MANITOBA MODEL FOREST

Forest Landscape Design: Fundamentals and Applications

Proceedings of a national workshop in Winnipeg, Manitoba *April 2008*

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Introduction

Brian Kotak, Manitoba Model Forest

The Forest Landscape and Design workshop was designed to provide a starting point for the development of a Forest Landscape Guidebook in Manitoba by bringing together scientists and practitioners to discuss the theoretical and practical applications of landscape planning and design. Funding for the workshop was provided by the Sustainable Forest Management Network, the Manitoba Model Forest, the Forest Communities Program of the Canadian Forest Service (Natural Resources Canada), Ducks Unlimited Canada and LP Canada. This document provides a brief summary of the workshop presentations. A DVD (*Forest Landscape Planning and Design: from Science to Implementation*) was also produced from the workshop and provides a collection of the actual video presentations with audio for all the speakers. Together this document and the DVD will hopefully provide useful reference material as Manitoba Conservation's Forest Practices Committee (FPC) moves forward with the development and implementation of the new guidelines.

The development of a Forest Landscape Planning and Design guidebook falls under the responsibility of the Manitoba FPC, which is comprised of various agencies of the Manitoba government and the forest industry. The agenda for the workshop was developed by a subcommittee of the FPC, tasked with designing a workshop to bring expertise from within Manitoba and across Canada to exchange knowledge and promote discussion on landscape management approaches. Government participants in this committee include Manitoba Conservation, in particular the Forestry, Wildlife, Parks and Manitoba Water Stewardship Branches. The forest industry representation includes Tolko Inc., Louisiana Pacific Canada Ltd., Tembec Inc. and the Forest Industry Association of Manitoba. In addition, two non-government organizations (NGOs) also participate on the committee, and include the Manitoba Model Forest and Ducks Unlimited Canada. The Forest Practices Committee has previously produced guidebooks pertaining to the development of pre-harvest surveys, road and access management, understory protection and riparian management in recent years. More information on the Forest Practices Committee and other forest management guidelines can be obtained from http://www.gov.mb.ca/conservation/forestry/index.html .

Currently, harvest block distribution patterns in some areas of the province of Manitoba mirror agricultural lands (checker board pattern), which does not reflect a natural landscape design or disturbance pattern. A shift to landscape based planning and design in Manitoba would:

- Promote the maintenance of natural landscape patterns and connectivity between habitats.
- Facilitate planning on a natural landscape boundary basis, which would more easily accommodate species at risk, species with large home ranges and provincially and regionally rare species.
- Ensure the provision of an adequate amount (number and size) of old forest areas. The landscape approach should also include protected and special conservation areas (these areas might not be static entities on the landscape).
- Integrate planning for forest operations with other land use practices and industries.
- Enable us to link stand-level planning to landscape-level planning.

The development of a landscape guide for the province of Manitoba is a step toward better planning.

Part I: Landscape Planning and Design – The Fundamentals

Ecosystem Management, the Natural Disturbance Model, and Sustainable Forest Management
David Andison, Bandaloop Consulting

The way forests are managed in North America has changed enormously over the last 100 years, and will continue to change.   There was an evolution from the profit-driven resource extraction model of the early 1900's into the sustainable extraction model of the 1950's, which then transitioned into multiple-use management in the 70's and 80's. Current forest management strategies are system-driven (ie. it stresses the importance of the health of the whole ecosystem rather than a single aspect such as timber) with an emphasis on ecosystem management, sustainable forest management and integrated landscape management. One of the most important recent developments in forest management is the shift towards the development of systems-based strategies. However, do we thoroughly understand sustainable ecosystem and landscape management? Probably not!! We actually strive to manage people and their activities, and how they change the landscape.

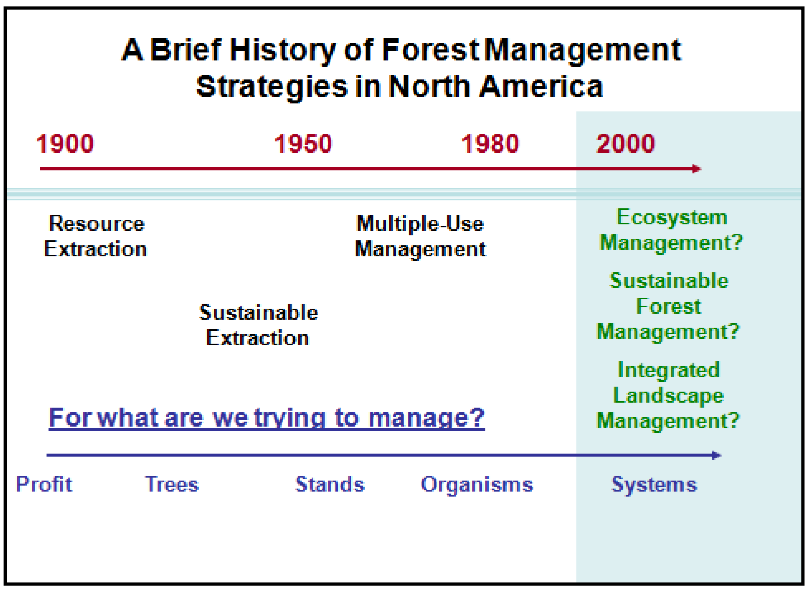


Figure 1 History of forest management strategies in North America

The common thread binding the evolution of forest management is that all forest management practices are borne of the best information available at that time and they will continue to change as our understanding changes. This resonates through the core elements, which sustainable forest management, ecosystem based management and ecosystem management has in common:

- A need to focus on wholes (ecosystems), and not the pieces.
- A natural functioning ecosystem is a priority
- The process must be science based.
- We must realize that "sustainability is a social choice with limitation" (Schleaper 1997)
- We should be more humble and realize that we don't know everything and likely never will.

In spite of the shift in management approaches, many aspects of the decision-making process within forest management planning have remained relatively unchanged over the last century. A specific objective provides a general starting point (i.e. natural resource extraction) with management strategies put through a series of filters ending in planning and monitoring systems. Essentially the only thing that has changed over the last the century is the amount of filters which are placed between the starting point and the final planning and monitoring systems. Commonly referred to as the 'Fine Filter Approach', this method only considers parts of the ecosystem without looking at the system as a whole, and may not best manage habitats for species whose habitat is not captured in the fine filter process or whose habitat requirements are unknown.

Current day forestry attempts to develop strategies that are science-based. Consider, as an example, managing habitat for a fine filter species such as grizzly bear in the Eastern Slopes of Alberta. The classical method of ecological research to understand habitat requirements involves the collaring and tracking of animals followed by the development of models for habitat suitability. The species itself is not being managed but instead it's the conditions and locations where they may exist, as determined by research that is being managed. The decision-making process in the management of these conditions involves the balancing of various elements, values and interests. As data is gathered and analyzed and models developed there are procedural assumptions, errors, bias or misjudgments that may represent habitats in different ways. Although this process is research or science-based, it follows more of a conciliatory path than one based upon science. So, although intentions are good, the resulting management direction may not be best for the specific species it was designed for, let alone the other species that reside in the forest. Also, although this may represent a science-based approach, when grizzly bear needs are combined with the need for water, timber, recreation and other values, decision-making is still complicated by what values are most important and how we choose. Therefore, Andison proposes we learn *to manage our disturbance activities to more closely correspond to those of Mother Nature in an effort to better manage for natural levels of biodiversity*.

As we move towards emulating natural disturbances in an effort to achieve natural levels of biodiversity, it is essential that we incorporate a coarse filter approach to our decision-making processes. There are several ways to do this. The first method involves the integration of a coarse filter within the current system. The starting point would remain the same, however a coarse filter (i.e. Natural Disturbance Patterns - NDP) would be included within the array of fine filters to achieve the goal of planning and monitoring systems. This would allow a constant (NDP) within the decision-making process that could be measured over time.

A second method could use a coarse filter first and fine filters second. This creates an automatic adaptive management system. The fine filter will now become more focused, as coarse filter information will dictate fine filter response.

The third method uses Natural Disturbance Patterns as the starting point (i.e. NDP replaces resource extraction as primary objective) with the addition of a series of fine filters. This system would ideally allow all stakeholders to be involved in the decisions-making process from a shared starting point; emulating natural disturbance patterns rather than a variety of different values or issues. Ideally this would lead to the elimination of partitioned forest management with a focus on the entire landscape.

As we integrate an NDP coarse filter approach to forest management it is essential the five core elements of sustainable forest management, ecological-based management and ecosystem management are met. Recall that ***"Implementation of ecosystem management requires a seismic shift in the mindset of humans" (Grumbine, 1992).***

Landscape Management Strategies for the Conservation of Large Mammal Species:
Micheline Manseau, Natural Resources Institute, University of Manitoba

The results of research on caribou habitat requirements in Manitoba relative to landscape planning and design were presented. There is interplay of conceptual and empirical model development and testing operating at three scales: site, range and landscape. Conceptual model development involves many stakeholders representing diverse cultures. Landscape planning in Manitoba will be technically and socially/culturally a complex undertaking. However, work already completed in Manitoba on understanding caribou landscape planning requirements is a reasonable starting point for broader landscape planning efforts.

The general framework proposed for landscape planning and design rests on the foundations of adaptive management and computer-supported collaborative work. The basic premise of adaptive management is learning through doing, by testing hypotheses through explicit forecasts or predictions of response to management activities, usually through the use of computer simulation and predictive models. The models are first calibrated and then either validated or invalidated by empirical evidence collected as part of a monitoring program. This process facilitates learning and leads to better forecasts of expected effects of various management actions or inactions and ultimately results in improved management actions over time.

This process can embrace both non-expert stakeholders and experts alike. Stakeholders have a more extensive role in conceptual model development, thereby increasing opportunities to learn, especially when stakeholders include or recognize cultural diversity such as Aboriginal community perspectives (Figure 2).

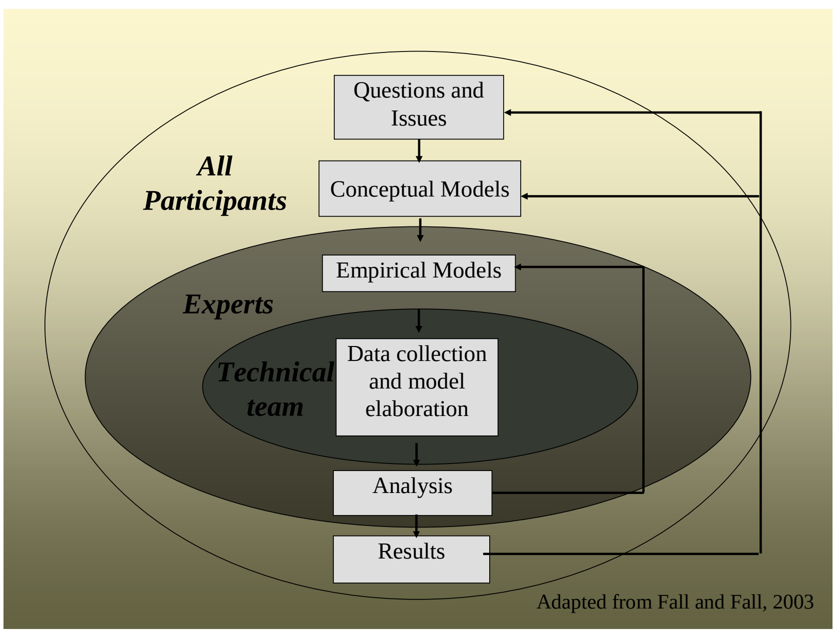


Figure 2 Predictive model development process, monitoring and management actions

Managing for a wide-ranging species like caribou evokes the same approaches needed for any landscape planning and design process. There is an obvious recognition of a scale dependent hierarchy within the forecasting, planning and monitoring process. For example, using a collaborative approach, landscape management goals were designed to provide a forest landscape, which ensures woodland caribou can move freely across the Manitoba landscape through time. The main objective was to provide the habitat through the careful management of the amount and type of disturbances (human and natural) on the landscape. These broad goals filtered into the development of conceptual models to address the following:

- Minimize disturbances around sensitive areas.
- Maintain and or increase large patches of suitable habitat
- Maintain and or restore connectivity between core habitat areas through the creation of a functional landscape mosaic.
- Maintain key species interactions and functional diversity
- Maintain an appropriate natural disturbance regime

Conceptual models were then used to develop **empirical [predictive] models** at the site, range and landscape levels.

- **Site level (animal)**

  Sensitive areas
- **Range level (herd)**

  Population and habitat analysis
- **Landscape level (meta-population)**

  Landscape genetic and habitat analysis

Telemetry and vegetation data are used along with expert knowledge at the site scale. Pre- and post-calving areas are delineated during this phase. Telemetry data helps to link pre- and post-calving sites with key landscape features using predictive modeling techniques. Results of the site level analysis indicate caribou will only use a small subset of the overall suitable habitat range during pre- and post-calving periods.

At the range level the empirical model includes a larger spatial (FMU, several thousand hectares) and temporal (20-25 yr planning cycle) scale. Pattern-based analysis at this level examines the quality and quantity of habitat types and the spatial distribution of natural and anthropogenic disturbances. A process-based approach is used to identify movement corridors, stepping-stones and functional attributes of habitat patches in terms of spatial separation from other ungulates and predators. This approach also looks at alternative habitat to account for natural landscape disturbances such as fire and insect infestation. Telemetry, population and vegetation data, in addition to expert knowledge, are used at the range scale.

The range level habitat analysis indicated caribou favor patches of older jack pine forest stands. However the analysis also shows linkages between suitable habitat ranges are equally as important (figure 2). Landscape connectivity refers to the degree to which a landscape facilitates or impedes movement relating to the amount of habitat, the configuration of habitat and the intervening land types. A landscape connectivity analysis was conducted on a southeast portion of Manitoba. Data from collared caribou was used to map travel corridors between large disturbance patches of suitable habitat. This research exercise indicates the caribou favored certain routes in order to access core habitat ranges. These results suggest a conceptual model where planners should consider the habitat connectivity of the landscape when developing new access routes and planning harvest disturbances.

