to 13:55	Patterns of Forest Cover Change at Regional and Ecosystem Levels in the Western Ghats, India: Assessing the Role of Development and Socioeconomic Factors Using GIS Tools - N. Barve, M.C. Kiran, R.U. Shaanker, K.S. Bawa, and K.N. Ganeshaiah	13:30 to 13:55	Defining a Monitoring System for Tropical Dry Forest in Costa Rica: Implementation of Algorithms Using Remote Sensing and GIS - P. Arroyo, G.A. Sanchez-Azofeifa, and J. Calvo
13:55 to 14:20	Property-based Analysis of Wood Supply and Biodiversity on Private Woodlots in New Brunswick - H. Arnold	13:55 to 14:20	Counting Individual Stems in Forest Plantations and Thinned Regions Using Images from the Compact Airborne Spectrographic Imager (casi) - D.S. Davison, S. Lataille, and S. Preiss
14:20 to 14:45	Survey of Forest Cover in Costa Rica Using LANDSAT Images 1986/87–1996/97 - J.C. Calvo, V. Watson, R. Bolanos, C.Q. Matco, G.A.Sanchez-Azofeifa, J. Saborio, P. Gonzalez, and M. Ramirez	14:20 to 14:45	Improved Forestry Information in Mountainous Terrain Using a Modified Canopy Reflectance Model and Airborne casi Imagery - R.L. Johnson, D.R. Peddle, and R.J. Hall
14:45 to 15:10		14:45 to 15:10	The Effects of Slope on Optical Methods and Allometric Equations for Estimating Conifer Leaf Area Index - D.P. Davidson, R.J. Hall, D.R. Peddle, and R.L. Johnson
15:10 to 15:30	Coffee Break		
15:30 to 16:30	**Poster Sessions - Time with Authors**		

Day 3	Industry Workshops - February 25, 2000	
Time	Event	Location
8:30 - 12:00	1. Silicon Graphics Inc.	TBA
8:30 - 12:00	2. Spatial Geo-Link Limited	TBA
8:30 - 12:00	3. Intergraph	TBA
8:30 - 12:00	4. ER Mapper	TBA
8:30 - 12:00	5. Space Imaging	TBA
8:30 - 12:00	6. PCI Geomatics	TBA
8:30 - 12:00	7. Integrated Mapping Technologies	TBA

Contents

Note

The views, conclusions, and recommendations published in this book are those of the authors and do not necessarily imply endorsement by the Canadian Forest Service.

The exclusion of certain manufactured products does not necessarily imply disapproval nor does the mention of other products necessarily imply endorsement by the Canadian Forest Service.

ABSTRACTS OF PRESENTATIONS

Session 1

Land Use and Cover Change (LUCC) 1

Remotely sensed thematic data—Alberta Environment

K. Dutchak

The Resource Data Division of Alberta Environment has maintained a long history in the development, procurement, and maintenance of thematic resource data. Four of these data sets have particular relevance to achieving sustainable forest management using a geographic information system (GIS). The Alberta Vegetation Inventory (AVI) is the most detailed of the thematic coverages and is based on interpretation of aerial photography. The other three include the Alberta Woodlot Inventory (AWI), the Alberta Ground Cover Classification (AGCC) inventory and Access Update for Base-features. These three are built upon remotely sensed satellite imagery. The AWI and the Alberta Ground Cover Classification use 30 m Landsat 5 Thematic Mapper data. The Access Update data is built upon 5 m Indian Remote Sensing Satellite data. Each data set was built to suit a specific client need. The scale of the product, resolution of information, the quality and means of presentation were all defined to meet those specific needs. Each data set stands on its own. Together they work to build a data framework upon which the Department works to manage the provincial forest resources. Increased computer processing speeds and the development of integrated software applications have provided us the opportunity to meld these individual data into a formidable suite of information products. The presentation will provide a brief overview of each of the thematic coverages. It will also discuss how they can be integrated through the use of GIS applications into furthering resource management within the province of Alberta.

Contact:

Ken Dutchak
Alberta Environment
12th Floor, 9820 – 106 Street
Edmonton, Alberta, Canada
T5K 2J6
780-422-0669
780-427-1215
ken.dutchak@gov.ab.ca

Monitoring land use and land cover change in boreal regions: implementation of a provincial protocol using remote sensing techniques: a case study in Alberta, Canada

G.A. Sanchez-Azofeifa, T. Polzin, G. Hamilton, K. Dutchak, B. Sleep, A. Richards, and R. Bennet

There is increasing pressure to evaluate and approve industrial development projects primarily dealing with oil sand and heavy oil extraction in the northeastern boreal region of Alberta. The cumulative impacts of multiple and massive industrial development within the region is still not well understood. Baseline inventories of current resource information are a key component in supporting a regional model designed to better understand the impact of cumulative effects on landscape structure. This paper describes the main achievements related to the development of a remote sensing and geographic information systems protocol aimed at monitoring land use and land cover change (LUCC) in boreal regions. The proposed protocol uses medium-resolution satellite images (Landsat Thematic Mapper) as a standard to map land cover under the Alberta Ground Cover Classification. The main goal of this research is to seek the most appropriate, and the most current, methodologies for multi-temporal and multi-year analysis of landscape structure and LUCC trends. It is expected that this joint initiative between academia, provincial and federal agencies, and non-governmental organizations will promote the development of standards for image interpretation at the provincial level using emerging satellite platforms and information already created by the province of Alberta. This paper presents a case study for the Fort McMurray region.

Contact:

G. Arturo Sanchez-Azofeifa
Earth and Atmospheric Sciences Department
University of Alberta
Edmonton, Alberta, Canada
T6G 2E3
780-492-1822
780-492-2030
arturo.sanchez@ualberta.ca

Land use/land cover mapping using integrated remote sensing and geographic information systems

J.S. Paterson and U. Nielsen

This paper reviews the methodology and results of two operational remote sensing geographic information system (GIS) land use and land cover mapping projects. The first is the Alberta Ground Cover Classification (AGCC) project, developed and funded by Alberta Environmental Protection. The AGCC project uses classified Landsat Thematic Mapper data, inventory data (Alberta Vegetation Inventory and Woodlot Inventory, where available) and field data to produce 1:50 000 scale ground cover maps of northeastern and west-central Alberta. The area mapped to date is significant, covering more than 200 1:50 000 National Topographic System (NTS) map sheets. The remote sensing and GIS techniques used to generate the GIS thematic map products are described. The second project is British Columbia's Large Scale Baseline Thematic Mapping (LSBTM) program. It is a project initiated by B.C.'s Ministry of Environment, Lands and Parks and builds upon the success of the 1:250 000 scale BTM project. The LSBTM is mapped at 1:20 000 scale and is compatible with B.C.'s Terrain Resource Information Management (TRIM) topographic base. The LSBTM uses an integrated mapping approach, with both digital and manual classification of fused Landsat and India Remote Sensing (IRS) Panchromatic data, air photo interpretation, field survey and ancillary data (e.g., TRIM, municipal zoning). This paper presents a review of the methodology and a comparison of information content between fused Landsat TM with IRS Panchromatic and fused Landsat 7 with the 15-m Panchromatic band.

Contact:

Scott Paterson
Dendron Resource Surveys Inc.
880 Lady Ellen Place
Ottawa, Ontario, Canada
K1Z 5L9
613-725-2971
613-725-1716
paterson@dendron.com

Cutblock update with India IRS-1C imagery

R.J. Hall, N. Walsworth, M. Gartrell, T. Balce, and K. Dutchak

Increasing demands on the forest resource and the high costs of the inventory process is driving the need for methods by which cost-effective update can be accomplished. Cutblock information is currently derived from aerial photographs, but an be expensive when large areas need to be updated. The India IRS-1C panchromatic sensor with 5.8-m spatial resolution has been the satellite with the highest spatial resolution prior to the recent launch of the IKONOS remote sensing satellite. The objective of this study is to compare photogrammetrically derived cutblock boundaries and areas with those interpreted from orthorectified and geometrically corrected IRS-1C panchromatic images. Aerial photographs at a scale of 1:20 000 were aero-triangulated digitally and displayed on a stereo photogrammetric workstation (DiAP viewer) from which cutblock information was derived. These cutblocks were spatially overlaid and statistically compared to those mapped from on-screen digitization of orthorectified and geometrically corrected India IRS-1C panchromatic images. Regardless of rectification methods, mapping accuracies will vary with factors such as cutblock size, shape, and topography.

Contact:

Ron Hall
Natural Resources Canada
Canadian Forest Service
5320 – 122 Street
Edmonton, Alberta, Canada
T6H 355
780-435-7209
780-435-7359
rhall@nrcan.gc.ca

Landscape fragmentation in Alberta through remote sensing

S. Shukla, G.A. Sanchez-Azofeifa, and S. Hannon

The boreal forest, or taiga, is one of the largest terrestrial ecosystems on earth and covers a large area in Canada, Russia, and the Nordic countries. Growing concerns over the loss of boreal forest has promoted the development of methods, using remote sensing and geographic information systems (GIS), to provide estimates of forest loss and the level of forest fragmentation of this fragile ecosystem. This paper is an attempt to study fragmentation of the boreal mixed-wood forest and intensity of land use in the agricultural area surrounding the Meanook Biological Station in central Alberta, Canada. This paper presents our efforts to measure major indicators of forest fragmentation using satellite images (Landsat Multispectral Scanner MSS, Landsat TM 5 and 7, and IRS 1C and 1D) in conjunction with existing 1:20 000 vector coverages of access features in the landscape. Additionally, this paper explores the method of fusion between medium- to high-resolution remote sensing platforms such as Landsat 7 and IRS 1C and 1D to increase the spatial resolution of extracted landscape features. Final results are integrated into landscape metrics developed to quantify the pattern, structure, and fragmentation in the study area. These metrics will be used to explain variation in bird community structure across the landscape. The results of this study can also be applied to other studies involving habitat fragmentation, land use and land cover changes, wildlife movement, forest fire suppression, and forest management programs. Additionally, we expect that methods developed by this research project will contribute to current international efforts aimed to understand land use/cover change processes worldwide.

Contact:

G. Arturo Sanchez-Azofeifa
Earth and Atmospheric Sciences Department
University of Alberta
Edmonton, Alberta, Canada
T6G 2E3
780-492-1822
780-492-2030
arturo.sanchez@ualberta.ca

Session 2

Technical Tools to Support Forest Management Decisions

Fire monitoring, mapping, and modelling using satellite and geographic information system technology

B.S. Lee, R. Landry, and Z. Li

The Fire Monitoring, Mapping, and Modelling System (Fire M3) is a joint initiative of the Canada Centre for Remote Sensing and the Canadian Forest Service. Fire M3 uses National Oceanic and Atmospheric Administration Advanced Very High Resolution Radiometer satellite imagery to monitor active large fires on a daily basis in Canada during the fire season. Landsat Thematic Mapper and Systeme Pour l'Observation de la Terre (SPOT) Vegetation satellite imagery is used for end-of-season fire mapping of all large fires (greater than 200 ha) in Canada. Fire behavior and impact modeling is conducted on all fires using data from the Canadian Wildland Fire Information System. These data are used for national reporting on fire activity. Methodologies currently under development to estimate carbon fluxes and greenhouse gas emissions from forest fires in Canada on an annual basis will also be described.

