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CANADIAN GEOSPATIAL DATA INFRASTRUCTURE

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REQUIREMENTS FOR AN OPEN FORESTRY DATA SHARING ENVIRONMENT TO SUPPORT BUSINESS SOLUTION DEVELOPMENT IN CANADA:

A NEW BRUNSWICK CASE STUDY

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LIST OF INITIALISMS AND ACRONYMS

AAC	Annual Allowable Cut
AWS	Amazon Web Services
CFS	Canadian Forest Service
CGDI	Canadian Geospatial Data Infrastructure
CHM	Canopy Height Model
CLI	Continuous Landscape Inventory
CSA	Canadian Standards Association
DEM	Digital Elevation Model
DSM	Digital Surface Model
EFI	Enhanced Forest Inventory
FOREM	(UNB Faculty of) Forestry and Environmental Management
FPL	Forest Protection Limited
FSC	Forest Stewardship Council
GIS	Geographic Information System
GNB	Government of New Brunswick
GPS	Global Positioning System
IK	Indigenous Knowledge
IPCA	Indigenous Protected Conservation Area
IT	Information Technology
JDI	J. D. Irving (Woodlands) Limited

LiDAR	Light Detection and Ranging
LII	Land Information Infrastructure
MTI	Mi'gmawe'l Tplu'taqnn Incorporated
NBDNRED (or just DNRED)	New Brunswick Department of Natural Resources and Energy Development
NBDTI	New Brunswick Department of Transportation and Infrastructure
NDA	Non-Disclosure Agreement
NRCan	Natural Resources Canada
PEFC	Programme for Endorsement of Forest Certification
PID	Property Identifier (Number)
SaaS	Software as a Service
SDI	Spatial Data Infrastructure
SENBWMB	South Eastern New Brunswick Forest Products Marketing Board
SFI	Sustainable Forest Initiative
SNB	Service New Brunswick
SNBFPMB	Southern New Brunswick Forest Products Marketing Board
UdeM	Université de Moncton
UNB	University of New Brunswick

Executive Summary

Background

In January 2021, the Canadian Forest Service within Natural Resources Canada commissioned an investigation into requirements of New Brunswick's Forestry Sector stakeholders and rights holders in order to better understand what capabilities they would like to see from geospatial standards-based applications.

The project objectives included:

1. Identifying and documenting, at a high level, specific Data Characteristics and Sharing needs the New Brunswick Forestry Sector has today and believes it will need in the future;
2. Documenting, at a high level, the types of geospatially related analyses the industry currently undertakes and identifying key future Analytical Capabilities that Sector members would like to take advantage of in order to assist in those analyses; and
3. Documenting current geospatial Technology Capabilities and Needs of the New Brunswick Forestry Sector, taking note of any existing gaps and identifying technologies that industry is interested in adopting in the future.

Dr. David J. Coleman was engaged as the Project Consultant, and the results of these investigations are described in this Report. Financial support was provided by GeoConnections.

Approach

To achieve these Objectives, input from the N.B. Forestry Sector was to be obtained by conducting interviews with members of individual representative organizations within that Sector. The list of potential interviewees was finalized through discussions between the Project Authority and the Consultant. A total of 30 interviewees participated in one of the 16 interview sessions held. Ten of these

interview sessions were conducted 1-on-1 with individuals, while the remaining six sessions involved groups of persons.

Interview questions were designed to draw out responses around the three original project themes: data requirements and sharing, desired analytical capabilities and desired technology capabilities. Two separate draft lists of interview questions were prepared - one list intended for forestry organizations, and the other targeted towards technology suppliers and consultants.

Key Interview Messages

- The informal Industry-Government partnership formed to create and manage New Brunswick's Enhanced Forest Inventory (EFI) has all the characteristics of a mature geospatial data infrastructure in its own right. This has been reinforced by Provincial and Federal Government initiatives to provide easy online access to the relevant comprehensive datasets and Web services that underpin this Enhanced Forest Inventory.
- Using advanced computerized analyses to quantify the forest inventory is resulting in more accurate forest inventories. *That* results in better information for planning, scheduling, and operational decision making. While originally implemented for longer-term forest management purposes, geospatial data, analyses and technologies are increasingly being introduced into operational workflows at other stages of the supply chain as well. This evolution in

Indigenous participation

- The Indigenous organization *Mi'gmawe'l Tplu'taqnn* possesses hardcopy forest management plans, which it also provides to NRCan. *Mi'gmawe'l Tplu'taqnn* is very concerned that these plans are not being used, as Indigenous communities do not have the financial resources to put them into action.
- Indigenous communities in New Brunswick receive no support for activities related to their own forest management plans. This contrasts with the non-Indigenous forest industry and private woodlot owners, which are supported through provincial programs funded through forestry royalties.
- As rights-holders, the participation and influence of Indigenous participants in forest management and planning activities is crucial.
- While Indigenous participants are familiar with geospatial technologies and applications, lack of resources makes it very difficult for their communities and organizations to make full use of these geospatial technologies data and analytics available to others.

focus is influencing the nature of requirements and expectations in terms of data, analytics and enabling technologies.

- Designated representatives from the Indigenous organization *Mi'gmawe'l Tplu'taqnn* (or "MTI") representing the nine Mi'gmaq communities in New Brunswick agreed to be interviewed for this project. Their GIS usage currently is focused on collection of Traditional Indigenous Knowledge. Most of the forest management plans MTI member communities currently possess are in hardcopy form only. Those plans are submitted to Natural Resources Canada. The MTI representatives were deeply concerned that these management plans were essentially "gathering dust" at this time because the Indigenous communities do not have the financial resources required to put them into action.
- MTI interviewees believed that while royalties collected off Crown Land are being used to fund Provincial programs and initiatives that supported the forest industry and private woodlot owners - Indigenous communities in New Brunswick received nothing to support activities related to their own forest management plans. As rights holders, Indigenous interviewees emphasized that their participation and influence in forest management and planning activities was critical. However, while familiar with geospatial technologies and applications, lack of resources makes it very difficult for their communities and organizations to make full use of these geospatial technologies data and analytics available to others.
- There was strong and enthusiastic support for the New Brunswick Government's investment in province-wide LiDAR and digital aerial imagery coverage. Interviewees expressed more qualified support and curiosity regarding Provincial Government plans for subsequent rounds of LiDAR coverage. As organizations increasingly look to LiDAR as a means of satisfying both long-term strategic and day-to-day operational requirements, users are increasing their expectations of LiDAR to *consistently and reliably* identify and classify species and other attributes of individual trees.
- Duplication of data content validation and updating efforts remain widespread among organizations interviewed due to privacy constraints, practical inabilities, or unwillingness to share information.
- Capacity-building remains an issue even in major organizations. Most Sector interviewees were very satisfied with their current internal GIS support staff. However, they were concerned over

the future availability to their organizations of skilled personnel familiar with the types of data, analytics and/or technologies employed.

- There is widespread usage among interviewees of positional data generated from handheld and equipment-mounted GPS from an assortment of different vendors for a variety of different applications. Similarly, at least two major Forestry companies appear to have integrated into their everyday workflow the use of harvester-head data as input to the Enhanced Forest Inventory.
- Most interviewees still perceive the New Brunswick Department of Natural Resources and Energy Development (NBDNRED) as a leading early adopter of geospatial technology today. That said, some felt its influence also depends upon the degree to which the Province is willing and able to share the resulting datasets from that technology – at little or no cost.
- Interviewees recognized the "paradigm-flip" now taking place in networked GIS usage where major processing of massive datasets and use of machine learning routines is migrating to the cloud. While larger public and private companies are now making the transition to cloud computing, smaller organizations feel constrained by technology issues, bandwidth limitations in some areas and sometimes difficult pricing arrangements for cloud-based services.

Recommendations

NB Forestry Sector members and sponsors of this Study should collaboratively determine and implement a means of sharing information, code or scripts, test data and other materials describing specific custom developments and software extensions that would support their forest management, planning and operations-related activities.

While legitimate concerns over protecting privacy and/or competitive advantage may always exist, cooperation on specific application and platform developments will ultimately improve productivity and effectiveness within the Sector. Ideally, Sector members would benefit from this through: (a) reduced duplication of effort; (b) possible shared costs of major development efforts; (c) gaining access to best practices of other members; (d) enjoying incremental improvements to code and scripts as problems or limitations in existing code are identified and addressed; and (d) gaining a better understanding of

where operational efficiencies can be gained through process automation at specific points in the supply chain.

In order to increase accessibility and productivity, Provincial and Federal Governments should use their influence, expertise and buying power to pursue province-wide licensing and usage arrangements of advanced technologies and datasets.

Interviewees suggested that negotiating province-wide site-licensing and bulk-purchasing arrangements would reduce costs, increase the access, and widen use of new equipment, software and even cloud computing services. If able to be implemented, Sector members would enjoy shared access to higher-quality datasets and state-of-the-art versions of software tools at a more affordable cost. This would serve to develop a larger critical mass of experienced technical specialists across the Sector AND enable quicker and more widespread uptake of desired changes to reporting, modelling and analysis requirements as they arise.

NB Forestry Sector members should at least be informed of – and ideally, be involved in – government-sponsored activities concerning the nature and planning for future rounds of digital surface model coverage.

Interviewees from industry, government, cooperatives and non-profits are all enthusiastic users of first-round provincial LiDAR coverage and concerned about how this will be continued or modified in the years to come. Interviewees within NBDNRED, Industry and UNB all indicated that *potential* alternative sources of digital forest canopy data were being investigated and assessed. Building an informed constituency of end users would increase support for future rounds of coverage and promote cooperation in the search and adoption of suitable technological alternatives if further rounds of comprehensive LiDAR coverage are deemed too costly to continue.

Federal and Provincial Governments should work with Indigenous communities and organizations on a government-to-government basis to ensure they have adequate

funding and resources to participate as rights holders in data and technology partnerships.

Long-term engagement with Indigenous organizations and communities is required to build trust, to better understand the priorities and practices driving their use of geospatial technologies, and to support their priorities. Targeted funding would encourage Indigenous organizations to continue to build their capacity to interact with geospatial data.

Every effort should be made to support research, development and implementation of improvements to LiDAR's ability to identify and characterize the species and attributes of individual trees within a forest stand.

Interviewees have seen both the benefits and limitations of first-round LiDAR coverage and can now appreciate its potential for wider application – even within the diverse Acadian/ Wabanaki Forest found here in New Brunswick. Interviewees recognized that other aspects of that operation (especially approaches to ground-based calibration) may need to be modified as well to reach this objective. A shared knowledge of commissioned R&D findings and test results - as well as news from technology vendors - would serve to help Sector members collectively improve the quality of the Province's Enhanced Forest Inventory and better incorporate LiDAR data into day-to-day operational decision-making.

NB Forestry Sector members should investigate and quantify the extent of duplication and redundancy that exists in the collection, classification and maintenance of digital land base graphics and attribute data existing between and among the GIS platforms they operate.

If the duplication and redundancies are determined to indeed be significant, then an alternative approach should be investigated and implemented to provide a single source of timely, reliable and authoritative data for key land base features. An important outcome could be the creation *and ongoing maintenance* of – as well as universal online access to - a single, up-to-date version of road/trail and water networks across the EFI. This could reduce the number of future incremental updates to these

features done at different times by different parties and increase the confidence in the reliability of these shared datasets.

As Sector members begin to apply geospatial data, platforms and tools to shorter-term operational needs and transactions, those members should collaborate on how these new needs should (if at all) influence updates, extensions and/or outright changes to the data, standards, tools and applications currently in use.

With increasing pressures related to the need for increased operational efficiencies, certification requirements, and environmental considerations, Sector members should be determining whether or not fundamental changes must be made to the nature of the data it is collecting in support of its EFI and the standards to which that data is being validated. A desired potential outcome to this would be a shared vision of the longer-term improvement of the EFI and corresponding improvements to resource management decision-making.

Background

Canada's forest industry is a significant component of the nation's natural resources sector. Given its size, many types and significant volumes of data are required for - and produced by - private companies, government departments, Indigenous organizations, and other stakeholders or rights holders to support management, operations, and advancement of forestry across Canada. Data and information sharing is critical for demonstrating sustainable forest management and vital for Canada's environmental reputation.

While web-based data sharing and access platforms for the forest sector have been developed at both the national and provincial levels, challenges remain for organizations to easily make use of the information they require - particularly in the context of massive datasets and new technologies.

To reduce these challenges and position Canada's forestry sector for the future, three different groups within Natural Resources Canada (NRCan) are working in cooperation to determine how non-proprietary geospatial standards, architectures, and applications can be better leveraged to enable improved sharing and integration of Canadian forestry data and information.

In January 2021, the Canadian Forest Service within Natural Resources Canada commissioned an investigation into requirements of New Brunswick's forest industry stakeholders and rights holders in order to better understand what capabilities they would like to see from geospatial standards-based applications. This project was initiated to obtain insights on the following:

- *what information the industry uses and produces;*
- *the technologies of which they want to take advantage;*
- *the nature and limitations of their current technological capabilities' and*
- *the challenges they currently experience when trying to find, access, share, and use information.*

Project Objectives

The goal of this project was to determine the requirements of New Brunswick's Forestry Sector in order to easily access and use service-based frameworks (e.g. Application Programming Interfaces) to fulfill its operational information needs. Through conducting interviews with key Forestry stakeholders and rights holders and compiling the results, specific objectives of this project included:

1. *To identify and document at a high-level specific Data Characteristics and Sharing needs the New Brunswick Forestry Sector has today and believes it will need in the future;*
2. *To document at a high level the types of geospatially related analyses the industry currently undertakes and identify key future Analytical Capabilities that Sector members would like to take advantage of in order to assist in those analyses; and*
3. *To document current geospatial Technology Capabilities and Needs of the New Brunswick Forestry Sector, taking note of any existing gaps and identifying technologies that industry is interested in adopting in the future.*

Interview Planning and Interviewees Contacted

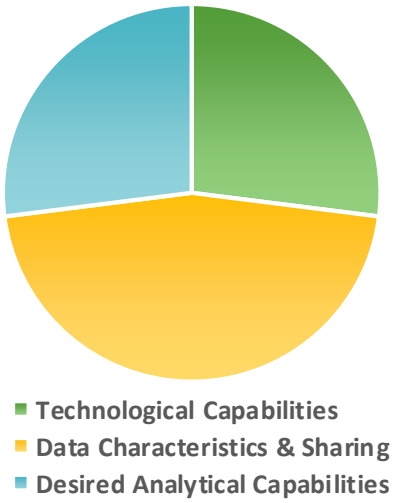
Following receipt of Authorization to Proceed on February 3rd, two separate video conferences were held with the Project Steering Committee members to cover outstanding issues and review important technical background information prior to organizing the interviews.

The list of potential interviewees was finalized through discussions between the Project Authority and the Consultant. Two separate draft Lists of Interview Questions were prepared and sent to Project Steering Committee members for review and approval – one list intended for Forestry Organizations, and the other targeted towards Technology Suppliers and Consultants to the Forestry Sector in New Brunswick. The two Lists are included as Appendices A.1 and A.2 respectively.

Interview questions were designed to draw out responses around the three original Project Themes: Data Requirements and Sharing, Desired Analytical Capabilities and Desired Technology Capabilities.

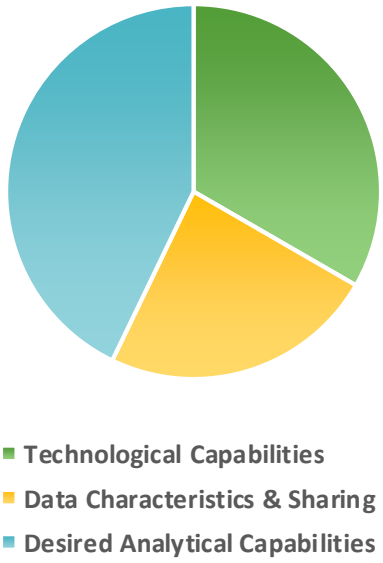
There was intentional overlap between two or more themes in some questions. Figures 1 and 2 illustrate the relative proportion of questions in each of the two Lists of Interview Questions.

FIGURE 1: NATURE OF INTERVIEW QUESTIONS TO FORESTRY PRACTITIONERS



This figure demonstrates the nature of interview questions to Forestry Practitioners. 46% of the questions were related to Data Characteristics & Sharing, 27% of the questions were related to Technological Capabilities and Desired Analytical Capabilities showed a proportion of 27% as well.

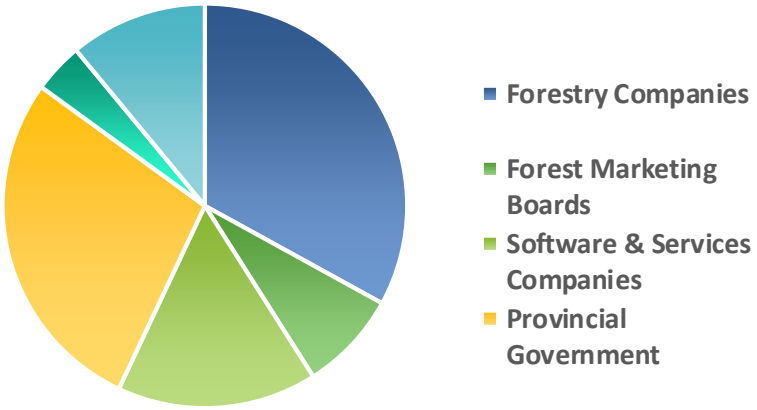
FIGURE 2: NATURE OF INTERVIEW QUESTIONS TO TECHNOLOGY SUPPLIERS AND CONSULTANTS



This figure demonstrates the nature of interview questions to Forestry Practitioners. 25% of the questions were related to Data Characteristics & Sharing, 35% of the questions were related to Technological Capabilities, and 45% were related to Desired Analytical Capabilities.

FIGURE 3: RELATIVE PROPORTION OF INDIVIDUALS FROM DIFFERENT ORGANIZATION TYPES INTERVIEWED FOR THIS PROJECT

Figure 3 charts the relative proportion of individuals from the different representative types of organizations who were interviewed for this Project. On the following page, Table 1 contains a more detailed list of organizations and individuals interviewed.



This figure demonstrates relative proportion of individuals from different organization types interviewed for this project. 33% were Forestry Companies, 28% were provincial governments, 16% were Software & Services Companies, 11% were Indigenous Organizations, 8% were Forest Marketing Boards, and 4% were from the Education sector.

Ten interviews were held with individuals. The remaining six were conducted as a series of group interviews containing all the representatives from a given organization. Interviews ranged from 40 to 90 minutes in length.

All interviews were conducted using ZOOM, and were recorded with permission of the interviewees. A confidential verbatim transcript was generated automatically using the Otter cloud-based transcription service, and a summary of each interview was prepared and shared with the interviewee for review and amendment. A final version of each summary is included in Appendix B of this Report.

Only three organizations that were originally invited declined to be interviewed for this Project, and at least two of those have since expressed interest in follow-up discussions.

TABLE 1: LIST OF INTERVIEWEES

Type	Organization	Individuals Interviewed
Forestry and Forest Products Company	• Acadian Timber • AV Group • Chaleur Forestry • Groupe Savoie • J.D. Irving Limited	• Jody Jenkins, Vice-President, Timber Services • Conway Elkins, Manager, Provincial Operations • Pierre Mezzetta, Management Forester • Patrick Filyer, GIS Analyst • Andry Barrieau, Vice-President • Andrew Elliot, Planning Forester • Yves O'Brien, Vice-President, Procurement • Joe Pelham, GIS Architect • Ian Taviss, Manager, Forest Planning and Inventory
Woodlot Marketing Brands	• Southern NB Forest Products Marketing Board • Southeastern New Brunswick Forest Products Marketing Board	• Neil Damon, Marketing/ Forest Management Forester • Travis Noftell, Silviculture Manager • Steven Spears, Forester/Silviculture Manager
Government of New Brunswick	• Department of Natural Resources and Energy Development • Service New Brunswick, Land Information Infrastructure Secretariat	• Dale Wilson, Manager, Renewable Resource, Inventory Section • Danny Crain, Director, Information Systems and Departmental Services • Clark Langridge, Senior GIS User Analyst • Jeremy Gullison, Forester, Timber Products Section • Andy MacNeil, Director • Julie McKay, Manager

Type	Organization	Individuals Interviewed
		• Bernie Connors, Geomatics Engineer
Indigenous Groups	• Mi'gmawe'l Tplu'taqnn Inc. (MTI)	• Steve Ginnish, Forestry and Natural Resource Coordinator • Tom Johnson, GIS Coordinator • Michael Isaac, Director of Indigenous Knowledge • Dean Vicaire, Executive Director
Industry Service and Technology Providers	• Esri Canada • Forest Protection Ltd. • Leading Edge Geomatics • Remsoft Inc	• Corey Nelson, Director, Atlantic Region Chris North, Director, Technology Adoption • Veronica Fortin, GIS Specialist • Matt Davis, Sales Manager • Alex Zscheile, Geospatial Processing and Solutions Manager • Doug Jones, Senior Vice President
Education	• UNB Faculty of Forestry and Environmental Management	• Jae Ogilvie, Instructor

Interview Results and Discussion

Individual summaries of each interview are contained in Appendix B of this Report. Key findings are organized and discussed here in terms of the three themes mentioned at the beginning of this Report.

General Observations

a) The requirement to collectively build and maintain an Enhanced Forest Inventory covering the Province - in support of the planning and reporting requirements of the New Brunswick Crown Lands Management Act – has created an informal but *de facto* partnership between industry, government and a major software vendor. That partnership has created – by any measure – a very impressive special-purpose geospatial data infrastructure that enables the organizations involved to easily access and share source data, updates or corrections to the inventory, requested forest management plans – and even data supporting environmental and professional certification requirements.

   As a similar impetus, it is critical for Marketing Boards and their members (Private Woodlot owners) to satisfy regulatory requirements and conditions for funding opportunities associated with the New Brunswick Private Woodlot Silviculture Program. Geospatial data and analysis are used extensively to support those requirements and conditions as well.

b) The inputs, processes and outputs associated with that Enhanced Forest Inventory were based first and foremost around the Provincial Government's strategic forest planning, management and reporting needs. Today, geospatial data, analyses and technologies are increasingly being introduced into shorter-term planning and day-to-day operations within the Sector.

c) NB Forestry Sector organizations have access to nationally- and internationally- competitive expertise in specific niche areas of technology and consulting. NBDNRED and the larger forestry companies are recognized as leaders and early adopters of technology and best practice. Members of UNB's Faculty of Forestry and Environmental Management and UdeM's Northern Hardwoods Research Institute are also recognized as experts in the assessment, refinement and application of geospatial tools and data used by Sector members.

d) Forestry Practitioners in smaller organizations are well-informed but often limited by lack of resources. In most cases, they are prepared to wait until the technology either becomes cost-competitive or mandatory for continued operations. In a few cases, they are partnering with

research and training organizations to become familiar with new geospatial technology developments in the sector.

e) Duplication of data content validation and updating efforts remain widespread among organizations interviewed due to privacy constraints, practical inabilities, or unwillingness to share information.

f) Attention to geospatial data standards is focused primarily on bulk file transfer rather than interoperability. However, there was widespread acknowledgement of the considerable influence and importance of standards associated with specific professional, operational and product certification initiatives.

Today, geospatial data, analyses and technologies are increasingly being introduced into shorter-term planning and day-to-day operations within the Sector.

g) Most industry interviewees were concerned over the availability to their organizations of skilled personnel familiar with the types of data, analytics and/or technologies employed. Added to these technical skills were individual requirements in terms of effective teamwork, communication, cultural appreciation and language skills. There was agreement that there was considerable national competition for persons with such skills in the marketplace today, and it will get more difficult to attract people to work with organizations in this Sector - particularly those headquartered in smaller rural New Brunswick communities.

h) When asked about hiring of new technical systems staff, responses were mixed over whether to: (a) hire foresters with an aptitude for computing and then train them in hardware/software/analysis specifics; (b) hire computing/programming specialists and provide them with the necessary forestry supply chain context as necessary to address a given project; or (c) engage specialists required on a contract basis as required.

Indigenous Considerations

Four representatives from the Indigenous organization *Mi'gmawe'l Tplu'taqnn* (MTI) were interviewed for this project. A summary of the entire interview with those representatives is included in Appendix B.

a) Representatives clarified the role of MTI as a rights-based organization and emphasized their role as rights holders rather than stakeholders. This is an especially important distinction in this conversation regarding the use of technology in a natural resources sector.

b) MTI's principal use of GIS and related geospatial data at this time supports its members' role as Custodians and Stewards of Traditional Knowledge. Recording this information is extremely important as a means of: (*i*) documenting their history and culture; (*ii*) identifying and demonstrating, using modern-day tools, the location of their settlements, sacred sites, an traditional lands where they hunt, fish, gather and hold their ceremonies; an (*iii*) helping others to better understand why Mi'kmaq want to protect specific areas and why they want to be part of discussions concerning harvesting in specific areas whether on land or in the water.

c) MTI and its members are currently using GIS to identify Indigenous Protected Conservation Areas (IPCAs). They are also working on a place names map that will be made accessible to the public through ArcGIS Online. They also make use of the GIS base data and digital aerial photography accessible online from the Province. While they also have online access to provincial LiDAR coverage, they are just beginning to make full use of this particular dataset.

d) All Mi'kmaq First Nation communities in New Brunswick have forest management plans. Some are 50-year plans, while others – like that of Natoaganeg (Eel Ground) First Nation, for example - are 100-year plans. The Mi'kmaq possess a different perspective on both the time-frame

Mi'gmawe'l Tplu'taqnn's use of GIS

Mi'gmawe'l Tplu'taqnn's principal use of GIS and related geospatial data at this time supports its members' role as Custodians and Stewards of Traditional Knowledge. Recording this information is extremely important as a means of:

(i) documenting their history and culture;

(ii) identifying and demonstrating, using modern-day tools, the location of their settlements, sacred sites, and traditional lands where they hunt, fish, gather and hold their ceremonies;

(iii) helping others to better understand why Mi'kmaq want to protect specific areas and why they want to be part of discussions concerning harvesting in specific areas whether on land or in the water.

and interpretation of what is meant by "long-term forest management planning, and plan with multiple future generations in mind.

e) In addition to structured timber resource data, these management plans also incorporate data concerning medicinal values, traditional medicines, and other important cultural aspects of the communities. Under the forest management plans they prepared and followed, the Natoaganeg (Eel Ground) First Nation Reserve lands earned international Forest Stewardship Council (FSC) certification in 2005.

f) Most of the forest management plans they currently possess are in hardcopy form only and the related data is not stored in their own GIS software. Those plans are submitted to Natural Resources Canada; while they may have been subsequently digitized there, neither MTI nor the communities involved have a copy of that information.

g) The MTI representatives were deeply concerned that these management plans were essentially "gathering dust" at this time because the Indigenous communities do not have the financial resources required to put them into action. The interviewees believed that, while royalties collected off Crown Land were used to fund Provincial programs and initiatives that supported the forest industry and private woodlot owners, Indigenous communities in New Brunswick received nothing to support activities related to their own forest management plans. Among many other things, this has constrained their adoption of GIS and related technologies for forestry purposes.

Author's Note: A significant number of the general observations and constraints made by the MTI interviewees in this project are also described in greater detail and scope in Part B of the 2018 Report Canadian Geospatial Data Infrastructure (CGDI) User Needs Assessment, which deals with Indigenous Communities and Spatial Data. While not all points raised in that Report are applicable to MTI, many are relevant and the Report's recommendations deserve thoughtful consideration.