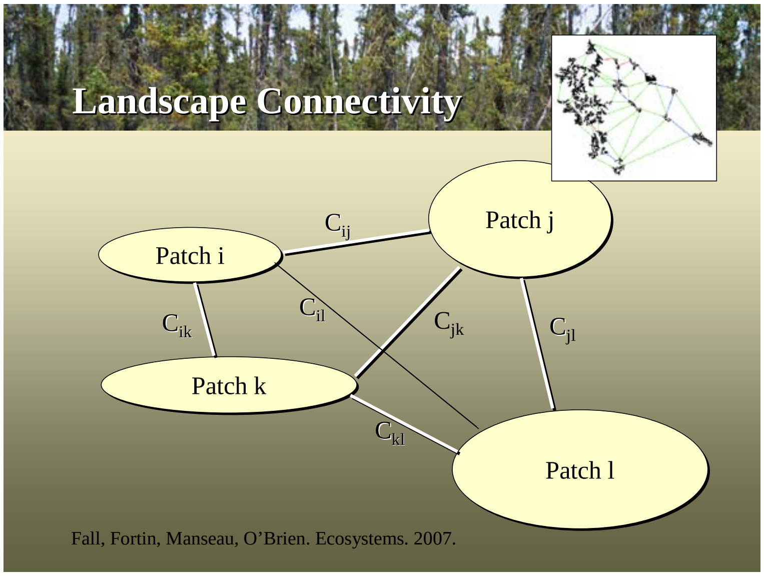


Figure 3: Example of empirical predictive model for caribou at the landscape scale

At the landscape level the empirical model works at an even larger scale examining meta-populations throughout the province. The temporal scale addresses habitat management spanning several decades. The primary source of information used at this scale was obtained from caribou fecal pellets, which provide critical genetic information. This information led to the delineation of sub-populations of caribou in Manitoba. When compared to previous population ranges it was evident herds on the southern boundary exhibited reduced genetic diversity with increased genetic fragmentation.

The various data used to develop the above empirical models at different scales will be supplemented with monitoring of the caribou herds over time. The collection of additional empirical evidence will lead to model rejection or model refinement. This in turn builds new conceptual models that drive management actions.

The above description emphasizes a landscape ecology approach based upon western scientific values and procedures. To be inclusive of all participants, the concerns for woodland caribou habitat requirements at the landscape level are being brought into decision-making at different organizational levels through the inclusion of other knowledge systems.

For example, Pikangikum First Nation elders perceive planning issues from a perspective that is situated within an intimate first-hand experience of the landscape. A landscape ecology perspective, on the other hand, is largely built up from the artefacts of another knowledge system (e.g., maps and models) that represent the landscape from an external perspective. The tension between these two perspectives—the locally situated "looking out" and the externally constructed "looking in"—and the corresponding desires for either a decentralized or centralized planning approach, is likely present in any cross-scale planning effort; however, this tension is amplified in a context of cross-cultural difference. Nonetheless, using maps and landscape models as a foundation for working across knowledge traditions enables, maybe even requires, external researchers and planners to reinterpret Pikangikum elders' knowledge and experience within a mode of representation that is familiar but not integral to how that knowledge is shared and put into use by Pikangikum people.

Landscape planning in Manitoba will be technically and socially/culturally a complex undertaking. However, work already completed in Manitoba for understanding caribou landscape planning needs is a reasonable starting point for broader landscape planning efforts.

An Ecosystem Diversity Planning Process for Forest Management

Jonathan Haufler, Ecosystem Management Research Institute, Sealey Lake, Montana

Ecosystem classification is a useful approach to describe historic, current and future ecosystem level biodiversity and habitat conditions for conservation planning. The development of an Ecosystem Diversity Matrix is described and its application to a species habitat-viability assessment illustrated through examples from the United States.

There are 3 principal objectives for sustainable forest management:

1. Ecological: Ensuring biodiversity is present throughout the landscape
2. Economic: Ensuring that fibre and other resources present on the landscape contribute to the economic and social well being of our communities
3. Social: Ensuring that aesthetic and other social values are preserved.

Forest management planning needs an approach that can integrate the different objectives in an effective, efficient and comprehensive manner. Haufleur proposes an ecosystem-based approach to forest management as the best means of meeting these objectives.

Biodiversity is defined as the landscape, ecosystems, species, and genetics that are native to an area. Any substantial change at the landscape level will lead to a domino effect at the underlying levels, for instance from the ecosystem to the species and finally the genetic levels. Traditional forest management has generally addressed the species level, focusing on specific habitat needs. Haufleur suggests we should instead be looking at the array of native ecosystems that comprise the landscape and work our way down. Under this model we assume properly managed ecosystems will provide suitable habitat conditions for the species which inhabit a given ecosystem type. Therefore our specific strategy is to maintain ecosystem diversity through an appropriate level of representation of all native ecosystem types found in the area.

The goals of an ecosystem-based approach to forest management include:

- To provide for appropriate ecosystem amounts and distributions across the landscape (landscape level)
- To provide appropriate composition, structure, and processes for each identified ecosystem (ecosystem level)
- To provide for resource utilization consistent with these first two goals.

When using an ecosystem-based approach to forest management it is essential to identify the native ecosystem diversity. A baseline must be established in order to measure any of the cumulative effects in the modeling process. Also, characteristics and processes of individual ecosystems need to be identified as a reference for setting representation objectives. The delineation of ecosystems can be quite challenging compared to managing at the species level. The scale at which ecosystems are classified is critical, since a balance must be met between appropriate detail and practical limits to applications.

There are 6 key steps involved in ecosystem diversity assessments:

1. Delineate the planning landscape
2. Characterize the ecosystem diversity
3. Quantify the reference conditions
4. Quantify existing conditions

5. Set management goals
6. Check representation goals

Landscape delineation should encompass an area big enough to incorporate a large range of native ecosystems. If areas become too large then the process will be bogged down by the complexities inherent with the number of native ecosystems. This will lead to a reduction in the resolution of the assessment, which subsequently contributes to a loss of detail needed for effective management. The use of geo-climatic boundaries in the delineation of the planning area does help reduce variability in ecosystem diversity.

The diversity of ecosystems within the landscape is dependent on two primary drivers - the abiotic features of ecological sites (landform, soil, topography, surficial geology) and disturbance regimes. The native ecosystem diversity within the landscape is a function of ecological sites and their responses to disturbances. It is important to understand how disturbances affect each eco-site type and the response over time to a specific type of disturbance (i.e. disease/insect, shade tolerance, wind throw, fire, etc.). An Ecosystem Diversity Matrix (EDM) is a conservation planning tool that is used to classify ecosystems according to ecological sites and responses to natural disturbances (Figure 4 & 5). Anthropogenic disturbances can be added to the matrix to enhance understanding of current and possible future conditions. This matrix allows for the quantification of the cumulative changes to ecosystem diversity and provides a basis for predicting future conditions including possible effects of climate change.

Reference conditions must then be characterized for each native ecosystem within an ecological site for the landscape to quantify the amount of each over a defined past historical time frame (i.e., the historical range of variability-HRV), and how the vegetative characteristics and processes varied over time in response to disturbance. The model used by the United States Forestry Service for ecosystem classification is the 'Simulating Patterns and Processes at Landscape Scales' (SIMPPLLE). It is a spatially explicit vegetation dynamics model that quantifies vegetation dynamics along the gradient of habitat types for all rows of a particular ecological site. These can be mapped within a dynamic GIS dynamic framework in order to understand what historical conditions were, as well as predict what future conditions might be.

The next step is to quantify existing conditions including the mapping of ecosystems at the landscape level and the current vegetation composition and structure at the ecosystem level. Estimates of the historic range and variability of the reference ecosystem type can be compared to actual conditions, highlighting areas of concerns within the landscape. These include changes in the amounts of ecosystems at the landscape scale as well as changes in composition (for instance, the occurrence of exotic species), structure and processes. Information obtained through the Ecosystem Diversity Matrix help guide management recommendations with respect to the desired amounts and distributions of native ecosystems (landscape level) and the desired compositions and structures for representative areas (ecosystem level).

The adequacy of representation goals can be assessed by determining a species response to ecosystem representation levels. Haufleur recommends a habitat-based species viability approach using the EDM to determine historical, current and future habitat conditions based on projected management recommendations, for a specific species of interest or concern (e.g., fisher). The habitat availability and quality through time is predicted across the landscape which enables resource managers to assess species viability and the adequacy of ecosystem representation levels as well as habitat fragmentation and connectivity. This is done in order to gauge the ecosystem-based management approach's ability to accommodate for individual species habitat by managing at the ecosystem level.

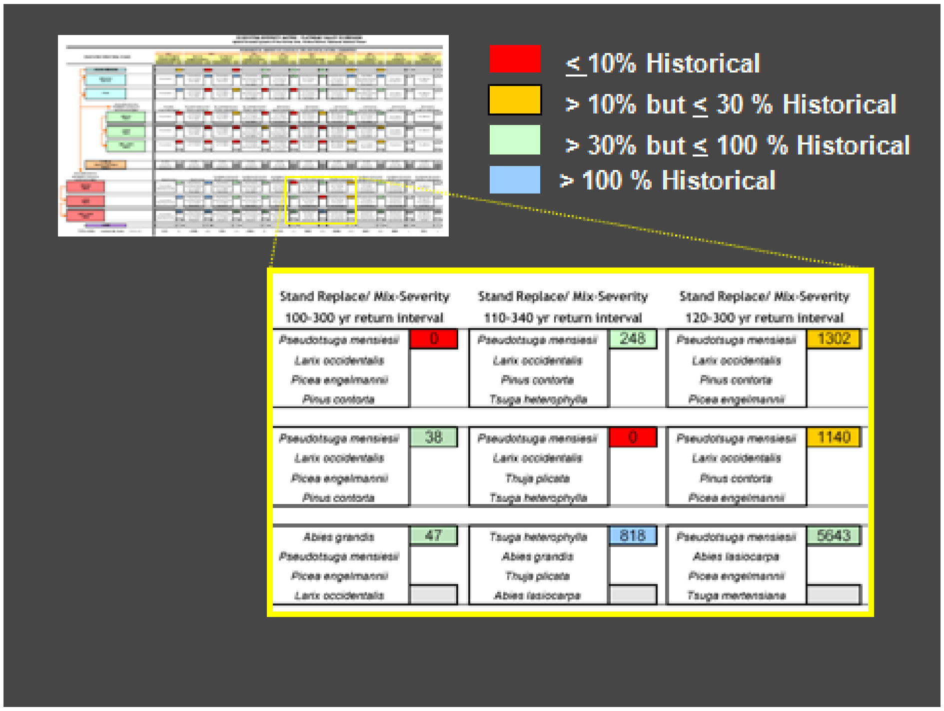


Figure 4 Ecosystem diversity matrix species level details

The classification of ecosystem diversity represents a cornerstone for the conservation of biodiversity. Ecosystem diversity can be effectively and efficiently characterized and mapped with a tool such as the Ecosystem Diversity Matrix and used to set management objectives. This ecosystem-based process has been used to develop management plans for numerous areas and integrate ecological, social and economic objectives for all types of ecosystems.

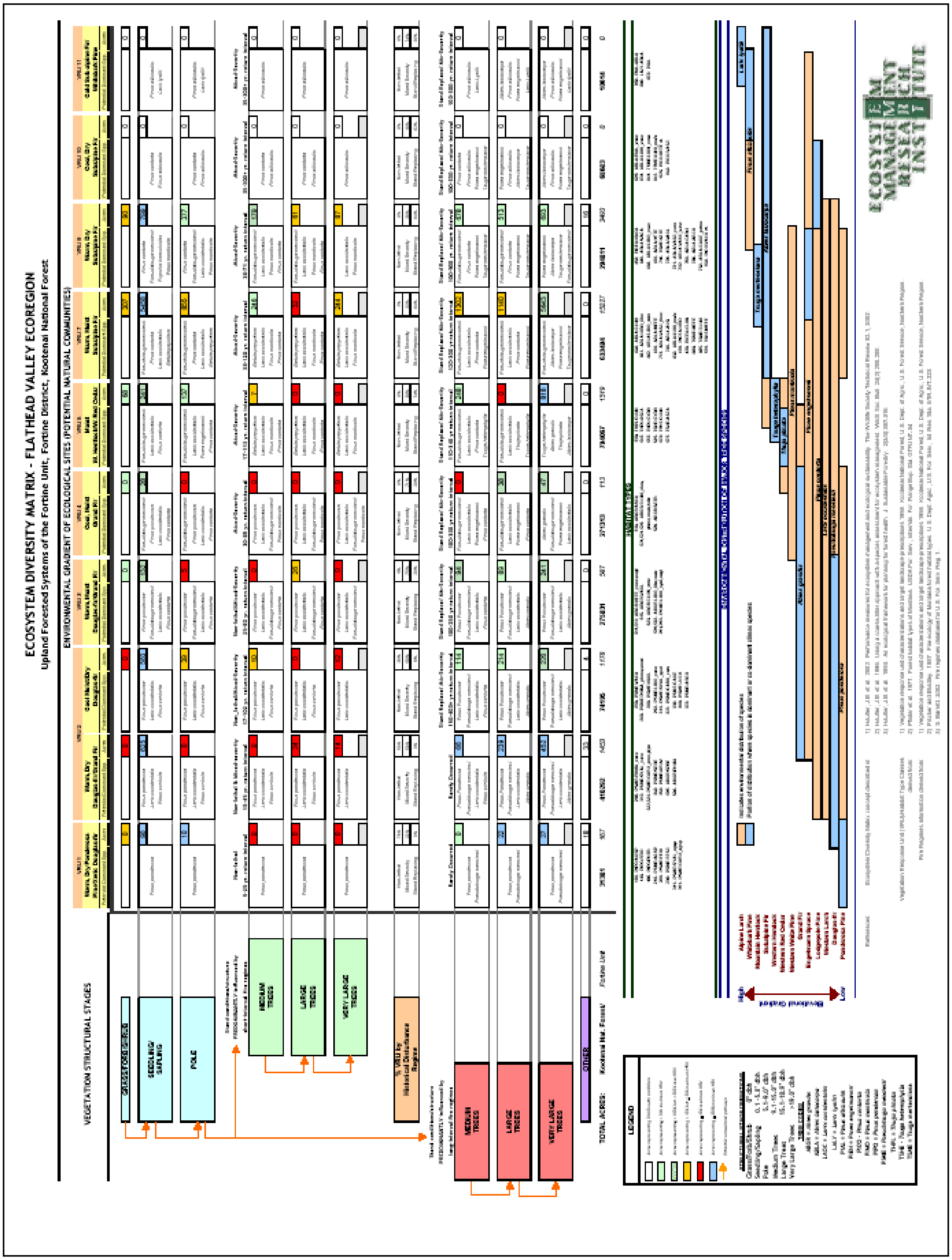


Figure 5 Overview of the Ecosystem Diversity Matrix

Water Resource Protection in a Forest Landscape Planning Context:

David Kreutzweiser, Canadian Forest Service, Natural Resources Canada

Although it may not be intuitive to associate forest landscape design impacts on the forest landscape with impacts to water resources, in reality a strong linkage exists between land and water. Forest water bodies and aquatic ecosystems are strongly linked to the surrounding terrestrial environment and what we do to a forest landscape can strongly affect the ecology and processes within aquatic ecosystems.