Contact:

Bryan S. Lee
Natural Resources Canada
Canadian Forest Service
5320 – 122 Street
Edmonton, Alberta, Canada
T6H 3S5
780-435-7303
780-435-7386
blee@nrcan.gc.ca

Satellite forest fire scar mapping as a tool for salvage logging planning

R. Landry, D. Raymond, H. MacLeod, R.J. Hall, A. Robertson, and J. Russell

Fires burn an average of 736 000 ha of commercial forest annually (74% of the area harvested), resulting in a loss of 70 million cubic metres of wood, with a value of about $1 billion. In commercial forestry, once a fire is controlled and extinct, the forest products industry gets actively involved in planning salvage logging operations. Information and timeliness are the key challenge when a major fire event strikes, such as the Virginia Hills fire that burned over 154 000 ha of the northern region of Whitecourt (Alberta) in May 1998. The presentation will focus on the current results of a joint project between the Canada Centre for Remote Sensing and the Canadian Forest Service to assess the use of Landsat Thematic Mapper for burn scar mapping. A review of the past 2 years of work with the Canadian forest products industry to promote and secure the potential of spaceborne remote sensing as a tool for planning salvage logging will be discussed. The end-to-end processes for fire scar mapping using satellite data will be presented and compared with conventional airborne methods. Recent work to assess the mapping of partial burns will also be briefly discussed.

Contact:

Robert Landry
Canada Centre for Remote Sensing
588 Booth Street, Room 339
Ottawa, Ontario, Canada
K1A 0Y7
613-947-1241
613-947-1385
Robert.Landry@ccrs.nrcan.gc.ca

Digital remote sensing imagery for forest management: hype or panacea? The 10-year experience of Blue Ridge Lumber (1981) Ltd.

A. Robertson

The Woodlands Division of Blue Ridge Lumber has been working with digital remote sensing data for the past 10 years. The products that we have used include Landsat MSS, Landsat TM, IRS 1C Panchromatic, airborne GPS, digital orthophoto mosaics, and ortho-rectified individual air-photo frames. These products are stored within our ArcInfo-based Woodlands Information System and are accessed by Woodlands staff using desktop tools such as ArcView and ArcExplorer. As a result of our experience using digital remote sensing imagery, we are well aware of the promise that such data sources hold for decision support related to sustainable forest management. We are also very aware of the reality of trying to make leading edge data products, such as satellite imagery, work in a production environment. Through this paper I will share the knowledge gained through 10 years of experience in the use of these products to support the activities of a typical forest products company. We will explore such questions as: how have the various products been used; which applications have been successful and which haven't; are these products cost effective; are they manageable within the context of a production geographic information system (GIS); and what resources are required (both human and technical) to make effective use of these data products? Finally, we will take a look at some of the new remote sensing products that will be available in the very near future and discuss the potential for applying them to sustainable forest management. These products will include 1-m resolution satellite imagery, airborne laser sensors, and off-the-shelf image classification tools. All of these products will be discussed within the framework of Blue Ridge Lumber's production GIS.

Contact:

Andy Robertson
Blue Ridge Lumber Ltd.
Box 1079
Whitecourt, Alberta, Canada
T7S 1P9
780-648-6298
780-648-6396
arobe@westfrasertimber.ca

Geographic information system (GIS) applications in Oregon's western forests: contributions and limitations of GIS technology to forest research

M. Wing

Organizations are increasingly using geographic information systems (GIS) to help manage forest resources. This paper examines several studies of forested ecosystems conducted by Oregon State University's Forest Engineering Department. Each study utilized spatial data and relied on GIS technology for analyzing the data. Study objectives included analyzing aquatic habitat, mapping slope stability, quantifying large woody debris distribution, and calculating visual sensitivity of a forest. Output and findings from each study are examined and critiqued in light of the role GIS played. Based on these findings, the contributions, limitations, and practicality of using a GIS to assist forest resource research are discussed. The GIS strengths included an ability to integrate data sources, reorganize and restructure data, and present visual or mapped results. Limitations to using a GIS included integrating different data structures, data availability and quality, and a lack of statistical tools within common GIS software.

Contact:

Michael Wing
Forest Engineering Department
Oregon State University
Peavy Hall 215
Corvallis, Oregon, USA
97331
541-737-4009
541-737-4316
michael.wing@orst.edu

Classifying herbaceous and shrubby vegetation for ecosystem management using modeled physical gradients

C.C. Dymond and E.A. Johnson

Current remote sensing methods are generally unable to detect herbaceous or shrub vegetation types beneath forest cover. This may be one factor that has slowed the implementation of herbs and shrubs into new forestry management plans. There has been some success at predicting vegetation distributions using correlations to physical gradients. Our objective was to develop a method to classify the spatial distribution of common herbs and shrubs using a digital elevation model of the Kananaskis watershed in southern Alberta. The first step was to input weather station data and a Digital Elevation Model to simple models of precipitation, drainage, radiation, and temperature. The next step was to classify the modeled gradients according to herb or shrub species abundance using ground truth data. The last step was to use independent ground truth data to assess the accuracy of the classification. Accuracy varied between 34 and 63%, depending on the species. The lowest accuracies were for rare species. Our conclusion is that simple ecological models can reduce the time and money required to map herbaceous and shrubby vegetation on the ground. Further development of these methods will help make ecosystem management of these species more effective.

Contact:

Caren C. Dymond
Department of Forest Ecology and Management
University of Wisconsin - Madison
1630 Linden Drive, #110
Madison, Wisconsin, USA
53705
608-265-6321
608-262-9922
ccdymond@facstaff.wisc.edu

Session 3

Applications of Remote Sensing and GIS to Forestry 1

Mapping conifer understory from satellite imagery

R.J. Hall, D.R. Peddle, and D.L. Klita

Information about the presence and spatial distribution of white spruce conifer understory within deciduous and deciduous-dominated mixed-wood stands is required for boreal mixed-wood management in Alberta. A method involving satellite data can provide useful information at the planning level by providing an initial stratification of the forest landscape for understory location, distribution, and amount. This study compared understory maps produced with an iterative supervised classification algorithm and a knowledge-based evidential reasoning classifier. Understory information from interpretation of leaf-off aerial photographs was overlaid onto two-date, leaf-off and leaf-on, Landsat Thematic Mapper images from which random pixel samples were extracted for classification. Variables used in classification included digital Landsat Thematic Mapper image data and stand structure information available from the Alberta Vegetation Inventory. Similar classification accuracy results were obtained from the two classifiers with spectral data alone, but accuracy increased significantly using the evidential reasoning classifier when information about stand structure was added to the classification exercise. Image maps were produced at a scale of 1:20 000 and are being evaluated for their informational value.

Contact:

Ron Hall
Natural Resources Canada
Canadian Forest Service
5320 – 122 Street
Edmonton, Alberta, Canada
T6H 3S5
780-435-7209
780-435-7359
rhall@nrcan.gc.ca

Deriving physical forest stand information from remotely sensed imagery using canopy reflectance models

D.R. Peddle

Forest canopy reflectance models provide a powerful link between physical attributes of a forest stand and the reflected energy from these stands recorded as spectral response patterns by airborne and satellite remote sensors. This is of importance to forestry studies because these remote sensing methods provide information such as stand density, tree height and canopy dimension, and volume based on a physical understanding of the interaction of solar radiation with forest canopies and stand geometry. This provision of physical and structural information is of greater relevance to foresters compared to the generally statistical outputs of conventional remote sensing image analysis. The principles of canopy reflectance models are first outlined, together with the concept of sub-pixel scale information extraction and the theoretical advantages of these approaches compared to previous methods. Results from a variety of global change and forestry remote sensing studies such as the NASA COVER Project, BOREAS, and the International Satellite Land Surface Climatology Project will be highlighted. These studies encompassed boreal and mountainous terrain at local to regional scales, and involved different forest attributes, species, image spatial and spectral resolutions, sensor types, and forestry information applications.

Contact:

Derek Peddle
University of Lethbridge
4401 University Drive West
Lethbridge, Alberta, Canada
T1K 3M4
403-329-2524
403-329-2016
derek.peddle@uleth.ca

Modeling stand volume from Landsat Thematic Mapper and geographic information system data in Fort Simpson, NWT

G. Gerylo, R.J. Hall, and S.E. Franklin

The potential integration of satellite data into Northwest Territory (NWT) inventory surveys may help to meet increasing demands for information about timber supply and its sustainability for forest development. The objective of this study is to determine the extent that stand volume could be estimated from Landsat Thematic Mapper (TM) and geographic information system (GIS) data. The study area was located in the Fort Simpson Region, NWT, where field plots were established in aspen, white spruce, jack pine, and mixed-species forested stands. In each plot, tree height, diameter at breast height, and species composition information were collected. These measurements were used to calculate the total volume of each plot within the study area (cubic metres per hectare). The extent to which stand volume may be derived from Landsat TM data was determined by using statistical models that estimated volume as a function of a) Landsat TM spectral and transformed data, b) GIS inventory, and c) combined remote sensing/GIS data. Preliminary results suggest that remote sensing data alone cannot provide detailed volume information; however, it can be used to model volume within a broad-level stratification, which may be valuable for forest management in remote regions where no pre-existing forestry information exists. Integration of remote sensing data and GIS data should improve the strength of these volume predictions.

Contact:

Graham Gerylo
Department of Geography
University of Calgary
Earth Science 356
2500 University Drive NW
Calgary, Alberta, Canada
T2N 1N4
403-701-3278
403-282-6561
grgerylo@ucalgary.ca

Ecological base mapping and wildlife habitat suitability interpretations: a sustainable forest management tool

A. Saxena and K. Gazey

Terrestrial Ecosystem Mapping (TEM) has been developed jointly by the British Columbia Ministries of Forests and Environment, Lands and Parks as a standardized baseline ecological mapping process. It allows the compilation of basic information on the distribution of ecosystems from which management interpretations can be developed, including broad-scale landscape plans and site-specific prescriptions. In British Columbia, government agencies and forestry companies have been mandated to use this product as a base for wildlife habitat suitability evaluations, particularly for sensitive species. Through the implementation of this habitat rating tool for sensitive or significant species, the habitat needs for each of these species can be met within the context of a sustainable, managed forest. Through use of a case study, this presentation will describe: 1) the method used in completing ecological base map products; 2) the methods used in determining habitat values for individual ecosystem units and in overlaying habitat ratings for sensitive species; and 3) the real-world application of this information in a forest development plan.

Contact:

Amit Saxena
Geowest Environmental Consultants Ltd.
Suite 203, 4209 - 99 Street
Edmonton, Alberta, Canada
T6E 5V7
780-461-5000
780-461-5036
asaxena@geowest.com

Session 4

Applications of Remote Sensing and GIS to Forestry 2

Integrating orthorectified RADARSAT data and geographic information system data for forest management

J.S. Paterson and U. Nielsen

Forest updating is the detection and recording of recent manmade or natural changes. The most common, currently accepted approach for forest updating is airphoto interpretation and subsequent updates using a geographic information system (GIS). This approach is well understood and accepted by the forestry community. Benefits include wide spread operational use of photography for additional forestry tasks, while limitations include cost, update ability, and weather dependence. This paper reviews how RADARSAT data can monitor forestry activity in several operational test sites in Canada and Ecuador. The methodology of processing, integrating, and analyzing multi-data sources, such as satellite data, GIS data, global positioning system (GPS) data, and aerial photography, can produce acceptable results for forestry management. Results show that the boundaries of high contrast forest clearcuts in RADARSAT fine mode data had a total root-mean-squared (RMS) error of 12.5 m compared to differentially corrected GPS data.

Contact:

Scott Paterson
Dendron Resource Surveys Inc.
808 Lady Ellen Place, Suite 206
Ottawa, Ontario, Canada
K1Z 5L9
613-725-2971
613-725-1716
paterson@dendron.com

Modeling ecosystem productivity using modern statistical techniques

R.C. Yang, Y. Wang, and I.G.W. Corns

The ability to identify sites and manipulate productivity variables for conservation and improvement of productivity is the basis of sustainable forest management. Productivity is influenced by climatic, topographical, geological, and soil factors. These factors are constituents of the ecosystem that can be assessed by numerical (quantitative and continuous) and categorical (qualitative, ordinal, or nominal) measures. Modeling ecosystem productivity, consequently, requires methods capable of handling both numerical and categorical variables. Neural network, generalized additive regression, and tree-based regression were used to model productivity of a forest management area in the central Alberta using site index as a productivity indicator. Results indicated that neural network and tree-based models were more realistic than others. With a mean squared error of 0.74 m, neural network method outperformed other techniques and was potent in modeling ecosystem productivity.