Interview Responses by Theme

Data Characteristics and Sharing

LiDAR Coverage

a) There was strong and enthusiastic support for the New Brunswick Government's investment in province-wide LiDAR coverage made freely accessible online to all interested users.

b) There was more qualified support among interviewees for second- and subsequent rounds of updates to LiDAR coverage of NB's forested areas in the future. As organizations increasingly look to LiDAR as a means of satisfying both long-term strategic and day-to- day operational requirements, users are increasing their expectations of LiDAR to *consistently and reliably* identify and classify species and other attributes of individual trees. Specific concerns were expressed around the following issues or questions:

- Organizations with more limited resources require technology upgrades and/or improved cloud access to optimize their use of these massive datasets;
- Who would pay for future rounds of LiDAR coverage?
- What should be the extent of 2nd Round coverage – comprehensive or selected areas only?
- Some skepticism that optimal use *has not yet been made* of the existing 1st round LiDAR coverage;
- Uncertainty over the suitability and cost of potential alternatives to LiDAR for updates to the digital forest canopy surface model; and
- How will our existing models and estimates be affected if whatever type of coverage we obtain is different from the previous round?

Imagery Coverage

c) Digital Aerial Imagery coverage funded by NBDNRED is a significant data source used daily. Accessible online, it was seen as being convenient and effective to use when higher-resolution imagery is required, and some use it as a principal source of georeferenced imagery when integrating it with the Enhanced Forest Inventory (EFI) and digital property information. Interviewees expressed considerable support for continuation of NBDNRED Digital Aerial Imagery Acquisition Program for forest management purposes.

d) The medium-resolution Sentinel-2 satellite imagery data was deemed to be fine to either delineate or confirm updates to forest block boundaries because: *(i)* coverage over any given location is updated many times per year, satisfying their operational requirements for currency; and (ii) it is easily accessible through an Esri online image service ArcGIS Living Atlas of the World, implying ready compatibility with that software as well.

e) There is a cost-sensitivity among the interviewees with respect to the use of different types of imagery. For example, while it is used for work inside mill yards, there was almost no indication of the use of UAV imagery for forest inventory purposes because it was perceived to be too expensive. The Sentinel-2 imagery is used in part because it is perceived as being "free", although the cost is actually covered through Esri's software licensing fees. Some would like to see the Province negotiate wider cost-shared usage of other sources of imagery NBDNRED uses as well (e.g., Planet's Dove satellite imagery).

Property Data

f) While many of the interviewees supported the Property line data obtained from Service New Brunswick (SNB) and used it almost daily, they noted that the spatial accuracy of this data could be low in parts of the province. Data concerning Crown and freehold properties are becoming more accurate over time – in part due to field updates and submissions from forestry companies and NBDNRED, and in part because SNB is integrating updates from new surveys into its database more frequently than it did before. This is important data supporting operational and business transactions undertaken especially by private companies and marketing boards. Interviewees supported the continued improvement of the positional accuracy and currency of this dataset.

Land Base - Road and Water Networks

g) While obtaining the Land Base data originally from the Province, at least three different interviewees indicated that they maintained and enhanced their own digital road network data internally. For technical, practical, attitudinal or corporate confidentiality reasons on both sides, the corrections and updates are rarely shared back with the government. This means that multiple versions of the road centrelines exist and are being maintained to different standards

and specifications across the province. Moreover, the Province itself believes it does not have complete and up-to-date road coverage information for a couple of very large industrial forestry freeholds.

h) Similarly, one interviewee noted that two different versions of the hydrography (seacoast, lakes, rivers and streams) network exist within the provincial government and are distributed on different online open data sites. While the reasons for this may be understandable to internal experts and necessary for different internal programs, it can be confusing to new or occasional users of NB Government GIS data.

i) This situation with the separate correction and updating of digital road, hydrography and selected property line information by different organizations at different times suggests a significant past duplication of effort that continues to take place incrementally today across different organizations. Practical rationalizations for continuing this practice vary and may include internal privacy and confidentiality constraints, technical incompatibilities, differences in data collection standards, conflicting updating cycles, or concerns over potential liability. Still, this practice has a cost associated to it and increases the risk of organizations using erroneous or outdated information.

In the Field

j) There is widespread usage among interviewees of positional data generated from handheld and equipment-mounted GPS from an assortment of different vendors for a variety of different applications. Such data can include but is not limited to corrections and updates to road and hydrography networks; harvest boundaries; tracks of GPS- enabled trucks and ATVs; planned and actual progress of harvester equipment; points of interest; and even the respective locations of different individual trees within a stand.

k) A number of Forestry companies have assessed the use of harvester-head data as input to the Enhanced Forest Inventory. Two major players appear to have integrated this into everyday workflow, others are still in trial stages, and at least one has tried and at least temporarily set aside the idea for the time being. StanForD was mentioned in two different interviews as an important emerging standard related to data from harvester equipment.

At a Higher Level

l) Attitudes regarding open access to data vary depending upon the party or parties involved and the intended application(s). While access to other organizations' data is acceptable and perhaps desirable for most, industry interviewees expressed reluctance or opposition to seeing LiDAR and (especially) EFI data covering their own properties or areas of interest being made publicly available. Most organizations have an agreement with the Provincial Government right now to share some data for inventory purposes. As well, most companies indicated that they were prepared to consider requests to share data on a case-by-case basis, and usually ask for a Non-Disclosure Agreement that specifies what the data is going to be needed for.

m) From NBDNRED's perspective, while privacy legislation influences the degree to which its EFI data can be shared, staff do experience friction when they refuse those requests. That said, the ban on sharing the EFI and Land base data covering private woodlots was removed on March 5, 2021. The data the Department does make accessible online to the general public can be found at NBDNRED's GIS Open Data Website.

Standards

n) NBDNRED in particular was praised taking a leading role in offering access to its most up-to-date data through online Web services rather than encouraging people to just download a snapshot of that data at one time. However, based on the interview comments, standards-related demands among most interviewees tend to focus primarily on file-based data transfer activities rather than on interoperability. With exceptions among technology suppliers and consultants, knowledge of geospatial standards among the forestry organizations interviewed is limited to a very small number of office technical staff.

Standards-related demands among most interviewees tend to focus primarily on file-based data transfer activities rather than on interoperability.

o) In fairness, wider concern has been expressed regarding the lack of interoperability standards specific to the Forest industry. There is understandably a strong reliance by most Sector users on the technology vendors of choice to "adopt-and-make-invisible" the standards necessary for the end-users to employ. At the same time, at least seven different interviewees indicated that

custom development efforts to (e.g.,) integrate data from different sources were common even in smaller organizations. Some also complained about the amount of time spent on custom development efforts to handle compatibility issues when dealing even with different versions of the same system.

p) While knowledge and appreciation of geospatial standards may have been limited, there was widespread acknowledgement of the importance of standards associated with specific professional, operational, and product certification initiatives. Especially the larger forestry companies are influenced by standards defined within (e.g.,) the Canadian Standards Association (CSA), the Forest Stewardship Council (FSC), the Sustainable Forest Initiative (SFI), and the Programme for Endorsement of Forest Certification (PEFC).

Desired Analytical Capabilities

a) Many of the companies are doing targeted custom-development work – mostly within (but not restricted to) the Esri software environment – to increase workflow efficiencies and empower their end-users in the office and in the field. Three different "early- adopter" interviewees described a similar evolution in special-purpose analytical requirement capability requirements for Forestry organizations since 1982. The focus evolved from:

- provision of custom hardcopy plotted maps to office and field staff… to…
- production of custom creation of special-purpose maps and reports on database queries… to…
- application of analytical models to (e.g.,) predict changes in forest inventory and timber volumes… to…
- Integrating the enterprise GIS with a wide variety of different sensors and location-based services to improve the efficiency and reliability of short-term planning, routine transactions and day-to-day operations.

At each stage, interviewees stressed that their developers' focus was first on ensuring the application worked as intended and delivered reliable results, and then on empowering end-users to be able to use the system to easily run this application themselves.

b) Early GIS analytics adoption by the NBDNRED – as well as most large Forestry companies interested in working on Crown Land Licenses - was influenced originally by planning and reporting requirements of the (at the time) new 1980 Crown Lands and Forests Act. Those needs

still drive these organizations today, with major government and major forest industry players looking to advanced Machine Learning to improve resolution and accuracy of image classification of digital aerial, satellite, and ground- based imagery to improve the quality of their Enhanced Forest Inventory. In particular, NBDNRED is concentrating both in-house and contract services onto improving species prediction using existing or new sensors.

c) Today, Provincial Government interviewees see the need for improved operational productivity around monitoring and reporting on regulation and environmental issues. Better and more accessible data leads to more efficient use of field staff time.

d) As a similar impetus, it is critical for Marketing Boards and their members (Private Woodlot owners) to satisfy regulatory requirements and conditions for funding opportunities associated with the New Brunswick Private Woodlot Silviculture Program. New Brunswick's Forest Product Marketing Boards all supported the development and use of custom developed software that brings together digital forest inventory, stream buffer information, LiDAR and property data and makes use of the processing and handling capabilities of ArcGIS and Microsoft Access.

By specifying the list of Property Identifiers (or PIDs) for specific land parcels of interest, the application generates custom maps and a full stand-by-stand description report of each stand within a woodlot – including its area, forest cover information, previous treatments PLUS (from the LiDAR data) average height, average multiple diameter, average multiple basal area, and stand volume. A related reporting capability applies government criteria to this same data in order to identify forest stands eligible for inclusion in specific government programs. This enables the property owner to make more informed decisions concerning what they want to do with each of a collection of different forest stands on their property.

e) Using advanced computerized analyses to quantify the forest inventory is resulting in a more accurate forest inventories. That, in turn, results in better information for planning, scheduling, and operational decision making. Among the largest organizations, integration of spatial data and analysis into their operational workflows at each stage of the supply chain. Sometimes that

Using advanced computerized analyses to quantify the forest inventory is resulting in a more accurate forest inventories. That, in turn, results in better information for planning, scheduling, and operational decision making.

analysis is extremely complex (growth and yield analysis; harvesting optimization) and handled by separate software, while in other cases in is handled within existing GIS functionality. In some cases, the application may involve GPS-based location tracking and recording. Interviewees from larger New Brunswick companies indicated that they were either investigating or already employing specialized application software and services in addressing two or more different aspects of the overall forest-to-customer supply chain, including Remsoft Operations Cloud, the Stratus™ and Op Tracker for Transport™ packages from Lim Geomatics, and STICKS™ harvester wood flow management software from Interpine in New Zealand.

f) The wood purchase, sales and delivery transaction-tracking conducted through one of the seven Marketing Boards (and subsequently reported to the Provincial Government) requires a considerable amount of property- and geospatially-related information. With a higher percentage of direct contracts now being issued compared to past practice, tracking wood sales has become more of a challenge. This has not only led to increased overhead costs for Marketing Board administration staff to track down the missing transportation slips, but it also raises many concerns on whether or not reported harvest levels are accurate and does not allow the Marketing Boards to track harvest levels spatially by the PID. General concerns around this issue, along with selected examples of application options available at that time, are further discussed in this 2019 blog posting.

Desired Technological Capabilities

Geospatial Technology Adoption

a) There was wide agreement among the interviewees that GPS, LiDAR, digital imaging and machine learning technologies have all made it faster, quicker and easier to get a far more accurate forest inventory than ever before. Interviewees collectively saw lots of promise in emerging GIS/GPS-, RFID- and cellphone-based tools and technologies to improve efficiencies and tracking elsewhere in their supply chain. UAV platforms are being used extensively in mill yards and sorting yards but – except on the smallest of private woodlots - have not yet used widely by interviewees in *forest inventory* applications in New Brunswick to date.

b) The Forestry Community in Canada in general – and NB in particular - - was considered to be an early adopter of GIS technology and it helped drive a lot of the analytical GIS functionality we see in Esri products today. Forestry users put pressure on Esri to increase the functionality of its products when it comes to applying new technologies like LiDAR and UAVs to that same core inventory business. That said, many forestry organizations have historically considered GIS a "point solution" for doing forest inventory rather than for handling tasks and transactions across the enterprise. Only recently have those same organizations are starting to see Esri as more of a platform upon which they can build focused applications in other parts of the supply chain.

c) Most interviewees still perceive NBDNRED as an early adopter of geospatial technology today. That said, its influence among Forestry Community members also depends upon the degree to which the Province is willing and able to share the resulting datasets from that technology – at little or no cost. There were suggestions about new technologies used by the government being introduced and accepted to the community more quickly if their acquisition or subscription cost was covered or at least subsidized by government as well.

LiDAR and Related DEM/DSM Technologies

d) As mentioned in Section 4.3.1 (b), interviewees expressed very high expectations in terms of the resolution and accuracy achievable from the current generation of aircraft- or satellite-based LiDAR sensors. A significant number of interviewees expressed the opinion that they were led to believe that they would be able to use the first-round LiDAR coverage to identify species and other selected attributes of *individual trees* rather than seeing such reports aggregated and reported on the basis of 20x20m cells.

e) That said, at least one UNB faculty member indicated that the bare-earth DEM obtained through 1st-round LiDAR coverage did potentially provide a useful basis for "calibrating" future forest canopy DSMs. Some interviewees felt it may be some time before the next round of comprehensive airborne LiDAR coverage would be funded. As a result, some were investigating how Digital Surface Models from lower-cost data sources (i.e., aircraft or UAV imagery; or high-altitude airborne or satellite based Synthetic Aperture Radar (SAR)) might be "differenced" against the corresponding existing LiDAR data to reliably detect and quantify changes at the higher resolution desired.

Cloud Computing

f) Interviewees from Esri Canada noted a "paradigm-flip" in networked GIS usage. Rather than continuing to devote their desktop workstations to handling all the processing- intensive GIS tasks, there is an increasing desire to move all of the major processing of massive datasets and use of machine learning routines up into the cloud *because* they do not want that processing weighing down those desktop computers. Esri's *ArcGIS Online* software-as-a-service (or *SaaS*) offering brings together all its desktop and server capabilities and makes them accessible in the cloud. That *ArcGIS Online* infrastructure is a hybrid of *Esri*-managed infrastructure, Amazon Web Services and Microsoft Azure infrastructure. In fact, ArcGIS Online is now one of Azure's top 10 customers world-wide.

g) The Province of New Brunswick employs a combination of internal server farms and third-party commercial services to serve its cloud-computing needs. Government Open Data programs around the world have migrated towards software as a service. For its GNB Open Data Initiative, Service New Brunswick (SNB) contracted out to Tyler Technologies, a private supplier, the responsibilities to set up, host, manage, maintain and operate the platform and the data at a guaranteed price per month.

h) Elsewhere in the NB Forestry Sector, the transition to Cloud Computing is also recognized as being inevitable. However, that transition is being delayed or constrained in smaller organizations by the following factors:

- Existing desktop computing technology (sometimes incapable of upgrade);
- Data communication limitations (performance varies significantly across the province);
- Concerns over security and confidentiality of data being stored in the cloud;
- New pricing models of cloud-based services which may not fit well into existing "capital-budget" and "operating-budget" spending envelopes; and
- Reluctance of some technical staff to move away from "on-premises" control of all data storage and processing facilities.

In the Field

i) Empowerment of field staff to reliably and consistently perform specific operations was seen to be an important driver of internal applications development. Almost all industrial and marketing board interviewees provided novel examples usage of low-cost cellphone and tablet apps for as measurement, mapping, navigation and visualization. Some interviewees indicated that they relied on Esri's suite of field apps for such work (often custom-modified to sit specific internal needs). Others were either using or investigating 3rd-party applications built on top of the Esri's field suite (e.g., Prism from LIM Geomatics in Ottawa). A number of those interviewed described their field staff using the low-cost Avenza Maps™ software for in-field navigation, feature updating, and activity mapping.

j) Usage of some of those tools can be difficult for the average user as their field devices and sometimes even their desktop computers are not capable of handling the massive amounts of digital imagery and LiDAR data being provided without significant advance processing. The inability to use tiles or snapshots of big data on handheld field devices is seen to be a limitation especially by interviewees in smaller organizations.

k) As mentioned earlier, there was considerable interest in harvester-head technology developments where built-in automation enables them to collect data to "self-inform". Machine learning embedded inside the Harvesting machines can use data from previous trees it harvested in the stand to predict what the next one will look like. As soon as it grabs that next tree and measures its diameter, it can make some calculations to optimize its harvesting in real-time. As of March 2021, at least two major NB forestry companies appear to have integrated this technology into their everyday workflow.

Wireless Communications Infrastructure

l) There was unanimous recognition of major gaps in cellular communications coverage across the province – especially in many of the areas with forest operations now underway. While a number of interviewees indicated they had experimented with satellite-based communication services to serve their needs, the existing commercial alternatives offered in New Brunswick were regarded as still being too expensive to adopt right now. That said, there was considerable awareness and interest about the potential of the satellite-based Starlink service now in beta-testing in different parts of the world (including test sites in New Brunswick).

m) Most interviewees indicated they would support improvements to wireless coverage if proposed, but make do for now with once-daily, twice-weekly or even monthly data updates between field devices and the relevant database(s) in the office.

n) Considerable vision already exists re: how specific operations could be automated if real- time connections to individuals and equipment were available province-wide. At least seven different interviewees speculated on how real-time communications capabilities into job sites could transform logistics scheduling and dispatch, planning and updating of daily field operational plans, communications with field staff, and optimizing the operation of harvesting equipment.

Human Resources Considerations

a) Most industry interviewees were concerned over the availability to their organizations of skilled personnel familiar with the types of data, analytics and/or technologies employed. Added to these technical skills were individual requirements in terms of effective teamwork, communication, cultural appreciation and language skills. While there is an increasing availability of in-class and online training and education options, graduates possessing these skills are in demand outside the Forestry field as well. Concerns were expressed that it will get more difficult to attract people to work with organizations in this Sector - particularly those headquartered in smaller rural New Brunswick communities.

b) Finally, there was some indication of a preference to train from within when it came to basic technology usage. However, when asked about hiring of new technical systems staff, responses were mixed over whether to: (a) hire foresters with an aptitude for computing and then train them in hardware/software/analysis specifics; (b) hire computing/programming specialists and provide them with the necessary forestry supply chain context as necessary to address a given project; or (c) engage specialists required on a contract basis as required.

c) There is also a growing demand in the Forestry Sector for individuals with integrated skills, e.g., a GIS analyst that can also handle remote sensing operations and understand field observation data coming in from mobile devices.

d) Organizations employing multiple GIS support staff members indicated a preference to obtaining individuals with more formal computer science education and IT experience when the organization's software functionality had to be extended beyond its "out-of-the - box"

capabilities. Given increasing requirements to automate production processes and/or handle massive and rich datasets, multiple interviewees stressed the importance of incoming GIS technical staff possessing scripting abilities using such languages as *Python* and *R*.

e) Because of the volumes and the richness of data, there are also requirements nowadays for people to not just be able to run geoprocessing tools, but also do at least some basic scripting to automate production processes as well. Possessing some basic scripting abilities in languages like Python and R is really becoming important in order to increase efficiencies.

Recommendations

1) **NB Forestry Sector members and sponsors of this Study should collaboratively determine and implement a means of sharing information, code or scripts, test data and other materials describing specific custom developments and software extensions that would support their forest management, planning and operations-related activities.**

Based on the work described in individual interviews, it is clear that: (a) a significant amount of impressive applications development expertise exists among the organizations within New Brunswick's Forestry Sector; and (b) considerable custom applications development has already been undertaken within many of those organizations. That said, interviewees also recognized the fragility of this situation, with growing competition for such expertise in the marketplace, and the need to update or restart these application development efforts if/when a particular version of a system or software component changes.

Are there opportunities for cooperation, sharing or collaboration on a specific new development here? Is there the possibility of somehow sharing specific developments OR engaging one developer or team to work for everyone in developing and maintaining shared scripts? While legitimate concerns over protecting privacy and/or competitive advantage may always exist, cooperation on specific application and platform developments will ultimately improve productivity and effectiveness within the Sector.

2) **In order to increase accessibility and productivity, Provincial and Federal Governments should use their influence, expertise and buying power to pursue province-wide licensing and usage arrangements of advanced technologies and datasets.**

Especially smaller organizations within the Sector indicated that limited resources made it difficult for them to build capacity and take better advantage of changing technologies to handle the massive image, LiDAR and mobile-tracking datasets now becoming available. Interviewees suggested that negotiating province-wide site-licensing and bulk-purchasing arrangements would reduce costs, increase the access, and widen use of new equipment, software and even cloud computing services.

3) **NB Forestry Sector members should at least be informed of – and ideally, be involved in – government-sponsored activities concerning the nature and planning for future rounds of digital surface model coverage.**

Given the widespread support for LiDAR in the Sector, there is legitimate concern over what comes next. Interviewees within NBDNRED, Industry and UNB all indicated that potential alternative sources of digital forest canopy data were being investigated and assessed. Based on results of those activities, a tentative vision and plan should be developed for discussion, support and implementation.

4) **The Federal and Provincial Governments should work with Indigenous communities and organizations on a government-to-government basis to ensure they have adequate funding and resources to collaborate and participate as rights holders in data, application development and technology partnerships.**

Long-term engagement with Indigenous organizations and communities is required to build trust, to better understand the priorities and practices driving their use of geospatial technologies, and to support their priorities. Funding is a major requirement for enabling Indigenous organizations to continue to build their capacity to interact with geospatial data.

5) **Every effort should be made by Governments and industry leaders to support research, development and implementation of improvements to LiDAR's ability to identify and characterize the species and attributes of individual trees within a forest stand.**

While some suggested that LiDAR's potential had been oversold in the beginning, they have seen the benefits of first-round coverage and can now appreciate its potential for wider application – even within the diverse Acadian/ Wabanaki Forest found here in New Brunswick. Interviewees recognized that other aspects of that operation (especially approaches to ground-based calibration) may need to be modified as well reach this objective.

6) **NB Forestry Sector members should investigate and quantify the extent of duplication and redundancy that exists in the collection, classification and maintenance of digital Land Base graphics and attribute data existing between and among the GIS platforms they operate.**

"Land Base" features include roads, trails and hydrographic features. If the duplication and redundancies are determined to indeed be significant, then an alternative approach should be investigated and implemented to provide a single source of timely, reliable and authoritative data for key land base features. Also regarding the Land Base, interviewees offered strong support for the continued improvement of the positional accuracy and timeliness of the Digital Property Mapping and related attribute data provided by Service New Brunswick.

7) **As interest among sector members evolves and expands to apply geospatial data, platforms and tools to support shorter-term operational needs and transactions, Sector members should collaborate on how these new needs should (if at all) influence updates, extensions and/or outright changes to the data, standards, tools and applications currently in use.**

With increasing pressures related to the need for increased efficiencies, certification requirements, and environmental considerations, Sector members should be determining whether or not fundamental changes must be made to the nature of the data it is collecting in support of its EFI and the standards to which that data is being validated.

Appendices

Appendix A - Interview Questionnaires

A.1 - Stakeholder/Rights holder Interview Questions for Forestry Organizations (Industry, Government and Indigenous)

For Forestry Organizations (Industry and Government):

1) What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

   Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

2) How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

3) What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

4) Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

5) What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datasets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

6) What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

7) How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

8) Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

9) What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and government departments to which you must report?

10) Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

11) What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? II so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

12) Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

13) If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

14) What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within, or do you engage specialized contractors?

Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

15) Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

16) Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

17) Is there anything you would like to add that you think would be helpful for this study?

A.2 - Stakeholder Interview Questions for Technology Suppliers and Consultants

For Technology and Services Suppliers:

1. Among your Forestry Sector clients, what are the principal application, needs or problems that require your services or products? (If helpful, please use the Framework from the McKinsey and Company Report attached.) Do those vary from "early adopters" to mainstream customers?
2. How do the products and/or services you provide help support those applications and needs and help solve those problems?
3. What types of economic and/or operational challenges do you think your Forestry clients are facing – and perhaps passing on you?
4. Have the demands of your customers changed or evolved over time? If so, how? Have those changes in demand influenced or changed the nature of your own product and service offerings? How?
5. In your experience, what do you think are the most important value-added aspects of the products and services you provide to your clients?
6. How do issues over standards and interoperability influence the products and services you offer? Are your forestry clients challenging you in this regard, or vice-versa?
7. What do your customers and your own market research tell you about new or changing challenges facing the New Brunswick Forestry sector over the next decade?
8. To what extent do you think your customers are making good use of the data sharing capabilities of your products?
9. To what extent do your products or services make use of cloud-based architectures for data storage and scalable processing? Describe the services you and/or your product are using. (e.g., Amazon Web Services?)

10. What about Field-to-Office technologies? How has that changed? Is that evolving among users in your organization? If so, for what tasks or operations in particular?
11. To what extent is the optimal usage of the products or services you provide limited by particular conditions, regulations, infrastructure, etc. in New Brunswick? What would have to change in order to improve the functionality, efficiency and/or effectiveness of these products in this market?
12. Is there anything you would like to add that you think would be helpful for this study?

Appendix B – Individual Summaries of Interview Conversations

B1: New Brunswick Department of Natural Resources and Energy Development

New Brunswick Department of Natural Resources and Energy Development:

- Dale Wilson, Manager, Renewable Resource Inventory Section, Forest Planning and Stewardship Branch
- Danny Crain, Director (Acting), Information Systems and Departmental Services
- Clark Langridge, Senior GIS User Analyst, GIS Section, Information Systems and Departmental Services Branch
- Jeremy Gullison, Forester, Timber Products Section, Forest Operations and Development Branch

Information also provided by:

- Jamie O'Donnell, Manager, Forest Operations Section, Forest Operations and Development Branch
- Suping Liu, Senior Systems Analyst, GIS Section, Information Systems and Departmental Services Branch

Background Context

The New Brunswick Department of Natural Resources and Energy Development is a major user of geospatial technologies within the Provincial Government to support both forest management and mineral exploration activities. In 1981/82, it was the first organization to acquire Esri's Arc/INFO software to act as the platform for creating and managing its province-wide digital Forest Inventory Geographic Information System. The mapping, database management, analysis and reporting capabilities of the system were seen to be vital to supporting the (then new) 1980 Crown Lands and Forests Act that had only recently been passed by the New Brunswick Legislature.

What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

The Renewable Resource Inventory Section (RRIS) of the Forest Planning and Stewardship Branch (FPS) of the Provincial Department of Natural Resources and Energy Development (DNRED) is responsible for the acquisition of remote sensing data including LiDAR, satellite imagery digital aerial photography on a provincial basis. Basic Forest inventory data in the form of photo interpretation, EFI and other derived layers for wetlands, water and non - forest. The primary client for the data produced is the Strategic Planning Section of FPS. This groups builds management planning layers for Crown land and woodlots. The RRIS also coordinated the provincial continuous landscape inventory ground plot program. The ground plot data collection program is an in-house DNRED program. From the schematic provided, RRIS can be found in the Digital Inventory section.

Geospatial technologies are also extensively used by the Forest Operations and Development (FOD) Branch to aid in the review and analysis of Crown land industrial operations.

Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

There is an internal motivation to provide forest inventory data more frequently and to provide inventory data that is not only suitable for planning but for operational use as well. There are required reporting mechanisms on the Provincial and Federal level for forestry information that also drives what data gets collected and when.

FOD saw the need for improved operational productivity around monitoring and reporting on regulation and environmental issues. Better and more accessible data leads to more efficient use of field staff time.

> "BETTER AND MORE ACCESSIBLE DATA LEADS TO MORE EFFICIENT USE OF FIELD STAFF TIME"

How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

Technology has played and continues to play a major role in how forest inventories are built in NB. Between 2015 and 2018 wall-to-wall LiDAR was collected as was EFI built on a 20m X 20m pixel. Since 2019, Satellite imagery has been used to build annual harvest update on Private land. Species prediction trials have been conducted primarily by industry, but government also has an interest in automating species prediction. Photo Interpretation is still the most effective way to get species attribute information into the forest inventory. Technology to get this info in other ways is at our doorstep but is not quite operational. Prior to these recent developments, Forest Inventory in New Brunswick had changed little from the approach we took in the 1950's.