When we consider water protection in the context of forest landscape planning there are several things to keep in mind. First, the principal unit of interest is the watershed level. Decisions must be made regarding the appropriate size or order of watershed to determine landscape level influences. Also, there are several important drivers outside of forest management activities at the landscape scale that influence water quality and aquatic ecosystem integrity including the following:

- Climate
- Geomorphology
- Geology (Soils)
- Land Cover/use

Land use tends to be one of least influential factors that affect aquatic system integrity until that land use becomes extreme (e.g., urbanization, deforestation and conversion to agriculture). Landscapes and associated aquatic ecosystems are fairly resistant to change at the landscape level. A large-scale perturbation is required in order to invoke a measurable change in aquatic systems and water quality, and will most often result in effects that are generally localized. However, these local effects are important in the context of aquatic ecosystems since these systems are largely defined by their geography, which means that any localized forest management impacts affect an entire ecosystem. So, although strategic planning for water resource protection is done at the landscape level (coarse filter) a large component of water protection is accomplished at the local scale (fine filter) through operational practices at the site level. This is evident in new riparian management guidelines under development in Ontario where an ecologically-based fine filter approach at the site level provides feedback to the management of water resources and aquatic ecosystems at the landscape level.

In terms of water resource protection, what needs to be managed at the landscape level? Although the answer still remains somewhat unclear, recent research has helped us to better understand these systems. Kreutzweiser believes two important aspects should be considered in a landscape level approach to the conservation of water resources: shoreline and riparian areas, and water contributing areas.

Shoreline and riparian areas are important since the land/water linkages that are most critical to aquatic ecosystem integrity are strongest in these areas. These areas are also important since they provide critical and/or productive habitat for a wide array of species. These are several of the reasons why riparian buffers or reserves are applied in most jurisdictions across the country. However, we have also learned that the systematic application of standardized riparian buffers (slope dependant) across the landscape may not be the best approach since it results in the creation of unnatural (linear) patterns across the landscape. There is a need to revisit current riparian management strategies to promote the creation of more natural disturbance patterns following harvest activities.

The second important consideration as we move to a landscape approach to water resource protection is the management of water contributing areas. These areas may not be as distinct or easy to detect on the landscape and consist of hydrologically connected upland areas linked by near surface water flows and ephemeral channels. They are important since they influence the temperature, nutrient flux and flow regimes of receiving waters. Although these areas are difficult to find and define on the landscape, detection and prediction methods are improving.

Recently there has been considerable advancement in terms of water resource conservation and landscape level management approaches. Ongoing research in Ontario is providing a better understanding of natural disturbance patterns and landscape level water resource protection as well as hydrological monitoring and modeling to define areas sensitive to forest management activities within the landscape. Considerable research is underway across the country investigating small, headwater streams (both intermittent and ephemeral) to better understand their biological importance, the role they play in terms of the total watershed and what kind of management would best conserve these areas. Research is also contributing new knowledge to the development of improved riparian management strategies with an emphasis on water protection, shoreline habitat conservation and sustaining biodiversity. Watershed level studies are underway in several locations in Canada, which provide empirical data and modeling efforts to inform the discussion on appropriate landscape level management approaches for water resource conservation.

Although there have been considerable advances in our understanding of aquatic system responses to disturbance across the landscape there are several outstanding issues that provide context to the development of landscape planning approaches. A significant influence relates to our current understanding of aquatic ecosystem responses to logging or forest management activities. Most of the information available on aquatic system response to disturbance is derived from studies in the Pacific North West or the Appalachian regions in the United States and is not necessarily relevant to many areas of Canada. The management issues and associated impacts vary regionally and are not always predictable or interchangeable among areas. Therefore, we must recognize the need for regionally relevant information.

Our understanding of cumulative impacts and downstream recovery of aquatic ecosystems is also lacking, especially relative to the protection and recovery of headwater ephemeral channels. Riparian management strategies still need to be improved, although there have been recent advances. In particular, alternative and innovative approaches to riparian buffer and reserve strategies are needed. A brief overview of existing studies across Canada that will contribute new information about riparian strategies was provided and a case study outlined on the White River Riparian Harvesting Impacts Project (WRRHIP) by the Canadian Forest Service. The WRRHIP is located in Ontario in the boreal shield mixed wood forest type. The study involved a before and after harvest design where up to 50% of the merchantable trees were removed during the winter from riparian reserves around 3 streams in logged watersheds, with 3 reference watersheds as a control. The whole-tree, 50% partial harvest was evenly distributed across species and size classes in accessible portions of riparian reserves with data collected 3 years prior and 3 years following harvest. The partial harvest in riparian buffers was designed to

- increase riparian habitat complexity by promoting early successional species
- sustain ecological corridor function by retaining 50% or more of the stand residual
- protect adjacent streams by retaining functional canopy cover
- emulate natural shoreline fire disturbance
- improve residual riparian stand structure and quality
- allow additional harvest to partially off-set declining wood supplies or re-allocate the harvest across the landscape to address other values

Data collection includes terrestrial and aquatic assessments including residual stand characteristics, songbird and insect communities, carbon flux and terrestrial decomposition processes, upland and lowland hydrology, soil and stream water chemistry, stream invertebrate and microbial communities, organic and inorganic inputs and dynamics and stream temperatures. Preliminary results show reasonable success on most design objectives, although data collection and analyses are on-going (Figure 6).

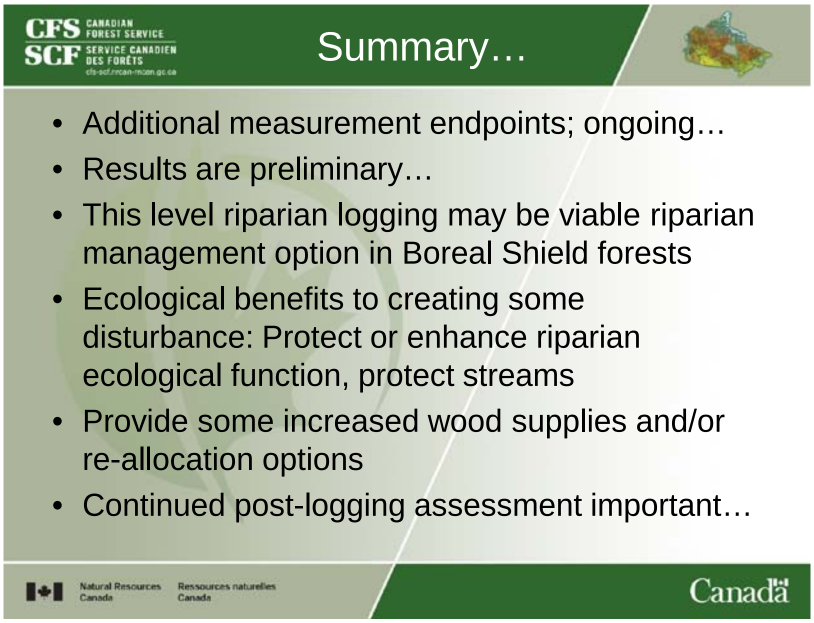


Figure 6 Summary of preliminary results

The ecological implications of changes to hydrological and biogeochemical processes following disturbance needs to be clarified. How relevant are these changes to aquatic ecosystems and are there negative ecological consequences; for instance, what are the ecological consequences of a 20% increase in nitrates? There is a need to truly integrate studies between hydrology and ecology and advance cross-disciplinary partnerships among academia, consultants, NGO's, First Nations and government agencies.

We also need to implement novel forest management strategies on the landscape through changes to operational practices, regulations and policy. This should be implemented using an adaptive management approach with effectiveness monitoring to assess the outcome and will likely result in a much more complex regulatory and policy framework. However, this may be what is needed to effectively manage these complex systems and may be more feasible now with advanced positioning systems and sophisticated operational equipment.

Landscape level management frameworks: incorporating terrestrial values

Margaret Donnelly, Sustainable Forest Management Network, University of Alberta

Forest managers and planners are faced with the difficult task of reaching a balance with ecological, social and economic values to achieve sustainable forest management targets. From a conceptual viewpoint, managers need to look at the forest as a 'matrix' within which 'fragments' are removed by harvesting. We need to consider the whole rather than pieces of the landscape, and focus on what is retained as well as what is removed. When managing biodiversity we need to consider what is being left behind and which values and objectives are inherent within that managed landscape. Many ecosystem attributes and processes tend to operate beyond the stand level scale, which highlights the importance of integrating multiple biodiversity conservation strategies at multiple scales.

> " Shift the emphasis from the FRAGMENTS to the management of the MATRIX in which they are embedded. If the biota in the fragmented landscape is to persist then the management of the matrix becomes all important. Ameliorating the matrix may be the most important way to manage fragments" (Crome, 1994)

In order to incorporate a truly integrated landscape approach to forest management, there is a need to understand the impacts and influences of hydrological and geomorphic processes on the landscape and how changes to the 'fragments' within that landscape affect those systems. Forest operations need to integrate development plans with other land users and industries to achieve landscape objectives.

An objective-based approach within an adaptive management framework is the best way to develop a landscape management strategy. This will ensure that long term ecosystem productivity is achieved while maintaining timber and non-timber values on the landscape. Equally important is the consideration of temporal and spatial factors on the landscape. How we manage values and their distribution on both the managed and un-managed landscape influences how we are able to meet our objectives. We must also learn from past mistakes and realize that what we implement on the landscape might not be as beneficial to certain species or systems as may have been hoped. To reduce the risk and uncertainty, a range of strategies and conditions should be provided. Strategies need to be implemented at both the landscape and stand level. Stand level strategies need to focus on the structures retained in the regenerating forest and the types of retention targets that need to be implemented. Landscape level strategies need to focus on patch sizes and their distribution on the landscape with respect to time and space.

A landscape-based approach is consistent with the principles of sustainable forest management. When done properly it should maintain variability in the forest at the site, stand and landscape levels in terms of:

- Species composition and seral classes including aquatic and wetland systems
- Landscape patterns more closely resembling natural patterns
- The availability of habitat structural elements such as coarse woody debris and snag trees.

A landscape approach should include a variety of harvest and silvicultural techniques and management intensities to promote habitat variability. The maintenance of structural elements on the landscape is as important to species as stand age. We need to promote the availability of habitat elements in regenerating stands through modified harvesting and silvicultural practices. Variable retention at the stand level should be implemented at different intensities dependant on site conditions. We should focus on mean retention levels instead of implementing rigid stand level guidelines. What works in one block may not work for another (Figure 7).

Figure 7 Forest structure at harvest block and landscape level (matrix)

When addressing the landscape level, planners must realize that trade-offs must be met. A balance of socio-economic, species and SFM should be included in objectives. We must realize that the boreal forest is not a homogenous stagnant area but a dynamic entity characterized by its heterogeneity. We must ensure the maintenance of special habitats for species or communities that require:

- Older forest and related habitat structural elements
- Early successional, post-fire habitats
- Non-disturbed or core habitat areas

We must also be aware of short-term vs. long-term effects. The cumulative effects of forest management may be more pronounced on common species in the long-term. However short-term effects may be more pronounced in uncommon species and un-noticed due to lack of available data. This situation is best addressed thru biodiversity conservation strategies at multiple scales. We must embrace an adaptive management and monitoring framework to reduce inherent risk and uncertainty.

Planners should integrate stand level practices within a strategic landscape level framework. A primary example is the systematic application of riparian buffers on the landscape. Many question the validity of this approach and the associated values these techniques protect. If we look to redesign these buffers we must consider their connectivity to the landscape or perhaps instances where riparian buffers could be large enough to provide habitat for interior species. We need to identify which inherent values exist in riparian buffers and what are the long-term objectives for these areas. Are we retaining riparian buffers to provide corridors for trappers or are we trying to promote wildlife habitat? Once we are able to define our values and objectives we can put in place strategies to achieve them.

It is important to promote landscape design concepts and planning approaches that maintain forest diversity to a level similar to the natural forest. This highlights the need to develop explicit strategies for the maintenance of old forest and late successional stages in the managed landscapes. It is critical both upland and lowland old forest sites are represented rather than relying on old forest content of riparian buffers to provide habitat for old forest denizens. Similarly, young riparian forest is an important habitat type that may be lacking due to requirements for riparian buffers on all wet sites. It is also important to explore alternative management strategies to maintain forest species composition, especially in mixed wood and uneven-aged forests. We should look at maintaining habitat derived from fire and insect infestation to provide critical habitat for certain species and maintain ecological benchmarks on the landscape.

General principles for landscape planning

- A landscape-based approach is consistent with SFM.
- Landscape issues are at least as important as stand-level issues.
- We can't manage for all species in all places at all times.
- Trade-offs are necessary.
- Maintenance of structural elements is as important as stand age.
- Incorporate conservation strategies for Species at Risk, critical habitats, special sites and biodiversity `hotspots'.
- Be aware of short-term versus long-term effects.
- Integrate stand level practices with landscape level planning
- Maintain habitats derived from fire events or insect/disease infestation.

Figure 8 General principles for landscape planning

Part Two: Landscape Planning Approaches and Tools

Aboriginal Peoples and Landscape Level Planning: Challenges and Best Practices

Peggy Smith, Lakehead University

Smith provides a social perspective from the aboriginal community on landscape planning. This social perspective is also highly political and politics is about power, both in how it is used and how it is shared. The aboriginal perspective is also based upon historical use rather than science or technological drivers.

Land treaties signed with First Nations cover most of the industrialized crown land in this country. When utilizing a landscape approach to forest management it is crucial that planners consider the knowledge and value sets that First Nations possess. The approach taken by government and industry to include First Nation communities in the planning process and the methods used to consider their values on the landscape are very important.

Stark differences exist in the way forest managers and First Nation people view forested lands. Planners view the land base in partitioned management units under the tenure of the forest companies that operate within them. First Nation people view the lands in terms of the boundaries set by the treaties they signed with the crown and do not associate their use with current zoning (Figure 9). Treaty boundaries generally encompass several forest license areas. Aboriginal people define themselves by the land and view it as a gift from the creator for which they are responsible. This link is further exemplified in their language, which defines the culture and reflects the lands use.

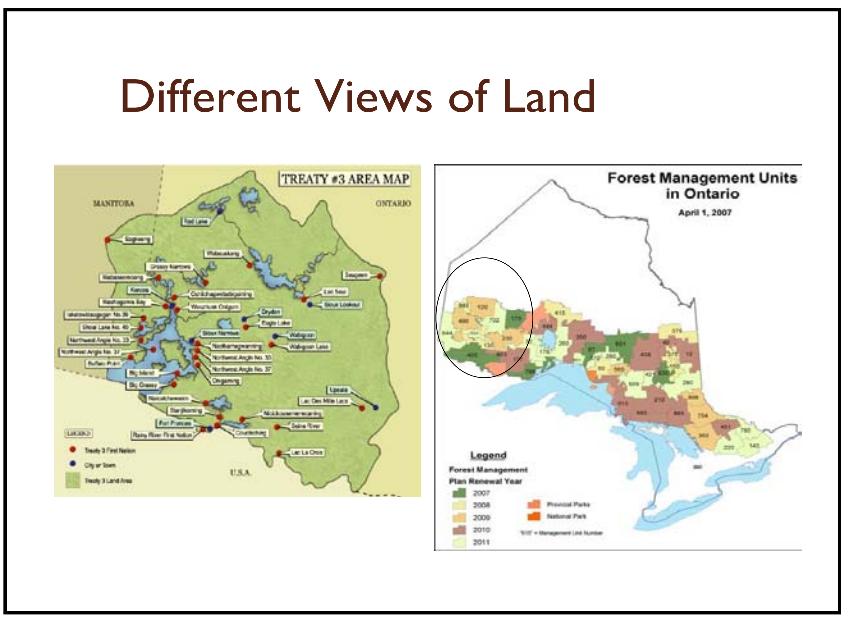


Figure 9: different views of the land based on treaties (L.) and forest administrative units (R.)

