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LANDSCAPE-ECOSYSTEM SERVICES

Short Course: A Primer on Natural Disturbance Approaches to Forest Land Management Planning

SIAST
SASKATCHEWAN INSTITUTE OF APPLIED SCIENCE AND TECHNOLOGY

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Short Course: A Primer on Natural Disturbance Emulation

Background

Interest in natural disturbance (ND) knowledge has grown at a rapid pace over the last 10 years within all of Canada. New research on natural disturbance patterns or processes is quickly absorbed by an ever-broadening audience of managers, planners, regulators, scientists, and the public. And although the work is far from complete, a substantial collection of natural disturbance knowledge has been complied.

The attraction to natural disturbance emulation strategies is understandable. Such knowledge can potentially be used as ecologically-defendable "coarse filters" to help objectively guide forest management decision-making. Consider the prospect of choosing and managing towards a landscape design that is not only described in familiar and direct terms of vegetation structure and composition, but is (at least theoretically) based on a form of ecological integrity.

We have also observed some remarkable convergences between natural knowledge and other sustainable forest management (SFM) objectives. For example, natural patterns demonstrate a logical and positive link to fire threat mitigation, large mammal habitat, avian habitat, aesthetics, access planning, old growth management, and even harvesting costs. This list alone represents a tremendous opportunity. Furthermore, natural patterns are by their very nature variable, thus allowing for the flexibility to accommodate, as opposed to compete with, other management objectives.

However, despite its potential, using natural disturbance patterns to help forest management is still a fragile proposal. There is broad agreement by forest and land managers that the concept of using natural patterns to guide management decisions is a good idea. However, there is a significant gap on how, where, when, and even if natural patterns should be applied in forest management decision-making. This disparity could potentially affect the quality of forest management activities as they relate to the ultimate goal of SFM. For example, small differences in levels of understanding, perception, or the meaning of natural disturbance terms can lead to disagreements, prolonged approval process, and the rejection of what might be progressive plans. These in turn lead to the erosion of trust, decreased likelihood of achieving innovative objectives, and the adoption of more conventional rules.

Such are the growing pains of any new idea. Everyone, without exception, is struggling with practical ND integration issues today. The solution for some jurisdictions has been to develop prescriptive "guidelines" that mandate the details of how, what, and where to harvest which fits within their existing system as compared to developing a "new" system. However, this solution does not always allow for exploration and experimentation, or necessarily a true understanding of the value of coarse-filter knowledge. It removes the need for looking for creative, viable solutions, and natural patterns become yet another set of variables thrown into the planning melting pot. The British Columbia biodiversity guidelines are an excellent example of this dilemma.

We strongly support the more flexible Alberta / Saskatchewan approach to moving forward with ND integration. However, we suggest at this point that the answers lay less in science than they do education and communication (based on sound science). By exposing everyone to the same basic general level of knowledge as we know it today about natural range of variation (NRV), we are better able to build a universal foundation of understanding and language. Education is one of the critical first steps towards the successful integration of any new ideas. The flexible learn-as-you-go method that we have adopted by default may work over time, but at the risk of not realizing the full potential of natural disturbance decision-making systems (whatever that may be). The worst-case scenario is that it becomes another fad because the communication gap cannot be overcome.

We will cover the basics, including nomenclature, the theoretical underpinnings, examples of comparisons with current practices, different models of integrating it, an overview of research challenges, and research output interpretation. Furthermore, the challenging nature of NRV knowledge is such that the course will emphasize "learning by doing" through hands-on exercises. We intend this course for virtually all levels and types of decision-makers to allow them to create, discuss, debate, and resolve planning integration issues *together* relating to natural patterns.

Dr. David Andison

Course Goal

To develop a common and basic understanding about the application of natural disturbance patterns to forest management planning and monitoring among sustainable forest management professionals.