We are also receiving many requests for very large datasets – terabytes worth of data. Logistically, that makes that tough to share.

With the Satellite and Aerial Imagery that are now more easily accessible, the understanding of where /when /what operation has happened is now accessible to a better frequency. This helps us with doing better monitoring of the forestry operation.

Our biggest changes over the last little while has to do with how we collect data and also how we how we share it. Much more emphasis on field-based tools for data collection now, and greater reliance on the cloud for data sharing and distribution. Sharing data by making accessible over the Web using ArcGIS Online rather than transferring files via CD, thumb drive or even FTP. And the information they are accessing is much more up to date. If users want to download files, those files are updated once a day. If they are accessing the data through online services, any updates are immediate.

What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

Open data issues prevent the sharing of a lot of the data that is collected. We are not permitted to share the data we hold concerning large industrial freehold, so we experience some friction when we refuse

those requests. That said, the ban on sharing private woodlot Enhanced Forest Inventory (EFI) and Landbase data was removed on March 5, 2021. The data the Department does make accessible online to the general public can be found at NBDNRED's GIS Open Data Website.

Data management issues limit the ability to store and serve data efficiently.

The industry is on the cusp of receiving huge amounts of data directly from harvesting machines. This will be a step-change, but there will be challenges around the storing, sharing, and use of the data.

Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

Data storage and processing roadblocks are affecting the ability to prepare and serve big data. (See earlier comment as well.)

The usage of some of those tools are difficult for the average user as their computer aren't built to handle this amount of information. This unfortunately results with a lot of waste as field staff would benefit from that additional information when they're in the field. The inability to use tiles or snapshots of big data on handheld field devices is a limitation.

Biggest issue is getting people to not do these things themselves instead of relying on the subject matter experts to provide the best approach to a solution.

Size – everything is getting bigger, LiDAR, imagery – 10 cm resolution, etc. – storage, serving to users and processing speeds for analysis; because everyone wants data that is so fine grained the system is not able to keep up – takes forever to run an analysis, if it will run at all. Training – people have another background and a few courses in GIS and feel that they are experts in the software. We don't always hire a GIS trained staff for a GIS position. User community has exploded; ArcMap, ArcPro and Mobile – Esri doesn't help when they say they can build a mobile app in 45 mins but don't explain all of the background checks and balances for data validation; What do you need for the end use? Does the data structure work for that purpose?

Sometimes people they don't spend the time up-front to understand the data and if it really meets their purposes.

What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datasets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

- Land base (polygonised forest inventory) (internally developed and maintained) Enhanced Forest Inventory (external) Digital Aerial Imagery (external) – 4-Band Multispectral with 20 cm resolution – province- wide coverage completed in 2020.
- Sentinel-2 and SPOT 6/7 Satellite Imagery (external and some with limited ability to share beyond our own use.
- LiDAR products DEM, CHM, etc. (external)
- Continuous Landscape Inventory Ground Plots (CLI) (Internally collected and maintained)

Data collection tools have been developed in-house; data cleaning tools are part of a license to FORUS Research. Issues on species prediction is the area we are concentrating both in-house and contract services.

There are certain aspects of the inventory update cycle that we could certainly speed up, but other aspects where we're not sure the increased frequency is required. We have a group of people in our Forest Strategic Planning section that feel quite comfortable in being able to "grow" our current forest inventory (i.e., using modelling to predict the growth) for about a 10- year period. On the other hand, we are getting pushed from above to collect and maintain better, more up-to-date data concerning update of harvest on all land ownerships.

Re: LiDAR: We have a year or two to decide and are still debating what we want to do in our next cycle of update coverage. LiDAR can be expensive. We might consider saving some money by acquiring new satellite or aerial imagery and perhaps generating a photogrammetric point cloud from that imagery. On the other hand, LiDAR has the advantage of penetrating so well into the forest canopy.

The LiDAR coverage can also be calibrated from ground plots we maintain. We maintain a pretty robust ground plot program in the province. We monitor about 1500 400 sq. metre plots annually. We plan to build that up to about 15,000 ground plots that we will continue to remeasure over time. Data from those plots can be used to help calibrate either new LiDAR measurements or whatever remote sensing

that we use going forward. The same data is helping to calibrate forest growth models in those areas as well.

- Crown Timber Licenses – Management Plan, Operating Plan, Forestry Operation Update (Internal)
- Issues: Inconsistency from the submission of the various Crown Timber Licenses which make it harder to created and provincial shapefile.
- Tools:
    - Using ArcGIS/Model Builder help to clean / improve the data
    - Tableau – help to clean / analyze / produce report and dashboard

What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

Compatibility issues: GIS platforms cause spatial issues with preparing aerial imagery. ArcGIS versions do not all run the same and new versions are coming relatively quickly. Issues with ArcGIS 10.7 and ArcPro have made it difficult for our group lately to produce forest inventory products efficiently.

Data management; FTP data transfers cause problems for receiving satellite data from vendors

Storage: data storage in our shop is servers and hard drives.

How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

LiDAR products, Satellite and Aerial Imagery are stored on in-house servers and access can be provided to those within the organization that need them. Stereo pairs and raw images are stored on hard drives and accessed by the appropriate staff with "toasters". *(Editor's Note: A "toaster" is an external hard drive that accepts bare metal hard drives of 10+TB per hard drive. A typical "toaster" can hold up to 4 of these hard drives.)*

Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

Data sets are made available to as many as 100-200 individual requests each year to universities and individual students, industry partners, woodlot owner groups, NGOs, First Nation groups, other government departments and individual citizens. Data is shared with most through data sharing agreements that control the use of the data.

Use ArcGIS Online (ArcGIS OnLine) for data sharing of the Crown Timber Licenses Provincial Operating Plan.

It depends on the data sensitivity; if the data is deemed to be open to the public we would make it open through our Department's Open GIS Data Portal. This may not be all of the data as there are some layers that are operational or interim and not applicable to outside usage.

Use ArcGIS Online for data sharing for First Nation and other external groups for sensitive information; closed or restricted groups. Use ArcGIS Online we create web apps for data for public who do not have access to a GIS software.

Share data with Licensees through the ftp or ftps sites.

Ad hoc data requests through email or data storage devices.

Most of the people we deal with use either ArcMap or ArcGIS. Other users require data for use on QGIS or (on few occasions) MapInfo software. Shapefiles have become a de facto Open Data standard.

What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and government departments to which you must report?

Some of our data (forest inventory data on Private Land) is not to be shared outside of government without permission. Data Management issues and IT requirements are the largest roadblocks when sharing within government.

Our Crown licensees pass to us annually their forest harvesting and silviculture updates. Some of that data gets put together from sensor data that they get from directly from harvester equipment.

Large need for better sharing of information (both ways) with Licensees. Need a live feed perhaps through something like a URL-to-URL connection.

Some staff feel their datasets are more sensitive than really need to be and require them to be locked down to only a very small group. Not fully documented metadata.

People have different datasets on their personal computers, and it causes challenges when they do not match.

We sometimes have issues when users feel they have better or more authoritative data than is held in the centralized authoritative dataset.

Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

GIS Support is within the department and is responsive to the needs of our section.

IT support through SNB is another matter. Often big data needs are not well understood by our IT group, so service from them is not always reliable.

Both. We have an IT group for programming, a GIS group for GIS solution development and data management and "super users" within different sections/units.

What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? II so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

Outdoor data collection is well covered. There are 2 main field requirements in the inventory system. Data collection of CLI program. These data consist of geo-positioning the plot centers, measuring trees, tagging individual trees in Permanent Sample Plots (or "PSPs"). There are 1500 plots done throughout the province annually. This work is carried by district forest ranger staff throughout the province. There are as many as 100 staff that participate in this program. It is coordinated from the inventory shop. Other outdoor data collection supports the photo interpretation function and requires 2 in-house staff to verify photo interpretation. Other field projects require the hiring of casual teams on a project-by-

project basis. In the past more field collection was done through forest industry and woodlot organizations but in 2016 this was all brought in-house. Technology used for field data collection is based on in-house data collection programs some built from scratch and other built on Esri Survey 123 software. As far as balance between data collectors and staff to do analysis, the inventory section could use more staff on the analysis side for cleaning data and preparing data for other users.

In the FOD Branch, 16 field staff capture approximately 7000 data points per year related to regulatory compliance. This data is compiled and analyzed in the office and reported upon frequently.

Much more balanced toward field staff collecting the data – more field staff collecting than office staff responsible for the analysis.

Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

Data is stored on data collectors and uploaded to databases that reside on servers at a later time.

Collected and stored – uploaded later on the server.

Collected and stored – uploaded later.

If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

Cell coverage and WiFi are inconsistent in the areas staff travel. The data we collect does not require the quick turnaround times some data might require, so this avenue has not been pursued actively.

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within, or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

Data Collection is done in-house and there are no issues getting staff.

We have 4 long standing staff they carry the bulk of our analysis with respect to GIS, Photo Interpretation, Wetland and CLI inventory.

If there are projects that require other expertise, contracts with service providers are often hired. EFI was done in 2018-19 by Forsite Consultants Ltd. Photo interpretation is being contracted out in 2021.

Current staff have been building change detection skills and other skills to build detailed automation into wetland inventory through training and experience.

Hire the expertise or train from within, depending on the position.

Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

Automation of forest species at an operational level – leading to photo interpretation becoming less important to our business and reducing turnaround time for our resource inventory.

Open data for all government-supported inventory data to allow it to be shared.

Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

Yes, but I wonder where this initiative fits in with all the other collaboration that is already going on between the Federal government and the provinces. The National Forest Inventory, the National Forest Information System, the National Forest Database, Initiatives like CASFRI, MAGPLOT.

B2: Service New Brunswick Land Information Infrastructure Secretariat

Service New Brunswick:

- Andrew MacNeil, Director, Land Information Infrastructure Secretariat, Business Opportunities and Digital Services Branch
- Julie McKay, Manager, Land Information Infrastructure Secretariat, Business Opportunities and Digital Services Branch
- Bernie Connors, Geomatics Engineer, Land Information Infrastructure Secretariat, Business Opportunities and Digital Services Branch

Background Context

Service New Brunswick (SNB) is a Crown Corporation within the Province of New Brunswick. Its principal mandates are: (1) to make government services more accessible: and (2) to act as stewards for authoritative information. This particular Branch of SNB combines the responsibilities of the Land Information Infrastructure (LII) Secretariat and the business operations of our common infrastructure that support the delivery of services to business and citizens such as GeoNB, Identity Management, Licensing and Permitting, Internet, Bizpal and GBiz.

Among its many activities, Service New Brunswick is also responsible for all Land Registry and Property Assessment services and for the corresponding ongoing maintenance of province-wide digital property mapping and parcel-based attribute information. Members of this Branch are responsible for the development and ongoing operation of GeoNB, the Province of New Brunswick's online open gateway to geographic information and related value-added applications.

Among your Forestry Sector clients, what are the principal application, needs or problems that require your services or products? (If helpful, please use the Framework from the McKinsey and Company Report attached.) Do those vary from "early adopters" to mainstream customers?

Most of the people who access our data online really don't tell us what they're doing with it. It's all open data, so access is anonymous. We only hear from them if they have an issue or a question. We have

heard from forest companies or Wood Co-Ops periodically, when there's issues with our data or potential issues with our data, but those calls are infrequent.

That said, part of our role is also to provide seed funding and innovation ideas, as well as offering collaboration for setting data standards and accuracy levels and building communities of interest to gather data as needed to support programs of importance to more than one sector in the province (as opposed to data needs that might be sector-specific). We balance creating a common standard that – at the minimum – meets everybody's needs and at the same time reduces duplication.

How do the products and/or services you provide help support those applications and needs and help solve those problems?

We were involved with NBDNRED and Forestry Canada right from the start on LIDAR, because it was important to agree upon and set common standards before we started acquiring that data. It was necessary for it to serve the needs of multiple sectors in the province - we couldn't afford to buy LiDAR just for forestry nor could we afford to buy it just for emergency response or climate change.

What types of economic and/or operational challenges do you think your Forestry clients are facing – and perhaps passing on you?

Have the demands of your customers changed or evolved over time? If so, how? Have those changes in demand influenced or changed the nature of your own product and service offerings? How?

Property Data: One of the biggest changes we've noticed is that people want very up to date data quickly and we have responded to that. For example, we used to update the online property mapping dataset only once or twice a year. Today, we post updates to that database online nightly.

Imagery: Right now, the digital aerial imagery originally flown for NBDNRED is the biggest source of our imagery, and that's anywhere between 15-to-30-centimeter resolution. Our property assessment group is flying Pictometry imagery at 7.5 cm resolution over different municipal areas. And we're also working with different municipalities like Fredericton and Moncton to offer access to their much higher resolution imagery. For example, the City of Fredericton flew its entire area once again in 2020 at 5-cm

resolution. We currently host that data and make it available through our servers as an online image service.

In addition to our GNB service, some of our image datasets (e.g., Pictometry assessment imagery) are provided to Esri Canada, and they provide online access to it as well.

Customer expectations on currency of the data extend to imagery as well. Customers will complain if the aerial photography we are offering is not right up to date. Two-year-old imagery is not good enough anymore.

LiDAR: There is a lot of demand within the New Brunswick Forestry Sector for the next round of LiDAR coverage. Even the Minister of Natural Resources and Energy Development has asked about that, and our response has been "When do we need the next LiDAR coverage from a multi- sectoral perspective?" That's going to be a challenge. A large amount of money was spent on that first pass, and we could not have been able to afford that without the funding support provided by Natural Resources Canada and Public Safety Canada. They provided almost 50% of that money, and then we were able to get money from other departments to cover the province.

The Environmental Trust Fund was a large contributor to the purchase as well, with understanding that our main business case built around obtaining a higher accuracy digital elevation model of the ground. Getting the forest canopy information from the LiDAR as well was a bonus.

All that said, however, we're paying particular attention to Canada Space Agency initiatives as well as those from the European Space Agency to see what opportunities exist for some of the newer sensors that are being put into orbit, and how they might be able to replace airborne approaches to gathering geographic data.

Applications: We don't specifically advertise the data viewing apps we produce (e.g., the *Riverwatch* app, which keeps track of St. John River flood levels) "mobile-friendly" with a lot of the apps that we put out. They may be "mobile-capable", but they were not originally designed with cellphones or tablets in mind. Most of the map viewers may be accessed on mobile devices, but we are getting customer feedback that they need to be even more mobile-friendly.

In your experience, what do you think are the most important value-added aspects of the products and services you provide to your clients?

How do issues over standards and interoperability influence the products and services you offer? Are your forestry clients challenging you in this regard, or vice-versa?

We serve up the LiDAR data online to our users in compressed laz format. We're not getting a whole lot of feedback on the standards we are using, so we have to assume that folks are happy and it's not creating any problems for them.

Most of the online services we build are designed with interoperability and openness in mind. When the LII Secretariat was created in 2006, part of our mandate was to reduce duplication of effort across government in terms of data collection and management. We set up a great amount of extra infrastructure within SNB, to provide that data to the government and public users as a GNB asset. But today, we have departments that are setting up the same infrastructure to host their own data. In fact. The government is now hosting multiple copies of the LiDAR coverage for their own internal use. The cost to the taxpayer to have that huge dataset sitting on multiple servers across government is not efficient. We find today that people are building their own "tents" (server farms) therefore possibly creating a missed opportunity here from a budgetary perspective. We should be looking at cloud services for shared computing and shared storage.

While we do have a "cloud-first" policy in New Brunswick, it is in its infancy and uptake is just beginning.

There are also differences of opinions regarding policies over free and open access to the data the province collects and/or manages. Not all of our users – industry or government - are open with information. Everything they do may be proprietary, and that can make collaboration very challenging. Members of some sectors embrace openness with more eagerness than others.

What do your customers and your own market research tell you about new or changing challenges facing the New Brunswick Forestry sector over the next decade?

To what extent do you think your customers are making good use of the data sharing capabilities of your products?

To what extent do your products or services make use of cloud-based architectures for data storage and scalable processing? Describe the services you and/or your product are using. (e.g., Amazon Web Services?)

The New Brunswick Government (GNB) has built its own virtual server farms. We' have two data centers here in Fredericton – one at Allison Boulevard and one at Marysville place - and have some redundancy there. We deal with the folks who manage that data, and they certainly appear to have set up a very robust system. All of our data is served up through web services on these provincial government servers.

SNB has also taken a step into the software service role with our GNB Open Data Initiative. For that service, we contracted out to Tyler Technologies, a private supplier, the responsibilities to set up, host, manage, maintain and operate the platform and the data at a guaranteed price per month. Government Open Data programs around the world have migrated towards software as a service. We have companies like Tyler Technologies, who provide services to multiple levels of government across the globe. We are one of many customers.

That's worked out extremely well for our open data and I think it's a model that we've got to look at for some of our other large data sets. For example, if we complete our Buildings footprint for the province, that's a large data set. Some of that data is "cold" (i.e., relatively static) while other parts of it are "hot" (i.e., change more frequently). That's where using a third-party cloud services provider comes in handy.

We'd really like to get there with Esri software as well. We are just now finishing a server upgrade we started 3 years ago. We have finally moved on to ArcGIS Server Version 10.7.1, and Esri is now up to Version 10.9.1.

The other comment concerns storage. Back in November of 2017, we were looking at other services to store our SNB data. We spoke with commercial cloud services providers and were quoted prices much lower than for on-premises storage. That was when there really were only two major cloud services providers. The cost per gigabyte bids we could get today are probably exponentially lower. One of the things we did learn from that, and subsequent exercises is that – through finding and using lower-cost cloud services to store your data, you can free up the cash and human resources you need to better collect and manage your data and keep it up to date. In particular, by watching your data and your customers, you can better identify what data is hot, what data is cold, and then pay different prices for the cold data storage than you do for the hot.

I think forestry probably into that paradigm quite nicely. They will collect aerial photography over given areas, access and use that data quite heavily for a period of time while those particular areas are being worked on, and then that data "becomes cold" and gets put on the shelf. Right now, for example, DNR is collecting 16-bit digital aerial photography, which is quite a monster to deal with in terms of storage and follow-on processing. One of the first things we do with it is convert it to 8-bit before we start further processing and tile-caching. So, if that was our data, we might work with the 16-bit data for the first couple months, and then move it to "super-cold" archival storage, because almost everything we do after that is going to be with the 8-bit data.

What about Field-to-Office technologies? How has that changed? Is that evolving among users in your organization? If so, for what tasks or operations in particular?

To what extent is the optimal usage of the products or services you provide limited by particular conditions, regulations, infrastructure, etc. in New Brunswick? What would have to change in order to improve the functionality, efficiency and/or effectiveness of these products in this market?

Part of our mandate is to offer open and unrestricted access to all of our data, which can pose a challenge for some partnerships. We had the opportunity to partner with municipalities on different scenarios for re-collecting aerial photos, and it failed to materialize due to inability to agree on conditions. We have made great inroads in New Brunswick as leaders in providing some of this data in a free, open and unrestricted manner. We need to understand how we can fund the collection and updating of these datasets without having to license them.

Is there anything you would like to add that you think would be helpful for this study?

It's important for people in our organizations not to get too tied to a particular technology or way of doing things. Assigning titles to staff based on particular technologies rather than fields of science is restrictive to embracing new technologies (LiDAR specialist vs. Earth Observation Specialist). If we don't want to paint ourselves into positional obsolescence, we need to keep position titles general and enough that people don't view their job as being tied to one type of technology or another. Also, everyone needs to do their best to bring down the silos between different Departments in terms of the

data they collect and the technology they use. If we all had more access to the industry and more interaction with them, it would be very beneficial to both sides and open up a lot more opportunities.

"EVERYONE NEEDS TO DO THEIR BEST TO BRING DOWN THE SILOS BETWEEN DIFFERENT DEPARTMENTS IN TERMS OF THE DATA THEY COLLECT AND THE TECHNOLOGY THEY USE. IF WE ALL HAD MORE ACCESS TO THE INDUSTRY AND MORE INTERACTION WITH THEM, IT WOULD BE VERY BENEFICIAL TO BOTH SIDES AND OPEN UP A LOT MORE OPPORTUNITIES."

B3: Mi'gmawe'l Tplu'taqnn Inc. (MTI)

MI'GMAWE'L TPLU'TAQNN (MTI)

- Steve Ginnish, Forestry and Natural Resource Coordinator
- Mike Isaac, Director of Indigenous Knowledge
- Tom Johnson, GIS Coordinator
- Dean Vicaire, Executive Director

Background Context

Mi'gmawe'l Tplu'taqnn (meaning "Mi'gmaq People's Laws" or "how we govern ourselves") is a non-profit organization whose members are the nine Mi'gmaq communities in New Brunswick: Amlamgog (Fort Folly) First Nation, Natoaganeg (Eel Ground) First Nation, Elsipogtog First Nation (Big Cove), Oinpegitjoig (Pabineau) First Nation, Esgenoôpetitj (Burnt Church) First Nation, Tjipõgtõtjg (Buctouche) First Nation, L'nui Menikuk (Indian Island) First Nation, Ugpi'ganjig (Eel River Bar) First Nation and Metepenagiag Mi'kmaq Nation.

Further Context from MTI Executive Director Dean Vicaire:

To be clear, we are a rights-based organization and want to stress the fundamental difference between a stakeholder and a rights holder. That fundamental difference informs and influences our dealings with all levels of government, whether it be municipal, provincial, or federal, and certainly with the proponents with whom we engage. Our challenge in many respects, is that we are faced to have a dual role. First, we participate in issues and situations - if we deem it safe to do so –while ensuring that we uphold OCAP Principles[1]. Second, we find ourselves quite often being in a role of the educator, which is something we don't shy away from.

[1] The First Nations Principles of OCAP™ (ownership, control, access, and possession) means that First Nations control data collection processes in their communities. First Nations own, protect and control how their information is used. Access to First Nations data is important and First Nations determine, under appropriate mandates and protocols, how access to external researchers is facilitated and respected. For moreinformation, see https://fnigc.ca/ocap-training/

What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

Much of our work has been in using GIS to increase or enhance awareness. We first started using GIS to record Indigenous Knowledge (IK) and land use information. While early on subcontracted that work out to another organization, we eventually started doing it in house and have since managed to keep everything within our organization.

With all due respect to this process, we certainly don't need GIS or GPS to identify where we had our traditional lands where we hunt, where we fish, and where we had our settlements. But as the Mi'gmaq people do, and as most native people do, we adapt to the simple fact that we have to prove that we were here, we have to prove that we did this, where we use the land, and so on. Governments said, "You want to lay claim to something? Show us proof that you were there." How we respond to that is a challenge and involves a moral question we have to ask ourselves. In response, we have engaged or trained experienced individuals like Tom, Steve and Mike to help us throughout that process.

We (the Mi'kmaq) have never been part of any historical storytelling. Over a period of time, there has been some presumption of wider society that Indigenous Peoples did not occupy specific areas simply because – as generations went by – we were secluded on our reserves. Some of our people were moved two or three times because the area in which they were located to became more valuable to others over time. People don't understand because that story is not recorded very well in the history books, if you will.

So, now we have to begin to tell our own story. Our stories come from our elders, and we go into our communities to speak with them. They provide us with information concerning specific areas, place names, and what they've done in specific territorial areas, even areas that are designated outside of the boundaries of a reservation or reserve. We need them to give us more and more of this information because it's becoming more difficult to have those intellectual conversations with government, with companies and with other entities because they themselves are not educated enough to understand that our territory – Mi'gma'gi - has never been given up. Nothing was signed over. Yet, over a period of time, certain things happened that reduced our inabilities to move around as we did, to function as we did, to harvest and gather as we did. The IK brings our own voice into studies. A lot of times it may support Europeans' accounts of where we were and how we traveled, and that that helps them better

understand that we occupied this territory, we utilize his territory, we harvest from this territory, and you know, and we need to educate those folks.

> "OUR STORIES COME FROM OUR ELDERS, AND WE GO INTO OUR COMMUNITIES TO SPEAK WITH THEM."
>
> "IT'S BECOMING MORE DIFFICULT TO HAVE THOSE INTELLECTUAL CONVERSATIONS WITH GOVERNMENT, WITH COMPANIES AND WITH OTHER ENTITIES BECAUSE THEY THEMSELVES ARE NOT EDUCATED ENOUGH TO UNDERSTAND THAT OUR TERRITORY – MI'GMA'GI - HAS NEVER BEEN GIVEN UP."

It's not a point of taking anything away. It's about recognition. It's about understanding why we want to protect specific areas, why we want to be part of discussions when we're harvesting in specific areas whether on land or in the water. I hope to see a time where we have enough information to bring into the classrooms in order to educate the next generation, so that when they become the politicians, policymakers, and decision makers, they're going to understand the big picture. And then maybe you won't have what we're having today – battles and struggles where people get hurt, property gets damaged, and so on. For me, that's going to be a time when there's going to be true reconciliation, where people understand where we are coming from, and why we are asking and doing the things that we want for our community and its members.

Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

All our communities in New Brunswick have forest management plans in place, but they don't have access to the structure that industry and government sets up for companies and for private woodlot owners to be successful. Private woodlot owners may complain about their access to the markets, but they still get great benefits from Mi'kmaq territories. We are asked all the time why we don't participate in discussions. The reason is because we don't get to share the resources, like the companies and the private woodlot owners do.

How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

For example, we use GIS quite a bit when we're identifying protected conservation areas – Indigenous Protected Conservation Areas (IPCAs). Right now, I'm working on a place names map that will be made accessible to the public through ArcGIS Online. We have worked with NBDNRED in the past, but we haven't done much with them lately.

MTI is fortunate to have such a valuable person as Tom get the necessary education and become an expert in that field. He has such a passion for GIS, and he spent the majority of his vacation finding those place names. That passion and knowledge is something that is so invaluable to us.

I was involved with Natural Resources Canada, and we brought in GIS, when it first came out to the communities to do our forest management plans. These were structured timber resource plans, but we also brought in data concerning medicinal values, medicinal medicines, and other important cultural aspects of the communities because – as Dean was saying – we always have to prove ourselves. Any time we deal with government or industry, we have to play by their rules in order to justify who we are as a people, and we don't like that. I do see the benefits of this technology but we don't see the benefits of the technology and data being reciprocated to us. For example, our MTI elders had a tour of Natural Resources Canada last year and saw the LiDAR technology and data in operation. There are real benefits of LiDAR when it comes to identifying old portage routes, old travel corridors, old hunting areas, and things like that. And yet, it is very difficult for First Nations to access the technology resources required

to properly make use of that data. This is one reason why I thought this interview process would be valuable. When we first had a session with Adam Dick back about a year ago, to discuss technology and information requirements, one of the biggest things that was completely omitted was First Nations.

Indigenous Knowledge… land use studies…putting that footprint on our land… was all totally missing. MTI sees the value of having a GIS department – we have to learn to work with modern-day tools to document our position. We have to learn to play this game if we want to be heard. I do think it's a sign of lack of respect towards our culture – we know where our hunting grounds are. We know where we are – but we have to participate and be heard.

When I read all these questions, I see them as industrial management and commercial questions being asked in order to look after industry … in order to give them more tools. We must be involved in this to make sure that our concerns are addressed. So that's why I thought this was a value to us.

Under the forest management plan, we prepared and followed, the Natoaganeg (Eel Ground) First Nation Reserve was the only piece of ground in Atlantic Canada that achieved FSC (Forest Stewardship Council) certification. That's the highest standard of timber resource certification in the world. And yet, we were not recognized for it by government. When industry succeeds, everyone talks about it. When industry fails, or if private woodlot owners are struggling, they get support or bailouts from government. Right now, they get a substantial amount of money to manage their land that comes from royalties on Crown land resources that comes off Mi'kmaq territory. You know what First Nations get from that? Nothing. They expect us to participate… to acquire the necessary IT infrastructure so we can communicate with them on the same level.