Consultation with First Nation people can be challenging due to the underlying cultural differences that exist. Often times the approach used by industry is viewed as insubstantial and alienating. These relationships are fragile and sometimes volatile as seen in recent events involving mining exploration on traditional native lands (K.I. Six). This clash has become a lightning rod with respect to First Nation consultation and traditional land use rights. The resulting environment for First Nation negotiation and collaboration has now become much more difficult. For this reason it is important that planners take the appropriate steps to utilize 'best practices' when consulting First Nations and incorporating their values and objectives into landscape level planning.

First Nations have been developing landscape-based plans for their traditional lands for the last 20 years. These plans generally encompass natural boundaries such as trap lines and watersheds and possess a wealth of historical information including traditional land use, occupancy, knowledge and teachings. Western science is melded with traditional knowledge and teachings to combine economic development with the conservation of traditional values and land rights.

There are also cases where integrated land-use plans have been developed with both government and industry. The Innu of Newfoundland and Labrador collaboratively developed an ecosystem-based plan, which protected important areas based on traditional First Nation cultural use. A 'Forest Guardian' program was put in place which trained community members to monitor practices on the land base and ensure they did not conflict with traditional teachings and values.

The Nuu-chah-nulth from the west coast of Vancouver Island was able to develop an interim measures agreement, negotiated on the basis of an ongoing land claim dispute. This subsequently led to the development of a comprehensive planning board, which required explicit consultation with the Nuu-chah-nulth who were granted veto power over all decisions. This ultimately led to the development of Iisaak Forest Resources Management, developed jointly with MacMillan-Bloedel.

The James Bay Cree of Northern Quebec negotiated a revenue-sharing agreement pertaining to mining, hydroelectric development and forestry activities occurring on traditional lands. One of the major keys to this agreement was the preservation of First Nation values such as trap lines on the landscape. The Cree-Quebec Forestry Board was developed partly to ensure the protection of these values.

In order to ensure progressive and productive consultations are conducted with First Nation people, government and industry need to be facilitators rather than adversaries. Government, industry and First Nation people need to view themselves as equal partners whose cultural differences can be used to promote learning and awareness. Co-operation between federal and provincial levels of government needs to be accomplished to uphold the fiduciary obligations to the First Nation peoples.

Spatial Modeling of Landscape Pattern

Tom Moore, Spatial Planning Systems

Moore describes spatial planning tools that combine the conceptual and empirical models described by Manseau into a robust decision support system (Patchworks - Pw) to evaluate competing policy options and proposed forest management plans at the landscape scale. These tools can be applied in any landscape planning and design exercise and are being used across the country. Examples from Ontario and Manitoba are presented. The Ontario example demonstrates how Pw can be applied to test newly developed provincial policy prior to implementation on a wide scale using the Ontario Ministry of Natural Resource (OMNR)s proposed landscape management guidelines that are soon to be released. The OMNR guidelines represent an approach that is reasonably consistent with the fundamentals of landscape design described by Andison. The second example, from Manitoba, provides an overview of the forest planning and scenario development framework by LP Canada Swan Valley.

Decision-making in forest management is essentially a choice between alternate futures. We need to be able to make informed predictions of possible future conditions, based on management options, to quantify the potential benefits of one scenario over another. We cannot manage what we cannot predict. There are various `active' management options involved in forest planning.

The key component of 'active' forest management is harvesting activities. Managing the wood supply is essentially a time-based forecast of stand and forest development including stand growth, available harvest volumes, retained growing stock and costs. However, it is just as important to assess changing forest patterns and location on the landscape over time. How do we accomplish this?

Spatial planning tools are a useful way to solve spatial issues on the landscape. These tools have only become practical for forest management applications since the development of Geographic Information Systems (GIS) over the last 7-15 years. Across Canada, Stochastic optimization (aspatial) models are typically used to model wood supply over time. An aspatial model such as SFMM (Sustainable Forest Management Model) does not consider spatial arrangement over time or how it pertains to either policy or operational feasibility (*see Martel*). In an aspatial model, factors not explicitly in the model cannot be directly controlled or adjusted in the forecast. Spatially-explicit forest management models simultaneously consider patterns and other conventional wood supply goals, and are able to make long-term forecasts of various spatial management policy options and explore trade-offs between mutually exclusive outcomes.

Two types of spatial models exist - design and assessment models. Design models such as Patchworks are a mix of conceptual (e.g. management controls such as desired harvest levels or patch distributions) and empirical models (e.g. yield curves) that propose spatial arrangement of harvest disturbances. The harvest disturbances are subject to management controls and weighted objective levels or targets for various indicators of landscape or economic conditions. Local level indicators of sustainable forest management have been developed across Canada and can easily be integrated into the Pw analysis and reported throughout the planning horizon. Assessment models on the other hand, are empirical models that evaluate existing or proposed spatial arrangements at a complex and detailed level. For example, in an assessment model the assumptions are based on biological hypotheses with respect to the type of habitat needed to satisfy the life cycle requirements of a specific species.

The Duck Mountain Provincial Forest in Manitoba provides an example of the use of spatial tools in the forest planning process. The Patchwork model was used in the development of a 20 year Strategic Forest Management Plan by LP Canada (LP). LP's planning framework included forecasts of future forest conditions based on a series of management scenarios including the timing and location of all proposed treatments. The future forest conditions were then subject to subsequent analysis using detailed spatial landscape assessment models (SLAMS) to evaluate the ability of the scenario to conserve biodiversity (Figure 10). In Figure 10, the predicted habitat occupancy for the Hermit Thrush is presented. It is based upon empirical models for the current forest condition of the Duck Mountain Provincial Forest, MB (upper left panel) and 100 years from now for three competing scenarios based upon Patchwork simulations (Rempel et al. 2007).

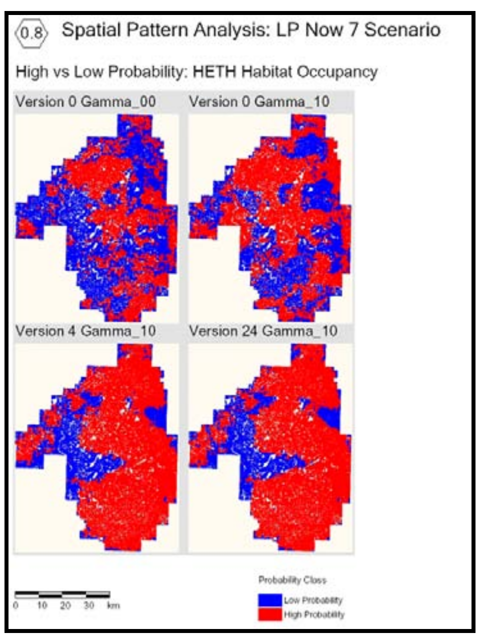


Figure 10 Predicted habitat occupancy for Hermit Thrush

Spatial models are primarily used as forest management planning tools to develop long-term strategic plans, which are consistent with current spatial guidelines. However, spatial models are also being used as a policy analysis tool to determine the effectiveness and impacts of alternate guidelines. The proposed OMNR Boreal Landscape Guide (anticipated release 2010) for the province of Ontario was analyzed using Pw to determine effectiveness at achieving the stated goals, to explore possible alternatives and examine implementation feasibility. Several types of models were used collaboratively to examine the impacts of implementing the proposed guidelines on the landscape.

The Boreal Forest Landscape Dynamics Simulator (BFOLDS) was used in combination with fire history to develop natural disturbance pattern templates for boreal forest management units. BFOLDS is a stochastic, spatially explicit, event driven landscape level model that simulates boreal forest fire regimes and succession, and forecasts regional and landscape level forest dynamics over extended time periods in the absence of harvesting. This information, along with management controls from approved forest management plans (FMPs), were input to the spatial model (Patchworks) and the outputs subsequently evaluated by an assessment model (which used habitat assessment tools similar to those used in the Duck Mountains). The 'road-testing' of landscape guidelines enables policy makers to explore the impacts and alternatives associated with proposed guides in a virtual world prior to implementation. Figure 12 is an example of Pw simulated output of forecasted area by forest cover class over time (each red dot represents ten years) against forest cover based on the bounds of natural variation (NRV) estimated from BFOLDS simulation as depicted by the green box and whisker diagrams.

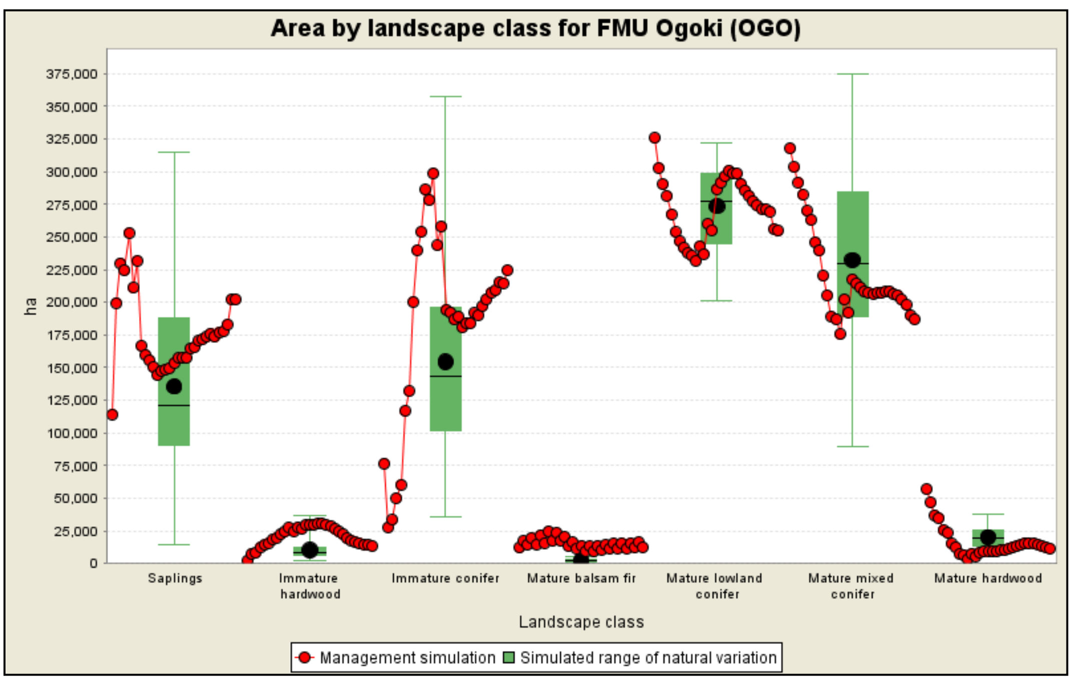


Figure 11: Patchworks output of forest cover class over time

The management of flammable forest landscapes: A hierarchical approach

David L. Martell, University of Toronto

The `fundamentals of landscape management' portion of the workshop emphasized a systems approach (e.g. Andison) and scale-dependent hierarchal planning. Martel shows that a systems approach and scale dependent hierarchies are also part of fire management. The method Ontario currently uses to address fire management issues is discussed. Martel's approach to fire and risk focuses on the economic dimension of sustainable forest management while others presented at the workshop have tended to focus upon the social and ecological dimensions. The utility of computer simulation and empirical predictive models is described, a theme common to other workshop presentations. Landscape management guidelines that evolve for Manitoba are likely to embrace the full economic, ecological and social elements of sustainable forest management and ecosystem-based management (e.g. Haufler).

Under a traditional forest management paradigm, stands are harvested when the optimal economic rotation age is reached. This is generally repeated in continuity without considering the impact of fire. In reality the growing cycle of a stand can be halted at any point within the rotation and reset when fire occurs on the landscape. Incorporating potential fire losses at the stand level results in a shortened harvest rotation with the objective of harvesting stands before they burn. This is essentially a risk management strategy, which balances incremental growth loss at the stump (due to early harvest) versus total stand loss to fire. From a landscape perspective, timber losses to fire essentially divert planned harvest schedules resulting in reduced timber volumes due to early harvesting of stands, and increased access costs within the operational timeframe (need to build roads earlier).

Figure 12: Fire management system considerations in forest land planning

In Ontario the estimated annual (forest) burned fraction is incorporated into an aspatial timber harvest scheduling model (Sustainable Forest Management Model - SFMM) to calculate an annual allowable cut that includes fire on the landscape during the planning process for each forest management unit (*There are currently 46 FMUs across the province*). When the burn fraction rate is incorporated into the planning model it has a significant impact on the allowable cut. The incorporation of a fire management strategy in Ontario has increased the AAC by nearly 36% on average across all FMUs because the strategy and program has demonstrated a decrease in the annual burn fraction. These analyses help rationalize funding of fire management programs.

When applying integrated fire management on a provincial scale, managers look at shifting the balance of resources allocated to suppress fires to areas where burn rates can be decreased at a reasonable cost while allowing burn rates to increase in other areas without significant impacts on the timber supply or other values at risk. These types of strategies are essential considerations for landscape planning and design (figure 13). In addition, FMUs are not an appropriate scale. These trade-off analyses must consider larger units such as fire management analysis units (FMAUs), which are associated with ecological rather than administrative boundaries (figure 14). Figure 14 presents the proposed fire management analysis units (FMAUs) for landscpe scale fire management planning in Ontario. The colours represent annual burn rates expressed as a percentage of the total land base under current fire management programs.

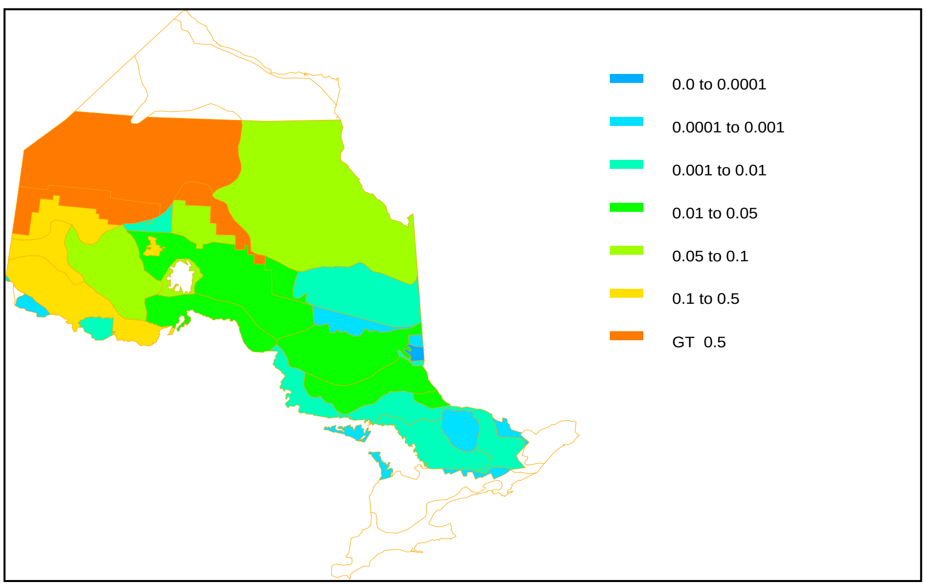


Figure 13 Fire management analysis units (FMAUs) annual burn rates.