Day 1 Establish conceptual framework
Day 2 Real-life examples
Day 3 Design natural disturbance management scenarios

Introduction

As with any new approach to an old set of problems, the concepts of forest management take time to become fully integrated into societal thinking. Below is a generalized diagram of how the modern approach to forest management operates (Figure 1.), molded by those present day societal values which are important to the individual, group, or resource sector. These values are subjective and while they may differ at the individual or societal levels, or temporally, they help foster ideas and formulate philosophical and theoretical framework of scientific thought. In other words, these values foster the development of a paradigm. This paradigm, when combined with current societal mores and scientific thought of the day, leads to the development of a framework which provides guidance enabling those charged with forest management to implement ideas. Systems are developed with the intentions to provide an organized procedure of guidelines and standards, and to show the working of the model and therefore the paradigm. Proper tools must be chosen that reflect the system developed. These tools will perform the physical aspect of management and result in the on-the-ground activities. Feedback loops allow for a self-checking system to see how effective things are working, if there are any weaknesses, what improvements can be made, and if so what are the best options.

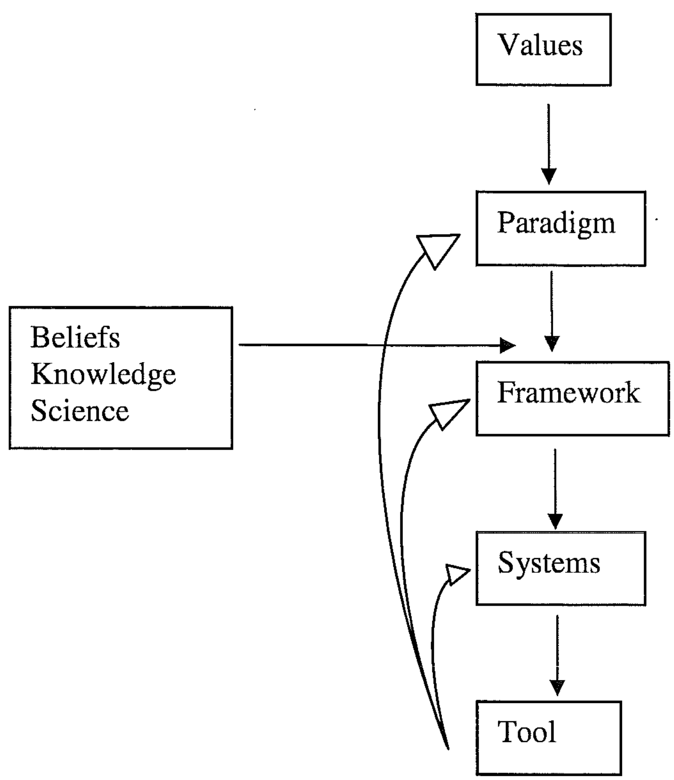

Figure 1. Generalized schematic of forest management

Paradigm Shift

What is a paradigm shift? A "paradigm shift" is a major swing in thinking, a major change in perception, and can (but not always) coincide with a shift in policies, practices, and tools...it is a "revolution instead of evolution". A basic change in beliefs, principles and our resulting values."

We believe public forests are there first and foremost to provide us with: profit, a sense of well being, ecological capital, etc...Year to year, we are probably always just evolving, but decade by decade perhaps we sometimes shift paradigms. What is the difference? Is it direction? Is it magnitude?

There are very few true paradigm shifts to speak of – they are THE most significant occurrence. Transitions are usually not quick, easy, or painless, and often you only recognize that you have gone through one in retrospect. Is every paradigm shift in forestry similar in direction? Do they always shift left (politically) towards more environmental and less single value thinking? Do we manage forests largely based on the values of society, which is in turn a reflection of the relative well being of society, wealth, etc. Or is it increased awareness that triggers it? Scientific knowledge? Or maybe it is more to do with a growing recognition of how much we have mistreated the environment? Combination of all factors, which we might call "cultural or social maturity"?

Why are we talking about it? Because we may be in the midst of one right now and ND patterns may be a key component. It may also be a passing fad. The difference between the two is important, and it comes down to whether or not it is a **simple tool**, or a **way of thinking?** The jury is out on this – but it is still good to know that opinions out there vary.

Below, in Figure 2, is a timeline of paradigm shifts in forest management, accompanied by a basic change in beliefs (Figure 3). These may not be all of them, but they are "*the big changes that have occurred historically*". Some may have happened over decades – in which case, is that a real paradigm shift?