All we ask of them is to give us the same tools, technology and research that they use – that they have developed or acquired and paid for using revenues from our natural resources.

I remember talking to the elders about forest management, and asking them very sensitive questions about hunting, what type of tree species you use, what do you use for medicines and stuff like that, because we want to protect all that. Unfortunately, while we can sell all the timber we want, we are breaking federal law if we try to manage it in a different way. Industry's response is to clear-cut our existing forested stands and then plant jack pine plantations. First Nations people would rather maintain the original species composition of the stand. Our elders would rather keep the Wabanaki/Acadian Forest in the state it's been in for millions of years.

That should be the objective of any manager rather than pursuing short term gains. The technology allows us to monitor that. But if governments are not giving those opportunities to the First Nations, how do they expect us to effectively participate with them?

What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datasets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

In the before COVID times, we would collect our IK at community meetings. That is where we would gather the information and that is where we would share our information as well. Now that we are dealing with COVID and its challenges, we have started looking at new technologies that allow us to hold these sessions online and gather our information remotely and make use of the ArcGIS platform.

Not for one minute is this IK information just freely given. It can be a real challenge for our staff to go into communities for the obvious reasons of the colonial mindset that's been embedded within us. In any culture, people are reluctant to share information with outsiders about their special, maybe secret harvesting or hunting areas. Members may share it with others inside the community, but it poses a challenge when people from outside the community come in and ask for such details. It takes time to build trust, and that's the challenge that these gentlemen face every day.

All of our GIS base data comes from the Province of New Brunswick. We also make use of the digital aerial photography and LiDAR data available online and free of charge from NBDNRED and Service New Brunswick.

Also, there might be digital surveys and mapping supporting different engineering and development projects, that take place on various reserves by outside contractors and consultants. However, none of that is stored centrally in our GIS.

What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

See responses to previous question.

How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

All of our GIS activities and the digitized IK data is stored on our laptops here.

We have started looking at the use of LiDAR and find it interesting, but just not have had the time and resources to organize ourselves with that dataset, look at what's there, and to identify what we want to find in it. We're interested by the possibilities LiDAR offers.

Right now, we are in the process of upgrading our database system and probably the most advanced part of negotiating this project is with Stó:lō Connect based out in Vancouver. That's not just for GIS – it's to serve the administrative and GIS needs of the entire MTI organization. It's ours to own and, and do with as we see fit, where Tom, Mike, Steve and even my admin staff can log in, search for data, cross-check, fill out forms and all kinds of other data management operations. It's going to be a significant investment.

Most of the forest management plans we have are in hardcopy form only and the data is not stored in our GIS software here. Those plans are submitted to Natural Resources Canada, and may have been subsequently digitized by them, but we do not have a copy of that information.

The Management plans for Eel Ground and, I think, Red Bank reserves were digitized and maybe in digital form, but they are just gathering dust at this time because we don't have the financial resources to put them into action. If you look at the DNRED forest inventory database, all the First Nations have blank because – like the private woodlots - they don't include us in the data collection with respect to land use. They might have some numbers, but they don't have the full GIS data. And if you're really going to manage the resource, all land users should be included.

Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

The traditional knowledge we have collected and loaded into our GIS is strictly for internal use and not generally made available to others. It is stored on our computer here but is not uploaded into the cloud.

Now, some of the IK information may be made public under certain circumstances - for example, the information and studies associated with peat moss work that we do with specific companies. Those studies are made public after MTI and the proponent have come to an agreement with respect to what is and what is not confidential

Through proper protocol and ceremony—the data could be shared with particular people who we see fit. But there is a process involved to permitting that access.

Certain maps associated with those studies might be made public, but the data itself related to those maps is secure.

What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and government departments to which you must report?

Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

Our GIS team consists of myself and two others. They both work with Mike Isaac's department in Indigenous Knowledge. We know what we're doing with regards to GIS on the Esri platform, and we are looking at possibly expanding it to some of the other departments within MTI - in particular, the Trilateral and some of their work involving IPCAs. We will continue to develop our expertise in-house. If we need more expertise, we will hire our own staff and build our capacity that way.

What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? II so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

All the IK information comes from community information sessions involving typically 15-20 community members. We ask a series of questions, and the community members, because they're all in there together, respond well. Based on those sessions, we will identify specific knowledge holders with whom we would like a more in-depth, 1-n-1 type of interview. In both the community sessions and the individual interviews, we're sitting there with our ArcMap open, and we're just building shapes.

Before COVID times, there was an aspect of ground truth and respect to IK data that was being collected. In some of the individual interviews, they would ask to go to a particular site and do some ground truth. Based on that visit, other memories might kick in and we would obtain even more information from them.

Forestry-wise, at Eel Ground we used to go out and do stand samplings, record the observations and then load it back into the GIS database we were maintaining at that time for forest management purposes. All that when we did it, because when we, when we did when we did forest management and at Eel Ground we had our own database, we had our own GIS system, we had the software and everything. That was in the early days when we were using ArcView software.

The expertise of using GPS for field measurements remains, but it's dormant right now. First Nations know how to go out and collect data, do tree sampling, do species identification, and do stand delineation in order to load it into a GIS system. We were using handheld GeoExplorer to collect the GPS measurements, send it right to the computers, and produce our maps. The capability is there and our people are still thirsty to use that. But, when the economy experienced a downturn, industry and government looked elsewhere, requirements were relaxed and those high-tech operations were discontinued.

Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

See responses to previous question.

If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is

there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

First and foremost, we are looking for well-balanced people with good interpersonal skills. So much depends on our dealings in the community, so we need tactful people with good listening skills who are able to build relationships. We value people who are able to quickly connect with community members and create the trust necessary for those members to feel comfortable sharing information with us. The technical training can come after that as required.

Just to add to that, we seek out people who can speak our language. If they are able to speak with others in the Mi'kmaq language, then I can assure you that trust is there. If they can have even simple conversation and address an elder or a traditional hunter, gatherer or harvester in our language, it shows great respect. That said, finding people with such language skills continues to be a heavy challenge. The future of our language is in trouble, so we have continued to seek funding to hire speakers as teachers and have been successful with fantastic participation in our language classes.

Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

I see improvements to education being an integral part of creating relationships. If folks are going to understand each other, they need to understand from where we come from. We realize that lack of understanding is not the public's fault – they grew up being taught a Eurocentric history and culture – not knowing who we are as a people and not knowing where we're coming from in our history. Addressing that will take many years, but will help everyone within Government, MTI and other organizations when it comes to dealing with sharing and management of our resources.

Building capacity within can be a game-changer for us. Right now, we are not doing as much as we can with regards to the geospatial capacity that we have. There are more ways that we can use GIS and geospatial information within our organization – and use it better. We're not there yet, so capacity building is critical.

"BUILDING CAPACITY WITHIN CAN BE A GAME-CHANGER FOR US. RIGHT NOW, WE ARE NOT DOING AS MUCH AS WE CAN WITH REGARDS TO THE GEOSPATIAL CAPACITY THAT WE HAVE. THERE ARE MORE WAYS THAT WE CAN USE GIS AND GEOSPATIAL INFORMATION WITHIN OUR ORGANIZATION – AND USE IT BETTER. WE'RE NOT THERE YET, SO CAPACITY BUILDING IS CRITICAL."

I have learned that any good leader will be smart enough and wise enough to put better and smarter people around them. Mike talked about education as a game-changer, Steve talked about inclusion – creating a "war chest" of funding so we don't have to keep going to different governments (which we're trying to do, by the way). And Tom talked about building capacity.

My response to all of that is for me to listen to what's been said and then put that into action. That's my game changer.

Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

Is there anything you would like to add that you think would be helpful for this study?

Again, all our New Brunswick First Nation communities have management plans. Some are 50- year plans, while others – like Eel Ground's for example – are 100-year plans. We look at things on a generational basis rather than by 5-year operation periods. Rather than developing 5- year, 25-year or even 35-year management plans, we plan will multiple future generations in mind.

Right now, talking about the scenario with the woodlot owners, everyone's management plans are stalled. When industry started falling apart in 2008 and all the pulp mills started shutting down, government started bailing them out. Woodlot owners complain about being unable to sell their fibre. Yet, they still receive $5 million a year to do silviculture work on their own private land. That funding comes from the royalties that are collected off Crown Land – Mi'kmaq territory. We receive nothing. We get nothing to implement those management plans. They sit idle because there's no revenue coming in from our land to support those plans. But yet, revenue from our Crown land – from my territory – is used to run government departments and half the social services systems in this province. Funds are used to support the woodlot owners' silviculture needs, but we can't even get a penny from them. That's not fair.

My father always taught me, "Look after what you have in your backyard." If you cannot demonstrate what's in your backyard and taking care of your backyard - your people, your culture, your well-being - how do you expect to look after anything else? I don't look at a forest as consisting of just the ten particular commercial species of trees standing within it that bring wealth to shareholders that the communities don't even know. I look at the whole forest that brings wealth to the community as a whole, whether it be economic, social, spiritual, or cultural, wealth. We took that to heart in the Eel Ground First Nation community and achieved a high level of FSC certification that industry and government want all the natural resource sectors to reach. We proved we could do it despite the hurdles involved – some from outside and some from within.

Part of attracting and keeping good people, requires having the infrastructure and resources necessary in order for the people take the interest in becoming managers. Right now, that interest to become the managers isn't there, because government and industry are keeping us off our land. I do think MTI has done a lot as an organization and feel things are better than they have in the past. However, until we get effective inclusion… until we get recognition of who we are as First Nation Mi'kmaq people as it pertains to the land base, we're always going to have this conversation. We need our own "A-Base" funding, we need our own source of revenue sharing, in order to look after at interests of First Nations people.

B4: Acadian Timber

Acadian Timber

- Jody Jenkins, Vice-President, Timber Services

Background Context

Acadian Timber owns about 750,000 acres of private land here in New Brunswick, plus approximately 300,000 acres in Baxter State Park in Maine. The Company also manages a Crown license about 1+ million additional acres on behalf of Twin Rivers Paper. Acadian Timber's products include softwood and hardwood sawlogs, pulpwood and biomass by-products, sold to approximately 85 regional customers.

We were, at one point, the Woodlands Department of Fraser Paper out of Edmundston. Fraser spun off the Lands aspect of its operations to another entity which became known as Acadian Timber.

I look after our planning and our silviculture programs, which include tree planting and tree thinning (excluding harvesting) as well as our work on our private landholdings that deal with other land uses - recreational uses, leasing and things like that.

What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

Our GIS use and everything else like that really began in the early 1980s under Fraser Paper. The company's early interest in GIS at that time was mainly map creation in order to have a better sense of what they had for inventory. Through the 1980s, though it became more important to ensure the Company was harvesting the right amount of wood. The GIS-based inventory was better able to support this, and so timber management planning became an important function of the GIS as well. Later on, map updating joined the list of important functions. It has been only lately probably that we've started to more fully leverage what the data set can provide to us.

Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

Influenced originally by planning and reporting aspects of the 1980 Crown Lands and Forests Act.

How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

Geospatial is more tightly integrated into the day-to-day business and all of our operational control systems now are built to be spatial. If you want to know how much of something you have, you also want to know where it is. Those used to be two separate sets of questions and answers. An example of that would be if we're harvesting wood, and we would have a roadside inventory of wood. Maybe at one point that would have been a table somewhere someone might have shared, but now it's very spatial and linked to our GIS system.

Originally, some of our employees viewed the GIS as purely a mapping tool. As we progressed and some of them retired or moved on, others would come in and say, "You know, there are other things we could know from this." We could find something out, add it to our data set, and then provide value for answering different sorts of questions that that that that could come up.

In the late 90s and early 2000s, when our senior vice president out what was in our data set, he couldn't stop asking questions. He would ask "What's this? Where's this? Where would I find this? And where would that be?" Organizationally, I think asking those questions led to recognition of a lot of value in the data set - and in the maintenance of that data set, too.

Importance of Database Updating: Early on, we used to do a great job of collecting the forest information using photo interpretation and manually drawing the forest type polygons on our base maps. However, the data update process was not viewed by many people to be an important job. What that view led to by the early 90s was a state where the data set really was no longer very usable. If you found something in the data and you went to that spot on the ground, you would no longer be exactly sure that you'd really find what the data set _said_ should be there. As a result, the Company put greater priority and resources toward maintenance of the data set, which I think was hugely important to getting to where we are today.

Empowering End Users: The GIS system would have fist arrived in the 1980s. If you wanted something, you would put in a request to the company's GIS specialist. After a while, they would produce a map from the GIS system, send it to you and that was it. Sometime in the early 1990s, a new GIS person we hired had said, "I'm tired of doing all these maps. Why don't people make these themselves? It wouldn't be hard." So he set up a menu and checkbox system for our internal users to design and produce the maps they needed themselves.

Slowly over time, we introduced more people to doing more small tasks with the GIS themselves. It's up to the point today where pretty much everyone understands that it's their job their job to make sure that what they do in the field is recorded with an accurate GIS update. And we have developed a lot of tools for them to make that process really, really quick. So, _now_ the responsibility for that data collection and updating lies with the operation supervisor out in the field and not with someone in the office.

What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

Sustainable Forestry Initiative (SFI) Certification has become very important, and much of the information to support these applications and progress reports is geospatial in nature.

Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datas ets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them

in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

Forest Inventory: Our forest inventory is probably a combination of the two. We did originally obtain base files from the NB Department of Natural Resources and Energy Development (NBDNRED) and share it with them afterward, but they tend to be very slow at updating. Now we maintain our own data set in their format, loosely, but we don't use their data set.

Road Network: We maintain our own road network data and have developed a number of applications to support that. This is arguably something the province could work at, but we do it ourselves because we do have trouble. The data they provide - even on NBDTI roads - is not very well maintained. In other cases, it perhaps is maintained but - for different reasons - NBDTI staff do not want to share what they have. I'm not sure what they think would happen - maybe they think we would use it for navigation, follow it too closely and wind up trying to drive off an overpass. Usually, we use the road network data for proximity analysis and not using it for navigation, per se.

That particular situation is now better than it was. We now maintain a "Barrier Layer" in the data set that includes additional data to identify road segments that may be impassable or at least limited for some reason (e.g., missing bridge, seasonal weight restrictions, etc.). We actually we use that for calculating the safest and shortest route from one location to another.

LiDAR: We are using the LiDAR information in the enhanced forest inventory that we get entirely from the province. That NB Government LiDAR ground elevation and forest canopy height data is very accurate in its current form. Unfortunately, our LiDAR coverage is getting a bit out of date. LiDAR really provides just a snapshot of the forest canopy on the day it was collected. If it was taken over areas where trees were rapidly growing, then the information can get out of date very quickly. A block that may have contained mostly young trees at the time the LiDAR was flown may now contain lots of merchantable timber. We use growth models to predict how much growth will occur over a number of years, but those predictions are really only estimates. That said, we are concerned that updating this point elevation coverage using other, less accurate means might actually make our models worse than they were before. We are not really sure what the best requirement is for that.

Imagery: We used to fly airborne imagery of our entire private lands at least every 10 years and sometimes even more often. For a lot of our operations, we sometimes will take aerial or ground photos which are pretty useful for detecting change, and we even do some ground-based updating using GPS

data. More recently, we have started using the Sentinel-2 satellite imagery data (available through an Esri online image service through the ArcGIS Living Atlas of the World). The Sentinel imagery provides us with a secondary check of things. We can run into situations where we've got GPS track logs coming in from the field staff, but maybe we miss part of the track log. As a result, we might think that the area is not harvested when it actually has been. The Sentinel imagery provides a double check for us free of charge, and that's a very good resource compared to where we were back in, say, 2000.

In those days, we would be flying new aerial photography over different areas annually. We would identify all the areas we needed to look at, and then we would we schedule a plane to fly around and the necessary photos of each harvest area. That was expensive. The photography alone would cost $50-60,000 a year because - even though you're not flying the whole area - you still have to mobilize the, the aircraft and the equipment and the harvest blocks would be scattered all over the place. We probably ended up flying over most of our land holdings, including the Crown Licenses, every year. It was a big job. Then, to use that stuff when it came in, we were manually rectifying the imagery so that we could, you know, digitize the shapes and all that sort of thing. And the quality of that was on and off, it seemed to be more of an art than a science to get the thing to, to line up really. It wasn't perfect by any means.

I have not signed a contract for photography in a very long time-- possibly as far back as 2012. Today, the quality of the Sentinel imagery is I think far better than what we were getting from that plane. Using that type of free satellite imagery was unimaginable to us even 10 years ago, and it's a great tool to have today.

What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

Property Line Data: We like to keep track of the condition of our property lines. By the early 2000s, as we obtained better photography and started to use GPS units, it was very clear that some our property line data obtained from Service New Brunswick was inaccurate. The lines were not anywhere close to the right place. You know, we'd have harvested to our property line, and we could see the line on the map or on the photo. And their line would be off sometimes 200 meters from its position on the mapping. Management said we should fix this stuff because it was becoming a management problem, so we carried out a lot of work up to about 2008/2009 to fix a lot of those issues. Today, the discrepancies between the mapped information and reality on the ground are much smaller. That was a difficult

process - much more complicated then than I imagined it might be -- and we worked with NBDNRED to fix some of the lines if they bordered Crown lands. I'm not sure if all those discrepancies have been fixed yet.

How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

It's all stored centrally at this point. We have a web-based application that runs our GIS and almost all the GIS processing is being handled on one of our servers. We do have some desktop ArcGIS licenses as well to handle do some specialized heavy analysis or modelling, but the server takes care of most of our day-to-day needs.

We have a menu of online GIS tools that cover off most things that any of our operational people have ever asked us to do. We can go in and look at the data that's been collected or add new data. Most of our operations staff can view the data, but only certain designated individuals can edit the database.

Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

We do share on a case-by-case basis and usually ask for a Non-Disclosure Agreement that specifies what the data is going to be needed for. We have an agreement with the government right now to share some data for inventory purposes, because they're doing a provincial inventory. So we share data with them for use on that project only. If the province gets an external request for some of our data, they just send the person to talk to us directly. We will share data to support external research projects, for example, but it really depends on the purpose and scope of the project. If it's a more limited data set, that's easy to provide. However, if someone says I just want to all your layers for your entire ownership, then we might ask a few more questions. That said, we do share pretty well with academic projects and with the government.

What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and government departments to which you must report?

With contractors, that's been a constant challenge. A good example today involves using the harvesting machines that employ an onboard positioning and navigation system. We need to download a GPS track log of where they've been, and upload to them data describing the boundaries of revised harvest blocks and that sort of thing. We have dealt a lot with FP Innovations on that. They had a satellite data collection system, which we use for applications like that and road maintenance machines that it could be far away. We actually have a payment system on that, too, it's actually tracking the hours that the machine is working in order to calculate the payment.

However, using the satellite communications very expensive and we didn't see the long-term value in it. We wound up going with another operator that uses a "data muling" app for a smartphone. Our supervisor can go to the site, stand nearby to establish a data connection with the harvesting equipment, and do the necessary data exchange transaction between the harvester and his cellphone. When the supervisor gets back into an area with cellular or WiFi coverage, he can upload to the server and sync all the information related to that transaction. It works well. In COVID, it was great, because the supervisors didn't have to physically get into the harvester itself.

Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

Employ a GIS expert in their operation to handle geospatial requirements. This employee is focussed on providing tools and online services that empower office and field staff to better use the technology and data on their own.

What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? If so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

Inspection and Problem Identification App: Geospatial data has become very integral to the way that we're doing things and we maintain a lot more data than we used to. We have an inspection app that's just on cell phones, though it's not set up live right now because we often don't have any cell service where we work anyway. An employee can go to their worksite and, if they see issues that need to be addressed, they can record its position and attributes on the app. If follow-up is required, everything has been recorded spatially and uploaded to our GIS. The other thing we do is we maintain all the points of concern that field staff have collected digitally, and that's one of our main tools for certification to demonstrate that we show continuous improvement: we're recording the problems, and we can show how we did the follow up. If an auditor would like to go and see some examples, where we can say exactly where they could go and verify on their own what things look like and what has been done.

Tool for Forest Management and Planting Decisions: Field staff can take a photo of their area and it gets saved into the into the GIS database as well. Then, you can go click on the location in the GIS, bring up the photo and see what it what it looked like at that point. It's saving a huge amount of field work when, for example, silviculture assessors are determining whether or not to plant new trees in a given area.

Use of QGIS on cellphones: We use a QGIS system and basically put almost our entire forest inventory on our cellphone. We had a request actually from our chairman who was visiting. He's a younger guy and very well versed in what's possible with geospatial data. So he asked "Could I have our whole land ownership on my phone? Then, when I go somewhere, I can see history of what has happened on the land over time." Using the QGIS product, we were able to do it pretty easily. Now, our planning staff might see something, question its current status or its history, and just go in the database and bring it up.

Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

Uploaded later on. No Real-Time Updates: Would like to have province wide high-speed cell coverage but – for now – will capture and store observations and supporting photographs, and then upload then when they are back in cell or Wi-Fi coverage.

All our field staff have cellphones, so we are creating more and more simple apps that allow easy upload and download of data. We are careful in how we implement new technology. We want to keep things simple to avoid any confusion or frustration. If things don't work well, then the negativity will take over.

We had early issues with more senior field staff accepting the ease and accuracy of GPS for field surveys rather than using more traditional equipment, but that was resolved over time. Today, many of our employees are millennials and expect a higher level of technology – especially in terms of things available as cellphone apps. I think we've hit a tipping point where we'll be struggling in future to meet the demand from our staff to implement those sorts of tools.

If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

We have looked into existing satellite service through Barrett XploreNet, but we saw that as being too slow and expensive. There was mild interest in investigating the StarLink Service when it is available. We can see ways of optimizing their workflow from Forest to Mill to distribution once fast and reliable broadband exists province-wide, but things are working fine as is for now.

We have designed and built our tools around being able to collect data, store it temporarily on the device, and then upload or download it when we can so that they don't need real time connections.

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

It has definitely changed the nature of the people we hire. Our initial GIS person was a perfect fit for our business: he had degrees in both forestry and computer science and had worked with the Province at the very introduction of ArcGIS so he had lots of experience. He's getting close to retirement now. He was challenged when we moved to the web-based development, so he had to train himself on this and we hired another developer to train with him. The younger staff member is also good in mobile app development. We also have a manager and an IT person as well who maintains the infrastructure for all the servers including the ones that handle all the business processes, and accounting systems.

DJC Clarification Question: So just to put this into perspective, are you looking for somebody with a forestry background that knows something about the technology and spatial analysis? OR Are you looking for somebody who's more on the software and systems side who can be trained to know what they need to know about forestry?

Definitely the latter. That said, we know how tough it is to find people with those systems and programming skills. People with those talents have many career options available to them, and so it's tough to find the right people in this field. We have been very spoiled with the senior GIS person we have on staff right now and hopefully he's not in any hurry to retire.

Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

We're doing some work right now looking at new harvesting equipment that is able to collect and store multiple measurements on every tree it cuts. I think that data is going to be incredibly valuable. There's some automation built in and they collect a lot of information to "self-inform". Machine learning embedded inside the Harvesting machines can use data from previous trees it harvested in the stand to predict what the next one will look like. As soon as it grabs that next tree and measures its diameter, it can make some calculations to optimize the harvesting of it in real-time.

All that harvester data can be an incredibly valuable source of information. Governments spend tens of thousands of dollars every year sending crews out to collect just a limited number of samples by cutting, say, 50 trees. These new harvesters could collect and provide much more detailed information for the hundreds of thousands of trees we cut. There's lots we could do with that kind of information, and it would allow us to be selective about what and where we cut. Customers are getting more and more exact about what they want, and this will help us obtain more exact and reliable information about what is in our inventory.

Another game changer would be the ability to remotely identify the species of each individual tree in our inventory. We see people trying to do this now just with LiDAR or just with multispectral imagery. Rather than competing, might it be better to somehow employ both types of data in combination with machine learning to produce the information we need.

> "ALL THAT HARVESTER DATA CAN BE AN INCREDIBLY VALUABLE SOURCE OF INFORMATION. GOVERNMENTS SPEND TENS OF THOUSANDS OF DOLLARS EVERY YEAR SENDING CREWS OUT TO COLLECT JUST A LIMITED NUMBER OF SAMPLES BY CUTTING, SAY, 50 TREES. THESE NEW HARVESTERS COULD COLLECT AND PROVIDE MUCH MORE DETAILED INFORMATION FOR THE HUNDREDS OF THOUSANDS OF TREES WE CUT."

Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

Yes. The only limitation is that we are a relatively small organization and do not always have the time to dig into these types of projects as we would like.

B5: AV Group NB Inc.

AV Group NB INC.

- Conway Elkins, Manager of Provincial Operations
- Pierre Mezzetta, Management Forester
- Patrick Filyer, GIS Analyst

Background Context

Established in 1997, AV Group New Brunswick is a member of The Aditya Birla Group based in India. The Company operates mills in both Nackawic and Atholville, with a mandate to produce specialty pulp products to service the textile and paper industries. The Company manages two provincial Crown land Forest Licenses comprising a total of 687,00 hectares (over 637,000 ha of which are classed as productive forest land), as well as 41,000 ha of freehold land (90% of it classified as productive forest land).

What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

Internally, we use GIS and related technologies to plan, monitor and track our operations and activities – silviculture, harvesting, etc. Externally, the government requires data to support our reports on those same forestry activities.

Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

Government Planning and Harvesting Ops thru Crown Lands and Forests Act. SFI Certification

Standards are becoming more important and "pulling more weight". So our company specifically wants FSC-certified fiber, but we are influenced by standards defined within the Canadian Standards

Association (CSA), the Forest Stewardship Council (FSC), the Sustainable Forest Initiative (SFI), and the Programme for Endorsement of Forest Certification (PEFC). In Canada, you can have any combination of those, but what they want is that end product. And whatever requirements goes with it, they want to be able to say their pulp is from FSC certified forests. We also do have some PEFC customers, which means we have to have an SFI certified landbase for those clients.

How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

We still use it for forest management, operations, and monitoring. More recently, we have been providing geospatial datasets to, or maintaining geospatial datasets for non-governmental certification boards, as well as Digital Block navigation, digital inventory, wood logistics, automation, optimization, field support data collection, and even dashboards to give us a heads up on what's going on within our operations. We also take measurements with drones in order the calculate volumes and changes in volumes of our log piles and our chip piles at the mills.

We also use it in the shipping of our final product from the mills in New Brunswick to the ports. All our trucking fleets have onboard geospatial tools so that can locate and track them live on the screen. And then you know, eventually, some of its in place now is this forest fiber initiative that our parent company has that when you buy clothing, you're going to be able to put in a code and will see on a map where the trees were cut to make your product.

Today, geospatial data is the foundation of everything that we do. Without it, there would be no way for us to communicate with the regulator or the government. That's just that's the common language.

> "TODAY, GEOSPATIAL DATA IS THE FOUNDATION OF EVERYTHING THAT WE DO. WITHOUT IT, THERE WOULD BE NO WAY FOR US TO COMMUNICATE WITH THE REGULATOR OR THE GOVERNMENT. THAT'S JUST THAT'S THE COMMON LANGUAGE."

What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

Today, it's more than just recording the location of cut-block boundaries. Like if you think about cutting, it's more even than block boundaries. We are recording the location of streams and stream buffers, special habitats, wet areas, conservation areas, corner posts, endangered species surveys, black ash, turtles and so on. We survey that stuff with our apps and send that to the government.

Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

We use GPS to identify and delineate wet areas and buffers. Our field staff can compete the work faster and we spend less money on flagging materials, which used to be a huge cost to us. People in the field can now locate a given point or area, take a picture of it, and type in the attribute data in the field. That goes to the guys who need it to plan their efficient operations around this wet area or around this cavity, nest, tree or whatever. It certainly makes for more efficient harvesting.

What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datasets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

Block planning and silviculture have their own requirements that we need to meet so we need to use different data sets to satisfy those requirements. Besides the actual block planning data sets, we may require different types of buffers we need to apply around the operation.

We're really lucky New Brunswick that the government does a lot of work. They are very proactive in acquiring LiDAR coverage over the entire province. They provide us with DEM, a slope model, canopy

height models - all things that we use for the block planning, silviculture planning and calculating volumes in our blocks.

In reference to your question, though, it is probably fair to say that 95% of the data is provided by the Crown. But that's not necessarily up to date. So we update that information through field observations and then provide the updates back to the Province. The really fine- point data that's usually missing is the species content so, if we plant trees, we have to provide them with the density and the species data. If we thin a PCT (pre-commercial thinning) block, we give them back the species and the density. For any selective harvest information, we take points and send them back the relevant data and they add it to their database.

RE: Off the shelf vs pre-processing: We pretty much just use it as is other than the LiDAR data, which has to be cached and tiled in order to be viewed on ArcGIS. Online.

Imagery: The imagery that we've been using mostly as of late would be the Sentinel-2 data sets, which are automatically updated online and served up through Esri as a service. Basically, we could be looking at imagery which might be only two weeks old. It's all free, and the resolution is decent enough for us. We do have a drone if we do need to obtain an aerial image to get more detailed information over a specific area. The Province of New Brunswick also provide ortho- rectified images over the whole province as well, so we don't really purchase any new imagery.

For land purchase, for stumpage estimates, and even for regular planning sometimes, we will use Google Maps to obtain a good reference photo taken in a specified year. So it gives you a picture what it looked like then compared to today. We also ArcGIS Online imagery, which is different than Google. Sometimes you can see some seasonality indicators in the image – for example, you can see the red maple pop out in Google Maps sometimes that you don't see in images from other sources – and that can give us a bit of an edge sometimes.

What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

There has been really no big challenges when accessing external data. Data may come in using different formats or being stored in different ways, but then it's just a matter of either converting into the file type you need or finding and downloading the same data from a different repository.

We do all of our submissions to the government using Esri shape files. Today, most of our monthly updates are shared with the government via ArcGIS Online, so they can see it get updated in almost real time. It is now only at the end of every 12 months that we have to provide them with the actual shape file datasets.

How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

Our GIS is hosted on an Amazon Web Service and is maintained externally by LIM Geomatics, a contractor that we hired. We also use their Operational Tracker for Transport to track our trucks. All the ArcGIS Online stuff is maintained obviously by Esri.

Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

Not answered directly, but comment was made about sharing some shapefile data with the ATV Federation. We share a copy of the live operating plan on our website for anyone to see. They can see cut blocks, prescriptions, road proposals, conservation forest, protected areas as well as current road network.

What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and government departments to which you must report?

None identified. Custom working solutions generally devised on an "as-required" basis.

Our reports to government and the certification boards must be transparent about where we're operating. That's the expectation now and not the exception, so people will always reference that. We

talk with stakeholders and other users in the forest using terminology about shapefiles and georeferencing things - and all that is just common language now. Even our own

Mill employees know that the Woodlands Department has this capability, and they are asking for hunting maps produced off the GIS!

Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

We have a small GIS group within our own department that supports our needs. The Company also has a larger IT group supporting other business computing operations, but they don't have anything to do with the GIS.

What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? If so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

Most of our field staff use the Esri suite of field apps, e.g., Collector, Survey 123 and Workforce. I administer the usage of all of those apps myself: I set them up, create the data sets on ArcGIS Online, and then share them with specific groups. In effect, the different field crews create "scratch layer" datasets. The field crews then upload those into the GIS and I have developed scripts to process the field datasets to support thew application they are working on – e.g., silviculture, harvesting or roads, etc.

Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

Ideally, uploads would be done on real-time, but one of our constraints in New Brunswick is a lack of cellular service. So, the data is stored on the collector device until it reaches cellular service or until someone hooked it up to Wi Fi and hits a "Sync" button. Then, that data is pushed right into the ArcGIS Online data store and we can access it from there.

If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

Cellular or Wi-Fi communications are used currently. It would be huge if we had wireless communications coverage over the entire province. There could there be different technologies that we could easily employ on our harvesting units that we cannot use today because satellite data transfers are so cost-prohibitive. There are software solutions out there where we could be getting the actual data from a harvesting head. The onboard computers are phenomenal today, but there's no way to transfer at this cost affordably unless you have high- speed cellular coverage over your entire area. Compared to Scandinavia, where they have such coverage, we're being held back about 30 years on that side of the business because of that.

The tracking system we have in our trucks also depends on cell coverage. Right now, we may lose a truck's signal in blind spots, but the onboard system stores up the location data until it gets back into cell coverage. There are times we might lose the signal on a truck for three hours. We eventually do get the data, so continuous contact is nice to have but not a "must have" capability.

Another advantage of province-wide cell coverage would be in having a direct line of communication with the field staff doing block layout if they're in cell coverage. It would increase operational efficiency and improve safety for staff working alone on the field.

Still another advantage would be in field staff being able to update a harvesting block if they encounter, for example, a stream or a track that was not on their original mapping. They could record the position of the new information, send it back to the GIS, make a new plan as required and not interrupt harvesting operations.

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

Skilled people are very hard to find and keep, no question. We used to hire foresters who liked to make maps and could learn to be GIS experts. In our latest hiring, we decided to go the opposite way and hire someone with a high level of computer skills and then teach them the necessary forestry context as required. In terms of field staff, we have had to do a lot of in-house training and the results vary. Some catch on easily, while others still prefer to use older technology. All of our drone photography work is now done in-house, since we have trained a number of staff members to be qualified drone pilots.

Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

Our particular customers in the textile market are really driving us towards FSC certification which has done a really good job of branding itself as the most environmentally friendly choice. FSC puts less demands on the "process-centric" aspects of operations that SFI may focus on, and more demands on landscape level management, stakeholder engagement and First Nations engagement among other things. We're starting down that road on a small piece of private land that we have, but it'll eventually be on all of our operations and will fundamentally change a lot of the ways we think about our business.

Increasingly, we also must consider the rights of Indigenous Peoples – Have we obtained the necessary free and prior informed consent? - and all those sorts of things that we that we haven't necessarily focused on before. As we start that journey, Indigenous communities will have more involvement in our operations. What will that look like? How will our workforce change? How will technologies factor into this?

Another "game-changer" is going to be in changes in harvesting practices and our carbon footprint. The Federal Government mandate has made it clear that we're going to be moving off fossil fuels sometime soon, and that will certainly require using some new harvesting technologies. Eventually, we will have to develop at least hybrid if not electric or alternative fuel machinery to get our wood cut. Fuel is going to be extremely expensive 10 years from now, so we must find different and more efficient ways to optimize the way we haul wood. There can't be any wasted miles. We will need new technologies - geared towards forestry applications – that ensure we send the right truck to the right block and that we're not driving anywhere with an empty load.

Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

Yes. Willing to participate.

B6: Chaleur Forest Products

Chaleur Forest Products

- Andy Barrieau, Vice-President
- Andrew Elliott, Planning Forester

Background Context

Employing over 400 people, Chaleur Forest Products operates fully automated sawmills in both Bathurst and Belledune and also acts as a harvesting subcontractor to other companies in New Brunswick. The logs used as raw material come from both private wood lots and crown land - mostly from New Brunswick, but also from outside the province. The Company's lumber is marketed throughout North America.

What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

We have long been involved with using different types of tools for collecting and mapping our forest information. We first hired a dedicated GIS specialist around 1990. He put the Esri software and equipment in place, set up the servers, and started digitizing our existing forest inventory mapping.

Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

I think there were both internal and external influences. At the time, the Company was really interested in the possibility of keeping track of different activities in perhaps four or five different departments though use of a centralized GIS database. At the same time, we have always worked closely with the Province of New Brunswick, and the Provincial Government has always been an early adopter of technology, whether it be with wood stock optimization planning or use of the Esri software.

A big internal application of our GIS is in tracking what we've done already. Where did we plant trees, and what was the data associated with those? Where did we thin areas? Where did we build roads? Keeping good information on what we have done helps satisfy our record-keeping requirements and inform our own longer-term forest management planning and decision-making.

How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

The ways in which we have used GIS have evolved as we gained a better understanding of it. We were getting deeper into answering specific questions whether it comes to trucking or modelling growth. That said, most of what we use GIS for fundamentally is the exact same thing we use it for when it was first introduced. Maybe the one biggest difference would be that, as it has become easier to use, we have seen over the last few years an increase in the ability of our nontechnical staff to utilize our GIS tools.

I would just add that we still mostly use the GIS to keep track of our forest management activities. Sometimes we get really interested in using the GIS for something else because we think it holds a lot of promise. However, we haven't yet been able to work many of these other applications into our regular business processes.

What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datasets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

The data we manage is spatially spread out over a third of New Brunswick. The ability for us to stay legally compliant in our harvesting operations and stay out of trouble is our ability to spatially reference hundreds of different features all the time. Our forest inventory needs to include specific stand-type information. The land base can include everything from roads, through water bodies and wetlands to information on bridge locations, camps, lease owners, protected areas and so on.

We receive the fundamental data, including LiDAR and digital photo imagery from the Provincial Government. We will also purchase additional satellite imagery if it is available for our area at a specific time.

We need specific data about the areas in which we can harvest. There are some areas where we're allowed to work and other areas that are exclusion areas. For example, we track everything in a layer of "archaeological importance". If there was a plane went down in the woods near the old CFB Chatham airbase, that's deemed to be archaeological area, and the government does not want us working in there. In other cases, we may be allowed to work in a given area but only under certain conditions. For example, we do some harvesting work in conservation. We have to be able to deliver to our field crews very specific stand boundaries and attribute data before they start their work, so that they can operate within the rules laid down. That way, we're not sending them back out afterwards to change the plans.

I would love reaching a time where I had a "full-resolution view" of what's going on in the forest. On the office, we only work with limited information. With a fuller view of the forest, I can be more confident that I'm making the right decisions. Our office staff can't be everywhere at the same time. The more GIS

"I WOULD LOVE REACHING A TIME WHERE I HAD A "FULL-RESOLUTION VIEW" OF WHAT'S GOING ON IN THE FOREST. ON THE OFFICE, WE ONLY WORK WITH LIMITED INFORMATION. WITH A FULLER VIEW OF THE FOREST, I CAN BE MORE CONFIDENT THAT I'M MAKING THE RIGHT DECISIONS."

can enable us to share the same view of the forest that our field staff has, the more productive and effective we can be as decision-makers.

What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

Our access has improved a lot in the past year. We were not up to date with the latest Esri tools, and it was very difficult to access a lot of the external information. We made some investments in the last year to take better advantage of ESRI's enterprise and online capabilities. That has allowed us to make data on our internal servers more secure, and we are now catching up with what external data is now accessible online. We find there IS much more data now available and being shared than there ever was before, and some of those datasets are being updated on a regular basis.

LiDAR is amazing technology and it is well-integrated into our everyday planning. It's great stuff – we can use it to determine elevations, tree heights, road elevations, changes in elevation or grade over a landscape, and so on. That said, it's capabilities and advantages with respect to species interpretation were oversold when it was first introduced. Ten years ago, I can recall being told that – using LiDAR – we would be able to differentiate between red spruce, black spruce and white spruce, because of an Acadian forestry policy we were going to implement in New Brunswick. LiDAR was going to give me that answer without anybody ever having to leave the office. Today, we are still struggling to obtain that level of detail with LiDAR and there is still a lot of uncertainty in the results.

We see LiDAR more practically now as just another tool in our collection that we use in conjunction with image interpretation and some ground verification what standard information or standard interpretation somebody did with looking at an image. And then we're almost still needing to some then verify that on the ground, to totally put our business together to go get wood and feed our facilities. There's still room for improvement. With more ground verification and better calibration of LiDAR, I think it will become more and more useful to us every year.

How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an

entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

While we may now access external datasets from the cloud, all of our internal Company data is kept on internal servers and our geospatial data is stored in Esri's Spatial Database Engine (SDE). Backups are also kept on internal servers.

We have seen much more high-level management support for updates to our IT infrastructure in the past two years than we saw in the 10 years before that. I think we will see in the near future a closer examination of what corporate data and services should be moved to the cloud and which ones should remain on internal systems. If changes are necessary, I think they will start to happen.

Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and govemment departments to which you must report?

A good example is when we tried to use computers and GPS right in our harvesters to track where they had been going and tell the operator what they had to do next. The first part worked out fine – the operators could actually see their current position within the harvesting block and where they had been already on that block. The problem came in trying to use it to help guide what they had to do next. Harvesting plans or priorities may change a bit based on some given decision made in the office. Sometimes the harvester operators would be out there working, and we would not have delivered to them the updated information they needed in time to adjust their workplan for that day. The process never really took hold and field staff still use updates printed on a paper map rather than use the computer screen. Would it have helped if we had a real-time data connection between the office and the field? Maybe. However, I think we needed to think through the whole workflow process a bit more before doing this – and that didn't happen.

In keeping with that application – and this is true on our trucks as well - we download all the data concerning the harvester tracks and activities just once at the end of the season. Sometimes, for a variety of possible reasons we find holes or gaps in that data and then you have to spend valuable time making assumptions and estimates to fill those holes, so it's limiting.

Some of the problem may be due to lack of communications coverage and workflow issues, but another important reason is that we don't have a workforce in the field that's driving the technology forward. I don't know if it's a mindset issue, but there's just there's a challenge there in trying to change existing practices there.

That said, we do make good use of Sentinel-2 satellite imagery in the office to track the progress on our harvesting blocks. The resolution and accuracy of that product suits our needs.

Sometimes we may use it for something as basic as determining whether or not somebody started operating there without telling us. Are there still trees on the ground there, or has that area been harvested? Sometimes you just need to know "Yes" or "No" for management purposes and don't require anything more specific.

We want to ensure that nothing goes on in our woods that we haven't first considered and approved. The satellite data is a good way of verifying whether or not we have worked according to plan, and if any activity has taken place that we don't know about. If we find surprises, then we look for causes and explanations. That same satellite imagery is also useful when we have to fill in gaps in harvester GPS track log data that sometimes occur, as we discussed earlier.

Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

All of our GIS support is driven locally with a limited technical staff, although we have used Esri itself for some custom development work. That can get expensive, though. We would be happy to find the right type of individuals with GIS development skills who may live further away but could perhaps do freelance development work with us online on a contract basis. That applies equally to individuals with LiDAR processing and analysis background, as well as people with machine learning and image interpretation or processing skills.

What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? II so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

We have seen exponential growth in our Company in recent years with the tools that we've built in house and then have put out into the field. We have gone from using basic off-the-shelf GPS units and data collectors to using apps on cellphones and tablets for tracking, collecting and displaying data in the field. Now with something gets collected in the field, it gets stored on the device temporarily and then it gets synced back into the GIS.

Today, it is so easy to build field workflow routines in Esri's Survey123 worker app, and that is where we are focusing all of our custom development efforts today.

Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

Right now, we upload our field data onto our office computers on a daily, seasonal, or as- required basis. That is all that is necessary for us at this time. In the future, one task thing that might benefit from real-time communication is if we were using a cellphone app to monitor a compliance issue, then that data could be sent to us in real-time. That would be useful.

If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within, or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

Due to the dynamic of our company, we don't have a lot of turnover or new hires. As a result, we do a lot of internal training and development – taking staff that already possess a particular skill set, and then make them better in terms of their ability to use new technologies.

Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

Over the past five years, the province has automated the way in which we pass information back and forth. Today, when the province wants us to do something or avoid something, they provide geospatially-referenced instructions to us in digital form. We used to have significant issues in communicating such information back and forth, and that is no longer is the case. In the old days, we used to prepare and submit plans to the government, and they would double check it against their GIS datasets. They would get back to us in, hopefully, a couple of days with their approval or comments. We don't do that anymore. They provide us the raw GIS datasets and say "Don't go near this stuff." Or maybe "You are allowed to work in that area, but you have to follow certain rules." That's it, and then we're held accountable for our performance according to those instructions and data they provide.

I think a big game-changer would be full broadband communications coverage in New Brunswick. Today, it's not just about sending field data back and forth. We have big satellite images that would be useful to transfer as well. The technology potential is there, but the costs are too expensive for us at this time. We don't have in New Brunswick the same inexpensive communications services as the forestry companies do in Europe.

Along the same lines, it would be a real game-changer if both the manager in the office and the field supervisor could see all the same data at the same time and be able to use that to make decisions and changes as necessary. That would make things a lot easier. Also, as this technology gets easier and easier to use, we will see more field staff begin to see the value in using it and put more investment into training and time.

Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

The easy answer is Yes – and who would say No to a question posed like that? Given the size of our organization and the limited overhead capacity, we must have a clearer understanding before we commit of the effort involved in that cooperation and how we will benefit from it at the end of the day.

B7: Groupe Savoie

Groupe Savoie

- Yves O'Brien, Vice-President, Procurement

Background Context

Founded in 1978, Groupe Savoie is a leading producer of high-quality hardwood products in New Brunswick. A family-owned business employing approximately 600 people, this vertically-integrated company harvests and acquires wood from both Crown lands and private wood lot owners, and then processes and transforms it into top-quality hardwood products at one of its four different facilities (3 in New Brunswick and 1 in Nova Scotia).

What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

In terms of timber harvesting, Groupe Savoie operates as a Sub-Licensee to, for example, the AV Group, Twin Rivers Paper and J.D. Irving (Woodlands) Ltd. Each of those companies hold a Crown License to manage the forest on different blocks of Crown Land. In this role, we have to exchange data with those companies and use a GIS to store the forest inventory data. We collect and store that data, along with other data concerning the modifications to harvest blocks, the locations of proposed roads, and so on.

The Licensee is responsible to allocate to us the harvesting of an agreed-upon volume of timber (measured in cubic feet) in a given block every year. They provide us with the necessary GIS-ready mapping data covering the entire area, and we have the flexibility to decide whereabouts within that block we are going to start and how we will conduct the work. We use the GIS data to then go out into the field to do the "ribboning" ourselves (i.e., using fluorescent ribbons to mark the perimeter of a given harvesting block).

Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datasets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

We use the digital Forest Inventory GIS data provided by the province or sometimes by the Licensee.

We are just beginning to use LiDAR data through our cooperation with the Northern Hardwoods Research Institute. They are showing us how to get the most out of this data, and we are providing them with our timber-cruising information to better calibrate the Forest Inventory and LiDAR databases they maintain. This is a valuable partnership for us, and I really want to make better and fuller use of this technology.

What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

We are not satisfied with the accuracy of the hardwood-related forest inventory data that we receive. I think softwood data is pretty close, but the hardwood data is not accurate when it comes to correctly identifying individual species like maple, yellow birch, soft Maple or hard maple and aspen. Each of those species do not have the same market value, and different species can affect the production rate of a harvester.

Last year, we decided to address this challenge by cruising every block in advance of the harvester and confirming or correcting the necessary information before the machine gets there. What kind of tree will we be working with in that stand? Is it long wood short wood? Is it rough or pretty straight? Our cruising staff originally recording this information on their cellphones using a type of spreadsheet program. This coming year, we will be using another type of tablet-based survey software package from Groupe Système Fôret (GSF) called *GSF Survey* that will allow the field staff to enter location-related cruising observations directly into the software as they go along, and that data will get transferred up to the GIS at the end of every day. That is brand new and we are just starting training on that software next week.

How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

We have a license for *Esri ArcGIS Online* on a computer in our office. All the data associated with a project is usually kept online and on that device. The computer, in turn, is part of our company's network and is backed up every night.

Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

When we are harvesting on a Crown Land License – even if we are acting as Sub-Licensees to AV Group or J. D. Irving – we share a production summary with NBDNRED every week. We let them know about operational issues as they arise, whether it concerns a small oil spill from a piece of equipment or maybe a minor trespass. It's not like an audit. Rather, it is a results-based way of working together and letting them know right away if something goes wrong. Most details go as text in a type of spreadsheet file but – if a particular incident occurs at a specific location, then NBDNRED wants us to send a shapefile that describes the location and area affected by that incident. We submit these reports as email file attachments to NBDNRED every week.

We have similar reporting arrangements with each of the Licensees we work with.

What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and government departments to which you must report?

Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

We have one GIS specialist on staff, although the Field Supervisor has some knowledge of the GIS software as well.

What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? II so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

While we are not managing the lands ourselves as a Sub-Licensee, we do monitor the productivity of each of our harvester machines to make sure each unit hits the agreed-upon productivity target. We had been using large Garmin GPS receivers to track our harvester equipment for quite awhile. Two or three years ago, we installed tablet-based, GPS-enabled *GSF Nav* systems into each harvester in order to track

and record its location and rate of production as it works through a harvesting block. The system imports a GIS shapefile containing all the block information needed by the operator. When the harvester is in operation, the *GSF Nav* map display on the tablet will show the location of the harvester in real time in relation to the location and shape of the block boundary, water buffers, roads, and everything else the Operator needs to know. They can even track and see their productive hours.

We do much less ribboning today than we did in previous years. Probably 75% of those requirements can now be handled by the GPS-enabled harvester keeping track of its position in relation to the border of the block in real-time. If it's just a regular forest area, GPS can handle this just fine. However, if a particular is deemed to be "high-risk" – maybe a specially- designated area or a protected area – we still are required to go in and ribbon the area ourselves.

Also, since last year, *Geotab* units have been installed on all our trucks for more effective fleet management. Geotab is a computer unit installed in the truck that gives us data about the operating hours, location, speed, fuel consumption of each truck all the time. It gives us all the data we need to know about the trucking and what we can do to make sure things are operated most efficiently. But right now, we are operating this system separately from our GIS.

Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

Using the GSF Nav software, the GPS track logs are exported as shapefiles from each harvester unit. The Field Supervisor will collect all that data and bring it back to the office to be uploaded into ArcGIS. After that, we can see in ArcGIS what percentage of the block has been covered by the harvester already, how much is left to do, and where that remaining area is located. We can also see if, by mistake, the harvester has gone outside the block or maybe even trespassed on another property.

The track log and production information stays on the *GSF Nav* tablet. Usually once a week, the Field Supervisor will transfer all that data from the tablet onto his cellphone using a Bluetooth connection between the two units. Then, the Supervisor either transmits that data back to the office once he gets back in cellular data coverage OR brings cellphone back into the office and uploads the data at that time.

If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

We know that, if the communications services existed in this part of the province, we could eve establish a cellular or satellite communications connection directly with the GSF Nav system on each harvester. However, cellular services in northwestern New Brunswick are not very usable in the woods. We have looked at satellite communications options, but they are expensive. Then again, we know that it takes time and costs money for the Supervisor to go the field every Monday, download the data and get it back to the office. There have been some improvements made to coverage and service in our area over the past two years, so maybe it's time to relook at our options.

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

We like to hire forest technicians and train them in the technology as necessary. I have a forest technician right now, a young woman, and we want her to learn how to use the GSF Nav and GSF Survey software packages. It is not good for our company if very few people can use this and our GIS software. We need to transfer the knowledge to other employees as well.

Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

We are working on a precision forestry research project with the Northern Hardwoods Research Institute. In this project, we are trying to develop a different kind of system for paying the contractor based on "wood chance". Rather than paying a harvesting contractor on the basis of a clearcut, a selective cut or overstory removal, he is going to be paid for the market possibility we have with that kind of wood.

I think a big game-changer we will face in the near future is having to deal with the shortage of qualified people to hire – first in our mills, and later for us in the field operations. It is hard right now and only going to get harder in the future. We are not located in cities like Fredericton or Moncton. We are in the woods up here. We have to think about how we can make this work more attractive to a new generation of workers. That might involve changing our work shift structure from two to three shifts per day.

"I THINK A BIG GAME-CHANGER WE WILL FACE IN THE NEAR FUTURE IS HAVING TO DEAL WITH THE SHORTAGE OF QUALIFIED PEOPLE TO HIRE – FIRST IN OUR MILLS, AND LATER FOR US IN THE FIELD OPERATIONS. IT IS HARD RIGHT NOW AND ONLY GOING TO GET HARDER IN THE FUTURE."

Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

Right now, we are putting a lot of field worker effort into quantifying and qualifying the wood by cruising directly in the field ahead of the harvester. If LiDAR is going to deliver better and better results every year in terms of species identification and quantification, then maybe 3-5 years from now we can put less effort into our cruising and still get information. We would be prepared to cooperate on developments like that.

Is there anything you would like to add that you think would be helpful for this study?

I have been thinking a lot about how our use of these technologies is changing the nature of the relationship between us as a Sub-Licensee and the Licensees themselves. In the old days, they used to provide us with all the information and instructions required to harvest the block. In other words, the Licensee provided the harvesting "prescription" or recipe" to us and a fixed price or fee on a per-cubic-

metre basis was agreed-upon that included an overhead paid to them for this prescription work they did for is.

Today, our own staff are going out ahead of the harvesting machines to get the best information possible concerning a particular stand or block. Using that better and more complete information, it is our supervisor that ultimately prepares the harvesting prescription or recipe today. However, the price we get paid for wood is still on a per-cubic-metre basis and we are still paying the same overhead fees to the Licensee we did before. How does Groupe Savoie save anything on this basis? If we are now doing more of the Licensee's preparation work, then shouldn't the overhead charges we pay to that Licensee be reduced?

B8: J. D. Irving (Woodlands)

J.D. Irving Limited (Woodlands)

- Ian Taviss, Manager, Forest Planning and Inventory

Background Context

J.D. Irving Woodlands Division owns 3.2 million acres and manages another 2.8 million acres of Crown land in New Brunswick. Adding its holdings in the rest of the Maritime Provinces and the State f Maine, the company one of the largest private landowners in North America. Outputs from these forests supply over 75 different mills and manufacturers - including some 20 JDI facilities. Today, Irving Woodlands is a team of almost 400 in Canada and the US. A major New Brunswick resource industry employer, the Company plans 80 years ahead to ensure healthy forests, biodiversity and the protection of the rivers, lakes and streams on land it owns or manages. It has planted over one billion trees since 1957, a national record in Canada.

The Company was a very early adopter of GIS and other geospatial technologies in support of its Woodland operations.

What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

We are in all of those categories except Water Management Systems, but I could also add "Asset Management" to that list. I'm thinking roads in particular as assets, but also buildings, facilities, camps, etc. Each one of those categories in itself is a big area to discuss. From digital forest inventory to optimizing scheduled maintenance to automated truck dispatch and delivery, you're talking about the control and tracking of your inventory - from when it's been cut to when it's delivered.

Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

We're a fully integrated supply chain – everything from the forest through the harvesting to the delivery, and on into primary manufacturing and secondary manufacturing. We are also one of the largest landowners in North America, so we're not only a business-driven supply chain operating company, we are also a sustainable land management company. And so everything we do is spatial. From Day 1, everything is about *Where is it*? and *What is it*? Regulation aside, we have a basic need to understand our resource… to understand our management… to understand our supply chain. That drives our edge on geospatial technology.

How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

Our forest management objectives, our supply chain needs, the way we do business, these things don't really change. Technology does change and the pace of this change is only increasing. We certainly have challenges as we attempt to keep up with this change and incorporate its value into our business and management.

What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

We're still functioning on the leading edge of technology- or attempting to – and that's not always a comfortable place to be.