Part III: Landscape Management Case Studies

The above examples demonstrate that the decision support tools developed for landscape planning and design are highly advanced. These tools have been used for forest management planning by several licensees in Manitoba as well as Manitoba Conservation. The next step in landscape planning can begin with the experiences gained in using landscape-based approaches in forest management planning in Manitoba and elsewhere.

Integrating Caribou Habitat Requirements into Forest Planning in Alberta

Luigi Morgantini, Weyerhaeuser Company, Alberta Forestlands

Morgantini provides a case study featuring forest management integration of caribou habitat needs under current planning regimes. Caribou are a wide-ranging species and like Manseau's research and Keenan's case study, they require a landscape management approach to conserve habitat and connectivity. Morgantini shows the progression of forest management from sustained yield, stand level approaches to landscape thinking through the operational lens of Weyerhaeuser's forest management activities in Alberta. He also discusses how hierarchal planning can be implemented with harvest operators working to meet stand level objectives while planners arrange harvest patterns at the landscape scale. He concludes by warning that despite technocratic or scientific rational for landscape planning the public has considerable say in how forests and landscapes are to be managed and must be included in the forest management planning process.

Forest management in Alberta has seen an evolution in forest practices from a sustained yield, fiber-based emphasis to landscape planning and biodiversity conservation, based on shifts in value sets through time. Prior to the 1980's, the use of large clear cuts on the landscape was largely driven by the value of fiber resources. The harvest of large portions of forest lands and regeneration through natural and artificial means was a method to ensure the availability of a sustainable level of wood fiber for future generations. The move to smaller patch harvesting systems in the 1980's was largely driven by concerns related to water quality and peak flows, as well as population numbers for game species. The use of smaller clear cuts and the associated forest fragmentation that resulted was based on the available science at the time and thought to be the best solution for the protection of these values. In the 1990's there was a shift away from managing primarily for fiber on a sustained yield basis towards an approach that considered many forest values and forest structure similar to patterns resulting from the natural disturbance regime, especially fire.   The focus became the maintenance of diversity at both stand and landscape scales to ensure ecosystem function and sustainability. The main forest elements of concern include:

- age class distribution
- species composition
- patch sizes
- landscape patterns
- stand structure

Morgantini developed a biodiversity conservation approach for Weyerhaeuser Alberta in 1996, which included stand level structural guidelines within a landscape management framework. The stand level structural guidelines are implemented by harvest operators, following training that is provided by Weyerhaeuser. At a stand level, it is fairly straight-forward to train operators to retain structure in harvested areas. However, to ensure variability, foresters and planners should be careful they are not too prescriptive with harvest layout and should instead concentrate on explaining the principles and objectives of the guidelines to the operators who are applying them. Decisions about structural retention are made at the field level, on a block-by-block basis, depending on local site conditions and what the operator believes is or is not feasible.

At the landscape level Weyerhaeuser's forest management strategy focuses on:

- Age structure (seral stages)
- % Forest left past rotation age (mature or old forest)
- Patch size, shape and distribution (Landscape Patterns)

Sustainable forest management, including both timber and non-timber values, is the primary objective. Considerations for wildlife habitat requirements are also addressed at the landscape level including a habitat management strategy for Mountain Caribou.

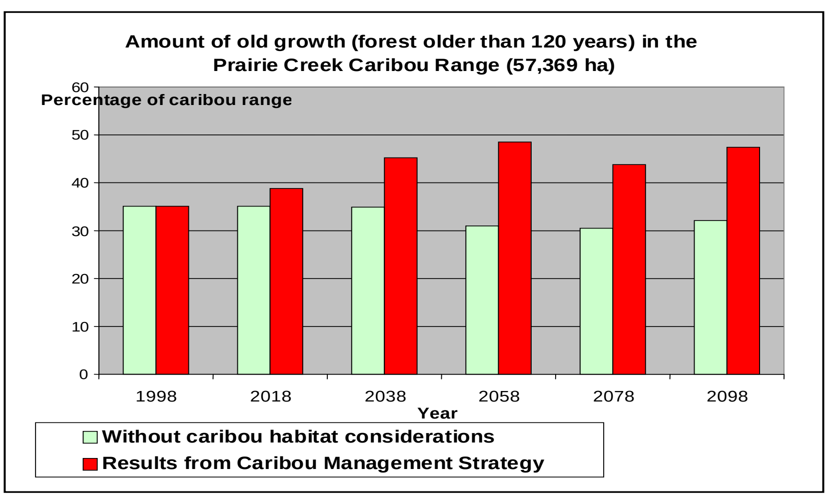
Mountain Caribou utilize a large area within Weyerhaeuser's FMA in the Foothills. Research has been conducted with the University of Calgary to understand genetic linkages between the various caribou herds in Alberta (there are several isolated herds, as well as herds that move between British Columbia and Alberta) as well as understand habitat requirements in winter and summer. Habitat loss and/or degradation are a primary concern, especially due to forestry and oil and gas activities. Indirect impacts also affect the caribou in terms of increased predation due to the prevalence of early seral class vegetation following disturbance, which is used by alternate prey species (moose).

Although Weyerhaeuser realized the need for a landscape pattern approach for caribou, they were unsure of the pattern that was needed. At first the idea of approximating the natural disturbance pattern was considered as a starting point, however there were special considerations needed for caribou in terms of its designation as a Species at Risk, as well as the social perception of large disturbance patches. Therefore, the first step was to develop Caribou Habitat Management Guidelines as part of Weyerhaeuser's landscape management approach. The main strategies were to:

- Maintain good quality habitat across each caribou range and establish minimum targets.
- Maintain large contiguous patches of forest.
- Manage and minimize linear features (i.e. roads)
- Integrate habitat management with other stakeholders on the landscape, especially oil and gas.

Caribou require a range of habitat types. Habitat quality is largely hinged on the availability of large tracts of older, even-aged stands with limited human access (Figure 14). Stand age is used as a main indicator of habitat supply over time. Caribou habitat management leads to constraints on the landscape, which result in a 150-year rotation cycle. This leads to an unnatural age class distribution on the landscape driven by social values, which prefer the maintenance of caribou habitat over the strategy to emulate natural disturbances on the landscape.

Figure 14 Old growth forest and caribou considerations



In order to maintain large contiguous patches of forest on the landscape, harvest operations focus on one operating area at a time rather than harvesting across the entire range using a traditional two- or three-pass harvest pattern. Maximum harvest block size targets of 1000 ha were agreed to after extensive consultation with government and the public, creating larger even-aged areas as future caribou habitat (Figure 15). Efforts are made to minimize the oil and gas footprint, as well as roads. Several areas have also been deferred for harvest due to repeated winter use by caribou.

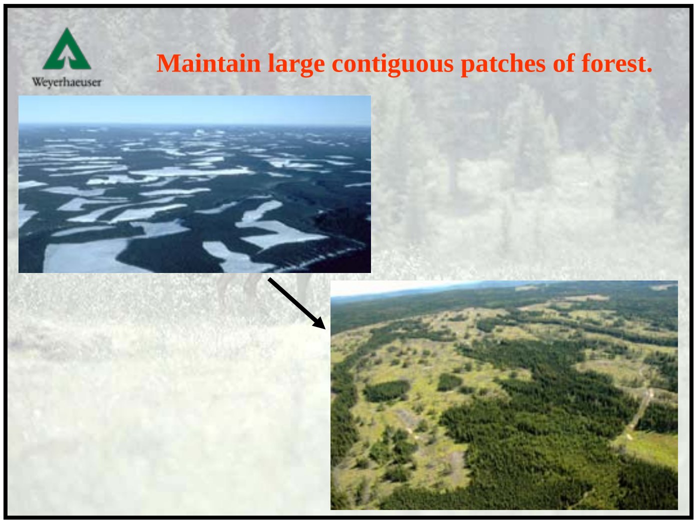


Figure 15 Harvest design change from small to larger disturbances for caribou

Although forest management and oil-gas development continue in the Weyerhaeuser FMA, there are several key questions remaining relative to caribou:

- how much harvest or development activities can be tolerated by caribou (ie. how big an industrial footprint)?
- what is the appropriate spatial pattern for harvest to meet woodland caribou habitat needs?
- what is the impact of changes in the predator-prey relationship on caribou?

Although planners were looking to increase the maximum disturbance size, the general public was not able to accept the trade-off of larger cuts in favor of increased future caribou habitat. Therefore, the natural disturbance model was used as a conceptual framework within which management objectives could be met. Caribou habitat requirements for older forest do not correspond well with the natural disturbance model since an `unnatural' age class distribution beyond the range of natural variability is what the public desires. We must accept that we do not live in a technocratic society governed by scientists, but a democratic society led by the prevailing desires of the public. This is a critical issue to consider in landscape planning in Manitoba.

Implementation of Natural Disturbance Management

Brian Christensen, Weyerhaeuser, Saskatchewan Forestlands

Within the last century forest management has moved from a single value, timber-based focus to a multiple values, ecosystem-based approach to sustainable forestry. The inclusion of ecological, social and economic considerations in planning has required resource managers to develop more complex strategies, tools and models to achieve their objectives. Weyerhaeuser Saskatchewan adopted the natural disturbance model as an underlying framework for their 20-year plan. Several pilot projects are discussed, as well as some of the challenges encountered with implementation of the ND model.

The evolution of forest management in Saskatchewan has followed a linear progression over the last century. A timber management focus, where forestry related effects on other resources was seldom considered, was generally followed from the start of logging activities around the 1870's through until 1975. This approach placed wood products as the primary value to be extracted from the forest with very little regard for other resources and values present on the landscape. As our understanding of the forest and our values changed, the next phase in forestry was a move towards integrated resource management (IRM). IRM worked on the principle that if forest and other resource managers worked together to integrate resource management objectives then the forested landscape would provide unreduced harvests of all resources. This vision was not necessarily a reality but this phase was essential so that planners could move forward to ecosystem-based management, which started in the mid-nineties and is still in use today.

Ecosystem based management is based on the careful balancing of ecological, economic & social considerations. This management approach relies on the natural forest condition and natural disturbance regime for guidance in determining appropriate forest management strategies. A critical aspect of this approach is the understanding that all forest users must compromise and reduce expectations to achieve the best overall solution for most users and the resource.

The next step in the evolution of Weyerhaeuser's forest management approaches in Saskatchewan was a shift towards emulating natural forest patterns. Significant research was conducted in recent years to understand natural disturbances (mostly fire) and the patterns they leave on the landscape. At the policy level in Saskatchewan recent initiatives relate to the development of landscape management standards and guidelines based on the results of the ND research, referred to as natural forest pattern emulation (NFPE). An extension of ecosystem based management; the underlying premise of NDFE is that we are less likely to make serious forest management mistakes if we model our strategies and harvesting activities to closely approximate the landscape patterns we find in the natural forest.

However, the NFPE approach has some inherent flaws that make implementation on the landscape quite challenging. The current forest condition is not necessarily *natural* – it is a product of nearly sixty years of fire suppression and nearly 100 years of forest harvesting and access. The suppression of wildfire has had a major effect on the current stand composition and age distributions of our forests. We are currently managing an industrialized forest born of human influence. This makes a shift to a NFPE system difficult given the current starting point and existing landscape patterns. Another issue associated with the implementation of an NFPE approach relates to the measurement of forest patterns. NFPE involves the determination of existing landscape patterns, often based on the forest inventory. The problem lies in the accuracy of the inventory information. Current inventory data is intended for timber supply models at a regional and FMA scale and is usually not accurate at the stand level. For instance, the accuracy of the stand age is within plus or minus twenty years. If we cannot guarantee that stand information is accurate then any attempt to measure patterns is futile. Also, NFPE often conflicts with social, economic and operational needs. For example, large event size standards (1000-5000 ha disturbance areas) may have devastating effects on local trappers and license outfitters who operate on a small area. Balancing wood flows to various facilities is difficult when the majority of the AAC volumes are tied up in fewer large cuts.

The 1999 Weyerhaeuser Prince Albert 20 year FMP was the first plan in Saskatchewan to consider NDPE on the landscape. Landscape level old forest retention targets where set based on analyzing both the current fire cycle (205 yrs) and the pre-1900 fire cycle (30-50 yrs). Although both fire return cycles could be considered natural, neither was acceptable from a social or economic viewpoint. Through consultation with government and various stakeholders, a future forest with an age class distribution similar to that with a 70-year fire return cycle was selected as the forest management target. Retention of old and very old forest was achieved by setting minimum retention targets for both old (70-100 yr) and very old (>100 yr) forests. These retention targets were set for 9 forest types in 10 landscape management units (based on soil types) and were modeled in the non-spatial wood supply analysis. Minimum retention level targets of 5% and 1% were set for old and very old forest types with the exception of white spruce forest types, which were set at 10% and 2%. These levels allowed operational flexibility while still ensuring distribution of older forest areas on the landscape. Harvesting levels for all nine forest types on the FMA were calculated from the timber supply model and converted to forest area. This method of allocating harvest volumes was designed to prevent the over harvest of any particular forest type. Although the planning team tried very hard to incorporate NDPE into the plan inaccuracies inherent with the inventory data made this task impossible. When fifty years of fire history was compared to the current forest the stand species distributions and ages derived from the last forest resource inventory did not correlate with the historical fire data. Based on these inconsistencies, the planning team decided the exercise was useless and abandoned the NDPE approach.

Another attempt at landscape planning by Weyerhaeuser was undertaken on two operating areas (Timex and Mile 31) as pilot projects with the Prince Albert Model Forest. The Timex project was located on a 20,000 ha operating area, which had no previous harvesting or road access. The area had limited traditional use by trappers and outfitters and a woodland caribou herd. An allowable cut of 3000 ha was completed within four years, and road reclamation and silvicultural obligations met within 2 years following the harvest. This area is no longer accessible due to the removal of the main 25-meter bridge, ensuring that human access will be extremely limited. The effective decommissioning of all access and the single-phase harvest system used in the operating area provide for favorable habitat for woodland caribou that continue to utilize the area.