Contact:

Richard Yang
Natural Resources Canada
Canadian Forest Service
5320 – 122 Street
Edmonton, Alberta, Canada
T6H 3S5
780-435-7247
780-435-7359
dyang@nrcan.gc.ca

Assessments of very dense stands in old burns with data from the Compact Airborne Multispectral Imager (casi)

D.S. Davison, S. Achal, R. Gauvin, S. Lataille, and G. Newsome

This paper will provide an overview of analysis results using Compact Airborne Spectrographic Imager (casi) imagery in areas with high stem counts with the objective of identifying candidate areas for remedial thinning. The casi imagery was collected at the beginning of October 1999 over an old burn site near Bidwell Creek in the Chilcotin area of central B.C., using 10 spectral bands and 60-cm pixels. During a field inspection of the site, the key parameters identified for making a thinning decision were the stem densities and the presence of healthy dominant stems of sufficient size. For most ITRES forestry programs, individual stems can be detected with 60-cm pixel imagery; however, for areas with high stem densities, individual trees often cannot be resolved reliably. Hence, a combination of spectral and textural methods was used. The analysis algorithms needed to be trained on ground-based observations and were then applied to map out the variabilities in stand structure over large areas. This general approach of an algorithm that needs to be trained was used previously for stem counting for dense stands in the Chetwynd area in northeastern B.C. The new elements in the present method are the integration of the variations in stand stress to generate an information product more tightly linked to the thinning decision.

Contact:

Douglas Davison
ITRES Research Ltd.
#155, 2635 – 37 Avenue NE
Calgary, Alberta, Canada
T1Y 5Z6
403-250-9944
403-250-9916
doug@itres.com

Estimating tree heights of the boreal forest using airborne laser altimetry

B.A. St-Onge

Estimation of tree heights is either expensive if done in the field or imprecise when accomplished through photogrammetry. Scanning laser altimetry offers the possibility of separating the altitude of the forest canopy surface from the altitude of the underlying terrain, thus allowing for the quick estimation of canopy heights. However, estimating the height on an individual tree requires that the laser spot fall on the point of maximum height, an event that cannot normally be verified unless ancillary data is available. Two distinct aerial surveys yielded respectively 50-cm resolution multispectral imagery and a laser altimetry digital terrain model (about 1 point per 1.5 m^2). Pre-processing consisted in subtracting the interpolated terrain altitudes from the interpolated canopy altitudes to create a 50-cm resolution image of canopy heights. It was followed by the rectification of the corresponding multispectral imagery. The height of trees could then be extracted by obtaining the heights of X, Y, and Z laser points, overlaid on the rectified imagery, that appear to fall on the center part of the crown. A field survey was carried out to determine the heights of trees in order to validate laser heights. Actual tree heights measured in the field and laser estimated heights were regressed, yielding a high R^2.

Contact:

Benoît St-Onge
Department of Geography
Université Québéc à Montréal
CP 8888, succ. Centre-Ville
Montreal, Quebec, Canada
H3C 3P8
514-987-3000 Ext. 0280
514-987-6784
st-onge.benoit@uqam.ca

Session 5

Biodiversity

Spatial dimensions of conservation: concepts supporting conservation nets

R.W. Wein, A.K. Franke, and N.L. Salamon

Our federal government, in response to the environmental pressures, has committed to rare and endangered species legislation, conserving more conservation areas, and promoting a better balance of greenhouse gases input and output. At the provincial level there are additional pressures, with the government committing to protecting more representative landscapes and a new *Natural Heritage Act*. We suggest that conservation within land controlled by resource industries should consider the concept of Conservation Nets (CN), which consist of recognized conservation areas connected by multiple corridors. These will ensure greater potential for species daily movements, seasonal migration, and longer-term movements caused by environmental stress. We present some of the principles of conservation that are necessary to consider in building and maintaining CNs in landscapes that are already heavily fragmented. Our working hypothesis is that most rare and endangered species are located in the waterways and other less intensively managed parts of the landscapes thus CNs are still a viable option. We will also address the issue of land ownership and economic incentives that could foster the development of CNs.

Contact:

Ross W. Wein
University of Alberta
442 Earth Science Building
Edmonton, Alberta, Canada
T6G 2E3
780-492-2038
780-492-1767
ross.wein@ualberta.ca

Remote sensing and forest biodiversity monitoring in Alberta

E.E. Dickson, L.M. Moskal, S.E. Franklin, R.J. Hall, and D. Farr

Protocols for the long-term monitoring of forest biodiversity are being developed and tested by the Alberta Forest Biodiversity Monitoring Program in sites within the foothills near Hinton and the boreal forest near Lac La Biche. As part of this effort, satellite and airborne remotely sensed data are being used to extract and analyze biodiversity elements at the levels of the landscape and forest stand. For both pilot sites, data from Landsat Thematic Mapper (30 m spatial resolution) and Compact Airborne Spectrographic Imager (casi) (60 cm and 2 m) have been classified based on spectral information and/or the relationships between ground and remotely sensed measures derived from multivariate analyses and spatial statistics (i.e., crown closure, stem count density). The pattern and complexity of image based classes (patches) at various spatial scales have been quantified using measures of size, shape, connectivity, mean nearest neighbor, and so on. Examples and measures of forest biodiversity elements derived from imagery at multiple spatial scales will be presented. The use of remote sensing for monitoring, detecting change, and predicting change affecting landscape and forest stand levels of biodiversity will be discussed. Examples of landscape fragmentation resulting from forest practices will be illustrated. Focus will be given to cases with potential to alter the habitat availability for certain plant and animal species, to decrease patch size, to increase distance between patches, and to decrease the connectivity between patches.

Contact:

Elizabeth E. Dickson
Department of Geography
University of Calgary
2500 University Drive NW
Calgary, Alberta, Canada
T2N 1N4
403-220-7718
403-282-6561
eedickso@ucalgary.ca

Land cover mapping and landscape fragmentation analysis in support of grizzly bear habitat management

J. Dechka, S. Franklin, D. Peddle, and G. Stenhouse

A comprehensive grizzly bear research program is underway to develop an integrated and regional approach to address concerns over grizzly bear conservation in Alberta. This practical demonstration project is being conducted in a large area (5350 km^2) south of Hinton, Alberta, and includes a portion of Jasper National Park. This practical demonstration program is to use satellite imagery and ancillary data for land cover classification of a complex ecosystem comprising foothills and montane environments. Two approaches to image classification are evaluated in this project—namely, a maximum likelihood and evidential reasoning classifier. Maximum likelihood classifiers are limited to a smaller number of normally distributed, ratio-level data while evidential reasoning can process data at any level (e.g., image data, thematic geographic information system (GIS) data, rank-order information), and it is not restricted by data distribution or data volume. It can also incorporate other data types such as attribute tables, topographical descriptors, field observations and inventory information (e.g., Alberta Vegetation Inventory). By integrating image and GIS data, it is possible to obtain land cover classification products at higher accuracies using evidential reasoning compared to maximum likelihood. These products will provide suitable information to assist in assessing grizzly bear management issues related to landscape fragmentation.

Contact:

Jeff Dechka
GeoAnalytic Inc.
1150, 633 – 6th Avenue SW
Calgary, Alberta, Canada
T2P 2YS
403-213-2700
403-213-2707
jdechka@geoanalytic.com

Anthropogenic factors shaping the structure of a tropical forest: a study at Biligiri Rangaswamy Temple sanctuary, Western Ghats, India

M.C. Kiran, N. Barve, J. Poulsen, R.U. Shaanker, and K.N. Ganeshaiah

Biligiri Rangaswamy Temple wild life sanctuary is subjected to four different kinds of human pressures: a) the indigenous people living in and off the forest, b) the developmental activities from the state and public sectors, c) the plantations inside the sanctuary, and d) the extraction pressures from private and public groups, at the peripheries of the sanctuary. Based on these information layers, and using geographic information system tools, we have developed a map depicting the disturbance regimes that represent gradients of the anthropogenic pressures in the forest ecosystem of the sanctuary at a scale of 30-ha grids. Using the imageries of the sanctuary, we have computed the Normalized Difference Vegetation Index (NDVI) values for the corresponding 30-ha grids and have assessed the macro-level influence of the anthropogenic pressures on the forest vegetation. At a micro-level, we have assessed the spatial heterogeneity patterns created in the forest productivity and structure when human activities are grained into an otherwise homogenous forest ecosystem. We discuss the possible methods of linking the micro-level processes to understand the macro-level landscape patterns created due to human activities.

Contact:

M.C. Kiran
Ashoka Trust for Research in Ecology and the Environment
No. 17, 2nd Cross, Amarjyothi Layout, Cholanagar
Bangalore, Karnataka, India
560 032
91-80-353-3942
91-80-353-0070
kiran@atree.org

Session 6

Spatial Data Integration and Management

Information models: a tool for optimizing spatial data for forest management

A.G. Levinsohn

The forest sector in Canada adopted geographic information systems (GIS) about 15 years ago. Efforts to date by government agencies and forest products companies have largely focused on system implementation, data base creation, and automated cartography. The emphasis has been on producing the conventional information products faster and better. However, if GIS is to fully justify its cost and provide meaningful benefits to forest management, it must be more tightly integrated with forest management decision making. A comprehensive understanding of the relationships among key data is fundamental to better data integration and alignment with forest management. Information models provide a diagnostic and prescriptive tool for data planning, administration, integration, and management. This paper will review relevant information modeling principles and apply them to forestry data to demonstrate how information models can be used as tools for optimizing data usage in forest management.

Contact:

Allan Levinsohn
A G Levinsohn Consulting, Inc.
3 Woodside Lane
Canmore, Alberta, Canada
T1W 1T1
403-678-4591
403-678-4597
a_g_levinsohn@agt.net

Geographic information system-based heritage potential modeling and heritage management in the forest industry

T.H. Gibson and J. Finnigan

One of the issues that modern forestry planning must address is cultural heritage. Heritage resources, especially archaeological sites, are particularly difficult for large-scale land managers to deal with because their locations are rarely known and are difficult to predict without expert assistance of trained archaeologists. Even then, it is inevitable that forestry operations will affect heritage sites, and it is the legal responsibility of the forestry developer to take due diligence in minimizing potential for resource damage and also to provide contingency plans to deal with any cultural resources that are affected by forestry practices. The problem is twofold: How can forest planners know where heritage resource sites are located, and how should they manage them once locations are know? With the advent of desktop geographic information systems (GIS), archaeologists and foresters have begun to solve this problem by developing heritage potential models and GIS-based management procedures that can be integrated into modern forest management approaches. This paper will review the state of heritage potential modeling and identify some of the key methodological issues that must be addressed by forest planners to ensure that the models they use provide an accurate reflection of the heritage potential in their management area. It will also provide examples of how to use models to avoid affects on heritage caused by forestry practices. It will conclude by showing a working example of how heritage potential modeling and management is implemented in a GIS-based forestry management system.

Contact:

T.H. Gibson
Western Heritage Services Inc.
110 Lancaster Crescent
St. Albert, Alberta, Canada
T8N 2N8
780-458-5698
780-458-6923
tgibson@westernheritage.ca

Geodatabase Data Model—its impact on data management in forest information systems, an ESRI Canada perspective

D. Parry and L. Dmitruk

Sharing spatially related data within and between enterprises is of vital importance to stewards of our natural resources. Improving access to resource information in terms that professional foresters, biologists, and environmental scientists can relate has long been the desire of ESRI. With the introduction of the Geodatabase, geographic information systems (GIS) will become easier for non-GIS professionals to utilize and integrate with what traditionally have been disparate data sources. The Geodatabase will allow users to think of objects instead of traditional point, line, and polygon features. For example, a forester will be able to model a forest stand based on its interaction with other objects within its environment. This model is a radically different way of thinking about spatial information.