What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datasets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

LiDAR: LiDAR has certainly been a game-changer in terms of data. That really kicked off the whole notion of "precision forestry" term and has led to a lot of what we're doing. If you think of standing trees as being the first box our supply chain - the raw material - then LiDAR started the digitalization around that supply chain. It led us see precision in the inventory in a way that we never were able to before. I see some of the LiDAR providers talking about a LiDAR light, which is kind of an interesting concept too. Because we already have our basic DEM established, now we could be only looking for height and maybe volumetric change. Maybe we don't need as many pulses or could fly higher and faster, make the swath width bigger…

Imagery: While LiDAR has been a game changer, it has not been so for species identification. LiDAR data can tell me net merchantable volume, tree height, basal area diameter, but not whether a tree is spruce, maple or beech. The NB Government flies high-resolution digital aerial imagery and that's a great tool for us. We are still tied to our photo-interpreted inventory, because we have no other means of gathering species information. We have had drones around for quite awhile – both in the woods and at the mills – but the value proposition for those in our business is still unclear.

Harvester Head Data: Improving the accuracy of our individual tree measurements is the next game changer. We just started a pilot project installing STICKS software from a company in New Zealand into some of our harvesters, and we'll use that to pull stem file data off the harvester head. Using this, I get data that I can use to validate my LiDAR predictions and adjust for bias if necessary. I will know what people are cutting. I can look at productivity and machine maintenance. I can see if I am meeting my specs for what the crews are supposed to be cutting, and from that can determine which inventories are in the pipe that have not been delivered yet.

What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

Nothing is kept just on desktop computers anymore, but we do maintain a lot of servers in-house. Not everything is stored and processed in the cloud because cloud is expensive. We serve up all our GIS on a Citrix server for example. Some of the third-party applications we use are moving to the cloud. For example, we work with Remsoft and integrate into their cloud environments.

Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

We share data on a contract-by-contract basis and require Non-Disclosure Agreements from the external parties involved.

What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and government departments to which you must report?

Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

We have a large internal IT Department, and Woodlands contracts work to that internal Department as well as to external IT services suppliers from time to time. Because the internal IT Department services the entire enterprise, it can be stretched in terms of resources. As a result, different divisions build skill sets internally. I look after planning and inventory at a corporate level and have staff members that

possess very good GIS and SQL database skills. I still have large projects going on with our GIS and our IT department because, while my folks can access data, they can't serve up data for the enterprise. That's the responsibility of the Enterprise's internal IT department.

What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? If so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

Over my time in the company, I have seen pendulum swing back and forth between centralized and decentralized IT support structures. Right now, we are decidedly working in a centralized IT support environment: We let the operators in the field execute, and the office staff handle the planning and the data and serving it up.

We don't want to see field staff going into the office, so we have tried over the last few years to migrate all their process requirements into a mobile environment. No more muling of data. Field staff used to be responsible for providing change updates, and now we do that by satellite imagery. We really want those folks mobile: the information they need at their fingertips in a digital environment and focused on driving the business in the woods. It's also one of the areas where you tend to see a very immediate return on investment.

Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

More and more we are taking advantage of current technology to allow for real time or near real time transfer of data. Most of this technology functions over a cell network. Because we operate in some remote areas, both in Canada and the US, cell connectivity can be intermittent. The technology allows for store and forward later so data is not lost but true "real time" connectivity is not fully achieved.

If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is

there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

We would like to sync that data across cellular communication services, but the reality is that those wireless services can be non-existent in some parts of the province and, at best, inconsistent in other places. Also, everything we do has to function inside of a secure Virtual Private Network (VPN) environment. We often don't need the data in real time – at least not yet.

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

We are very careful in our hiring practices and have large and on-going needs for people We offer a tremendous career environment, huge opportunities, and salaries well above the provincial average.

Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

LiDAR has been a game-changer for us for a number of years. On the immediate horizon, we've talked about already the StanForD files and stem file data off the harvesters. That's going to be an immediate game-changer for everything from inventory validation and inventory forecasting right to how we pay people. Also - if we have a much better understanding of what harvested inventory is sitting roadside, then it even provides a new foundation for optimized routing of our trucks.

Another game changer on the rise is carbon, and I'm not sure if that's positive or negative yet. We have this huge, vast resource of carbon. We didn't talk about genetics, tree improvements, all the biotechnology research that's going on at the maritime lab we have in Sussex. I'm probably not the best person to talk about it, but those developments are influencing another side of the business that's important for growing more wood.

Still another game-changer is the Internet of Things – increasing use of these live data streams flowing daily from sensors in our forests. It's those live data streams that drive all the things we're talking about, they drive that AI- and machine learning-based processing that can all those opportunities we talked about earlier.

Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

Absolutely we always want to collaborate with the folks you're talking about. But I need better understanding of what these developments are supposed to do. For example, what is meant by a collaborative platform and how does it fit with the work we are already pursuing? More information is needed about what is planned before we can make a decision.

"STILL ANOTHER GAME-CHANGER IS THE INTERNET OF THINGS – INCREASING USE OF THESE LIVE DATA STREAMS FLOWING DAILY FROM SENSORS IN OUR FORESTS. IT'S THOSE LIVE DATA STREAMS THAT DRIVE ALL THE THINGS WE'RE TALKING ABOUT, THEY DRIVE THAT AI- AND MACHINE LEARNING-BASED PROCESSING THAT CAN ALL THOSE OPPORTUNITIES WE TALKED ABOUT EARLIER."

B9: Southern New Brunswick Forest Products Marketing Board

Southern New Brunswick Forest Products Marketing Board

- Neil Damon, Marketing and Forest Management Forester
- Travis Noftell, Silviculture Manager

Background Context

Private woodlots account for 30% of New Brunswick's forests or 1.9 million hectares and are an integral component of the provincial wood supply and rural economy. To grow a sustainable supply of quality forest products which will be used in processing facilities, the provincial government partners with private woodlot owners and Forest Product Marketing Boards to fund certain silviculture treatments.

The Private Woodlot Silviculture Program is administered by the Forest Operations and Development (FOD) branch of the New Brunswick Department of Natural Resources and Energy Development (NBDNRED). Participation by woodlot owners is voluntary and the program is available to woodlot owners through one of the seven Forest Products Marketing Boards. Program funding is determined annually based on a cost-sharing arrangement whereby government contributes a percentage of the total estimated treatment cost. The woodlot owner is expected to contribute the remainder of the total treatment cost.

Formed in 1979, the Southern New Brunswick Forest Products Marketing Board (SNBFPMB) represents over 8000 Private Woodlot Owners who collectively own approximately 1 million acres of forested land in the counties of Albert, Kings, Queens, Saint John, and the parish of Salisbury in Westmorland County. The Marketing Board has legal powers to negotiate the terms of sale of forest products. Every person who owns or controls a private woodlot of 10 hectares or more is legally considered to be a woodlot owner and member of this Board.

Woodlot Marketing Boards play an important intermediary role: (1) between woodlot owners and potential customers for their harvested timber; as well as (2) between the owners and the Provincial Government in terms of managing provincially supported funds for ongoing forest management of these woodlots. A full summary of the forest management services the Board provides to its members can be found at https://snbfpmb.ca/forest-management.

What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

We provide funding to woodlot owners and contractors to carry out silviculture and forest management activities on their woodlots. Part of the requirement of the funding is that we must keep track of the activities spatially. This allows us to record what, when and where activities have taken place so that we can better manage the land base of our stakeholders. Environmental legislation around mapped and unmapped watercourses and wetlands has also influenced our requirement to us geospatial mapping.

ND: Also, we are a Marketing Board and we look after wood purchase and sales on behalf of our members. The necessary descriptions and documentation of wood sales transactions also rely on spatial information, and this work is an important part of our daily business. A landowner or contractor may call the office and to indicate that they will be working on a particular parcel defined by a PID. They identify who will be cutting it (with rates), who will be trucking it (with trucking rates), and what the stumpage rates are (if stumpage applies). Our office staff can issue four cheques per PID so, when those load slips come into our office, the staff manually enter the information into their accounting system – by PID – the volume of wood sorted by product, by mill destination, date, etc. This is powerful and important spatial data for marketing boards to collect. It provides the landowner with a detailed summary by transaction date, of the volume that was harvested spatially on their PID. It also allows marketing board staff to better understand our harvest levels spatially across the private land base, which is important for sustainable management and ensuring we are not over cutting our AAC. We are required to report these volumes to the NB Forest Products Commission each month, separated by mill and whether the volume was brokered through our board, or direct delivery. There is some concern in the direct delivery information we receive, as these deliveries may not be reported in a timely fashion. Also, when reporting the direct deliveries, they are spatial to the mill, and not the PID. This is not consistent with how we track brokered deliveries through the marketing board. These direct deliveries may also not be reported at all, if the marketing board doesn't receive the levy, or a copy of the transportation certificate. This is a concern when trying to manage the wood supply and understanding the harvest levels.

Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

A large part of our budget is provided from DNRED. The Private Woodlot Silviculture Program budget provides funding to landowners to have these treatments carried out. We manage that on behalf of our stakeholders. We record the activity undertaken by the Woodlot owners or their contractors and submit it to the government for payment. We use Esri shape files to support the information concerning the silviculture activities undertaken.

In house, we also have our own forest management fund that is built up from levies from private wood sales in our area. For our own in-house monitoring, we also keep track of shape files to know which treatments have been undertaken and/or changes that might have occurred on a given woodlot during a specific calendar period.

All of these shape files are used to help with scheduling of future management activities across our land base.

How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

Twenty years ago, foresters were only using a map and compass to record forest management activities in the field and then would transfer their hand drawn files to large paper maps in the office. Since then GPS technology has changed quite a bit, we have gone from old, archaic Trimble Geo 3 units (which used a green screen with little black lines) to today, where we can display digital aerial photography on the screen of our handheld Trimble Juno devices. Some forestry companies have now moved away from GPS units and are now just using their cell phones or tablets for data collection. The technology around recording and managing geospatial data is constantly changing and presents financial and personnel challenges. The cost to upgrade existing hardware and to train employees on new techniques and software can be costly.

We are constantly trying to provide our clients with better quality maps. As a result, we try to make use of various different mapping software that meet the needs of our clients. This has resulted in us using a variety of programs such as ArcView, ArcMap, and Avenza Maps. Each program has its own benefits and

downfalls but together they allow us to help our stakeholders better manage the land base. The introduction of enhanced forest inventory through LiDAR data, hill shade topography data, and satellite imagery have been the driving force for us to shift our mapping software to more up to date programs such as ArcMap.

ND: We produce georeferenced PDF maps daily for contractors, owners, or staff, to use with Avenza maps. We do this with ArcMap or QGIS. It would be nice to be able to use GeoNB to produce a PDF map for Avenza. We use ArcGIS Pro to create maps that are compatible with Explorer. Explorer doesn't allow us to collect data, but it does allow us to click on shapefiles and see attributes when in the field.

Determine watershed areas, for sizing culverts, or minimum opening sizes for bridges.

GIS is used to create stand layers for management plans/PID level. All available themes from Service NB are used when preparing a stand map on GIS.

Tracking wood sales has become more of a challenge as of late, with a higher percentage of direct contracts now being issued compared to in the past. As stated earlier, this has not only caused increased overhead costs for our administration staff to track down the missing transportation slips, but it also raises many concerns on whether or not our harvest levels are accurate and it doesn't allow us to track harvest levels spatially by the PID (landowners cannot rely on marketing boards to provide an accurate transaction report on wood sales for their property).

What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

> "GEOSPATIAL DATA WE RECORD CAN BETTER HELP WITH SCHEDULING FOREST MANAGEMENT ACTIVITIES ACROSS THE LAND BASE SUCH AS SILVICULTURE, HARVESTING, AND TRUCKING. MANAGEMENT OF THIS DATA WOULD HELP INCREASE PRODUCTIVITY AND COMPETITIVENESS IN THE PRIVATE FOREST SECTOR."

Geospatial data we record can better help with scheduling forest management activities across the land base such as silviculture, harvesting, and trucking. Management of this data would help increase productivity and competitiveness in the private forest sector.

Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

Cost of upgrading to newer GIS technology is an issue. New software, hardware, and the training of staff to use new technology can be quite costly. A few years back, the Federation of Woodlot Owners was able to buy a couple of Esri licenses and then distribute them amongst the seven Marketing Boards. As one license is only good for one computer, if you have multiple staff that need to use the program, that cost can add up quickly if you need multiple licenses. It would make sense if a new cost sharing arrangement was made that could support a greater number of stakeholders making use of the Esri software. This would allow for stakeholders to stay up to date with some of the latest technology and be able to process high quality data. A potential arrangement amongst the seven Marketing Boards or an arrangement with NBDNRED and the Marketing Boards would be beneficial for everyone.

We would also like to have some kind of geospatial mechanism that could help us more efficiently schedule harvest and silviculture treatments.

The stand layer we create for the individual woodlot is not stored on our main GIS Project at office, and a consistent attribute table is not made. Improvements could be made. We have talked about creating a feature class with “pick lists” that could be used for stand delineations. The pick lists would be important to ensure recommended treatments are entered consistently for queries down the road, to track treatment schedules, etc.

We do not collect or store any spatial delineation of clearcut areas. The only blocks we delineate and record are treatments that need to be measured for forest management assistance. Most contractors on private do not ribbon and GPS their cutblock areas. That being said, we do record transaction history/PID by wood sales, product, and year. We can run a transaction report for a PID, to see how much volume by product was cut in a given year. This is useful information at the PID level, and we do run transaction reports for PID's from time to time. This information isn't 100% accurate, due to direct sales, exports, and other transactions (fuelwood, cedar to private yards, cash transactions etc.).

Transaction reports at the PID level used to be much more accurate, when the majority of the wood flowed through the board. More direct contracts now, make these reports less accurate. Direct deliveries by mills are reported to MB for the most part (as levies are remitted), but not spatially by PID, as MB brokered deliveries are. These deliveries are reported by board area, and wood sale delivery reports/mill are sent to the Forest Products Commission monthly. Direct export deliveries to US and NS are not always being reported. This is a concern, as we are regulated to manage our AAC for the regulated product in our regulated area. Understanding how much we harvest is an important component to that. Having electronic Transportation Certificates (TC's) that are geo referenced to truckers locations would be an improvement (TC booklets could also go missing or lost - There is no way to account for this volume on our end with certainty.) Wrong PID numbers are often entered, so an electronic Transportation Certificate App that is geo referenced to the trucker's location to ensure accuracy in PID identification would be very beneficial to managing our private resource with a better understanding. Having this in place would also give us the ability to locate trucks, for organizing back hauls, etc.

What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datasets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

Forest Inventory: NBDNRED provides us with the EFI for our region, and has broken it out into all the different attributes that are relevant to us such as volume, heights, etc. We try to use it as much as we can, but it works better and you can do more with it by using the newer software.

We collect and store all silviculture treatments and alternative harvesting treatments dating back to the late 80's. Attribute tables have changes over the years, but we have these shapefiles merged together as one. We do our best to maintain this layer overtime, as changes occur. This is done manually, errors could occur.

Aerial and Satellite Imagery: We have an inventory in our office of aerial photography covering our region from as far back as 1950 all the way up until the early 2000s. Depending on the job, we may look up the old photos, but we primarily use the high-resolution imagery that the province has flown.

Recently, using ArcMap's world imagery tool, we can tie into more up to date Sentinel-2 satellite imagery as well. I know some companies are using photography from drones to collect their post assessment and pre-assessments data. For example, with plantations, I think they're sending their drones up ahead of time to see what the density is like and sending them up again after thinners have gone in to see if any sections of a plantation might have been missed. The technology is there, but we haven't really yet jumped into it as extensively as we could be.

We daily use the digital aerial photography from NBDNRED in conjunction with the digital Property Mapping PID layers from Service New Brunswick. We constantly field requests from landowners who may want to know their management options concerning a specific woodlot. In order to identify the woodlot, we ask for their PID or their name, search it on our GIS, and it brings up their property. We also have multiple years of georeferenced air photo imagery available as different base map options, but this is limited to 2003, 2013, and the updated world imagery photos available. This information is helpful to see if any harvesting has occurred over the years, and sometimes one photo has cloud cover, and an older imagery is better to look at.

We also have historical imagery (dating back to the 40's but use the aerial imagery from 71- 2003 most often). The 2003 aerial photos are geo-referenced, the earlier photographs are not. It would be nice to have some funding to hire a student to georeference the older imagery, as this is useful information for managing woodlots, and to understand past history for management (boundary line locations, previous activity on woodlot- treatments/roads/etc., identifying any other landmarks on property, and helpful for doing capital gain assessments).

LiDAR: We use LiDAR data to estimate how much wood is on the land base for a particular owner. With that, we can provide appraisals for a landowner concerning what their woodlot is worth or provide them with information needed concerning timber harvesting. Also, the LiDAR DEM is so accurate that it can identify small streams that were previously unmapped – and do it before we find them out in the field. This is important, because the government has recently changed regulations around the requirement for buffers around watercourses on private land.

We use the LiDAR data daily when preparing forest management plans, or providing assistance with forest management at the PID level. The hillshade layer is great for identifying operability constraints and new road locations. Understanding the topography characteristics at the PID level. The forest measurement metrics from LiDAR are useful, but we still need to do ground checks.

Other Digital Graphics and Attribute Datasets: We also collect and store parcel boundary line point information, with attributes. Also, new road construction, with culvert locations. Anything that is funded through the PFA or our in-house SNB Forest Management Fund, we collect.

What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

The biggest challenge is definitely being able to afford to have the appropriate GIS and GPS hardware and software. We are a non-profit organization, so it is difficult for us to be able to, for example, purchase seven ArcMap licenses required to outfit our whole staff. I know that free (open source) GIS software is available, but that would mean considerable retraining of staff to learn how to use new software, and that's expensive too.

As mentioned earlier, we face challenges with accessing loadslip information from direct deliveries. When we receive/or if we receive this information, the PID is not referenced, and this data cannot be integrated with our wood sales transaction history/PID. In some cases, we could trace the transportation certificate number back to the actual slip in the returned book, but this would take way too much time.

How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

Right now, everything is stored on a network of desktop computers at the office. Some individuals may also use their own cloud storage services like Dropbox to store their own personal files or for sharing files. Part of my job recently has been to look into newer technology to try and help us store data more securely. I would like us to move towards a Cloud Storage based system. It would be good to eventually have a system where basically all our processing was done in the cloud as well. I know that Esri would like to see everyone move over to its ArcGIS Online service, but the credit-based method Esri uses to charge its customers for online storage and processing is very expensive.

Our data storage and computing arrangements are mostly in-house rather than in the cloud at this time. We do access some of the more massive data files from servers in the cloud (e.g., for imagery and LiDAR), and there is some talk of moving our accounting systems onto a cloud-based service, but that has not happened yet. Between my home and the office, I am working on three different computers. I store a lot of information on one or more of those computers which I can email or share with others online when necessary. The Province would like all the marketing boards to move onto Sage accounting software and, if that happens, all our accounting data will be stored on the cloud.

Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

We do not readily make our data files available in order to respect the privacy concerns of our members. Any data we record as part of the Provincial Private Woodlot Silviculture Program is shared with DNRED. We have our own internal Forest Management Fund that funds additional forest management activities on private land, and we record that separately from the provincial data. Together the two data sets are quite large and show a vast array of forest management history on private land. If a landowner would like a map printout of their property that shows all the forest management work that has been completed on it over the years, then we'll provide them with maps and data. However, we won't give out data to just anybody else unless the owner has given us permission to do so.

What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and government departments to which you must report?

It would be good to have a more effective tracking system that allows us to both keep track of what forest management work has been done on owners' parcels AND notify us when some follow-up action is required. While we may visit a given property and update the silviculture information and/or management plan information, there is currently nothing efficient in place to use the information in the database to remind us when, for example, a new visit or a recommended follow-up action is necessary. We have been talking about this with NBDNRED, I know there are companies out there right now that

offer that type of software product integrated to your GIS, and we have people looking at this internally as well.

Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

I provide the basic technical support we need, however if we have a need for more advanced tech support, we use a local company to help us. Our technicians collect the field data and we store it internally here in the office. Each year, one person from the office goes through the process of merging together that field data with information from previous years.

While each of us store our own project data on our own systems, at least once a year we do transfer and merge all those shapefiles into a common database on one computer to help with preparing information for payments, etc. I think there could be room for improvement there.

What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? II so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

All of our field staff are equipped right now with Trimble Juno receivers integrated with Esri ArcPad. That's the main program that we use for collecting our field data, which is recorded as shapefiles with specific attributes. We're slowly progressing into newer software, but it's always a challenge financially to equip our people with the latest up-to-date equipment. All of our field staff are capable of collecting our required data and then analyzing it once returning to the office.

I personally use Esri's ArcGIS Explorer as a field app on my phone. Using ArcGIS Pro on a desktop, I developed a map of our entire board area, added in the graphics and attribute data for all the wetlands, streams, property lines, silviculture, all of our other boundary line information. I could download that all onto my phone. The phone georeferences my location, I can click on a property and see who owns that property. I can click on a silviculture polygon and see what treatment was done there and who did the treatment. I can see what was there for species composition, and so on. It's great for navigating - I just can't collect data on it.

In the longer term, we and other Marketing Boards in New Brunswick have been working the Nova Scotia Landowners and Forest Fibre Products Association in trying to develop forest management and marketing database software that – using geospatial data - has the potential to both simplify and transform the day-to-day interactions between woodlot owners, contractors, mills and markets. That software was originally developed by Kari Easthouse and Peter Burchill, who were based with the NSLFFPA in Cape Breton. Using a shared GIS database, it would provide all these groups with a common platform to remind the parties involved of recommended work on a woodlot that needs to be done, track that work as it progresses, provide contractors with access to the necessary information online, keep track of work orders and information for accounting purposes, and so on. Funding details are still being worked out.

Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

Data collected in the field is brought back brought back into the office and uploaded to a desktop computer. There might be 2-3 days before a technician can upload their data to our server as they might be in the field for all that time before having the chance to come back to the office. This has been a workflow issue that we will be trying to improve for this upcoming season. As we move to cloud-based storage and remote work from home, technicians could upload their daily data from home. If we can equip our technicians with laptops or tablets linked to their cell phones, then they can upload that data directly from the field. New satellite broadband services (like StarLink now in beta testing here) may help in that regard.

If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

While there are definitely some "dead zones" in our area, cellphone coverage is pretty good for the most part. We may face challenges going forward as we gear up our technicians to process and upload work remotely from home as Rural New Brunswick does not have the best broadband internet coverage.

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

We're in the process right now of hiring some additional staff for our upcoming season. We are looking for people with a forestry background and with experience in both GPS data collection and GPS/GIS post processing software. Ideally any new staff will already have the basic knowledge and training of the skill set we require. However, we do train new and existing employees on new or updated techniques as required.

Any graduate from a forestry program within the last 10 years will have the basic geospatial expertise that we require. More recent graduates are more familiar with the latest technologies, however, there can be some difficulty in training if they have to learn how to use out of date software and hardware.

Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

One big game-changer is the frequency at which satellite imagery is now being updated. Formerly, the province only updated aerial imagery on a 10-year cycle. Currently there is technology to get new imagery on a more frequent basis if needed. If these images were made more readily available to stakeholders and they were able to analyze them efficiently with up-to-date software, this would help increase forest management strategies across the land base.

Another big changer is the potential availability of geospatial smartphone apps that can enable field staff to be able to do things like: (a) select a point and delineate an entire watershed, which tells you the size of a culvert that you need; or (b) after you use GPS to map the boundary of a harvest block, the app will calculate the quickest route to mills, and even take potential road closures or load limits into account. This could help reduce trucking costs and possibly improve harvest scheduling. Apps like these could be tied into cloud-based storage systems so that data could be easily shared amongst employees.

There are apps currently like this in the forest sector, however, they have high price tags and are just way too costly for us at this time.

I spoke earlier about developing and employing electronic Transportation Certificates. There's an opportunity there to not only reduce inaccuracies in load slip information but –linking it to GPS - also give us the ability to locate trucks where they are within the province, and maybe coordinate backhauls for certain mills. Further, with the software project and the interface I mentioned earlier, maybe all the parcels that are currently being worked on could be highlighted and I would know where and what types of potential roadside inventories would be on those properties, and we might even see where the trucks are moving in real-time. That could really improve efficiencies in the operations of marketing boards across the province.

Also, DNRED has a subscription with Planet for access to its Dove satellite imagery on demand. That data is attractive to us in that it is updated almost on a daily basis, which is really helpful in monitoring our woodlots at certain times of the year. Might it be possible to negotiate a wider cost-sharing arrangement amongst all the stakeholders in which that data could be shared with marketing boards across the province? That would make that imagery more affordable.

Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

We always want to provide the best service possible to landowners and producers in our area. If we can work together with other organizations to help develop procedures or technologies that can go back into helping our stakeholders manage their properties, then we're definitely interested in participating.

Is there anything you would like to add that you think would be helpful for this study?

Going back to the software project, I think that – with support and cooperation - there's a real opportunity there for us to better manage our sales activities and benefit woodlot owners, contractors and the mills at the same time. Through the online interface, landowners could submit their requests for the thinning, harvest or treatment work that they want done. There could also be a contractor interface where that contractor could see that request, bid on the job and/or work out an agreement with the

landowner to perform the work. We could use the LiDAR data for that woodlot to come up with an estimated volume, by product type and species. With that data and those processes in place, the Board could manage our land base a little more effectively and provide better and more reliable wood supply forecasts to the mills for their planning purposes. That would give us the ability to, in a way, mirror the use of geospatial data and GIS to manage and schedule operations on Crown and large freehold lands.

B10: Southeastern New Brunswick Forest Products Marketing Board

Southeast New Brunswick Wood Marketing Board

- Steven Spears, Forester/Silviculture Manager

Background Context

Private woodlots account for 30% of New Brunswick's forests or 1.9 million hectares and are an integral component of the provincial wood supply and rural economy. To grow a sustainable supply of quality forest products which will be used in processing facilities, the provincial government partners with private woodlot owners and Forest Product Marketing Boards to fund certain silviculture treatments.

The Private Woodlot Silviculture Program is administered by the Forest Operations and Development (FOD) branch of the Department of Natural Resources and Energy Development (DNRED). Participation by woodlot owners is voluntary and the program is available to woodlot owners through one of the seven Forest Products Marketing Boards. Program funding is determined annually based on a cost-sharing arrangement whereby government contributes a percentage of the total estimated treatment cost. The woodlot owner is expected to contribute the remainder of the total treatment cost.

Formed in 1981, the South Eastern New Brunswick Forest Products Marketing Board (SENBWMB) represents more than 8000 private woodlot owners in Westmorland and Kent counties along with the Parish of Rogersville. A private woodlot owner is anyone who owns 25 acres (10ha) or more of woodland.

What particular applications or requirements drew your organization into the use of geospatial technologies and data for mapping, positioning, modelling/analyses and reporting? (If helpful, please use the Framework from the McKinsey and Company Report attached.)

Were those activities influenced by internal requirement (e.g., improved operational productivity)? By external Reporting Requirements of specific legislation or regulations? Planning Requirements? Environmental Legislation? Safety Regulations? Please explain.

To satisfy forest planning and reporting requirements under the NB Crown Lands and Forests Act of 1980. As well, to satisfy regulatory requirements of Regulations and funding opportunities associated with the New Brunswick Private Woodlot Silviculture Program.

How have those applications, requirements or conditions changed over time, if at all? Is your organization facing any new or different challenges now that weren't there 10 or 15 years ago?