In terms of learning from these pilot projects, Christensen suggests the landscape patterns used in the Timex and other landscape pilot projects should be compared with recent forest fire residual pattern study results. Similarities and differences between harvest event patterns and forest fire patterns should be identified and the differences considered in terms of ecological effects. This information would provide a useful guide to the development of future landscape level operating plans.

Incorporating Forest Certification and Species at Risk into Forest Management Planning

Vince Keenan, Tembec Inc Pine Falls, MB

An overview of the landscape planning approaches developed in Tembec Manitoba's 2009-2028 Forest Stewardship plan was provided. Tembec has incorporated the FSC forest certification standards into their planning and operational practices. Landscape planning is required under the FSC standards and provides an efficient method to incorporate and achieve FSC requirements for biodiversity conservation with particular emphasis on caribou management.

Landscape planning strategies on Tembec's Manitoba Forest Management License Area (FML) No.1 are primarily driven by provincial forest management direction, requirements under the FSC (Forest Stewardship Council) forest certification standards and woodland caribou management. Directives from Manitoba Conservation Forestry Branch (MC) recommend that Tembec concentrate operations and complete operating areas as soon as possible. This is accomplished by aggregating harvest areas using single pass systems, resulting in concentrated operating boundaries and timely completion and closure of operating areas. Rapid reforestation following harvest activities and the subsequent long term decommissioning of watercourse crossings and strategic portions of secondary and tertiary road systems further reduces the amount of time an operating area is active.

Landscape planning approaches in Tembec's newly developed 20 Year Forest Stewardship plan are also designed to meet the FSC Boreal Standards and caribou management. The Forest Stewardship Council landscape planning criteria include:

- Development of a pre-industrial condition (PIC) analysis.
- Use of spatial planning models
- Maintenance of a range of old forests.
- Establishment of patch size targets
- Maintenance of core forest areas (20%)

Pre-industrial condition analysis (PIC): A PIC analysis was completed by the Manitoba Model Forest. PIC results were used to determine targets for old forest conservation. The *spatial model* Patchworks (Pw) was used to accommodate the variety of constraints and targets required for the landscape planning exercise. Manitoba Conservation Woodstock™ Base Case files were converted for use in Pw, and Pw results converted back to Woodstock for results sharing with Manitoba Conservation.

Maintain a range of old forest: A total of five strata were used to delineate old forest stands. Strata were differentiated based on species composition and 'mature stand' age, which varied by species. Old forest retention levels for each stratum were based on the information from the PIC analysis with old forest targets ranging from 15-22%. A minimum of 20% retention is required if the PIC analysis could not determine pre-industrial old forest levels for a particular stratum as required under FSC. The MC Base Case aspatial constraints for old forest retention from the Woodstock analysis were entered into Patchworks to find a suitable spatial solution on the landscape. Since Pw is an optimization model, although the OG retention targets were met they were dispersed across the FML resulting in many small patches which were not socially acceptable or operationally feasible. Spatial requirements for patch size targets were then applied to develop core areas, which would also encompass the old growth retention areas.

Patch size targets: The first step in the establishment of patch size targets (Figure 16) was the delineation of two distinct zones for the FML based on the presence or absence of recreational cottages. Within the Cottage Zone l concerns from local residents required small patch size targets to minimize large disturbances near cottage developments. Therefore the patch size targets in the 'cottage zone' fall mainly in the 40-100 ha (37.5% of patches) while the 'non-cottage zone' mainly had larger patch sizes targets in the 100-1000 ha range (47.5% of patches). Since FSC also includes requirements for larger size core patch areas (e.g., 10, 000 & 20,000^{+} ha) a minimum of 120,000 ha and 100,000 ha, were also set as targets. This resulted in a harvest schedule in the cottage zone that is dispersed over a 50-year period due to the small patch sizes while in the core area harvesting will be concentrated over a 20-year period.

Keenan noted that the patch size targets based on FSC certification requirements differ from current MC guidelines (i.e., maximum cutblock area <100 ha in size), which may not be acceptable to the local public or government regulators. However, he further described how these targets would be achieved, using 2 operating areas- the Happy Lake and Garner Gem – to illustrate his point. The larger patch targets (>1000 ha) would be attained using an aggregate harvest system rather than traditional clear-cut harvest systems. These aggregate harvest areas would have approximately 60% total residual structure within them (7-9% island residuals, 37-48% productive forest residual).

Maintenance of Core Forest Areas: FSC standards for biodiversity conservation require the maintenance of 20% of the defined forest area as Core Areas. These areas are not Protected Areas[1] per se but can contain Protected

Areas within them and can move across the landscape over time (ie. they are not static areas and should be subject to disturbance, management activities and succession). The Core Areas required by FSC are loosely defined

Patch Type	**Size Classes and Targets**				
Cottage Zone Regen Patch					
Size classes	0-2	2-40	40-100	100-250	250+
Minimum (%)	0	32.5	37.5	12.5	0
Maximum (%)	0	37.5	42.5	17.5	0
Non-Cottage Zone Regen Patch					
Size classes	0-5	5-100	100-1,000	1,000+	
Minimum (%)		37.5	47.5	10	
Maximum (%)	0	42.5	52.5		
FMU Core Patch					
Size classes	10,000+	20,000+			
Minimum (ha)	120,000	100,000			
FMU Caribou Patch					
Size classes	1,000+	2,000+			
Minimum (ha)	24,000	18,000			

Figure 16 Patch type, size class and targets by management zone

as 1000's of ha in size with the expectation they will be more clearly defined through the planning and analysis process. FSC further requires these areas to be roadless (or subject to decommissioning) and be predominately compromised of old forest with a maximum of 5% young forest. These criteria were entered into Patchworks so the optimal location and size of the Core Areas could be modeled rather than pre-determining where they would be located. The model results provide a layout that will maintain 20% of the core area in the first period, with an increase to 30% in the next 20-year period.

A landscape management strategy was developed for the Owl Lake Woodland Caribou herd by the Manitoba Model Forest. The strategy requires the maintenance of at least 2/3 of high quality habitat units within the defined management area, which will provide 2-3 times more habitat than the current winter core areas that are being used by the herd. This strategy cycles habitat as large contiguous blocks over time with the location of 'winter core use areas' driving habitat sequencing. Using Patchworks, the aspatial MC Base Case strategy was translated to a spatial harvest sequence. While developing the spatial harvest sequence the planning team incorporated temporal changes in habitat noting that caribou habitat is not static and as the habitat changes and location of high quality habitat moves, so will the caribou. Complimentary to this Tembec, in cooperation with the Canadian Parks and Wilderness Society (CPAWS), has committed to defer harvest operations in the Owl Lake Core winter areas for the next 50 years, wherever these core areas may be located (it is difficult to know now where the future habitat the caribou use will be located, so the harvest schedule will be adjusted once the caribou transition to habitat located outside the current core areas). A 200-year harvest schedule outlining caribou habitat was provided and discussed. Following the caribou habitat modeling exercise the results were entered back into Pw and added to the harvest schedule for the entire area included in the 2009-2028 Forest Stewardship Plan.

1 Protected Areas are a provincially defined and designated land use category. Companies cannot assign the Protected Area designation to any areas within their FML.

Landscape Level Planning for the Dog River-Matawin Forest: Practicality vs. Policy in the 2009-2019 Forest Management Plan

Bill Wiltshire, Wiltshire & Associates, Thunder Bay, ON

Wiltshire describes the current status of landscape planning as part of Ontario's forest management planning requirements using the Dog River-Matawin Forest outside of Thunder Bay as an example. The landscape plans consist of patches for marten habitat and patch size distributions emulating fire patterns. These patterns are hard to develop in a forest that has a long harvest history. Wiltshire also presents the idea of patterns and design that emerges from past practices which differs from a prescriptive design associated with landscape planning.

The Dog River Matawin Forest (DRMF) west of Thunder Bay, Ontario has been managed for many years, through a succession of forest companies to the current day forest manager Bowater-Mersey Co. The forest has been extensively harvested over the years, based on annual allowable cut (AAC) volumes, regulations and Forest Management Plan (FMP) approvals by the Ontario Ministry of Natural Resources (OMNR). There have been many different iterations of landscape design. There is no mechanism for regular strategic planning in Ontario and most of central and northern Ontario is currently allocated under a SFL (Sustainable Forest License) for wood procurement. Therefore, virtually all planning for things such as landscape pattern, wildlife habitat, watershed protection and conservation of old growth are done within the context of the FMP and applied on a management unit by management unit basis.

In Ontario, a coarse and fine filter approach is used for ecosystem planning. The coarse filter, higher-level policies are applied initially and provide direction for landscape design while fine filter policies are used to refine management to meet the needs of particular species or ecosystem elements. Landscape design is the product of five sets of guidelines, which are applied in FMPs. These include the

- Landscape Guide (anticipated completion boreal volume - 2010)
- Stand and Site Guide (completed - 2010)
- Silvicultural Guides (completed - 2003)
- Tourism Guide (completed - 2001; reviewed 2006)
- Cultural Heritage Values Guide (completed - 2007)

Initially, the landscape was altered through radically progressive clear-cuts. This type of harvesting pattern was largely borne from the need to access timber in close proximity to harvest camps. When proximity to the camps was too far, the camp was moved. This was also a time when only the best stands were harvested, following the low-hanging fruit principle. This trend was further accelerated by the introduction of mechanized harvesting in the early 80's. The landscape on the DRM forest was also subject to moose management guidelines (100 ha maximum block size, in checkerboard pattern) introduced in the late 80's, leading to smaller cuts fragmenting the landscape. There is very little remaining in terms of 'untouched' areas on the DRMF and there now exists an extensive road network throughout the forest.

In Ontario, the predominant guide for landscape management (*prior to the release of the new landscape guide in 2010*) is the 'Forest Management Guide for Natural Disturbance Pattern Emulation' (NDPE guide), which was implemented in 2001. Its' primary purpose was to develop harvest patterns on the managed forest landscape that resemble the patterns created by natural processes such as fire. There are 4 main objectives for the NDPE guide:

- To demonstrate a movement toward the 'natural disturbance pattern template' (derived from recent recorded fire history)
- To manage clear cut area size so the ratio of clear cuts is 80% <260 ha in size and 20%>260 ha in size

- To incorporate a sliding scale of spatial distribution of disturbances of various sizes. Smaller cuts can be closer while larger cuts need to be spaced further apart.
- To implement increased stand level retention targets for timber to include both insular and peninsular retention areas as well as retain snag trees (25 per ha with 6 living and representative of the stand).

During the guideline development process environmental groups (ENGOs) expressed concern over the move towards larger clear cuts regardless of any future benefits to the landscape that might occur. Although the OMNR had conducted research and collected scientific evidence about the fire history in the boreal, indicating fires burned areas larger than 260 ha on a regular basis prior to fire control, the 80:20 rule was a necessary compromise to satisfy the ENGOs concerns.

Another challenge to the NDPE guide was that it was very difficult to implement the guide on a forest with many years of existing harvest patterns without making significant concessions in terms of available wood supply. In this case the NDPEG becomes more of a reporting mechanism than a planning tool.

The FMP developed for the Dog River-Matawin Forest was also subject to the 'Forest Management Guidelines for the Provision of Marten Habitat'. This guide was designed to provide habitat for those species that 'require' large contiguous patches of conifer-dominated forest (e.g. pine marten, great grey owl, black backed woodpecker). Modeling various scenarios for the DRMF based on the application of the marten guide indicated nearly half of the available wood supply would be required to reach the 10% core area target and was not attainable in the plan. Therefore the achievement of suitable habitat levels required negotiation and subjective balancing of objectives (Figure 17). As with the implementation of the NDPEG guidelines the marten guides are difficult to implement on a forest with a long harvesting history without a significant reduction in wood supply. These guides have reduced harvest levels by 14% and increased wood cost by forcing operations to widely dispersed areas of previously by-passed timber. Similarly, the DRMF was also subject to the 20 year old Timber Management Guidelines for the Provision of Moose Habitat (OMNR 1988). This guide called for an average harvest block size of 100 ha with 400 meter cover to cover distance through the use of alternating blocks, corridors and shelter patches. A return harvest would be permitted when harvested areas reached 2 meters in height. The net effect of the moose habitat guide was the broad dispersion of the harvest into small patches of the very best timber leaving behind patches of poorer timber on a fragmented landscape. Although the majority of the landscape parameters have now been superseded by the NDPEG, Marten and Caribou Guides (to be replaced by the landscape guide), the Ministry still applies certain parts of the moose guidelines, particularly specific provisions for the protection of salt licks, calving areas, aquatic feeding areas and late winter habitat. Concerns by the Ministry in the last DRMF plan with respect to adequate provision of late winter moose habitat was satisfied by removing 100 ha patches of conifer reserve on a 5 km grid across the license from harvesting eligibility.

Many of the guides that apply to the DRMF require planning of spatial attributes. This can be challenging since the modeling standard required by the OMNR is the aspatial optimization model SFMM (Strategic Forest Management Model). The solution generated by the model does not fit directly in the 'real world' since there is no spatial plan produced as direct output. Also, during the modeling phase of planning two natural benchmarks are set. The natural disturbance template which is based on the Forest Fire History Atlas is used for the NDPEG analysis. A natural benchmark run is generated by SFMM using no harvesting and a 'natural fire cycle' as disturbance patterns. The outputs are used for forest structure and habitat supply targets.

When developing and implementing guides and policies for landscape level design there must be enough flexibility to account for the starting condition of the management unit. This also applies to benchmarks as they must be compatible with a managed forest landscape. It is essential that landscape design ideals are important to the functioning of healthy ecosystems and not just an academic pursuit or a 'flavor of the week'. The tradeoffs of achieving the ideal forest conditions need to be articulated in terms of increased cost to the wood supply. And lastly spatial modeling must be integrated into the implementation of landscape design.