Contact:

David Parry
ESRI Canada
Box 11 Sterling Place
Suite 200, 9940 – 106 Street
Edmonton, Alberta, Canada
T5K 2N2
780-424-3774, Ext. 14
780-424-6110
dparry@esricanada.com

The transition from timber supply to resource supply analysis

D.R. Webb

Timber supply analysis has been carried out in some form for a very long time. For the most part, the approach to timber supply analysis has not changed. Computers have allowed us to look at the problem in far greater detail, but the general process has remained constant. It is difficult to identify the exact time when this changed, but timber supply analysis has now become resource supply analysis, and we are interested in far more than just how much volume the forest can supply. Habitat, biodiversity, landscape structure, and water quality are just some of the other resources that must be considered in conjunction with the timber. In order to deal with these issues, new tools have been required. These include spatially explicit forest planning models that have an ability to model more than just volume and tools to help evaluate results in terms of the other non-timber resources. The challenge with these other resources is to be able to quantify and measure them in a manner that can be easily understood and accepted by the public at large. A case study from Alberta is used as the basis for this discussion.

Contact:

David Webb
Olympic Resource Management
300, 475 West Georgia Street
Vancouver, British Columbia, Canada
V6B 4M9
04-806-3725
604-806-3701
rwebb@ormcanada.com

Session 7

Land Use and Cover Change (LUCC) 2

Patterns of forest cover change at regional and ecosystem levels in the Western Ghats, India: assessing the role of development and socioeconomic factors using geographic information system tools

N. Barve, M.C. Kiran, R.U. Shaanker, K.S. Bawa, and K.N. Ganeshaiah

We have traced the spatial and temporal patterns of land cover change from the early part of this century to the present in the central Western Ghats, India. Based on the archive maps and recent satellite imageries, we have documented the quantitative changes in the forest cover during three time periods at a regional level involving several districts of Karnataka State. Using geographic information system tools, we have attempted to relate the spatial and temporal patterns of forest cover changes at the district level to the expansion of plantations, agriculture and other development and socio-economic drivers. At the ecosystem level we have analyzed the spatial dynamics of forest cover change in and around Biligiri Rangaswamy Temple, a well-known wildlife sanctuary. We specifically compared the area that enjoys the protection as wildlife sanctuary with those in the neighborhood and assess the role of such policy decisions in the conservation of the forest areas. Further at the ecosystem level, we also analyzed the role of economic developments and agricultural activities in impacting the health of the forest.

Contact:

Narayani Barve
Ashoka Trust for Research in Ecology and the Environment
No. 17, 2nd Cross, Amarjyothi Layout, Cholanagar
Bangalore, Karnataka, India
560032
91-80-353-3942
91-80-353-0070
narayani@atree.org

Property-based analysis of wood supply and biodiversity on private woodlots in New Brunswick

H. Arnold

Private woodlots cover 31% of the forested landbase in New Brunswick (1.9 million ha). Current estimates indicate that private woodlots are being overharvested by 20–40%. The impacts of overharvesting on wood supply and forest biodiversity are unknown. In order to sustain these forest values, we need to understand how the forest will change over time as well as the impacts of the thousands of owners who are managing these forests. A project is underway to gather information on the management behavior of woodlot owners. The first step is to set up a geographic information system (GIS) that integrates forest inventory data with property data. The second step is to incorporate owner objectives (e.g., timber production, conservation) from a survey into the GIS. This inventory will be the starting point for a forecast of wood supply and biodiversity (of forest communities) on private woodlots that will track these values in response to current and alternative management strategies. The results will indicate if and when a wood supply shortage occurs, the impacts on forest biodiversity, and the sustainable harvest level or annual allowable cut. This information will be used to help make policy and management decisions for the sustainable management of private woodlots.

Contact:

Holly Arnold
Faculty of Forestry and Environmental Management
University of New Brunswick
P.O. Box 4400
Fredericton, New Brunswick, Canada
E3B 5A3
506-447-3469
506-453-4817
e01x@unb.ca

Survey of forest cover in Costa Rica using Landsat images 1986/87–1996/97

J.C. Calvo, G.A. Sanchez-Azofeifa, V. Watson, R. Bolaños, P. González, J. Saborío, C. Quesada, and M. Ramírez

This study seeks to generate information that would enable researchers to analyze and value the degree and extent of fragmentation of forest cover in Costa Rica, and to quantify the rate of deforestation and forest regeneration. This information would be greatly useful for future studies concerning biodiversity conservation and the analysis of possibilities for different environmental services related to the current state of forest cover. For purposes of this study, seven satellite images were analyzed. Criteria for selection established that the images should not have more than 20% cloud cover. These images date from the end of 1996 and the beginning of 1997. Standard procedures established by the NASA Landsat Pathfinder project were used in the automated classification of satellite images of different types of forest cover and other land uses. Analysis of satellite-image interpretation for 1996/97 indicate that Costa Rica has about 40% of total forest cover, which includes primary forests, secondary-growth forests, mangroves, palm forest swamps, and tree plantations. Due to cloud cover and shadows on the images, 8.7% of national territory could not be clearly interpreted. About 10% of forest cover was lost during the 10-year period from 1986/87 to 1997. However, 7.9% of total forest cover present in 1986/87 was recovered through plantations and secondary-growth forest. During this period the mangrove deforestation rate was low, calculated at 500 ha or 1% of the total area of mangroves.

Contact:

G. Arturo Sanchez-Azofeifa
Earth and Atmospheric Sciences Department
University of Alberta
Edmonton, Alberta, Canada
T6G 2E3
780-492-1822
780-492-2030
arturo.sanchez@ualberta.ca

Session 8

Applications of Remote Sensing and GIS to Forestry 3

Defining a monitoring system for tropical dry forest in Costa Rica: implementation of algorithms using remote sensing and geographical information systems

P. Arroyo, G.A. Sanchez-Azofeifa, and J. Calvo

It is estimated that less than 2% of the tropical dry forest remains as relatively undisturbed wildlands in Mesoamerica, and only 0.08% of it lies within national parks or other kinds of protected areas, mainly in the province of Guanacaste, Costa Rica. Until 1998, when the most recent remote sensing based forest cover assessment of Costa Rica was carried out, some issues could not be resolved using available remote sensing techniques. One of the most significant limitations was the inability to identify different types of land cover in the Tropical Dry Forest life zone (i.e., pasture lands, wood plantations, pristine forests, secondary forests, etc.). A Landsat Thematic Mapper (TM) image from the dry season had been used unsuccessfully because the deciduous forests and the pasture land had very similar spectral responses. Because of the importance of accurately identifying tropical dry forests, as opposed to other land cover, this study is developing a methodology that helps to identify different land cover characteristics of the Tropical Dry Forest life zone using a new set of Landsat 5 and 7 TM images and high-resolution images from the IKONOS™satellite. These images represent the rainy season (including a unique Landsat TM image without clouds from October 1987) and the dry season (January, February, March, and April). By analyzing the seasonal response of the vegetation, it is possible to get an average spectral response that can be applied to the 1999/2000 Landsat TM images. With the help of this methodology, information on land cover and land use for the province of Guanacaste can be provided to government agencies and other organizations, assisting them in the analysis and prioritization of forested areas or conservation, research, and management. Furthermore, this study is fundamental to integrate Costa Rica's tropical dry forest formations into the Mesoamerican Corridor, which is an international proposal that strives to conserve forest areas in all countries between Mexico and El Darien in Panama.

Contact:

G. Arturo Sanchez-Azofeifa
Earth and Atmospheric Sciences Department
University of Alberta
Edmonton, Alberta, Canada
T6G 2E3
780-492-1822
780-492-2030
arturo.sanchez@ualberta.ca

Counting individual stems in forest plantations and thinned regions using images from the Compact Airborne Spectrographic Imager (casi)

D.S. Davison, S. Lataille, and S. Preiss

Compact Airborne Spectrographic Imager (casi) imagery was collected over a number of different sites that had either been planted in a reasonably regular grid or that had been thinned to a nominal density. These types of sites can represent differing forest management concerns and often require different casi analysis methodologies. This paper provides an outline of some of the practical concerns in generating the appropriate information product. This paper first outlines the results from a demonstration project in Ontario boreal forests where the planted species was jack pine (*Pinus banksiana* Lamb.). The planted trees were typically 2 to 3 m tall and had a nominal separation of 2 m. In this case, both the stem counts and health of the desired (planted) species and the invasion of less desirable species were important. The stems were counted using a combined spectral and spatial technique and were compared to ground-based counts. The test areas included areas of partial cloud shadow demonstrating the illumination-independence of the analysis methodology. The major non-desired invasive species was larch (*Larix laricina* [Du Roi] K. Koch). The spectral characteristics of the jack pine changed dramatically, as the planted area became less fertile or more waterlogged. Spectral masks can then be used to include only the healthy jack pines for stem statistics. Thinned stands can have a similar type of regular spacing as plantations but often require modified techniques depending upon the tree size and the type of ground cover. The operational objectives for these areas are usually related to monitoring the success of the thinning and generating new stem density estimates. A comparison of the methods and results will be shown from a partial cut region in an area of large Douglas-fir (*Psuedotsuga menziesii* Mirb.) on Vancouver Island and from a thinned area of lodgepole pine (*Pinus contorta* Dougl. ex. Loud. var. *latifolia* Engelm.), having typical DBHs of 6–10 cm, in the Chilcotin area of central B.C.

Contact:

Douglas Davison
ITRES Research Ltd.
#155, 2635 – 37 Avenue NE
Calgary, Alberta, Canada
T1Y 5Z6
403-250-9944
403-250-9916
doug@itres.com

Improved forestry information in mountainous terrain using a modified canopy reflectance model and airborne casi imagery

R.L. Johnson, D.R. Peddle, and R.J. Hall

Obtaining quality forest information over mountainous areas is important for forest management in western Canada. The effects of terrain and forest structure on the radiometric properties of multispectral casi imagery were examined in the context of remote sensing ground-based optical measurements of leaf area index (LAI). To account for these variations, a new modified approach using the Li and Strahler Geometric Optical Mutual Shadowing (GOMS) model in 'multiple forward mode' (MFM) has been developed. The MFM approach relaxes the rigorous requirements for actual measurements of stand attributes compared to standard modeling cases. This is because the MFM approach requires only a range of stand attributes typically available in base line inventory data (e.g., Alberta Vegetation Inventory). As output, the MFM approach produces a series of graphical tables providing forest managers with an easy-to-understand representation of the complex relationships between forest structure, terrain, and stand reflectance. Using this method, significant improvements in the estimation of forest information such as LAI has been realized compared to four other conventional, statistically based approaches. The main advantage to forest managers using this approach is the introduction of a physical basis that is related directly to forest structure, as an improvement on previous approaches, which provide general statistical information only.