When I joined SENBWMB a few years back, they were using ArcMap just to make maps, make updates or corrections on them, and send everything off to DNRED on a regular reporting basis. Since receiving full LiDAR coverage over our area a few years back, I have developed and application that brings together digital forest inventory, stream buffer information, LiDAR and property data and makes use of the processing and handling capabilities of ArcGIS and Microsoft Access. With this application, I can input PIDs for specific land parcels of interest, hit the button, and receive back maps and a full stand-by-stand description report of each stand within a woodlot – including its area, forest cover information, previous treatments PLUS (from the LiDAR data) average height, average multiple diameter, average multiple basal area, and stand volume. I have even included base layer information broken out by diameter class. I also developed a related reporting capability that, using government criteria, identified stands eligible for inclusion in specific government programs. This enables the property owner to make more informed decisions concerning what they want to do with each of a collection of different forest stands on their property.

I have all the marketing boards in the province working with us on this project now. Wherever you go in this province, you can get create the same report and the same type of supporting maps.

What ARE the key questions (existing or envisioned) — required by legislation, for improved productivity, or for increased competitive advantage — that need to be answered? Are there any proposed changes to legislation planned that would influence these questions? If you operate within government, how about "Right to Information" requests — Is there any pattern to those or new questions arising there?

Can you talk about how your usage and capabilities in this regard have evolved over time? What limitations, weaknesses or challenges do you see — if any — in the geospatial information and tools you are using right now? How do they need to improve?

Some of that data may be a bit of date – the LiDAR data is 2017 or 2018, for example. All the same, we can offer much better information about the condition of a member's woodlot than we could previously – and that's before he sends field crews out to cruise the property.

Also, the format and content of the forest inventory and LiDAR data provided by the province changes over time. Each time it does, I have to go in and modify the coding and database structure of the application to make sure the program finds what it is looking for. That takes time. This work requires specialized talents and knowledge of the data involved, and I need to train others to carry on with this if I ever have to leave.

What are the key geospatial datasets in your business? (i.e., If applicable, which 20% of your datasets do you use 80% of the time?) Which of these do you obtain externally, and which are built from data collected in-house? Do you employ them right off the shelf or must you modify and/or improve them in some manner first? If so, do you have the right tools to clean, improve and prepare data for further analysis?

Most of the data we require – including forest inventory and imagery data - actually comes from NBDNRED. Nowadays, I can actually just use ArcGIS Online to find and download it without ever having to go to the NBDNRED staff.

What challenges do you face with accessing external data? Do you have challenges with integrating external and in-house data?

I now have all the data coverage split up between different marketing boards. The actual work is not hard, but I am limited by the power of my laptop computer. I had to split the coverage up before I could process them because my old laptop did not have enough memory to be able to handle the whole dataset as a single block.

I have a better computer with more memory now, and I can transfer data and process reports in minutes rather than the hours it took before.

Another issue – we're concerned over when that LiDAR data is going to get flown again. A lot of federal funding was used to pay for the first round of LiDAR coverage, and it would be a shame to see that coverage become out of date. We must have some sort of update strategy, and it's got to come from the province because no one else will be paying for it. The LiDAR must be updated and updated properly - even if they do it the way they used to with aerial photography (10% every year for 10 years). But it must be flown at a similar "points per square metre" density as our last coverage or else you're just throwing your data off again.

How are your current datasets (imagery, GIS data, LiDAR data, fieldwork, etc.) stored? Are they typically stored on one or more individual desktop computers? On an in-house server accessible to an entire working office or organization? On an external cloud-based service accessible to an entire working office or organization?

Everything is stored on a server in my office. Nothing is stored in the cloud. I am working from my home office right now, so I have a copy of all the datasets here at my house as well.

Do you make your own internal datasets available to others? If "Yes", then to whom and under what conditions?

We only share with either DNRED, individual woodlot owners or their designates. Any basic inventory data or updates we do under the government forest management program goes to DNRED, and we support our members by providing to them maps and information on their woodlots.

What are the barriers or constraints (if any) that inhibit your ability to share information between different individual employees? Between different groups within your organization? Between your organization and your key suppliers and/or contractors? Between your organization and your key customers? Between your organization and govemment departments to which you must report?

All the data is available on the office server and all our field employees have ArcGIS Online licenses. They can go online, upload or download the data they need, create their own maps and get their fieldwork underway.

Are your IT requirements supported by a separate IT support group of people within your organization or do the necessary tech experts work within your own unit among the end users of your systems?

While our field staff can use the GIS in support of their own basic activities, I provide the main GIS technical support to this organization. I also provide the same GIS technical support and expertise to other marketing boards as well when they require it.

What about Field-to-Office technologies? What is the relative balance and focus of outdoor data collection staff vs. In-house analysis staff? How has that changed or evolved over time? II so, for what tasks or operations in particular? (Differentiate between different types of field "data collection" activities, e.g., positioning, tagging, measurement, imaging, mapping, etc.)

I'm also building data collection apps for CP3 ruggedized smartphone Android devices aimed at collecting inventory and timber cruising data in the woods to support the assessments we have to do for government. Crews can communicate with us from the woods using Avenza Maps software, we can use ArcMap provide additional data back to them, as necessary. Also, I'm working on an application that – using LiDAR data – can better model and outline areas that are suitable for harvesting in a given area. That will save harvesting contractors time and money.

There is also free software we can use to support our activities as well. For example, when we are updating management plans, we can send over the internet both the shapefile of the woodlot and a PDF of the plan as an attribute. The crews can then use the Avenza software to display everything on their cellphone.

Are field observations and measurements initially stored on the device and then uploaded onto company computers/servers at a later time OR is it uploaded in real-time?

All field observations are stored on a handheld device initially. Cell coverage is good in about 70% of our area, but there are spots where coverage does not exist or is unstable at best. We're never in a situation where office or field staff must have data in real-time. I sent the data by email as a file attachment, so field staff can download the necessary data when they come into an area with suitable signal strength.

If data collection and uploads are conducted in real-time, what type of wireless communication services are used? Are there any specific barriers or constraints with respect to these services? If so, is there a particular tech breakthrough that you expect will address this problem in the foreseeable future?

I don't think real-time data communications are necessary to support the field operations we have now. We will just send the information back and forth when we need to.

The idea of province-wide broadband coverage is nice, but it's got to be affordable before it can become a game-changer.

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

We like to hire people with more than just technical skills. We have been fortunate that some of our new hires are dedicated people who are hard workers, know how to talk to people and understand that they still have a lot learn. Our members hire their own harvesting contractors, and they can vary widely in their technical skills and services. One contractor may not be tech- savvy at all, while another will be capable in terms of GPS data collection and basic ArcMap usage. Still another may provide a full suite of mapping capabilities (even LiDAR) and be able to cruise a site, prepare maps, and basically provide a mini management plan to each client.

Can you identify one or two potential "game-changers" — e.g., technologies, regulatory requirements, market conditions, customer demands, etc. — which, if they occur, will make a major change to your business?

Shifts in government policy and attitudes may be one. The current minister (of DNRED) wants more conservation forest out there. I know it's taking place on some Crown lands, but I think he'd like to see it on private holdings as well. There's also pressure on us from the government to become more efficient in both our fieldwork and office work – and that's what I'm trying to do with some of this software development.

Finally, loss of markets is a big concern. The closure of Northern Pulp in Nova Scotia was a blow to all of us. Ten per cent of our pulpwood went down there, and we now have pulpwood sitting along the roadside that we can't sell. We need another pulp market or something else that could use that biomass and would buy it from us at a decent price.

Would you and your organization be open to participate with others across Canada (public and private) on the development of a collaborative platform that will facilitate access to data, analytical tools, best practices, and Key Performance Indicators for decision support?

I would want to talk to our management here and the rest of the boards first, but I think we would first of all want to know whether or not this development was really going to help us out. Is it really going to do anything for the small private woodlot owner? There are also privacy concerns around the woodlot data we manage here – it's not all public information. That said, I would be definitely interested in finding out more about these developments.

Is there anything you would like to add that you think would be helpful for this study?

I have a concern with the LiDAR being used by the Province to build yield curves for their planning. It's lovely data, but it has only been around what since 2013. Are they now going to base the full AAC (Allowable Annual Cut) for both private and crown land on this without testing it further? I think the density of our LiDAR data is still too low and should be improved for forestry estimation purposes.

Finally, the software and systems I have built are all pretty basic - I built with what we had available. It would be great to see new funding support opportunities from the Federal Government to make this more robust, maybe a little simpler to use, and come up with some new tools that would make our job easier.

"FINALLY, THE SOFTWARE AND SYSTEMS I HAVE BUILT ARE ALL PRETTY BASIC - I BUILT WITH WHAT WE HAD AVAILABLE. IT WOULD BE GREAT TO SEE NEW FUNDING SUPPORT OPPORTUNITIES FROM THE FEDERAL GOVERNMENT TO MAKE THIS MORE ROBUST, MAYBE A LITTLE SIMPLER TO USE, AND COME UP WITH SOME NEW TOOLS THAT WOULD MAKE OUR JOB EASIER."

B11: Esri Canada

Esri Canada Ltd.

- Corey Nelson, Director, Atlantic Region
- Chris North, Director of Technology Adoption

Background Context

Esri Canada is a private Canadian-owned company founded in 1984 that provides world-class enterprise GIS solutions. Headquartered in Toronto, Esri Canada operates 16 offices across the country serving 12,000+ customers. It is the Canadian representative of Esri (Environmental Systems Research Institute), the world's largest supplier of geographic information system (GIS) software, web GIS and geodatabase management applications. The Company's international headquarters are in Redlands, California.

Among your Forestry Sector clients, what are the principal application, needs or problems that require your services or products? (If helpful, please use the Framework from the McKinsey and Company Report attached.) Do those vary from "early adopters" to mainstream customers?

Forestry customers in Canada in general and New Brunswick in particular have been using our technology for over 30 years to support forest inventory and strategic forest modelling.

How do the products and/or services you provide help support those applications and needs and help solve those problems?

There's a great example in New Brunswick's forestry sector involving a partnership between government and private sector around regulations. Using Esri platforms, they able to share forest inventory data across those organizations via web services. That makes for quicker and better collaboration which, in turn, results in greater operational efficiency.

Today, GPS, LiDAR, digital imaging and machine learning technologies have all made it much faster, quicker and easier to get a far more accurate inventory. That said, I think where we are seeing the most change is in the recognition by our Forestry customers that spatial data and technologies can be

leveraged to improve the performance of other parts of their business as well. While these companies and organizations originally considered GIS a "point solution" for doing forest inventory, they are now are starting to see Esri as more of a platform upon which they can build focused applications in many different areas.

What types of economic and/or operational challenges do you think your Forestry clients are facing – and perhaps passing on you?

Have the demands of your customers changed or evolved over time? If so, how? Have those changes in demand influenced or changed the nature of your own product and service offerings? How?

While forest inventory is still as the core of their business, how they are continuously improving the quality of data in that inventory has drastically changed over time. Foresters are now using Artificial Intelligence and Machine Learning on integrated digital imagery and LiDAR datasets to better identify individual species in their inventories.

We now see more and more forestry companies using GIS across their operation- from planting, through to harvesting, picking up products, delivering it to mills for processing, right through to delivery of end products into stores and lumberyards. The evolution of our technology has allowed for the mid- to small-tier organizations to deploy more GIS based solutions made available through cloud computing and software as a service. Forestry has long been a big driver of our mobile applications, but it's becoming even more so now with purpose-built field applications that Esri develops and deploys for our customers to use across the business.

The Forestry Community in Canada in general – and NB in particular - - was considered to be an early adopter of GIS technology and it helped drive a lot of the analytical GIS functionality we see in Esri products today. More recently, they have also been perceived to be an early adopter of LiDAR technology, and that has driven Esri to provide more and more capabilities around LiDAR on their platform. Interesting that –given their focus on inventory - forestry companies may be only now applying GIS to other operational problems in their business (e.g., logistics, work order processing, etc.). However, those same users put pressure on Esri to increase the functionality of its products when it

comes to applying new technologies to their core inventory business – whether it's use of LiDAR, drones, etc.

In your experience, what do you think are the most important value-added aspects of the products and services you provide to your clients?

As a company, Esri increasingly sees itself as a trusted "content" provider as well as a software solutions provider. Building a network of customers worldwide allows us to provide "curated" datasets and offer online access to "public authoritative" content. Important examples of this are NB EFI data, as well as the Sentinel-2 imagery that many of our forestry customers use to update their forest harvest-block boundaries and related information.

We increasingly view our software, content, cloud services, analytics and so on as interoperable "Lego blocks" that, with some work, can be snapped together and used for everything from basic processing through analysis through dashboard visualization. The "content" blocks include base mapping and imagery, as well as compatible demographic content.

That approach also enables our business partners to building application solutions right on top of our technology. We have some really good partners in Canada, including one in New Brunswick, that are building solutions specific to the Forestry Sector.

How do issues over standards and interoperability influence the products and services you offer? Are your forestry clients challenging you in this regard, or vice-versa?

Esri has to deal with an interconnected web of different families of standards – and not just geospatial ones. We also must deal with financial standards, building information modelling standards, software standards, and so on. We try to build our products in such a manner that the use of those different standards helps us – but is invisible to the end user. We want them to keep thinking about the discipline-specific problem they are trying to solve rather than about how our software works.

One of the challenges around forestry in particular is the continued prevalence of file-based data transfer using our Shapefile format, which really has become a de facto standard in its own right and is no longer really under Esri's control. File-based transfer really is something we need to move away from. It is very cumbersome, it leads to duplication of data, and it eventually leads to replication or re-introduction of datasets that have long since changed. We're glad to see the New Brunswick government taking a leading role in offering access to its most up-to-date data through online Web services rather than encouraging people to just download a snapshot of that data at one time.

"FILE-BASED TRANSFER REALLY IS SOMETHING WE NEED TO MOVE AWAY FROM. IT IS VERY CUMBERSOME, IT LEADS TO DUPLICATION OF DATA, AND IT EVENTUALLY LEADS TO REPLICATION OR RE-INTRODUCTION OF DATASETS THAT HAVE LONG SINCE CHANGED."

What do your customers and your own market research tell you about new or changing challenges facing the New Brunswick Forestry sector over the next decade?

Today, forestry companies want to know what they have in their inventory on a "tree-by-tree basis. They are working towards objective right now in order to answer operational questions like "How do we operate more efficiently?" and "How do we ensure we cut our wood at the right time based on market conditions?" and "If there is a market uptake for a particular product, how do we go find the products that meet that demand – to harvest it and get it delivered to the mill to maximize the market potential?"

To what extent do you think your customers are making good use of the data sharing capabilities of your products?

Our customers are making very good use of the data sharing capabilities of ArcGIS in particular using Web services. Our products offer our customers a number of options when it comes to sharing data through open and interoperable web standards in our web-based products and technology. A good example of this in New Brunswick is the data and web services being made available by the Department

of Natural Resources and Energy Development through their public website. The Department's Minerals and Petroleum Web Page contains links to numerous datasets available for download along with numerous web services available for Minerals and Petroleum (see also the Geological Survey Open Data Site) with the plan to release a site for Forestry in the very near future.

To what extent do your products or services make use of cloud-based architectures for data storage and scalable processing? Describe the services you and/or your product are using. (e.g., Amazon Web Services?)

We are dealing with a changing paradigm. For many years, even while networking existed, GIS users were still doing all the processing-intensive tasks on their desktop workstation. That is still happening, especially among users working in rural areas where bandwidth is low. However, that paradigm is now starting to flip, and we want to move all of our major processing of big data and machine learning routines up into the cloud. We don't want that processing weighing down our desktop.

Our software supporting drone technology is a good example of this. We have a desktop drone application today that that works well for small mapping projects. However, when you try to scale that up - doing multiple jobs and/or managing drone fleet - it doesn't scale very well. So we have shifted to making something available via the cloud. I can upload and store all that information into the cloud, have it run, and give me the derived products that I'm looking for from the imagery and the LiDAR. Processing takes much less time and, when the processing is done, I get an email notification and can connect and pull down just the products I need.

In our *ArcGIS Online*, we have taken the entire capabilities of what we can do on our customer managed infrastructure – all the desktop and all the server capabilities – and have made them accessible in the cloud as a software-as-a-service (or *SaaS*) offering. That *ArcGIS Online* infrastructure is a hybrid of *Esri*-managed infrastructure, Amazon Web Services and Microsoft Azure infrastructure. In fact, ArcGIS Online is one of Azure's top 10 customers world-wide. Using Corey's drone example, if you flew 1000 hectares and wanted to process the imagery of LiDAR to create a 3D mesh, you would send that to the cloud to get it processed. From your perspective as a customer, that data would be processed in a "multi-tenant" shared environment with an *elastic* set of compute resources - resources that are temporarily dedicated to your job and then spun down as your job is finished. That's our fastest growing market right now, and it's not just simple web mapping. We are launching a full image processing service in ArcGIS. Online.

There is a full drone imagery management system, and special big data and geo-analytics capabilities. Processing that would take days on the desktop only takes hours in the cloud. Enabling our customers to leverage cloud technology through our SaaS model is a huge new paradigm for us.

Until our broadband connectivity improves in rural areas, though, this will remain a problem for some of our users. It also involves a cultural change, and that can be hard. Sometimes, it is our most experienced long-time customers who are the most resistant to change and require the most persuasion. Nowadays, we are trying to transparently combine both the desktop and cloud environments, where we may be doing the work on my desktop, but are also leveraging services, data and even analytics through the cloud.

What about Field-to-Office technologies? How has that changed? Is that evolving among users in your organization? If so, for what tasks or operations in particular?

I really think we are going to get to a point where connection to the internet will be everywhere. However, we are not there yet, so we design our field solutions to support both connected and disconnected workflows. Esri was early to adapt and extend its product line onto tablets for use in the field. Today, we have lots of internal research and product development projects underway in our field applications in order to leverage a new generation of sensors embedded in cellphones and tables – including laser rangefinders, barcode readers and LiDAR.

Going forward, the question we have to ask ourselves is, "What are the business requirements that are going to drive that 'personal scope' individual data collection?" Technology may allow us to do that kind of thing, but we need to think about the applications, markets and conditions in which it makes sense to do it that way.

Regarding earlier comments about foresters wanting to understand their inventory on a tree-by-tree basis, we may eventually reach a day where, when saplings are planted in a new stand, each one has a little RFID tag attached to it. As they grow, that RFID tag remains operational. Eventually, we could fly an unmanned vehicle over that area that queries the RFID tag on every tree to determine how high each one of those tags now sits off the ground? In effect, that forest "self-reports" when it's ready to be harvested.

That said, there are certainly technologies being worked on to get people connected in the field - as a group, or in collaboration with each other. We see this coming out of the public safety and military space, where we have this requirement and technologies are being developed to do that. In Forestry, there has been work done by our Esri distributor in New Zealand regarding how to adapt a two-way radio network in order to put real-time communications and data transfer capabilities into the hands of a forestry field staff out in the woods.

To what extent is the optimal usage of the products or services you provide limited by particular conditions, regulations, infrastructure, etc. in New Brunswick? What would have to change in order to improve the functionality, efficiency and/or effectiveness of these products in this market?

We and our customers are still working through determining the optimal business budget model around SaaS offerings in the cloud. The challenge is still there, particularly for some of our large institutional customers, is the reallocation of software acquisition costs from annual capital budgets to regular operating budgets. That said, many *are* figuring out how they operationalize the access to technology and the cost associated with that. They are seeing operational cost savings through re-thinking arrangements for balancing and managing on-premises and cloud- based computing and server capacity with resources best located in the cloud. They are asking such questions as *What data and processing really needs to stay on-premises? What can be offered from the cloud?* Even *How might an external web services company better manage some of my on-premises resources?* Every customer has a different set of conditions they must work through.

I think part of what is driving the shift in thinking regarding use of cloud services is the recognition that massive geospatial processing needs are very elastic in nature. Do you really want or even need to outright purchase the next generation of servers and processors capable of handling these massive geospatial datasets, when you know you may only really require those capabilities 5% of the time? What if we get a surge of 1000 users, and then it drops down to 10? And then surge back up to 1000? And drops back down? In a SaaS based business model, you pay only for what you use. The high-cost barrier to entry flattens out.

B12: Forest Protection Ltd.

Forest Protection Ltd.

- Veronica Fortin, GIS Specialist

Background Context

Incorporated in 1952, Forest Protection Limited is a private company owned by a group of New Brunswick Forest Stakeholders. With offices are located in Fredericton and Miramichi, N.B., the Company's mandate is to protect forests with services such as fire management, pest management and aerial surveys. FPL has a long history of involvement in scientific research and application of new technologies to enhance the ability of managers and operators to protect forests responsibly, effectively and safely with attention to cost control.

Among your Forestry Sector clients, what are the principal application, needs or problems that require your services or products? (If helpful, please use the Framework from the McKinsey and Company Report attached.) Do those vary from "early adopters" to mainstream customers?

See notes in Background Context above.

How do the products and/or services you provide help support those applications and needs and help solve those problems?

We streamline flight planning, tracking and invoicing with ArcGIS Pro and ArcGIS Online.

What types of economic and/or operational challenges do you think your Forestry clients are facing – and perhaps passing on you?

We provide the capability to perform flights faster with the technology we leverage. With our clients current limited technology/funds/time, we provide that service and expertise for them.

Have the demands of your customers changed or evolved over time? If so, how? Have those changes in demand influenced or changed the nature of your own product and service offerings? How?

Requirements for greater transparency and detail in reporting. Today, our GIS group at FPL is doing a lot of web mapping, and we're ramping up our quality assurance activities to help check that everything is being sprayed where we say it's being sprayed. We are ramping up our accuracy and billing verification that was influenced by us gaining the Province of Newfoundland and Labrador as a client last year. They're expecting a lot more from us in terms of reporting and deliverables than New Brunswick has in the past so now we are going to start offering the same package to New Brunswick. It is going to be a much more detailed package than it was before.

In our past projects with the provinces of New Brunswick and Quebec, most of the project management and planning work was done by the client and FPL was simply a flying contractor. The Province of Newfoundland and Labrador requires much more from us. For example, they wanted real-time updates of what and where we flew, along with data quantifying how our actual flight lines matched up with the original plan. They wanted the data from our aircraft spray systems to be exported into a GIS format that they could load up in ArcGIS Pro and then view in an online map.

Those additional functionality and data transfer requirements have required a substantial amount of custom development work on my part. Using ArcGIS as a base platform, the new system will provide more detailed and reliable information for mission planning and logistics, including flight line details, spray control requirements along each flight line, and fuel and spray chemical load estimates. From a quality control and verification perspective, the updated system will also use the actual flightline data and spray system logs details to calculate and compare– on a flightline-by-flightline basis – the actual versus planned area flown.

In your experience, what do you think are the most important value-added aspects of the products and services you provide to your clients?

In our projects this year, these improvements will provide our clients with a more detailed package and more accurate analysis of what was actually completed to support our progress and final invoices. Along with field check information, it also gives us and the Client the information necessary to demonstrate that we are not spraying over bodies of water or other sensitive areas.

How do issues over standards and interoperability influence the products and services you offer? Are your forestry clients challenging you in this regard, or vice-versa?

We must use data from several different sources in our mission planning and actual aerial operations. For example, detailed terrain information is obtained from LiDAR to prepare the instructions which ensure the spray aircraft stays at a constant height above ground. The mission planning and actual flight line information and spray control data is handled by either MapStar or Ag-Nav software depending on the application, and there are specific difficulties associated with transferring those files into ArcGIS on our computers. While both those packages can export into Shapefile format, restructuring the corresponding attribute table data for specific import and export operations can be complicated.

On a related note, there is lots of great open data available online here in New Brunswick, but it's not always clear where to go get it, how up to date it is, and who uses what data for particular purposes. For example, there are two different GIS hydrographic (water features) layers available through the Provincial Government – one from Service New Brunswick's GeoNB service, and a different one available through NBDNRED's GIS Open Data Site. They were created at different times and contain slightly different representations of the water features. We need to use NBDNRED's version of the water layer for our work, and I didn't know that at first. It would be easier for a lot of folks if links to all that online open data were placed in a single hub from which people could order.

> "THERE IS LOTS OF GREAT OPEN DATA AVAILABLE ONLINE HERE IN NEW BRUNSWICK, BUT IT'S NOT ALWAYS CLEAR WHERE TO GO GET IT, HOW UP TO DATE IT IS, AND WHO USES WHAT DATA FOR PARTICULAR PURPOSES."

What do your customers and your own market research tell you about new or changing challenges facing the New Brunswick Forestry sector over the next decade?

To what extent do you think your customers are making good use of the data sharing capabilities of your products?

Products that we share are being used for executive/upper management to have operational awareness on both FPL's side and the client's side. I believe for viewing maps and statistics on specific projects are being used but hope to see more utilization of interactive mapping web apps in the future.

To what extent do your products or services make use of cloud-based architectures for data storage and scalable processing? Describe the services you and/or your product are using. (e.g., Amazon Web Services?)

We typically deal with large datasets, so we use laptops linked to the cloud for most of our work. We store almost everything using ArcGIS Online on the cloud, and Esri's service is generally pretty good. Speaking of Web services, we just launched the database supporting all our custom software's up on Microsoft Azure. That database includes the attributes from the flight lines and information about our plans in order to aid in the flight planning process.

After we receive feedback this year, there is more work that needs to be done to maintain and improve the custom software, and that will involve the use of ArcGIS development toolkits and possibly the use of opens source services like Jupyter Notebooks. I want to look into these toolkits because I think there's probably a better way of handling some of the tasks than the way I'm doing it now.

What about Field-to-Office technologies? How has that changed? Is that evolving among users in your organization? If so, for what tasks or operations in particular?

To what extent is the optimal usage of the products or services you provide limited by particular conditions, regulations, infrastructure, etc. in New Brunswick? What would have to change in order to improve the functionality, efficiency and/or effectiveness of these products in this market?

Is there anything you would like to add that you think would be helpful for this study?

I think Esri's technology is really flourishing – and it's getting really complicated as well. It is important for the GIS specialists in forestry companies to keep training and stay up to date with what their software can do and how to do it. For example, we are seeing an increasing focus on the use of scripting

for custom developments, and I see lots of GIS job applicants showing no scripting experience or training on their resumes. If they are going to be working with ArcGIS, for example, they need to be aware of where developments are headed in this regard. Python is my scripting language of chance, but I see others involved with Javascript for other applications.

B.13: Leading Edge Geomatics

Leading Edge Geomatics, Fredericton, NB

- Matthew Davis, Sales Manager
- Alex Zscheile, Geospatial Processing and Solutions Manager

Background Context

Headquartered in Fredericton, New Brunswick, Leading Edge Geomatics provides aerial survey and geomatics services across North America. With a fleet of seven aircraft and eleven digital sensors, Leading Edge offers customized solutions to clients across a number of industries including energy, forestry, mining, and bathymetry. LEG has flown over 300,000 km² of LiDAR, and more than 180,000 km² of aerial photography.

Among your Forestry Sector clients, what are the principal application, needs or problems that require your services or products? (If helpful, please use the Framework from the McKinsey and Company Report attached.) Do those vary from "early adopters" to mainstream customers?

Digital Inventory – as well as projecting changes to that inventory in the future based on forest modelling.

How do the products and/or services you provide help support those applications and needs and help solve those problems?

What types of economic and/or operational challenges do you think your Forestry clients are facing – and perhaps passing on you?

Need to employ integrated imaging and LiDAR to do a better job of species classification and volume estimation down to the level of the individual tree.

Interest in different techniques to update LiDAR ground cover data to better monitor change in the forest canopy as it takes place. Looking at different options, including satellite-based radar; spaceborne LiDAR; flying higher and collecting LiDAR at a lower density, etc. All of these produce something that is not quite as accurate but still considerably less expensive than reflying the entire area of interest again.

Have the demands of your customers changed or evolved over time? If so, how? Have those changes in demand influenced or changed the nature of your own product and service offerings? How?

"Next-generation" Inventory requirements - How to best use the inventory data? How to reliably update it? How to make it make it widely available?