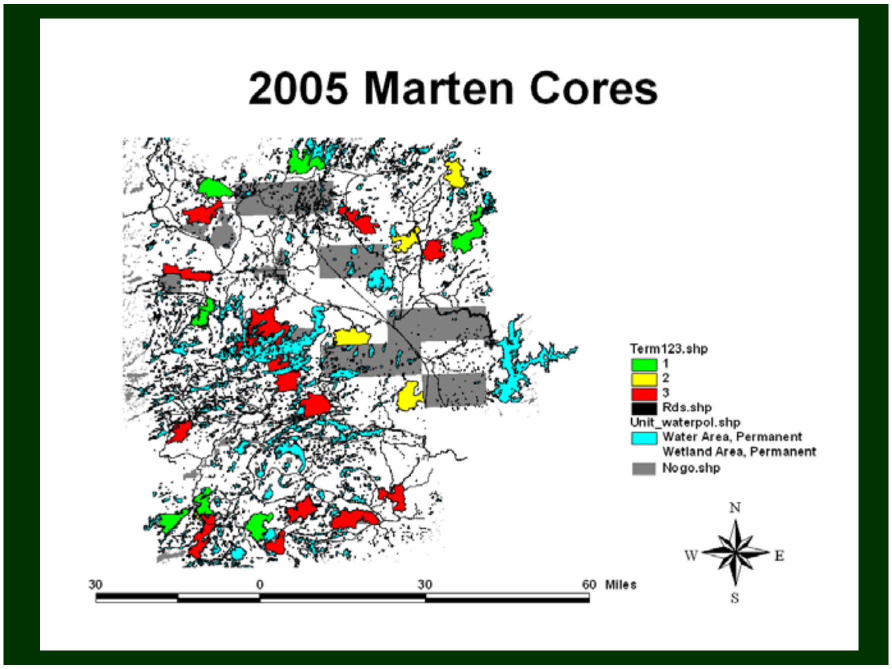


Figure 17 Marten core patches on the Dog River Matawan Forest, Ontario

Implementing the Natural Disturbance Model: Stand and Landscape Level Approaches

Elston Dzus, Alberta-Pacific Forest Industries Inc

Alberta-Pacific Forest Industries (Al-Pac) forest management area is 58,000 km^2 in size and contains roughly 10% of Alberta's land base. Approximately 33% of the area is merchantable forest, which provides 2.4 million m^3 deciduous fiber for pulp and 1.2 million m^3 in conifer for overlapping licensees. A TRIAD- based (zoning) approach to forest management is used to manage the supply of fiber which is obtained from both private and crown sources. The TRIAD[1] system allows flexibility in terms of selecting strategies to best match forest land types and management objectives. These approaches range from intensive silvicultural undertakings on private lands, extensive management with an emphasis on biodiversity conservation on overlapping tenures (conifer quota holders plus oil & gas) and protected areas for ecological benchmarking. Crown lands in the license area are managed primarily using extensive management strategies.

A risk management approach is utilized to manage for biodiversity conservation on the landscape. The use of a coarse and fine filter process when managing habitat and species biodiversity ensures that the majority of the habitat and species needs are met. Ecosystem based management (EBM) on the license entails the use of a natural disturbance model to create targets at the landscape and stand level. The spatial and temporal variability of fire on the landscape needs to be incorporated in all aspects of forest management. Al-Pac's EBM strategy also incorporated stand succession through a suite of mixed wood management approaches to assure the 'mix' in mixed wood forests was maintained.

Al-Pac first introduced the natural disturbance model at the stand level. Ensuring variability within the forest was a key objective based on the ND model (NDM), and was managed by varying the shape, size and amount of interior residuals among harvest areas. The 'architects' of the stand level NDM were essentially the harvest operators. Operators were trained to ensure variable retention targets were met during operations however larger residual patches within harvest areas were flagged out by Al-Pac field staff.

At the landscape level the shift to the NDM mainly involved changing the prevailing mindset concerning the traditional two -pass harvest system. The two-pass system does not approximate the natural disturbance model. Cut block sizes under this system are generally smaller, fragmenting the landscape and increasing the amount of edge. Since conifer and deciduous quota are allocated to separate operators the two pass system actually becomes a four-pass harvest. This leads to higher road densities and repeated operational disturbances making decommissioning strategies very difficult. Al-Pac has since moved to an aggregated harvest system, which is closer to the ND pattern. Harvest areas are designed to emulate the diversity in forest patterns associated with fire in terms of cut block size, shape and distribution on the landscape. An integrated harvest schedule has also been developed for conifer and deciduous operators resulting in shorter durations for disturbances, reduced road density and costs, and timely deactivation and abandonment of road networks. The switch to the integrated harvest system does however pose some operational challenges. Logistical issues pertaining to operational planning, layout and road building/maintenance can be difficult when trying to accommodate operations, which traditionally have functioned independent of one another. It has also been difficult to convince the public that a shift to larger cut block sizes will have positive ecological impacts on the landscape.

While developing their harvest design strategies Al-Pac compared both anthropogenic and natural disturbance areas on the landscape. Following this analysis, Al-Pac realized they needed to develop a more meaningful metric to describe the larger harvest areas that result from the implementation of the NDM. The term 'disturbance event' is now used by Al-Pac to describe aggregated harvest patterns. A disturbance event is an amalgamation of separate cut blocks harvested in a 10-15 yr time period, that are located within 100-200m of each other, in order to create larger disturbance areas that more closely approximate a fire event. This created a more meaningful metric for reporting and comparison with natural disturbance patterns. A breakdown of forest fire history in Alberta spanning from the 60's through until 2006 shows that the majority of the disturbance areas are created by larger fires (10,000 ha and up). This is in stark contrast to the industrial footprint created from 1980-2004, which shows that the majority of the cut areas (52%) falls under the 500 ha disturbance event class (Figure 18). The objective of Al-Pac's planning strategy is to move the harvest patch distribution to larger disturbance patches (5000-20000 ha's) however the need for very large disturbances (>30,000 ha's) will be satisfied by fire.

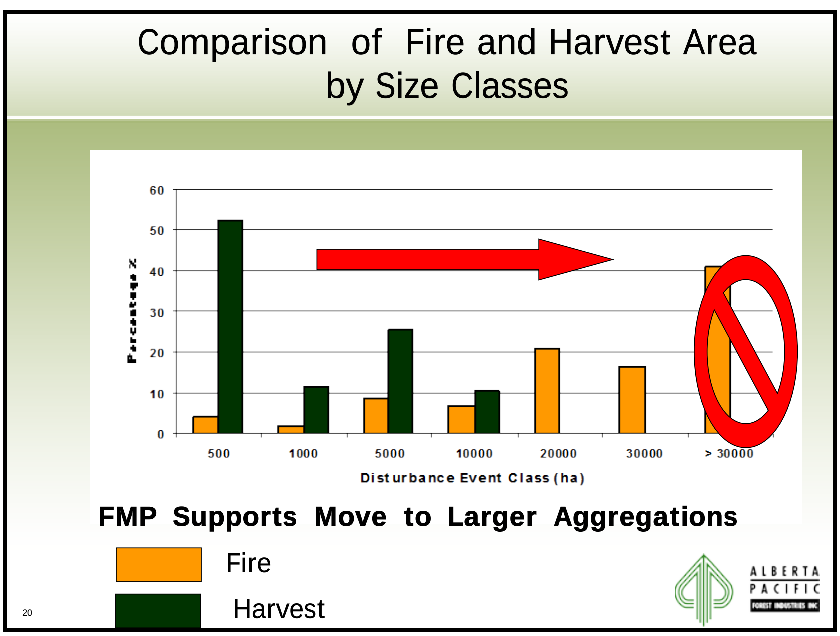


Figure 18 Comparison of fire and harvest area size classes

Old forest areas are an ecologically important component of the landscape. The retention of older forest stands and the complex structures found within them is important to many unique plant and animal communities. However planners must decide how much old forest is needed and where it should be located. Al-Pac decided to use a natural disturbance based strategy to address old forest retention. Working with Dr. David Andison, a natural range of variation (NRV) approach was followed using the Landline model. By modeling fire on the landscape (FMA scale) using known probabilities of fire frequency, size and flammability over a range of timeframes, an estimate of the historical and natural range of old forest on the landscape was achieved. It was determined that there is no single best amount of old forest from an ecological point of view. A natural range of variability consisting of plus or minus 25% of the mean was used as an old forest retention target for five strata (species specific) across the FMA. In order to achieve these targets, a 10% step down of harvesting levels was required from 2061 through until 2201 for certain strata on the FMA. This is due primarily to the species age class structure resulting from wildfires at the turn of the century. This strategy for old forest retention does not consider future oil sand developments on the landscape however currently developed oil sand mining areas were removed from the modeling exercise. Although the modeling exercise was informative, the results were not spatial nor were future fires and energy sector development considered in the model.

The province of Alberta does require the reporting of spatial harvest sequences on a 10, 50, 100 and 200-year basis. Al-Pac evaluates these spatial outputs using empirical models developed for certain indicator species such as the Canada Warbler and the Bay –breasted Warbler. These models allow planners to assess potential effects of the spatial sequencing of harvest patterns on availability of species habitat over a 10, 50 and 100 year cycle.

The next step in the evolution of forest management planning on the Al-Pac FMA is the development of spatial targets and spatial planning tools to quantify the harvest intensities and patterns on the landscape. The tools used to develop spatial targets and the scale at which they are being considered greatly influences the range of these targets. Planners must also decide if the strata used in the current plan will pertain to the next planning cycle.

Lastly planners for the Al-Pac FMA need to consider new ideas to solve existing issues, such as the use of floating reserves for meeting future old forest conservation targets. The proximity and connectivity of old forest areas needs to be examined along with the identification of key indicators for the testing of hypotheses. The occurrence of 'wild card' factors such as fire and the development of new energy sectors also need to be considered.

[1] *TRIAD (first coined by Seymour and Hunter 1999) is a management strategy devised as a means of reconciling the objectives of forest management and biodiversity conservation. The TRIAD strategy identifies distinct zones with differing sets of objectives and procedures - usually based on three zones: production (intensive) zone, extensive (multiple use) zone and ecological (reserves) zone. The objective of the TRIAD approach is to produce a landscape design and management system that will provide for all societal demands using intelligent decision-making and trade-off analyses. One of the central concepts to this approach is the notion that representative reserves can be set aside while attempting to maintain timber yields through a compensatory increase in production silviculture in other zones (D'Eon et al. 2004)*

Adaptive Management: Integrating Policy, Science and Management for Sustaining Woodland Caribou in Ontario

Dr. Tom Nudds, University of Guelph

Nudds presents a strong theoretical framework linking policy, science, management and learning together for decision analysis and adaptive management that should be an essential element of landscape planning. A case study of research on Caribou is presented which used probability-based empirical models with outcomes also expressed in terms of probability. This approach to quantifying risk facilitates both decision analysis and adaptive management

The protection of woodland caribou in Ontario is an important social value that requires attention. However, what are the processes we must undertake to ensure the policies we implement will benefit the Caribou population? How do we ensure the integration of science within the policy decision-making process and the subsequent melding of policy onto the operational framework of the landscape? Within that dilemma we must also consider a model for effective monitoring and process feedback. How do we integrate all of these things to ensure that we are doing the right thing on the landscape?

Before considering the system, we must understand that science is essentially a process for learning, which corrects flaws within the currently acceptable train of thought. In order for science to work, we must accept that the current train of thought is flawed and that we are not at the 'end' of learning. 'Science based' is the process while 'current knowledge' is the product.

When looking at policies we need to classify them based on their impact and the ability to change them (i.e. sustainable harvest policy vs. 10% harvest policy). Management is subsequently responsive to policy developed with the 'best available science'. When following a 'learning, then doing' approach the connection between science, policy and management is very linear, offering passive feedback which is often too slow to incorporate new ideas and relevant science.

The idea of adaptive forest management has been around since the mid 70's and is essentially a means to achieving two goals -meeting management objectives and gaining reliable knowledge at the same time. Within this framework the link between policy and management is cyclical, driven by the process of science. The policy becomes the hypothesis and the management is the experiment.

Within the cycle of adaptive management the importance of good decision analysis (DA) is crucial. In order to implement successful decision analysis and adaptive management (AM) processes these 10 steps should be followed:

1. All parties need to be involved
2. Need inclusive specification of management objectives and options
3. Need the identification of critical uncertainties as hypotheses
4. Need critical, rigorous examination of evidence for alternative hypotheses
5. Need the development of models to forecast outcomes, given different hypotheses
6. Require the evaluation and ranking of competing hypotheses by likelihood in light of uncertainty (DA)
7. Require the evaluation of experimental management options (DA)
8. Require the design and implementation of management experiments according to sound principles of experimental design (AM)
9. Need to monitor key responses (AM)
10. Need to update ranking of completing hypotheses by likelihood given monitoring results (DA& AM)

Integrating adaptive management with decision analysis requires a truly collaborative approach from all who are involved. On the decision analysis loop, NGO's and private interest groups must be open to objective dialogue while resource scientists should establish working trust with policy makers and stakeholders. On the adaptive management loop, resource mangers should be open to 'management experiments' and ensure collaboration with resource scientists exists. Policy makers should be open to institutional change and stakeholder input (Figure 19).

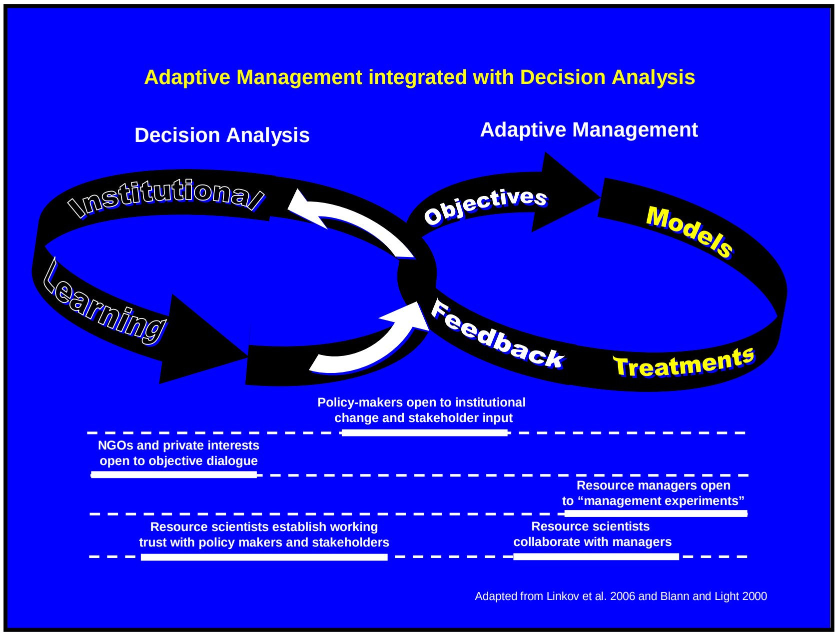


Figure 19: Interplay of decision analysis and adaptive management

The management of crown resources is largely driven by societal values. However, the health and vigor of crown forests must be balanced with achieving values of societal importance. The protection of woodland caribou has become an increasingly important societal value. Our system requires that a balance be reached between the probability of caribou persistence and a range of silvicultural, social, economic, recreational and heritage values.

The first step is to develop a model that predicts the probability of caribou persistence as a function of a range of factors (e.g. habitat, predators, competitors, climate etc.). These factors are then used to develop a caribou population variability analysis (PVA), which melds the following:

- A non-spatial moose-wolf trophic model
- A non-spatial caribou-wolf-moose trophic model
- Spatial habitat dynamics
- Spatial caribou dynamics
- Spatial caribou PVA

When using these models, policies are being used as hypotheses to change landscape and predatory parameters, which consequently affects caribou population dynamics. This allows for the simulation of multiple scenarios and policy environments to determine which policy will lead to the balance that is necessitated by current societal standards.