Contact:

Derek Peddle
University of Lethbridge
4401 University Drive
Lethbridge, Alberta, Canada
T1K 3M4
403-329-2524
derek.peddle@uleth.ca

The effects of slope on optical methods and allometric equations for estimating conifer leaf area index

D.P. Davidson, R.J. Hall, D.R. Peddle, and R.L. Johnson

Leaf Area Index (LAI) is a measure of vegetation structure that is related to biomass, carbon and energy exchange and is an important input to ecological and climate change models. It can be estimated using algorithms applied to airborne and satellite images, but it requires reliable ground-based measurements of LAI. In this paper, LAI estimates from four optical ground-based methods, a set of allometric equations, and high resolution remote sensing images were compared from lodgepole pine, white spruce, and mixed conifer stands located on two slope classes (0–20° and greater than 20°) in the Kananaskis area, Canadian Rocky Mountains. Optical LAI measurements were made using a LI-COR LAI-2000 instrument, a hemispherical camera system, a Tracing Radiation and Architecture of Canopies (TRAC) system, and an integrated method, which combines LAI-2000 and TRAC measurements. Allometric equations have been constructed to relate individual tree LAI to species-specific cross-sectional sapwood basal area. These measurements were compared to LAI estimates obtained from Normalized Difference Vegetation Index (NDVI), spectral mixture analysis, and optical modeling of Compact Airborne Spectrographic Imager (casi) images. An understanding of the influence of terrain on the variability of field-based optical LAI measurements and remote sensing LAI estimates will give researchers a tool for field instrument selection for remote sensing field validation and image analysis.

Contact:

Diedre Davidson
University of Lethbridge
4401 University Drive
Lethbridge, Alberta, Canada
T1K 3M4
403-381-7129
davidp@uleth.ca

ABSTRACTS OF POSTERS

An analysis of geographic information system-based habitat modeling for the Canada Lynx in west-central Alberta

A. Doucette

Research to be presented on the poster relates to biodiversity and forest management on Millar Western Forest Management Area lands (Whitecourt, Alberta). A geographic information system-based habitat model has been developed for the Canada Lynx (*Lynx canadensis* Kerr) and is specific to this area. The purpose of the model is to assess habitat changes through space and time as environmental conditions transform based on timber harvesting practices. In assessing lynx habitat response to harvest operations, it will be determined if biodiversity is being conserved and if not, sound research and monitoring for forest biodiversity will be implemented. This model requires explicit testing to ensure a high level of performance and reliability for future planning studies. The research I am conducting will validate whether the model is sufficiently robust as a projection tool. The poster will briefly outline the purpose of the research project, the lynx ecology/biology, the general structure of the model via a flow chart, and results of the sensitivity analysis. At the time of the conference I will be snow-tracking lynx in Whitecourt to test projected uncertainties discovered during the sensitivity analysis. Preliminary results of my field work may also be presented at that time.

Contact:

Andrea Doucette
School for Resource and Environmental
Dalhousie University
1312 Robie Street
Halifax, Nova Scotia, Canada
B3H 3E2
902-423-5468
902-494-3728
amdoucet@is2.dal.ca

Creation of distribution map and estimation of available stand volume of Hiba in Japan

E. Nakazono, H. Sawada, K. Kawabata, M. Anazawa, I. Nagatani, and N. Mituduka

To ensure sustainable wood supply, it is necessary to estimate the distribution of stand volume of Hiba (*Thujopsis dolabrata* S.et Z) in the natural forests of Shimokita Peninsula in Japan. For this purpose, it is necessary to find the index that corresponds to the basal area of Hiba. We applied the pattern decomposition method, one of the methods for overcoming mixed problem, which decomposite thematic mapper data to water (W), soil (S), and vegetation (V) patterns. This method reduces the topographical effect of remote sensing data. It is found that the relation between W pattern value and basal area is useful to estimate the stand volume. Then we produced the distribution map of the Hiba stand volume. Using the distribution map, we analyzed the relationship between stand volume of Hiba and two geographical conditions, the inclination angle, and the distance from roads. We assumed that the location where inclination angle is less than 25° and distance from road is 200 m is suitable for felling, and estimated available volume of Hiba. Finally, we found that less than 20% of the stand volume is available for wood supply.

Contact:

Etsuko Nakazono
Forestry and Forest Products Research Institute (FFPRI)
1, Matsunosato, Kukizaki-cho
Inashiki-gun, Ibaragi prefecture, Japan
305-8687
81-298-73-3211
81-298-74-3720
nakazono@ffpri.affrc.go.jp

Cutblock update with India IRS-1C imagery

R.J. Hall, N. Walsworth, M. Gartrell, T. Balce, and K. Dutchak

Increasing demands on the forest resource and the high costs of the inventory process is driving the need for methods by which cost-effective update can be accomplished. Cutblock information is currently derived from aerial photographs, but an be expensive when large areas need to be updated. The India IRS-1C panchromatic sensor with 5.8-m spatial resolution has been the satellite with the highest spatial resolution prior to the recent launch of the IKONOS remote sensing satellite. The objective of this study is to compare photogrammetrically derived cutblock boundaries and areas with those interpreted from orthorectified and geometrically corrected IRS-1C panchromatic images. Aerial photographs at a scale of 1:20 000 were aero-triangulated digitally and displayed on a stereo photogrammetric workstation (DiAP viewer) from which cutblock information was derived. These cutblocks were spatially overlaid and statistically compared to those mapped from on-screen digitization of orthorectified and geometrically corrected India IRS-1C panchromatic images. Regardless of rectification methods, mapping accuracies will vary with factors such as cutblock size, shape, and topography.

Contact:

Ron Hall
Natural Resources Canada
Canadian Forest Service
5320 – 122 Street
Edmonton, Alberta, Canada
T6H 3S5
780-435-7209
780-435-7359
rhall@nrcan.gc.ca

Development of a decision support system for management of roadside trees

E. Ducheyne and R. De Wulf

Management of roadside trees has often been neglected over the last four decades, notwithstanding their considerable ecological, social, and productive functions in rural areas. Decision Support Systems (DSS) have been created mainly for harvest scheduling in forestry, but these DSSs have rarely been implemented outside the forestry sector. In Flanders, Belgium, roadside trees are usually owned by a public agency. Often, these public owners lack tree management skills. In the experimental region (province of West-Flanders) the OCMW (English equivalent: Public Centre for Social Welfare) owns 2500 roadside trees (*Populus* and *Quercus* spp.). There was no evidence of management in the past. The study's objective was to design a decision support tool to assist the owner in making decisions concerning pruning, felling, and restocking. To achieve this a full inventory was performed. Different tree parameters were measured and linked to their spatial position in a geographic information system in order to create a visual representation. In the modeling phase, several pruning and felling scenarios were developed and evaluated. All scenarios were retained in the final product, together with a ranking of their applicability. This final DSS will be implemented shortly and will be closely adhered to over the next years for future validation purposes.

Contact:

R. De Wulf
University of Gent
Coupure Links 653
Gent, East-Flanders, Belgium
9000
32-9-264-61-10
32-9-264-62-40
robert.dewulf@rug.ac.be

Eco-distribution mapping of medicinal plants of conservation concern in southern India

D.K. Ved, V. Barve, and S.N. Begum

The Indian sub-continent is one of the most distinct bio-geographic regions of the world, with a rich repository of medicinal plant species. As a consequence of unregulated use, the plant populations are heading towards alarming depletion, coupled with fragmentation of natural habitats. More than 2000 medicinal plants are estimated to be present in the southern Indian states of Kerala, Karnataka, and Tamilnadu. These are distributed across the different forest types of the region ranging from wet evergreen to dry deciduous forest. Understanding of natural distribution pattern and eco-climatic limits of these taxa helps in formulation of their conservation strategies. Identification of zones of speciation and demarcation of hotspots of biological diversity, covering all kinds of habitats that are rich in biological diversity also aid in the conservation measures. The conservation efforts are best aided by vegetation and land-use maps. Systematic mapping of the occurrence of the species in an area provides distribution patterns related to the ecological parameters. It gives an insight into the region where the conservation has to be initiated and the extent of protection required. In this paper we are presenting how FRLHT, Foundation for Revitilization of Local Health Traditions, is using GIS for eco-distribution mapping of prioritizes medicinal plants of southern India.

Contact:

Vijay Vasant Barve
FRLHT
50 MSH Layout, Anand Nagar
Bangalore, Karnataka, India
560024
91-80-3336909
91-80-3334167
vijay@frlht.ernet.in

Forest fuel classification in Yukon using remotely sensed land cover of Canada

S.R. Francis, N. Flynn, O.B. Armitage, and B.D. Lawson

Yukon is predominantly a forested landscape; over 60% of the territory is covered by coniferous forests. An important component of forest management in Yukon and all of northern Canada is fire suppression and fire risk reduction around the widely dispersed communities. Like many other jurisdictions, Yukon is moving from a phase of fire suppression to fire management. The implementation of effective fire management requires an accurate forest fuel classification and risk assessment. Until recently, this information was generally lacking in the territory as forest cover mapping only covers southern Yukon. In an effort to provide cost-effective fire management information for large geographic areas, a forest fuel classification was produced for all of Yukon using the 1 km National Oceanic and Atmospheric Administration Advanced Very High Resolution Radiometer land cover of Canada (ver. 1.1) classification produced by the Northern BIOsphere and Modeling Experiment project. Forest fuel typing algorithms generated through two seasons of ground and aerial surveys in southern Yukon were used to assign Fire Behavior Prediction fuel types to each land cover class from the satellite imagery. This was an exploratory exercise designed to provide a comparison between the accuracy of 1:50 000 scale forest cover mapping and 1 km land cover of Canada. Forest fuel type verification and accuracy assessment is ongoing.

Contact:

Shawn Francis
Applied Ecosystem Management Ltd.
Suite 100, 211 Hawkins Street
Whitehorse, Yukon, Canada
Y1A 1X3
867-393-3793
867-393-2247
sfrancis@yknet.yk.ca

Geographic information systems and remote sensing: tools for assessing responses of mountain caribou to different types of linear developments in west-central Alberta

P. Oberg, C. Rohner, and F. Schmiegelow

Since 1985, woodland caribou (*Rangifer tarandus caribou* [Gmelin]) have been designated as an endangered species in Alberta, under the *Wildlife Act*. Human developments resulting in linear features (roads, pipeline right-of-ways (ROWs), seismic lines, and powerline ROWs), and associated increases in access, have been implicated as one of the primary conservation concerns for caribou. This study investigates the movement and distribution of migratory mountain caribou to different types of linear developments, with variable internal attributes, in west-central Alberta. Prior to assessing the distribution of caribou with respect to linear features, an accurate and current base map coverage of linear developments was required. The base map coverage was developed by digitizing 1998 Indian Resource Satellite (IRS) imagery (5 m × 5 m pixels). The IRS imagery, aerial photographs, and available development maps were interpreted for vegetation, type of development, and width attributes. These attributes were verified through ground-truthing. Caribou were fitted with automatic global positioning system (GPS) transmitters, and location data has been collected over the winters of 1998/99 and 1999/00. The GPS data have been intersected with the base map, and caribou locations are being analyzed with respect to linear developments, using a buffer analysis. Both the accuracy and timeliness of the base map and caribou location data offer a unique fine-scale investigation into the potential impacts of different types of linear developments, with variable attributes, on mountain caribou.

Contact:

Paula Oberg
Department of Renewable Resources, GSB 7-51
University of Alberta
Edmonton, Alberta, Canada
T6G 2H1
780-492-9240
780-492-4323
poberg@gpu.srv.ualberta.ca

How landscape characterization may affect the interpretation of woodland caribou habitat selection in southeast Yukon: implications for forest management

N. Flynn, R. Florkiewicz, S. Francis, and N. MacLean

Liard Basin, in southeast Yukon Territory has come under increased forest-harvesting pressures. Some areas targeted for harvesting are in direct conflict with an important wintering range of Little Rancheria caribou herd. To manage this area for both forestry and protection of caribou habitat, it is important to understand the resources required to sustain a viable caribou winter range. Four systems of landscape classification were examined in order to identify habitat selection by caribou within their winter range. Three seasons of very high frequency (VHF) telemetry collar data for 27 caribou (*Rangifer tarandus caribou* [Gmelin]) were collected by biologists from 1996 to 1999. The four systems of habitat characterization used in the analysis were 1) Broad Ecosystem Mapping (BEI), 2) soil/surficial geology, 3) modified ecosystem classification vegetation types (V-types), and 4) Yukon forest cover. Telemetry locations were combined with each of the four landscape representations within a geographic information system environment. It was found that each method had limitations. These limitations included how well the understory component of the forest structure was described; the scale at which the information was collected; and extent of the area covered. Overall the BEI, soil, and forest cover mapping were found to be of limited use. To make operational-level forest management decisions it is suggested that ecologically based habitat classes, which incorporate soil and vegetation community associations, be developed at a scale of 1:50 000. Currently, digital forest cover mapping is the most readily available source of habitat characterization for forest management planning.