Increasing need for high accuracy on the metrics being delivered. And more metrics being required as deliverables now. It's now overall volume of timber, volume by species, and things of that nature. Getting the Enhanced Forest Inventory (EFI) involves more than just summarizing stands on their own. It means digging into details of the component species as well. And now we're looking at taking things more into a management environment.

Move to "Eco-Forestry" - More input from wildlife biologists re: hydrology, wetlands identification and wildlife habitat mapping

In your experience, what do you think are the most important value-added aspects of the products and services you provide to your clients?

New opportunity to create a shared workspace in which people can access and manage all this geospatial data. Customers are looking for a platform where they can take the EFI and related datasets, integrate them, and then make everything easily accessible to the experts who need to use it for their operational plans.

Also now looking at supporting the development of carbon assessments. While our EFI already supports forest management, some of our customers also want our help to assess carbon sinks. While the imagery and LiDAR data we offer doesn't fully provide a carbon specific service, it does help you get to a useful by-product of it.

We have invested in developing new static products which incorporate new algorithms to better identify and delineate roads, trails and smaller streams underneath the forest canopy, which has been great to help better define hydrology and wetlands across a project area.

We are moving more into providing value-added modelling services. For example, we are providing one client with 30 separate forest modelling predictions covering different aspects of his EFI data. To create those predictions, we integrate LiDAR collection with digital imagery AND have our crew of foresters doing block collection on the ground.

Good summary observation – "While we may have originally introduced some new technologies and services to our Forestry customers, now they are coming to with new questions which have driven us to explore new options and new technologies."

How do issues over standards and interoperability influence the products and services you offer? Are your forestry clients challenging you in this regard, or vice-versa?

The more standards-based the outputs that you can produce, the more they can be cross referenced and shared between groups. You can't share information or products if they are not tied to some sort of standard.

> "YOU CAN'T SHARE INFORMATION OR PRODUCTS IF THEY ARE NOT TIED TO SOME SORT OF STANDARD."

What do your customers and your own market research tell you about new or changing challenges facing the New Brunswick Forestry sector over the next decade?

Changing demographics of employees – Key forestry employees getting older, so how do companies retain their "corporate knowledge" of resource holdings and experiences, as well as bring in new knowledge? Where do you get the personnel from? If you cannot attract suitably qualified new personnel, then they have to look at other alternatives that allow them to get more done with fewer people. In some cases, they are now employing external consultants to provide the expertise they can no longer find internally.

To what extent do you think your customers are making good use of the data sharing capabilities of your products?

Compared to other sectors, it seems there's more company-wide use and confidence in the deliverables we provide. That is not always the case in other vertical market segments we serve, where our products may be used by a smaller group and not be fully utilized across the company.

To what extent do your products or services make use of cloud-based architectures for data storage and scalable processing? Describe the services you and/or your product are using. (e.g., Amazon Web Services?)

We're actively looking at the cloud more and more. For example, just a couple weeks ago we were running an EFI in the cloud on virtual machines. We were moving to new office space and it was hard to physically use the machine, so we set up some virtual machines in the cloud. We are looking at that as a possible path going forward for us internally, and that's also where we want to go to help provide solutions to forestry clients with regards to data sharing and data application.

Internally, moving to cloud computing is allowing us to make better use of the equipment and human resources we have.

Right now we are utilizing a lot of 3rd party cloud-based computing and storage services with Microsoft.

We are seeing early calls for proposals in other vertical market segments (e.g. large utilities) where they are requiring us to host and manage their data. Being heavily regulated, they provide the framework and structure around which we build these services. We would like to go further in thus direction. That service allows clients to tap into our development and R&D resources. It goes beyond just hosting that data: we are enabling customers to use our platforms and toolkits to better access and work with their own data.

What about Field-to-Office technologies? How has that changed? Is that evolving among users in your organization? If so, for what tasks or operations in particular?

Yes – Handheld devices (even cellphones with new imaging and LiDAR capabilities) hold potential to provide improved data collection of forest. Today, you can send field staff out in the woods with inexpensive equipment and provide more accurate confirmatory observations or amendments to the inventory and terrain conditions.

Also, having faster and more robust fibre and wireless communications networks has opened up the option for FTP transfers from field office, which allows us to build automations in our processing and our developments at a more centrally supported location rather than out in the field.

A big pain point of data collection process is reflights. We are always implementing processes that will increase efficiency and decrease our lead times on deliverables. You need to QC the data as quickly as possible in order to limit reflights and identify the ones that must be done so you can complete and deliver reliable data quickly.

We've been looking into utilizing "hot spotting" and wireless internet providers to explore how we might do some initial processing in the aircraft while collecting at the same time. That way, you could see in almost real-time how the data is looking and whether any reflights might be required. However, how do we how do we put some of that hardware into the plane without affecting the load balance?

Upgrading the wireless communications infrastructure would be huge for us. Our crews rarely operate out of a city center, and many of the forestry land holdings are located in areas that don't necessarily have a lot of network coverage. If the price is right, new services like Elon Musk's Starlink satellite service could give us a big advantage.

To what extent is the optimal usage of the products or services you provide limited by particular conditions, regulations, infrastructure, etc. in New Brunswick? What would have to change in order to improve the functionality, efficiency and/or effectiveness of these products in this market?

Rather than limiting us, they create new opportunities. Today, different regulations and requirements cause our clients to constantly look for new methods and strategies to balance different things. For example, retention policies and practices are changing. At one time, it might have been more likely to clearcut maybe 90% of a block and leave 10% for regrowth. Nowadays, and especially with changing product demands and changes in regulations, not everything is just going off to the pulp and paper mill or sawmill anymore. Sometimes you can make the same money or more if you cut less and target

certain species (e.g., for biocharcoal markets). Clients need to look at balancing their existing retention rates while thinking about carbon sinks, habitat protection, and so on. Different strategies require different solutions, and our data and modelling services help them get to the balance they require.

We do think it's important to have a member or members of our forestry team keeping up with those legislation and regulation changes. If we can better understand what those changes are trying to balance, we can be proactive and come up with solutions ahead of time. That makes us more valuable to our client.

B14: Remsoft

Remsoft

- Doug Jones, Senior Vice President, Solutions and Innovation

Background Context

Based in Fredericton, New Brunswick with international offices in Brazil and New Zealand, Remsoft provides planning analytics and decision optimization solutions for forest, land and asset management.

Among your Forestry Sector clients, what are the principal application, needs or problems that require your services or products? (If helpful, please use the Framework from the McKinsey and Company Report attached.) Do those vary from "early adopters" to mainstream customers?

How do the products and/or services you provide help support those applications and needs and help solve those problems?

Remsoft's core focus is looking at the planning and scheduling of forest processes and operations – right across the whole value chain. From Day 1, our niche has been leveraging data and turning it into information and intelligence. We employ advanced analytics from operations research - primarily linear programming, mixed integer programming, and some heuristics as well - to solve complex forest planning problems.

Advancement in digitally derived inventories has been a lift to the value of our solutions for closer to the ground planning solutions (i.e. tactical and operational planning). Using advanced digital techniques to quantify the forest inventory is resulting in a more accurate forest inventories. That, in turn, results in better information for planning and scheduling. We can tap into that - pull out information and start using it to drive improved decision making. The better the information, the more value that our company can provide to the to our customers.

We provide planning solutions across the whole supply chain/ value chain, beginning with long- term, big-picture strategic planning through multiple rotations. For example, what should I do with the land

base from an ecosystem perspective? A wood supply perspective? Even a cash flow perspective? What is it we need to produce? How much and what kind of silviculture we should be doing? Remsoft has been in that space a long time.

Over the past 10 years, we have focussed more on providing planning solutions closer to the ground. By that, I mean the mid-term space right down to assisting our customers' sales and operational planning for the coming year. "This coming year, what should the whole operation look like in terms of where we should harvest? What products should produce? What particular point in time should that production take place? Where are they? How do we get them to the market to make sure we're meeting the market demands on a given day? Or over a given month?

What types of economic and/or operational challenges do you think your Forestry clients are facing – and perhaps passing on you?

Have the demands of your customers changed or evolved over time? If so, how? Have those changes in demand influenced or changed the nature of your own product and service offerings? How?

Today, the demand for data-driven decision-making has become mainstream among forestry companies. Our customers want more rigorous optimization and decision analytics complementing the experience and gut-level decision-making applied to their planning and operations. I think we're seeing a younger cohort of managers who are a little more open to technology and realizing that they can use these tools to help them make things better.

That creates a challenge for both Remsoft and its customers. It is difficult to find people who possess the high technical aptitude and are analytical in nature. We aren't seeing many of those people in the natural resources field in Canada. That's true in other countries as well, so I'm assuming that people with the necessary skills and aptitude are moving into higher-paying sectors like finance or healthcare services. That's creating a challenge as we all move into the digital world.

Because we are in and still serve customers in the forestry business, we still look for applicants with forestry background. As the nature of our business evolves, those people are getting harder to find. We have been forced to change our mindset a bit, hire analysts who already possess the technical skills but are from outside the forestry field, and train them with the necessary forestry context. This approach usually works because, at the end of the day, solving these operational problems all essentially deal with managing a supply chain. While that may not always work and may depend on the technical problem being faced, I think we need to start thinking broader and bringing different people into the industry. They may look at things differently than we do, that can be healthy. We have to adapt.

> "WE NEED TO START THINKING BROADER AND BRINGING DIFFERENT PEOPLE INTO THE INDUSTRY. THEY MAY LOOK AT THINGS DIFFERENTLY THAN WE DO, THAT CAN BE HEALTHY. WE HAVE TO ADAPT."

In your experience, what do you think are the most important value-added aspects of the products and services you provide to your clients?

As part of our own digital transformation, Remsoft now offers a cloud-based software solution that enables our customers to manage their whole supply chain. Customers can use it daily to schedule their harvesting crews on blocks, seeing what products they are going to produce, where it's going to go down, where the mills are being supplied, and actually right down to the inventory within their mill yards and their sorting yards. They can see the whole connected supply chain from the beginning right down to the gate of the mill. It's fully accessible, visible and connected – they can see their whole supply chain in one spot rather than in 100 different spreadsheets.

Right now, that application is being used to manage all of Weyerhauser's operations, and Weyerhauser is the biggest forestry company in the world. All the business of their Pacific Northwest and US Southeast operations is being managed in the cloud. That means multi - billion dollars of wood value is managed and flowing through this solution.

We are starting to see more uptake in demand from companies across the world because there's a challenge there. How do you run your core business without knowing the details in near time?

Running the business using only financial accounting information means they are always reacting to historical data. Now they can react to real live data and that's great. The driver is about becoming more digital within the business. There is lots of interest from these companies, but it is an *enterprise*-grade sale so a great deal of change management has to be undertaken. That's one of the challenges – and it's usually harder with larger organizations because you're impacting more people.

We are also seeing tremendous value being offered to our customers through AI and machine learning. Machine learning algorithms can detect patterns in historical data and start making future predictions. We are seeing that with our customers using our cloud-based *Remsoft Operations* software. Some have 3+ years' worth of structured data on the planning platform. We know what was originally planned, what actions were taken, and what the actual results were versus what was forecast. All of this information is in one spot, and we can start applying machine learning algorithms to look at it and make predictions for the future. It can even tell you where you are having problems with your operations. Where were your plans always off? What specific attributes are causing things to be always off? In other words, what attributes are most important to you in terms of getting better predictions, so then you can make better, more accurate and more predictable schedules going forward. Using the data for some of the companies we' have worked with so far, the observations are pretty amazing. Their actual versus planned results may be off by 40 or even 50% in some instances. Using machine learning, we can get those differences down to about 16-17%. That can make a big difference in scheduling and resource allocation. It can help our customers more accurate schedules they can depend on.

We are not actually creating and coding these machine learning algorithms. They are already available off-the-shelf in most cases. Through our project experience, we are building expertise in determining the best algorithm to use in solving a particular problem.

How do issues over standards and interoperability influence the products and services you offer? Are your forestry clients challenging you in this regard, or vice-versa?

There are no standard data structures in Forestry and that's a big challenge. In the forestry sector, everybody has designed their own inventories and classification schemes. While they may make use of some standard base data, everybody then characterizes and organizes it in their own way – and nobody

talks to anybody else. You might get a bit more consistency here in New Brunswick, where the Province generates and provides the base forest inventory information to everyone. However, after the different organizations download that data, they each manipulate, amend, and look at that data in their own different ways – and there are no accepted standards and structures concerning that. As a result, data transformation is big task for us in implementing an enterprise grade solution. Even our shorter-term optimizations require a lot of data transformation work in order to put it into a format that we can use. If that was all structured and formalized, we could have easily build applications that were almost "plug and play". Unfortunately, that's not the case. Each new customer we take on requires "one-off" consulting, data transformation, and data mapping services, and we have processes for those.

The relationship between the industry and the provincial government has an influence as well. Who is responsible for generating that inventory? Is it the Province? Is it the industry? Is it both? If that's the case, how closely and effectively are they sharing the information required? That's going to be always a big issue.

What do your customers and your own market research tell you about new or changing challenges facing the New Brunswick Forestry sector over the next decade?

To date, we have had more success in providing more analytic solutions, like tactical planning solutions, Annual Planning solutions, crew scheduling solutions outside of New Brunswick and, in fact, outside of Canada. There has been more interest and uptake on these analytics tools to drive operational decision-making from users in Australia, New Zealand, and Brazil.

I think one of the biggest reasons Canada has been a little bit slower to adopt is that our forest inventories have been designed such that they contain very coarse, generalized inventory data which - is fine for strategic planning but not for operational decision-making. For strategic planning, the averages support the process since the deviations between what's in a given stand doesn't matter. The average works out when you're looking at it long-term. When you get down to operational decision-making, that type of inventory is not good enough. The lack of precision of the inventory has been a major obstacle for most Canadian companies. Because of the nature of the forest that we're managing, it's much more difficult - especially here in New Brunswick, where we might have 20 different commercial species. It's hard to quantify that with a lot of precision. And we are not just managing our forests for the

roundwood– we manage it for the ecosystem as well. So it's a tougher game in New Brunswick, there's no question about it.

To what extent do you think your customers are making good use of the data sharing capabilities of your products?

I would say the those who are closer to the ground and who have adopted our optimization solutions are doing well. They're driving value and driving up millions of dollars in cost savings. They're the ones that are going to be more proactive and get ahead of the curve. They are leaders in terms of analytics and data, have the R&D teams, and have the science to leapfrog other folks that are operating the product.

The question mark is how to encourage the others to move along the same path towards their digital transformation. Remsoft provides consulting services to help forestry companies make that digital leap.

To what extent do your products or services make use of cloud-based architectures for data storage and scalable processing? Describe the services you and/or your product are using. (e.g., Amazon Web Services?)

Right now, Remsoft is using both a Cloud and hybrid cloud model – some things are conducted in the cloud while other things should probably stay local, or in some kind of VM network and still be connected to the cloud. While we are moving most of our analytics to the cloud, tackling bigger, more complex optimization problems in the cloud may be too expensive, so operations like that may still be better suited to local processing.

What about Field-to-Office technologies? How has that changed? Is that evolving among users in your organization? If so, for what tasks or operations in particular?

We see that having a big impact in the future. Remsoft is not in the business of creating mobile apps but, if someone had an app to collect specific forest inventory or harvesting data, we can take that information through API's and pull it right into our systems and update the database. That's what excites me about having a supply chain application. In future, no single vendor will provide the whole software

and services solution. It's impossible – we are all good at certain things. What is critical is that those different technologies and applications must be able to talk to each other. We may not be running an inventory system *per se*, but because we use inventory data to inform our operations, there has to be a seamless way of extracting that data for our purposes.

To what extent is the optimal usage of the products or services you provide limited by particular conditions, regulations, infrastructure, etc. in New Brunswick? What would have to change in order to improve the functionality, efficiency and/or effectiveness of these products in this market?

Re: Need for Province wide Broadband Communications: I'm not convinced that province-wide broadband communications infrastructure is super- imperative right now. In managing the forestry side of the business, we are not "real-time" companies; we're more "*near* real-time" in nature. If we get the data we collect during the day sometime that night, it's probably good enough.

One of the primary areas for broad connectivity is for real-time logistics scheduling and dispatch. Another place where real time may be critical is in collecting and using digital harvester-head measurements coming from harvesting equipment. In the harvest head example, I still think that the requirements there are more "near real-time". Firms we work with in Australia and New Zealand are collecting harvester head information as part of their operations right now, but they don't have connectivity in the forest either. They store the information in the machine. When required, they transfer the data onto a USB drive, plug the drive into their laptop, and it automatically feeds up into the system when they are back in Wi-Fi or cellular communications coverage. It might be more convenient to be able to do that automatically but – so long as you train your operators to make that backup and upload task is part of their mandate and routine – wireless communications coverage in the forest is not essential. What's important is that the data is connected in a seamless way such that data can move from system to system automatically and served up to the people managing the business such that the single source data is available when they need it.

Is there anything you would like to add that you think would be helpful for this study?

The premise that we must deliver higher-and higher inventory resolution before companies will undertake digital transformation is a potential roadblock. For example, if we are able to identify species

through LiDAR, will the next level of detail be needed such as tree form before making decisions on digital investment. *"Okay, I know that's a sugar maple, but what's the form? Is it one log, or are there two logs in that tree? What's the breakout*?" You can wait forever to get perfect data. It would be better to start working with and making decisions based on the data you have today - because you are making those decisions today anyway. Then you can do continuous improvement, see where you need to be investing more time and effort, and act accordingly.

Our client companies that are getting closer to the ground know their inventory is not perfect, but it's the best they have and work with it accordingly. They use quick forest "walk-throughs" to confirm where there may be problems with their inventory, pursue easy ways to improve the data and then update the information where required. It may not yield the highest accuracy, but they know that it's better than what they have now and that in time, it will even get better through digital means.

B15: UNB Faculty of Forestry and Environmental Management

Faculty Of Forestry And Environmental Management University Of New Brunswick

- Jae Ogilvie, Instructor

Background Context

UNB's Faculty of Forestry and Environmental Management is more than 100 years old. Thousands of its graduates have worked in forestry and environmental organizations in countries around the world. Members of the Faculty of Forestry and Environmental Management have been educating undergraduate and postgraduate students in the fields of applied Computer Mapping and Geographic Information Systems for over 45 years. While involved very early in the application of raster-based GIS to forestry problems, the Faculty was also one of the very earliest users of Esri's Arc/Info software.

NOTE: This was a specially arranged interview that followed the mixed responses received from interviewees in Forestry Companies to the Question 14 in their list of interview questions; i.e.,:

What are your hiring strategies re: data collection, processing and analysis? Do you hire all the experts as employees, do you train from within, or do you engage specialized contractors? Supplemental Question: Is the requisite geospatial expertise easy to find and retain? Are you experiencing any hiring or contracting difficulties in this regard?

Responses received were mixed. While the Lead GIS person in some organizations possessed both a Forestry background and an aptitude for computing and programming, his or her counterpart in other companies had more of a general IT background and learned the necessary forestry application context to GIS through internal company training and culture. Interviewees predominantly from larger organizations saw an increased need for IT specialists with strong programming, scripting, and mobile applications development skills who could be taught the requisite GIS and Forestry context as required. Virtually every interviewee was concerned about the scarcity of personnel with such skills available in New Brunswick – especially in the small towns or rural areas where some of these organizations are based.

It was agreed that Jae Ogilvie, an Instructor of GPS-, GIS and LiDAR-related courses in FOREM at UNB, would provide useful input from an educator's perspective.

Training Needs and Considerations: There is no single correct answer to this particular question since the end users in the Canadian Forestry Sector are so diverse. A lot will depend on the entry point of the position. That said, I do find that more and more companies are expecting GIS staff or GIS analysts to also be subject matter experts in the area in which that they're tending to model or manipulate data. They typically have an appreciation for what that data is, and what that data can tell them.

In my experience, I also find that there's getting to be more requirement for folks to be able to understand both GIS and remote sensing. There is going to be so many different sorts of data involved in Forestry – digitized maps, aerial or satellite imagery, LiDAR data, GPS-based observations, mobile devices, and even sensor networks - and there is no single one that can answer all the questions. As a result, there is a growing demand for people with integrated skills, a GIS analyst that can also handle remote sensing operations and field observations from mobile devices.

There is also a need for professionals on the back end who can manage the IT infrastructure necessary to host and offer these massive, high-resolution, rich datasets. Because of the volumes and the richness of data, there are also requirements nowadays for people to not just be able to run geoprocessing tools, but also do at least some basic scripting to automate production processes as well. Possessing some basic scripting abilities in languages like Python and R is really becoming important in order to increase efficiencies. There is also more and more cloud- based hosting of data and even processing of data, and we are just beginning to teach our students about how deal with such options.

"THERE IS GOING TO BE SO MANY DIFFERENT SORTS OF DATA INVOLVED IN FORESTRY – DIGITIZED MAPS, AERIAL OR SATELLITE IMAGERY, LIDAR DATA, GPS-BASED OBSERVATIONS, MOBILE DEVICES, AND EVEN SENSOR NETWORKS - AND THERE IS NO SINGLE ONE THAT CAN ANSWER ALL THE QUESTIONS. AS A RESULT, THERE IS A GROWING DEMAND FOR PEOPLE WITH INTEGRATED SKILLS, A GIS ANALYST THAT CAN ALSO HANDLE REMOTE SENSING OPERATIONS AND FIELD OBSERVATIONS FROM MOBILE DEVICES."

From an Education Perspective, are you seeing any difficulties in moving to the Cloud?

There's a balance that needs to be maintained. Many of our industry and government colleagues have not moved over to the cloud yet, and there is no point teaching our students a version of the software they will not encounter in their workplace. Organizations may have a lot of investment built up in particular version of a software package or scripting language, and it can be expensive and time-consuming to move to a new version. We are seeing that right now in the evolution from ArcGIS Desktop to ArcGIS Pro. That being said, we are seeing that move starting to take place. I will be rebuilding all my courses in Pro over the summer, and then offering courses in both versions for a period of time.

Are there financial implications to UNB moving to a Cloud environment with its Esri software?

That's hard to know yet. We do have access to ArcGIS Pro on our current site license. These site licenses are created and priced based on the size of the University, how many potential users you have, and so on. As far as cloud-based data storage goes, Esri gives us a fixed number of "ArcGIS Online credits" per year, and those credits can be used for geoprocessing or for data storage. It's up to us how we manage that and, so far, we have not gone over our assigned limit. If we ever get to a point where we were getting close to that limit, we would move data storage onto local servers and we have that facilities in place to be able to do that. I don't foresee the extra costs due to cloud operations being an issue, but it's certainly something of which we always need to be cognizant.

Where we are seeing an impact as we move to the Cloud is in the increased administration requirements for managing individual "named users" in Esri's Cloud environment. In government or industry, a particular GIS user is going to be persistent for quite some time – you hire an employee and ideally they will stay with you for at least 10-15 years. In a university or a community college, rollovers in users occur every 2-3 years – especially if an individual student only needs access to the software for a particular term-long course. Esri's new "named user" conditions require a lot of extra steps from us as overall account administrators. We now must administer named users, make sure that we only keep the names of active students that need to be in there in a given term, and remove their names from the system once they have completed their courses and/or their research here at UNB.

How do faculty, students and staff access the software – especially now with all the COVID- related restrictions?

Many of our regular users will obtain a special license that allows them to download much of the required Esri software components onto their own desktop or laptop computer. In addition, UNB's Information Technology Services has this year installed virtual machines through Microsoft Azure cloud services. That means that every computer in every computer lab environment on campus offers an image of those lab machines available in the cloud to students within those faculties. Those virtual machine images are also accessible online from both Windows and Mac machines so - if they don't want to install the software locally on their computer – remote users can log into this virtual machine and have access to all the same physical software they would have in-person. ArcGIS, PCI Geomatica, as well as our forest modeling and optimization software are all now accessible within that virtual environment.

LiDAR Coverage Options and Directions

You have many years of experience with the processing and assessment of LiDAR data in Forestry applications through your experience here and in Alberta. What is your sense of where New Brunswick is now in terms of its effective use of LiDAR coverage? Where is it going, and where it does it need to be going?

It has been fantastic to see the speed at which a relatively small province like New Brunswick was able to gather the necessary people around the table, secure the necessary funding arrangements, and obtain LiDAR coverage of the entire province in such a relatively short time. I think there is huge value in the province-wide LiDAR dataset that we have now, and I am delighted to see it has been designated as open access and publicly available online at no additional cost.

I think it is unlikely we will see a second round of LiDAR coverage over the province in the near future for two reasons:

i. The majority of the user community is interested in the "bare-earth" DEMs derived from the LiDAR, right. Unless you have significant amounts of earth movement due to a natural disaster or something, that bare-earth DEM is not really going to change very much in the future.
ii. The users that really care about a re-flying the LiDAR coverage over the entire province tend to be the natural resource practitioners with an interest in the contribution of forest canopy

> information to the Enhanced Forest Inventory (EFI). There are other, less expensive ways to obtain data for those purposes, whether it's "growing" EFI data forward using modeling techniques or determining new top heights using stereo photogrammetry and/or digital surface models from satellites, for example. Those approaches would likely get you 75 to 80% of the way there in terms of precision relative to the original LiDAR coverage at a greatly reduced cost. I think that that's probably the direction that groups in New Brunswick are going to take.

Now that New Brunswick has full bare-earth DEM coverage from that first round of LiDAR, I think there's huge potential in some of the satellite-borne elevation systems. For example, we have experimented with TerraSAR-X radar data that can help you get at the treetops in the first returns, and that's really all we need now. By using that data in conjunction with that bare-earth DEM from our 1st-round coverage, we can calculate the relative heights of all our above-ground features – including trees. I think hugely increases our ability to continue to add value down the road.

The resolution and accuracy of the current LiDAR coverage more than satisfies the requirements of our Enhanced Forest Inventories as they are defined right now. If we keep planning, modelling and monitoring on the basis of a 20x20 metre grid cell, we don't need to know the exact height of every tree. We just need to know the general composition or mix of the forest type within that cell, we can use growth models to estimate forest growth over multiple years. Now, there is value in single-tree data, but we don't manage on a single-tree basis in Canada like they do in Sweden – at least not right now.

Is there anything you would like to add that you think would be helpful for this study?

I am really excited about a new, cross-disciplinary, online Certificate in Geomatics we have been developing in conjunction with Dr. Brigitte Leblon from FOREM, Dr. Emmanuel Stefanakis (formerly from UNB Geodesy and Geomatics Engineering) and a colleague in UNB's Department of Sociology. It is currently going through review by the Maritime Provinces Higher Education Commission.

I'm also excited about a new "Forest Characterization" course we are seeking to develop that will increase our students' skills in critical analysis of the results from GIS and forest-growth modelling tools. Right now, that is a valuable skill that students are missing. They learn how to collect data in the field in the early years of their university education, and then we immerse them in how to use different software tools to summarize all this data and aggregating it into useful forms. After that, we teach them about the modeling necessary to "grow a forest forward". However, they never get the chance to

critically consider how well the results of this entire modelling process compare with observed results on the ground. How can we better visualize how the entire process unfolds and how can we improve it in the future? This new course will help address those questions.

Finally, it seems like there's more public expectation of transparency of data these days with more "open" data, and I'm finding that we are not giving our students enough experience and exposure to the concept of usage of metadata. We teach them that metadata exists, but don't discuss its value. These days, so much data is accessible online for free or at low cost through public portals or government portals. Metadata is really the key to finding the data. If you want someone to be able to find your data, or if you want to be able to find somebody else's, then metadata is the key to making that connection. It's hard to get students to understand the value in this and describing process. Steps and the proper formats. It's not light stuff that's easily consumed. However - and especially as people expect more and more data to be available through the cloud, the proper documentation and interpretation of metadata is going to be really important.