This type of analysis was conducted for woodland caribou in Ontario. It was apparent that competition with moose and wolves may be strong enough to cause extinction. The analysis also showed that reserves of mature forest could sustain Caribou populations provided they were large enough. Smaller reserves of mature forest would also be applicable if done in combination with a moose or wolf harvest.

Part IV: Policy and Regulation Impacts on Landscape Planning and Design

Effect of Manitoba policy on future forest fragmentation- a case study in the Duck Mountain forest
Jianwei Lui, Forestry Branch, Manitoba Conservation

The current forest policy framework in Manitoba is a major contributing factor in the ongoing fragmentation of the forest landscape. Changes to provincial legislation and guidelines are required to provide direction for landscape planning. In addition to policy reform, a shift to natural disturbance pattern emulation on the landscape requires an additional suite of tools and supporting information based on research.

Prior to the implementation of disturbance patterns on the landscape, planners must have accurate knowledge of the existing forest composition. Planners require reliable stand level inventory data to properly estimate current and future available wood supply. The available wood supply is a function of: the current inventory, growth and yield information, resource management objectives and land base determination.

Natural disturbance pattern emulation requires an intimate understanding of historic fire disturbance patterns on the landscape. Better understanding and additional analysis of the historical fire regime is required to develop the best approximation of scale, frequency and size of anthropogenic disturbance events on the landscape.

The understanding of spatial and temporal elements affecting the forested landscape is critical to planning. Research is needed to increase our knowledge and scientific understanding of the spatial requirements of Manitoba's forests, especially related to the spatial aspects of:

- Ecological land classification
- Natural disturbance (fire regime analysis, etc)
- Old forest areas and conservation targets
- Forest patch size
- Maximum harvest block size
- Harvest block size and frequency
- Adjacent / proximal distance
- Wildlife tree retention
- Wildlife habitat requirements
- Road networks
- Silvicultural practices for landscape planning

Planners need to utilize spatial planning tools such as Fragstats (fragmentation analysis), Patchworks (patch size control, road network etc.), watershed analysis models and wildlife habitat models in order to more effectively design harvest patterns and sustainable practices within a landscape planning approach.

Landscape Planning in Alberta
John Stadt, Forest Management Branch, Alberta Sustainable Resource Development

Alberta does not have clearly defined landscape planning polices, however both planning and monitoring initiatives are operating at the landscape scale. Stadt provides an overview of these initiatives and compares them to landscape planning approaches in British Columbia. In BC the planning is hierarchal and linear but lacks a monitoring component. The monitoring aspects of adaptive management are well developed in Alberta but the forecasting elements for planning are under development and not linked at this time.

Landscape planning occurs within a larger policy context influenced by the socio-economic environment prevalent at the time. This context will vary immensely throughout jurisdictions and provinces, which therefore requires different types of planning strategies.

A hierarchical planning system was implemented in British Columbia in the late 90's to satisfy a need for public involvement in the setting of values at the beginning of the planning cycle (Figure 20). Values are set at the beginning of the planning process through regional plans and sub regional plans which have a high degree of public involvement. The subsequent landscape plan derives all values and objectives from the regional plans. Landscape plans are a technical way of taking broad visions and applying them spatially onto the landscape. It is at this phase that parameters such as seral stage targets, access and wildlife plans are defined. This system helps to restore predictability in the operational planning. This type of planning cycle works well when dealing with 'traditional' resource values however does not apply very well when dealing with sub-surface resources, a growing problem in BC and a long standing problem in Alberta.

Figure 20 BC's hierarchal approach to landscape planning

There is currently no landscape planning policies in place for the province of Alberta. Many of the programs and standards in place for the province do hold a strong landscape component, however there is nothing linking them to one another. Among the many resource plans and programs in Alberta, only the Integrated Resource Plans attempt to address cumulative impacts of oil, gas and forest development.

The Canadian Standards Association (CSA) Z809 Sustainable Forest Management Standards and the Canadian Council of Forest Ministers Criteria and Indicators (CCFM C&I) is the basis for forest management planning in Alberta, however compromise needs to be achieved due to the strong oil and gas sector present in the province. In the Alberta planning standards, a generalized coarse filter approach is primarily used followed by a fine filter mechanism to capture values that may have been omitted. Values are set through negotiation, and trade-offs need to be reached when setting objectives. The forest industry is basically doing the best they can when trying to implement landscape objectives. The majority of the fragmentation occurring on the landscape is due to road networks constructed for oil and gas extraction since the unpredictability of oil exploration and related markets makes it very difficult to make long term plans.

A conceptual or idealized resource planning cycle functions on three interconnected phases (figure 21). A 'policy and strategic planning' phase makes trade-offs with respect to pertinent values on the landscapes. These trade-offs are reflected in broad objectives with the implementation of regulations and strategic plans. The 'operational planning and management' phase is where policy objectives are further refined into operational plans and implemented on the landscape. A 'monitoring and science' phase is interconnected to both the policy and operational phases giving feedback on the effectiveness of meeting objectives with respect to desired values such as habitat requirements, tourism and sustainable timber supply.

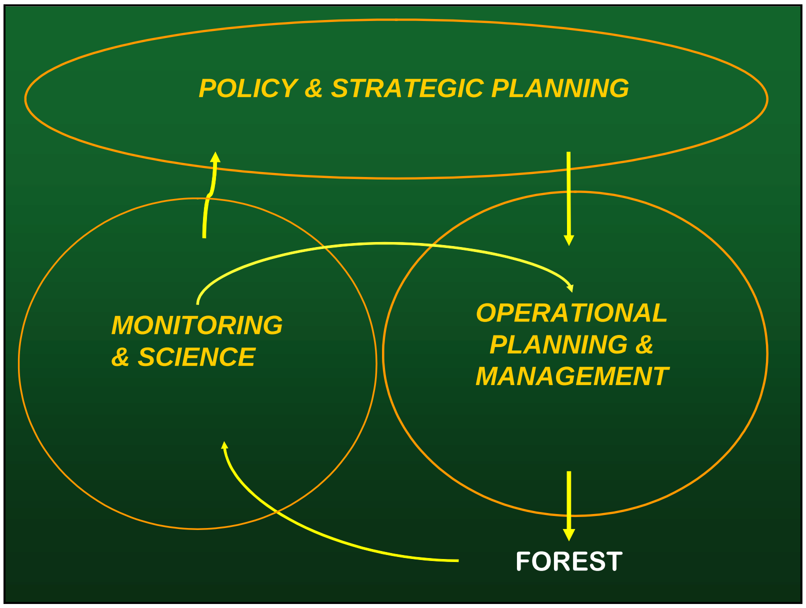


Figure 21 Conceptual planning model

The 'monitoring and science' phase of the conceptual planning model is achieved in the Province of Alberta through the use of science-based planning tools and the Alberta Biodiversity Monitoring Institute (ABMI). The natural disturbance emulation planning tool (NEPTUNE) is an ArcGIS tool that automates the conversion of fire and harvest patterns into disturbance events. This tool classifies disturbances into matrix elements consisting of undisturbed areas within the disturbance connected to areas outside the disturbance and island remnants, which are areas within the disturbance event which are lightly disturbed or undisturbed areas. Patterns are subsequently measured and compared to existing harvest pattern to evaluate where they fall within the natural bounds of variation. The Grizzly bear ArcGIS tool is used to assist in the management for landscape conditions required for long-term heath and persistence of grizzly bear. Favorable habitat and theoretic travel corridors are used to identify grizzly bear source and sink habitat.

The ABMI is a systematic approach used to detect unanticipated changes in biodiversity. This program was created to prior to the setting of values and measures a wide range of species on a systematic 20 x 20 km grid (1650 sample sites) with a five-year sampling return interval. This program was not meant to be a research study but a means of developing hypothesis for future research.

Currently the province is in the process of developing a planning framework for land management. A broad based land-use framework would lead to the development of large scale integrated plans outlining strategic direction which would then be expressed on the landscape through tactical and operational plans. An integrated land management program would be initiated throughout all of the phases of the conceptual framework of Figure 3 to minimize the industrial footprint on the landscape while balancing economic viability. A cumulative effects management program would also be ongoing to measure the cumulative effects of the management strategy on the landscape.

Appendices

- **Workshop agenda and sponsors**

Knowledge Exchange Workshop

Landscape Planning and Design: From Science to Implementation

Holiday Inn Airport West, Winnipeg, Manitoba
April 15 – 16, 2008

Agenda

Theme:
The workshop will explore the theoretical and practical science concerning landscape development. The intent is to give forest practitioners and managers the necessary background to develop landscape management strategies, practices, and policies to integrate multiple forest values to achieve sustainable forest management in Manitoba.

Objectives:

1. To provide an overview of the latest in landscape planning and landscape design concepts from some of Canada's leading researchers.

2. To promote dialogue and discussion with presenters and participants on the challenges and opportunities of managing boreal landscapes.

3. To share examples of alternative landscape management strategies and pilot projects implemented by industry, government and non-government sectors in Manitoba and other provinces.

4. To inform the dialogue around development of guidelines for landscape management in the forest sector in Manitoba.

Workshop sponsored by:

Day 1: Tuesday, April 15

0730-0830	Registration and Continental Breakfast (Main Ballroom, Holiday Inn Airport West, Winnipeg, MB)
0830-0835	Welcome and Introduction
0835-0900	Opening Remarks: Forest landscape design in Manitoba • *Brian Kotak, Manitoba Model Forest*
0900-1030	Landscape Planning and Design – The Fundamentals Ecosystem management, the natural disturbance model and sustainable forest management • *Dave Andison, Bandaloop Landscape Ecosystem Services* Landscape management strategies for the conservation of large mammal species – a collaborative approach • *Micheline Manseau, Natural Resource Institute, University of Manitoba* An Ecosystem Diversity Planning Process for Forest Management • *Jon Haufler, Ecosystem Management Research Institute*
1030-1100	Coffee Break
1100-1200	Landscape Planning and Design – The Fundamentals Water Resource Protection in a Forest Landscape Planning Context • *Dave Kreutzweiser, Canadian Forest Service, Great Lakes Forestry Centre* Landscape Level Management Frameworks: incorporating terrestrial values • *Margaret Donnelly, Sustainable Forest Management Network*
1200-1300	Lunch
1300-1430	Landscape Planning Approaches and Tools Aboriginal Peoples and Landscape Level Planning: Challenges and Best Practices • *Peggy Smith, Lakehead University* Landscape modelling considerations • *Tom Moore, Spatial Planning Systems* The Management of Flammable Forest Landscapes: A Hierarchical Approach *Dave Martell, University of Toronto*
1430-1500	Coffee Break
1500-1630	Landscape Management Case Studies Integrating a caribou recovery strategy into landscape planning in Alberta • *Luigi Morgantini, Weyerhaeuser Alberta* Implementation of natural disturbance management and landscape guides • *Brian Christensen, Weyerhaeuser Prince Albert* Landscape planning in Manitoba: caribou and certification • *Vince Keenan, Tembec Industries Ltd.*
1700 - 1830	Mix and mingle. Cash bar and appetizers provided.
1800 – 1900 (?)	**Informal presentations and discussion by workshop participants.** People interested in sharing their ongoing research or management issues are asked to

identify themselves to the Registration team on Tuesday morning. They will have the opportunity to share 3-5 slides on their research to make others aware of their research work, to solicit feedback, and to stimulate discussion in an open session.

Day 2 (a.m.): Wednesday, April 16

0730-0830	Continental Breakfast
0830-0835	Welcome and Housekeeping
0835-1000	Landscape Management Case Studies Developing a Forest Management Plan for Dog River, Ontario • *Bill Wiltshire, AbitibiBowater* Integrated landscape management case study • *Elston Dzus, Alberta-Pacific Industries Ltd.* Adaptive management: integrating policy, science and management for sustaining woodland caribou in Ontario • *Tom Nudds, University of Guelph*
1000-1300	Coffee Break
1030-1130	Policy and Regulation Impacts on Landscape Planning and Design Effect of Manitoba Policy on Future Forest Fragmentation - A Case Study in the Duck Mountains Forests • *Jianwei Lui, Forestry Branch, Manitoba Conservation* Landscape planning policy in Alberta • *John Stadt, Alberta Sustainable Resource Development, Forest Management Branch* Wrap-up and Closing Remarks • *Margaret Donnelly, SFM Network and Brian Kotak, Manitoba Model Forest*
Afternoon	Moving Forward to Landscape Planning Guidelines Invitation-only working session.

Knowledge Exchange Workshop

Moving Forward to Landscape Planning Guidelines in Manitoba

Holiday Inn Airport West, Winnipeg, Manitoba
April 16 – 17, 2008

Agenda

Note: this 1.5 day session will follow immediately the Landscape Design Workshop. The speakers from day 1 and 2 have been invited to stay to contribute ideas and share experiences and lessons learned from landscape level practices, policy and research that has been conducted across Canada. The attendees will be a subset of the previous workshop, including the invited speakers, the Landscape Design subcommittee, and representatives from Manitoba Conservation. The goal of this session is to provide a forum to discuss landscape-level forest management approaches and develop a draft framework for landscape design in Manitoba. The framework will assist the Forest Practices Guidelines Committee as they move forward on developing landscape planning guidelines for Manitoba.

Day 2 (p.m.): Wednesday, April 16

1200 -1300	Lunch
1300 -1430	Summary of Workshop Results to Frame the Discussion

	- *Facilitator: Margaret Donnelly, SFM Network, with input from the speakers* - *Power point (from presenters' summary slides)* - *Summary of main ideas received by members of the audience*
1430-1500	Coffee break
1500	Landscape Design Guidelines: the fundamentals - *Break-out session & round table discussion* - *Facilitator: Margaret Donnelly, SFM Network* This session is intended to explore & discuss fundamental aspects and conceptual models for landscape design options in Manitoba. The following points will be used in the break out groups to guide discussions.
1515-1600	Break-out discussions to discuss; 1. Do we need a Landscape Design approach in Manitoba? Why or why not? 2. List the advantages and disadvantages of a landscape based approach. 3. List the 5 key objectives/reasons for using a landscape-based approach. 4. What is a landscape? What would the most appropriate scale/units for landscape design be? 5. List the key/desired attributes of a landscape-based approach for Manitoba.
1600-1630	Plenary to report back to group & discussion

Day 3: Thursday, April 17

0800 - 0830	Continental Breakfast
0830 - 0900	Objectives for the Day: incorporating lessons from the case studies in the Landscape design framework
0900 -1030	Policy and Regulatory Approaches ***Landscape Design Framework, and Integration with existing Manitoba Policy:*** - Integrating current policy and approaches into a landscape design - Gaps in Policy and Guidelines that would need to be addressed
1030 -1100	Coffee Break
1100 - 1230	Policy and Regulatory Approaches (cont) ***Feasibility of landscape design policy*** - Appropriate planning approaches and models - Data needs and availability - Incentives or Obstacles to adoption
1230 – 1330	Lunch
1330 -1500	Discussion and Conclusion *Summary of consensus points, outline of gaps, direction for future activities.*