Contact:

Nadele Flynn
Applied Ecosystem Management Ltd.
Suite 100, 211 Hawkins Street
Whitehorse, Yukon, Canada
Y1A 1X3
867-393-3793
867-393-2247
nflynn@yknet.yk.ca

Implementation of a countrywide tropical deforestation monitoring system in Costa Rica: quantification of tropical rainforest fragmentation

G.A. Sanchez-Azofeifa, J. Calvo, P. Arroyo, and P. Van Laake

The transformation and degradation of tropical forests represents the primary driving force in the loss of biological diversity worldwide. The challenge of seeking balance between undisturbed nature and the human domination of ecosystems in tropical regions will be increasingly contentious in the next few decades due to population growth and the need for improved socioeconomic welfare phenomena that will be coupled with internationalization and globalization of national economies. Environmental degradation of tropical environments is a major concern for developing countries in the Central American region. Deforestation and its impact on biodiversity loss, soil erosion, water pollution, and the degradation of scenic values influences the economic productivity and quality of life in this region, and is, therefore, considered to represent one of the most pressing environmental issues in the region. Despite growing public concern, and increasing political rhetoric, actions have been relatively ineffective in managing this problem. Tropical forests in the Central American region are being destroyed and degraded in critical ecosystems, and tropical forests suitable for timber production are being lost at rates exceeding reforestation efforts. This paper presents major research efforts by the Earth Observation Systems Laboratory (EOSL) at the University of Alberta and the Tropical Science Center to develop and implement a monitoring system using remote sensing techniques. The main goal is the development of protocols aimed to quantify the extent of forest loss, the dynamics of deforestation rates and the level of forest fragmentation in Costa Rica, Central America. This paper reports results from a first wall-to-wall assessment of forest cover that was implemented for three epochs: 1970s, 1980s, and 1990s for this tropical country. Results indicate that even though the country has a total of 40.3% of forest cover, the level of forest loss and fragmentation has affected crucial ecological zones. In a country that holds about 5% of all tropical biodiversity, these results provide important information for the definition of conservation policies and carbon sequestration initiatives under the Biodiversity Convention and the Kyoto Protocol, respectively.

Contact:

G. Arturo Sanchez-Azofeifa
Earth and Atmospheric Sciences Department
University of Alberta
Edmonton, Alberta, Canada
T6G 2E3
780-492-1822
780-492-2030
arturo.sanchez@ualberta.ca

Incorporating woodland caribou habitat into forest management planning in northwestern Alberta

R.B. Anderson and D. Kmet

Alberta's boreal woodland caribou (*Rangifer tarandus caribou*) are listed as a threatened species and are considered to be at risk of declining to non-viable population levels if limiting factors are not reduced. Research conducted by the Boreal Caribou Research Program indicates that caribou avoid some types of industrial activity, thereby effectively reducing the amount of available habitat. Natural resource companies may be able to reduce their impact on woodland caribou by planning activity on caribou range to coincide with areas that are naturally avoided by caribou. The purpose of this project was to develop models for predicting caribou distribution over a large land base. The ultimate objective was to use this information to aid in forest management planning for the Daishowa-Marubeni International Ltd. (DMI) Peace River Forest Management Area (FMA). Models were developed from Alberta Vegetation Inventory data and caribou radio-telemetry data using ArcView and ArcInfo. Model predictions were verified using additional caribou location data. Maps of potential caribou distribution were then produced for the DMI Peace River FMA. These maps have been incorporated into the DMI Forest Management Plan and will aid planners in decision making for areas of potential conflict between woodland caribou and industrial activity.

Contact:

Robert Anderson
Applied Ecosystem Management Ltd.
Suite C, 11301 – 89th Avenue
Grande Prairie, Alberta, Canada
T8V 5X3
780-831-7331
780-831-7331
rba@telusplanet.net

Landscape controls on the loading of phosphorus to boreal lakes following timber harvest: a physical basis for adaptive buffer strip strategies

K.J. Devito, I.F. Creed, R.L. Rothwell, and E.E. Prepas

This paper considers the influence of upland-riparian-lake hydrologic linkages on the potential impacts of timber harvesting and the potential effectiveness of buffer strips on the phosphorus chemistry of lakes in the western boreal forest. We hypothesize that landscape properties will influence the potential susceptibility of a lake to a disturbance. To test this hypothesis, we examine relationships between indexes of landscape properties and changes in the concentration and mass of total phosphorus (TP) in headwater lakes following a timber harvest. Among the lakes, a large portion of the variation in changes in TP could be explained by: 1) an index of the hydrogeologic setting of the lake, which influences the degree of interaction of the lake with the regional, intermediate, and/or local groundwater flow system; 2) the size and organization of saturated source areas of TP (wetlands and ephemeral draws), that influences the potential for hydrologic flushing of TP through surface hydrologic connections to the lake; and 3) the curvature of the shoreline of the lake, that influences the pathway of water moving through the riparian forest to the lake. We synthesize our landscape indexes into a conceptual hierarchy of processes to provide a physical basis for generating adaptive buffer strip strategies for lakes overlying complex hydrogeology.

Contact:

I.F. Creed
University of Western Ontario
Biology and Geology Building
London, Ontario, Canada
N6A 587
519-661-4265
519-661-3935
icreed@julian.uwo.ca

Mapping conifer understory from satellite imagery

R.J. Hall, D.R. Peddle, and D.L. Klita

Information about the presence and spatial distribution of white spruce conifer understory within deciduous and deciduous-dominated mixed-wood stands is required for boreal mixed-wood management in Alberta. A method involving satellite data can provide useful information at the planning level by providing an initial stratification of the forest landscape for understory location, distribution, and amount. This study compared understory maps produced with an iterative supervised classification algorithm and a knowledge-based evidential reasoning classifier. Understory information from interpretation of leaf-off aerial photographs was overlaid onto two-date, leaf-off and leaf-on, Landsat Thematic Mapper images from which random pixel samples were extracted for classification. Variables used in classification included digital Landsat Thematic Mapper image data and stand structure information available from the Alberta Vegetation Inventory. Similar classification accuracy results were obtained from the two classifiers with spectral data alone, but accuracy increased significantly using the evidential reasoning classifier when information about stand structure was added to the classification exercise. Image maps were produced at a scale of 1:20 000 and are being evaluated for their informational value.

Contact:

Ron Hall
Natural Resources Canada
Canadian Forest Service
5320 – 122 Street
Edmonton, Alberta, Canada
T6H 3S5
780-435-7209
780-435-7359
rhall@nrcan.gc.ca

Polygon decomposition: a procedure for using remotely sensed data to add new information and update existing information in geographic information system databases of forest inventories

M.A. Wulder, S.E. Franklin, L.M. Moskal, and M.B. Lavigne

Polygon decomposition refers to the process of analyzing previously delineated polygon areas using ancillary digital information acquired from an independent source, such as remotely sensed data. The polygon data are used as the context for the analysis of the remotely sensed data. The polygonal data represent areas of generalization and the remotely sensed data can be used to make measurements or aggregate information in a meaningful way within those generalized areas. The fusion of the raster and vector data allows for the augmentation of current information in the previously delineated polygon areas. The current information available from the remotely sensed data may be physical properties, such as spectral reflectance values, or categorical properties, such as the result of an image classification or change detection procedure. This poster will illustrate the process for undertaking polygon decomposition procedures in research and application contexts. Specifically, we provide examples of polygon decomposition in the update of forest stand polygon labels and in the identification of forest cover and structural change.

Contact:

Mike Wulder
Natural Resources Canada
Canadian Forest Service
506 West Burnside Road
Victoria, British Columbia, Canada
V8Z 1M5
250-363-6090
250-363-0775
mike.wulder@nrcan.gc.ca

Geographic information system (GIS) applications in Oregon's western forests: contributions and limitations of GIS technology to forest research

M. Wing

Organizations are increasingly using a geographic information system (GIS) to help manage forest resources. This paper examines several studies of forested ecosystems conducted by Oregon State University's Forest Engineering Department. Each study utilized spatial data and relied on GIS technology for analyzing the data. Study objectives included analyzing aquatic habitat, mapping slope stability, quantifying large woody debris distribution, and calculating visual sensitivity of a forest. Output and findings from each study are examined and critiqued in light of the role GIS played. Based on these findings, the contributions, limitations, and practicality of using a GIS to assist forest resource research are discussed. The GIS strengths included an ability to integrate data sources, reorganize and restructure data, and to present visual or mapped results. Limitations to using a GIS included integrating different data structures, data availability and quality, and a lack of statistical tools within common GIS software.

Contact:

Michael Wing
Forest Engineering Department
Oregon State University
Peavy Hall 215
Corvallis, Oregon, USA
97331
541-737-4009
541-737-4316
michael.wing@orst.edu

Quantification of animal movement in the Amboseli-Tsavo region of Kenya

A. Franke, R.W. Wein, G.A. Sanchez-Azofeifa, and R. Hudson

This research proposes a multi-phase approach to quantifying animal movement within spatially explicit landscapes and has broad implications to conservation and management of biodiversity using remote sensing techniques. A corridor shall be identified by combining satellite image data with least-cost path analysis and hierarchical scaling of friction indexes. An individual based movement model will describe how virtual individuals move through spatially explicit least-cost paths. Finally, actual individuals shall be tracked remotely and their movement compared to that of virtual individuals. The objectives are to map the landscape and identify a least-cost path, determine and prioritize the variables associated with animal movement, model the movement of virtual individuals through a least cost path and compare the movement of virtual individuals to actual individuals. Remote sensing (RS) and geographic information system (GIS) technology is potentially the most accurate way to prepare the synoptic view required to characterize the landscape, and, in addition, is integral to development of the spatially explicit movement model. Gap analysis using RS and GIS technology could potentially identify current land use, land cover conversion, and ideal location of conservation networks—a strategy that may facilitate recolonization, counter species extinction, and increase carbon sequestration and gene flow.

Contact:

Alastair Franke
University of Alberta
11118 – 71 Avenue
Edmonton, Alberta, Canada
T6G 0A4
780-435-9499
780-435-9499
afranke@planet.eon.net

Quantifying tree encroachment in rangelands using image classification and pattern detection

Y. Bai, N. Walsworth, B. Roddan, D.A. Hill, K. Broersma, and D. Thompson

Tree encroachment has reduced grasslands in British Columbia. Recent developments in remote sensing focus on high resolution, multi-spectral digital imageries and often overlook the 'old', black-and-white aerial photos. In addition, most tree delineation techniques are better for dense forests than for scattered trees. We tested the usefulness of black-and-white aerial photos in image analysis for studying tree encroachment using commercially available remote sensing and geographic information system software. Aerial photos from 1966 and 1995 were scanned at 0.5 m resolution, covering 100 ha of grasslands and forests. The maximum likelihood classifier was used to separate tree, shadow, and grassland pixels. Tree-shadow contacts were used to model circular crown masks. A moving sample window was applied to calculate tree coverage and the imagery was classified into open grassland (0–4.9% tree cover), treed grassland (5–14.9%), open forest (15–34.9%), and closed forest (greater than 35%). Results showed that about 27% open grassland was lost to tree encroachment between 1966 and 1995 within the test area. Compared to field measurements, tree coverage from image analysis was 0.8, 2.6, and 1.0% lower for open and treed grasslands, and open forests, but the error increased significantly when trees were dense (12.4% lower for closed forests). The under-estimation of tree coverage was possibly caused by 1) limited information in the black-and-white photos, and 2) omission of small trees and generalization of tree groups, which are also problems with high resolution, multi-spectral imageries. The accuracy was reasonable for the concerned grasslands, but improvement is needed for areas with high tree density.

Contact:

Nick Walsworth
Natural Resources Canada
Canadian Forest Service
5320 – 122 Street
Edmonton, Alberta, Canada
T6H 3S5
780-435-7384
780-435-7359
nwalswor@nrcan.gc.ca

The forest management planning process in Ontario requires that managers monitor the spatial and temporal trends in net primary productivity (NPP) across management units and planning regions. In support of this requirement, we implemented an analytical process to derive monthly mean provincial-scale NPP surfaces for each of 3 years, using geographic information systems and remotely sensed data. The analysis utilized a number of data sources and models: the National Oceanic and Atmospheric Administration Advanced Very High Resolution Radiometer monthly composites were used to predict normalized difference vegetation index (NDVI) at an 8 km resolution for the entire province. The NDVI was re-scaled to yield the fraction of intercepted photosynthetically active radiation (FPAR). Photosynthetically active radiation (PAR) was estimated using mountain microclimate simulator and calibrated with Geostationary Operational Environmental Satellite data. Light use efficiency (LUE) was modeled as a function of climate using the Regional Hydro-Ecological Simulation System at four study sites. Climate data from several hundred weather stations was extrapolated to an 8-km provincial grid and used to derive PAR, APAR (absorbed PAR), and LUE surfaces. Ultimately, NPP surfaces were derived as a function of LUE and APAR, for each month in the years 1992, 1993, and 1994. Data management and processing were carried out using ArcInfo and the Geographic Resources Analysis Support System.

Contact:

Frank Schnekenburger
Ministry of Natural Resources
1235 Queen Street East
Sault Ste. Marie, Ontario, Canada
P6A 2E5
705-946-2981
705-946-2030
frank.schnekenburger@mnr.gov.on.ca

One of the main problems for the conservation and the intelligent use into perpetuity of the biological richness in the tropics is the lack of updated information for decision making. Looking to solve this problem in Costa Rica, the ECOMAPAS (Collection of ecological data and mapping of ecosystem distribution in five Conservation Areas) Project has been implemented. This project is based on the gathering of ecological data and in mapping of the ecosystem's distribution in five Conservation Areas. Using aerial photographs (1:40 000) and an exhaustive ground-truthing it was possible to recognize, classify, map, and describe a considerable number of ecosystems and vegetation types. The first Conservation Area in the ECOMAPAS project that was worked on was the Osa Conservation Area (ACOSA), one of the most important for its richness in biodiversity and endemism. The ACOSA is also one of those areas with a very strong pressure on its natural resources. This pressure is highly noticeable in the Osa Peninsula, mainly through the timber activities, as well as the expansion of the agricultural frontier. It has reached a level of substantial concern because of the forest and landscape fragmentation. Using the information generated by ECOMAPAS, among other sources, we have been able to make an assessment of the possibilities of creating a biological corridor between the two biggest forest masses in the region: the Corcovado National Park and the Piedras Blancas National Park. Likewise, some items are suggested that should be taken into account for the consolidation of the biological corridor.

Contact:

Marco Castro
Instituto Nacional de Biodiversidad
Apdo 22
Santo Domingo, Heredia, Costa Rica
3100
506-244-0690
506-244-2816
mcastro@inbio.ac.cr

Trail network realignment model

A. Hebb and M. Lindberg

Forested areas with mountainous topography often have naturally fragmented landscapes. These areas are usually home to populations of large bodied animals, and they also attract a high amount of recreational use. The highly fragmented landscape of the Bow Valley, resulting from both development and topography, has had serious implications for wildlife persistence and ecological function potentially leading to a loss of local biodiversity. Historically no tool was available to recreation planners to assess ecological, wildlife, and recreation criteria for the realignment of existing trail networks or the design of new trail segments. We developed a geographic information system (GIS) application in ArcInfo that assesses an existing trail network and produces an optimal trail alignment. Optimal trail alignments provide a basis for consolidating the existing network trails by assigning ecological, wildlife, and recreation suitability scores to landscape features. The optimal trail alignment therefore minimizes ecological impacts while providing the highest quality recreational trail experience to the public. Our preliminary results for the Bow Valley show how a complex trail system could be aligned within a wildlife corridor system in a highly developed montane valley.

Contact:

Mark Lindberg
Alberta Environment
3rd floor, 2938 – 11 Street NE
Calgary, Alberta, Canada
T2N 1T7
403-297-5369
403-297-6069
mark.lindberg@gov.ab.ca

Use of geographic information systems to supplement high resolution imagery: combining India Remote Sensing satellite images with provincial base data

S. Hamilton

In response to a request from the Lac La Biche Fire Centre, India Remote Sensing orthorectified satellite imagery was used to build a 1:150 000 scale wall map covering most of the forest area's fire protection zone, detailing pertinent boundaries, roads, streams, and settlements. This 4.6 million ha subset was constructed from mosaicked east–west strips, and then decimated and tone-matched in PCI prior to the final assembly of the map in ArcView. ArcInfo was used to prepare the vector overlays for the mosaic. The resulting image was then plotted to fit a 6 × 3 ft wall map for strategic planning in the Fire Centre. Of particular interest is the process used to minimize the file size of individual strips. Each strip was loaded into ImageWorks at 50% resolution, and then saved as such, thus quartering the number of pixels and, consequently, the size of the file. While a resampling operation would have been a more accurate account of the ground surface, this method was thought to be adequate since the product was for display purposes only. In a similar project, IRS imagery was used as the base for a geographic information system designed in ArcView for Alberta Agriculture. In this venture, a 1:20 000 scale map was created for the Connor Creek Grazing Reserve, complete with vector overlays including access, boundaries, ownership, soil types (from Agricultural Region of Alberta Soil Inventory Database [AGRASID]) and the Alberta Woodlot Inventory data.

Contact:

Stephen Hamilton
University of Alberta
11118 – 76 Avenue
Edmonton, Alberta, Canada
T6G 0J8
780-439-7452
sgh1@ualberta.ca

Operational aspects of the Compact Airborne Spectrographic Imager data collection in providing inventory tools for the operational forester

D. Trudeau, S. Mah, J. Aitken, J. Howse, and M. Kerr

Since 1995, ITRES Research Limited has worked closely with the Ministry of Forests in British Columbia and various commercial forestry companies to develop and validate efficient, accurate, and cost-effective softwood inventory tools derived from the casi (Compact Airborne Spectrographic Imager) remote sensing instrument. The success realized from these early programs drove the refinement of the data acquisition and analysis methodologies since used by ITRES to produce useful end-products over large areas for operational forest managers. To date, ITRES has flown over 120 000 forested ha and generated products to assist operational foresters in their decision making. Past programs have focused on stem counting to assess the stems per hectare distribution of small conifer trees (1 m tall) for regeneration and for selection of candidated areas for thinning. The flexibility of the instrument to collect useful data in partly cloudy and low illumination conditions, as well as its high spatial and spectral resolution, extends its usefulness past most other types of remote sensing instruments, including air photography and satellites. The ability to cover difficult-to-access regions efficiently from the air also allows the casi to complement existing ground sampling inventory programs. An overview of the salient components of typical casi forest inventory programs conducted by ITRES for commercial clients is discussed. Issues related to casi-derived products, costs, scheduling, data acquisition rates, and typical acquisition parameters are presented.

Contact:

Daren Trudeau
ITRES Research Ltd.
#155, 2635 – 37 Avenue NE
Calgary, Alberta, Canada
T1Y 5Z6
403-250-9944
403-250-9916
darent@itres.com

Spatial and topological refinement of forest polygons using Compact Airborne Spectrographic Imager image analysis

S. Lataille, D. Davison, T. Wittebrood, and R. Gauvin

The use of new Earth observation technologies for building forest management geographic information system (GIS) layers can lead to considerable advantages. Among these we can consider spatial continuity, high discrimination and surface characterization (land cover, tree species, etc.), and the assurance of consistently reproducible interpretation. In the last decade, Compact Airborne Spectrographic imager has been used for conifer stem density estimation, conifer and deciduous species discrimination, stress identification, and other information for forest management. The present challenge is to use these detailed information and exploit their full potential to refine spatially and topnlogically the forest unit polygons at an appropriate scale for forest management. Different post-analysis generalization methods were explored in order to observe their capacity to automatically redefine the polygons and add the topology of these newly created GIS polygons to the GIS database. A case of conifer stem map refinement is presented and shows the promising results of some of these methods to generate and update polygons for density and partial cuts estimation.

Contact:

Stephan Lataille
ITRES Research Ltd.
#155, 2635 –37 Avenue NE
Calgary, Alberta, Canada
T1Y5Z6
403-250-9944
403-250-9916
lataille@itres.com

Applying conservation nets to agricultural landscapes

N.L. Salamon and R.W. Wein

Albertans are very much aware that conservation islands surrounded by agricultural lands are susceptible to species diversity loss and invasion by non-native species when disrupted by forces such as grazing, drought, and fire and even fertilizers and pesticides. There are emerging political developments to expand conservation areas, and Alberta agriculture will be susceptible to fallout from these issues. Alberta and Canadian agriculture need to quantify the degree to which their waterways and roughland landscapes still conserve biodiversity. We believe that conservation within agriculture land can come into focus using the concept of Conservation Nets (CN), which are essentially biodiversity hot-spots that are connected by corridors. These ensure greater potential for species daily movements and seasonal migration. In accordance with conservation discussions, landowners will continue to be stewards (with compensation) to ensure long-term sustainability of waterways and roughland areas on agricultural lands. It should be noted that if CN were allowed to regenerate their native plant biodiversity, the land should store carbon for carbon tax credits as well. The study area in eastern Alberta is the Wainwright Dunes Ecological Reserve, which consists of approximately 2800 ha of native grassland within a much larger area (30 × 120 km) of similar habitat from Kinsella to Sounding Lake. We will report on our progress to identify, using remote sensing data and geographic information systems, CNs (nodes and corridors) over this larger area.

Contact:

Ross W. Wein
University of Alberta
442 Earth Sciences Building
Edmonton, Alberta, Canada
T6G 2E3
780-492-2038
780-492-1767
ross.wein@ualberta.ca

The Gulf Canada and Alberta Pacific pilot integration plan

J. O'Neill, P. Koning, and S. Wasel

Gulf Canada Resources (Gulf) and Alberta Pacific (Al-Pac) Forest Industries have undertaken a pilot project to investigate the feasibility of coordinating their plans for the Surmont area. Gulf has plans for a multi-phase SAGD (Steam Assisted Gravity Drained) bitumen project, while Al-Pac holds the timber rights for the area. A geographic information system has been used to view the areas of overlap and to calculate the human footprint and costs associated with an integrated design. At this stage, the sharing of a road network has been used as an indicator of the potential benefits of integration. Recognition of the overlapping interests and potential benefits at the planning stages, instead of during development, will ensure that fragmentation is kept to a minimum, well pads occupy harvested cut blocks, and that roads are built in a time sequence that coincides with both parties' interests.

Contact:

Jack O'Neill
J. O'Neill GIS Consulting
#114 3210 Cornwall Drive
Athabasca, Alberta, Canada
T9S 1P4
780-525-8418
780-525-8097
oneillja@alpac.ca

Deriving physical forest stand information from remotely sensed imagery using canopy reflectance models

D.R. Peddle

Forest canopy reflectance models provide a powerful link between physical attributes of a forest stand and the reflected energy from these stands recorded as spectral response patterns by airborne and satellite remote sensors. This is of importance to forestry studies because these remote sensing methods provide information such as stand density, tree height and canopy dimension, and volume based on a physical understanding of the interaction of solar radiation with forest canopies and stand geometry. This provision of physical and structural information is of greater relevance to foresters compared to the generally statistical outputs of conventional remote sensing image analysis. The principles of canopy reflectance models are first outlined, together with the concept of sub-pixel scale information extraction and the theoretical advantages of these approaches compared to previous methods. Results from a variety of global change and forestry remote sensing studies such as the NASA COVER Project, BOREAS, and the International Satellite Land Surface Climatology Project will be highlighted. These studies encompassed boreal and mountainous terrain at local to regional scales, and involved different forest attributes, species, image spatial and spectral resolutions, sensor types, and forestry information applications.

Contact:

Derek Peddle
University of Lethbridge
4401 University Drive West
Lethbridge, Alberta, Canada
T1K3M4
403-329-2524
403-329-2016
derek.peddle@uleth.ca

Satellite forest fire scar mapping as a tool for salvage logging planning

R. Landry, D. Raymond, H. MacLeod, R.J. Hall, A. Robertson, and J. Russell

Fires burn an average of 736 000 ha of commercial forest annually (74% of the area harvested), resulting in a loss of 70 million cubic metres of wood, with a value of about $1 billion. In commercial forestry, once a fire is controlled and extinct, the forest products industry gets actively involved in planning salvage logging operations. Information and timeliness are the key challenge when a major fire event strikes, such as the Virginia Hills fire that burned over 154 000 ha of the northern region of Whitecourt (Alberta) in May 1998. The presentation will focus on the current results of a joint project between the Canada Centre for Remote Sensing and the Canadian Forest Service to assess the use of Landsat Thematic Mapper for burn scar mapping. A review of the past 2 years of work with the Canadian forest products industry to promote and secure the potential of spaceborne remote sensing as a tool for planning salvage logging will be discussed. The end-to-end processes for fire scar mapping using satellite data will be presented and compared with conventional airborne methods. Recent work to assess the mapping of partial burns will also be briefly discussed.

Contact:

Robert Landry
Canada Centre for Remote Sensing
588 Booth Street, Room 339
Ottawa, Ontario, Canada
K1A 0Y7
613-947-1241
613-947-1385
Robert.Landry@ccrs.nrcan.gc.ca

Monitoring land use and land cover change in boreal regions: implementation of a provincial protocol using remote sensing techniques: a case study in Alberta, Canada

G.A. Sanchez-Azofeifa, T. Polzin, G. Hamilton, K. Dutchak, B. Sleep, A. Richards, and R. Bennet

There is increasing pressure to evaluate and approve industrial development projects primarily dealing with oil sand and heavy oil extraction in the northeastern boreal egion of Alberta. The cumulative impacts of multiple and massive industrial development within the region is still not well understood. Baseline inventories of current resource information are a key component in supporting a regional model designed to better understand the impact of cumulative effects on landscape structure. This paper describes the main achievements related to the development of a remote sensing and geographic information systems protocol aimed at monitoring land use and land cover change (LUCC) in boreal regions. The proposed protocol uses medium-resolution satellite images (Landsat Thematic Mapper) as a standard to map land cover under the Alberta Ground Cover Classification. The main goal of this research is to seek the most appropriate, and the most current, methodologies for multi-temporal and multi-year analysis of landscape structure and LUCC trends. It is expected that this joint initiative between academia, provincial and federal agencies, and non-governmental organizations will promote the development of standards for image interpretation at the provincial level using emerging satellite platforms and information already created by the province of Alberta. This paper presents a case study for the Fort McMurray region.

Contact:

G. Arturo Sanchez-Azofeifa
Earth and Atmospheric Sciences Department
University of Alberta
Edmonton, Alberta, Canada
T6G 2E3
780-492-1822
780-492-2030
arturo.sanchez@ualberta.ca

Landscape fragmentation in Alberta through remote sensing

S. Shukla, G.A. Sanchez-Azofeifa, and S. Hannon

The boreal forest, or taiga, is one of the largest terrestrial ecosystems on earth and covers a large area in Canada, Russia, and the Nordic countries. Growing concerns over the loss of boreal forest has promoted the development of methods, using remote sensing and geographic information systems (GIS), to provide estimates of forest loss and the level of forest fragmentation of this fragile ecosystem. This paper is an attempt to study fragmentation of the boreal mixed-wood forest and intensity of land use in the agricultural area surrounding the Meanook Biological Station in central Alberta, Canada. This paper presents our efforts to measure major indicators of forest fragmentation using satellite images (Landsat Multispectral Scanner MSS, Landsat TM 5 and 7, and IRS 1C and 1D) in conjunction with existing 1:20 000 vector coverages of access features in the landscape. Additionally, this paper explores the method of fusion between medium- to high-resolution remote sensing platforms such as Landsat 7 and IRS 1C and 1D to increase the spatial resolution of extracted landscape features. Final results are integrated into landscape metrics developed to quantify the pattern, structure, and fragmentation in the study area. These metrics will be used to explain variation in bird community structure across the landscape. The results of this study can also be applied to other studies involving habitat fragmentation, land use and land cover changes, wildlife movement, forest fire suppression, and forest management programs. Additionally, we expect that methods developed by this research project will contribute to current international efforts aimed to understand land use/cover change processes worldwide.

Contact:

G. Arturo Sanchez-Azofeifa
Earth and Atmospheric Sciences Department
University of Alberta
Edmonton, Alberta, Canada
T6G 2E3
780-492-1822
780-492-2030
arturo.sanchez@ualberta.ca

Use of geographic information systems in explaining avian responses to landscape structure and composition

S. Hannon and B. Olsen

Geographic information systems (GIS) are useful tools for exploring bird-habitat relationships at different scales. We present information on the use of GIS in two projects examining bird responses to logging. Raptors have large home ranges and hence may integrate patterns of habitat fragmentation over large scales (i.e., 1000s ha) in choosing their home ranges and foraging sites, but they may also choose habitat on a small scale for nesting. We looked at three orders of habitat selection of the barred owl (*Strix varia* Barton) by plotting radio telemetry locations of tagged owls on GIS maps produced from digital Alberta Vegetation Inventory data using ArcInfo. Landscape structure and composition were determined using a spatial pattern analysis program for quantifying landscape structure (FRAGSTATS). We found that owls chose old forest at the home range and nest site scales but not at the foraging location scale, indicating that habitat selection varies by scale and behavior of the animal. Second, using a similar GIS platform, we quantified the response of songbirds (abundance, presence/absence) to variation in landscape structure and composition and in response to different landscape disturbances (fire, logging) and land uses (e.g., agriculture). Birds were surveyed using point counts on four landscapes. Generalized linear models were run to characterize variables at the stand and landscape scale (within 100-, 250-, 500-, and 1000-m radii circles around points). Responses to landscape composition were species specific in terms of the scale of response and landscape configuration (or heterogeneity) did not explain much of the variation in species' responses. These results will help forest company planners to determine whether landscape level variables are important in planning for sustainable biodiversity in the forest.

Contact:

Susan Hannon
Department of Biological Sciences
University of Alberta Edmonton, Alberta, Canada
T6G 2E9
780-492-7544
780-491-9234
sue.hannon@ualberta.ca

Land use and ownership influences on aquatic habitat conditions

M. Wing

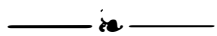
The declining status of Pacific salmon populations in the Pacific Northwest has received significant attention in recent years. Pacific salmon can no longer be found in about 40% of their historical breeding areas in the Pacific Northwest. In response, aquatic inventory data is being collected in an attempt to capture aquatic habitat conditions for salmonid populations and to increase understanding of the processes and factors that influence habitat quality. With substantial effort, we spatially referenced a large database of aquatic habitat conditions for western Oregon (7.6 million ha) using a geographic information system (GIS). The database was originally collected by field survey crews who used a protocol developed by the Oregon Department of Fish and Wildlife and was originally in a tabular format. Our research objectives included assessing the ability of the database to 1) reliably describe aquatic habitat conditions throughout western Oregon, and 2) determine the influence of land ownership and land use patterns on key indicators of aquatic habitat quality. Our GIS database contains data for 3793 stream reaches totaling 5600 km in length and represents one of the most comprehensive, spatially accurate representations of habitat conditions for western Oregon. The spatial referencing enabled us to add several variables to the database that were critical for our analysis objectives: geology, stream order, and ownership. We used two multivariate statistical techniques, regression tree analysis and general linear models, to test the influence of geomorphic, physical, and societal factors on a set of key habitat indicators. Key habitat variables included stream channel structure, pools, large woody debris, riparian vegetation, and substrate composition. Our results found that geomorphic and landscape qualities of streams were generally the most influential factors in describing key habitat indicators. We found little support for significant impacts on key habitat indicators from land ownership and forested land use patterns. Streams that were bordered by lands that featured agriculture, grazing, or rural residential uses, however, were correlated with decreased aquatic habitat conditions.

Contact:

Michael Wing
Forest Engineering Department
Oregon State University
Peavy Hall 215
Corvallis, Oregon, USA
97331
541-737-4009
541-737-4316
michael.wing@orst.edu

Integrating remote sensing and geographic information systems for wetland and waterbird conservation in the western boreal forest: Ducks Unlimited's Western Boreal Forest Initiative

A.J. Richard, M. Gendron, S.A. Smyth, G.R. Stewart, and J.B. Pollard



Western Boreal Forest (WBF) fens, marshes, riparian wetlands, shallow lakes, floodplains and deltas are among the most productive ecosystems on the continent. In Canada, this 2.6 million km^2 ecosystem is second only to the Prairie Pothole Region in terms of waterfowluse. Millions of ducks, geese and other waterbirds, comprising approximately 40% of the waterfowl annually surveyed, are found breeding in boreal and taiga habitats of Alaska, the Canadian territories and the western Canadian provinces. Ducks Unlimited recognized the importance of the WBF in 1994 when it ranked this region number three in priority of the 26 most important, limiting and threatened habitat areas on the continent. In recent years, increased activity by forestry, oil and gas, hydroelectric, mining, agricultural and recreational interests has greatly expanded the potential for impacts on this forest ecosystem, the consequences of which remain largely unknown. Cumulative impacts also include regional climate change scenarios, altered fire frequency, and atmospheric deposition of pollutants. The WBF Initiative was established in 1997 to proactively build partnerships with industry, government agencies, universities, foundations, native groups, and others that share Ducks Unlimited's goal of protecting and sustaining these important boreal wetland ecosystems. This paper will present an overview of the WBF Initiative and the initial partnerships formed to carry out Thematic Mapper satellite imagery landcover mapping, water-bird survey inventories, water chemistry sampling, and integrating these and other datasets for analysis and modeling purposes throughout the western Canadian boreal forest ecosystem.

Contact:

Al Richard
Ducks Unlimited Canada
200,10720 – 178 Street
Edmonton, Alberta, Canada
TSS 1J3
780-489-2002
780-489-1856
a_richard@ducks.ca

ıe hydrologic effects of geographic context

L. Sawatsky, and M. Bender

ıissioned to perform a review of the current ›logic data for a Forest Management Area ł recommend an approach for estimating ling for the purpose of long-term harvest act were identified and modeling tools were ity to the specific FMA. Finally, an approach ıning tools to be developed during future drologic assessment framework, which had hase of the study, Golder was tasked with trategic harvesting plans on an FMA basis. evaluates the forest management plan and or harvesting to mitigate potential impacts, of harvesting. The assessment is based on les and environmental endpoints. Hydrologic en generated for a river basin.