Dr. David Andison

(Personal document March 30, 2006)

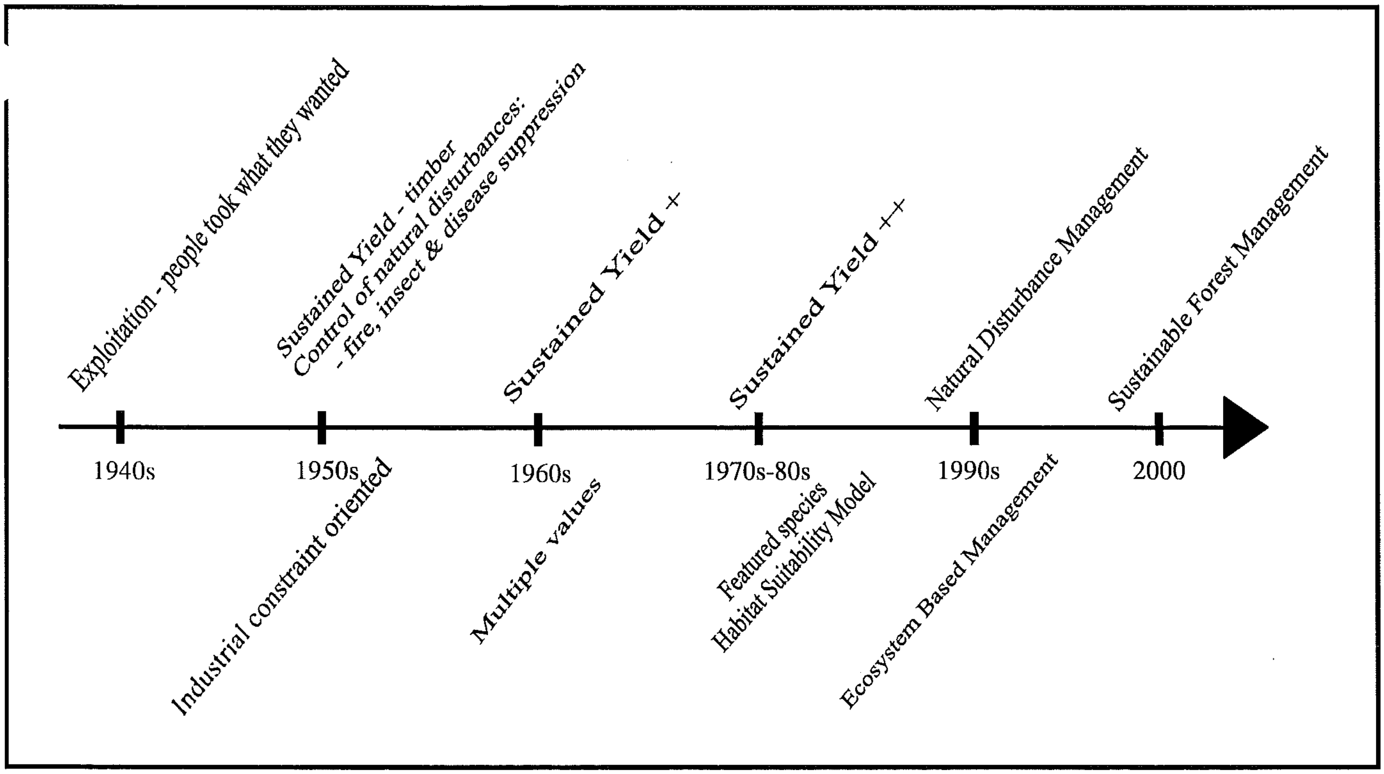

Figure 2. Paradigm shifts in Canadian forest management

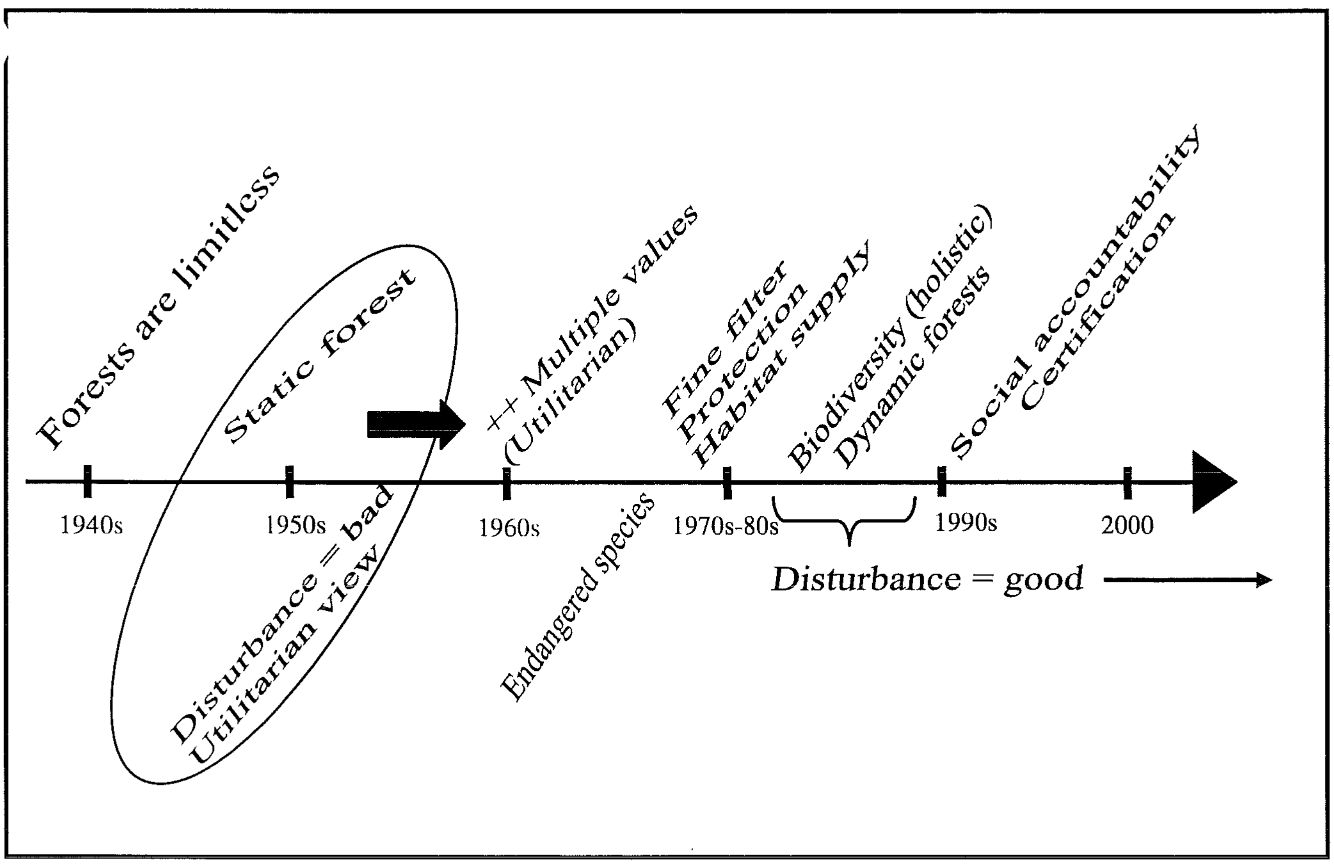

Figure 3. A change in beliefs over time

Learning Outcome 1 Explain the conceptual underpinnings, assumptions, strengths and weaknesses of using the natural disturbance approach within forest management

Learning Step 1 Describe the various philosophical/historical approaches to achieve forest management

European experience

Much of North America's knowledge of forest management is drawn from the European experience and development of forestry practices (Kimmins 2004b). In Europe forests were exploited for their timber, charcoal, tar extraction, mining, home building materials, food, tools, transportation and other raw materials **until the end of the 19th century** (Nilsson 1997 as cited by Conard 1997). Indeed, by the latter part of the 19th century, a wide variety of management and silviculture systems which had been developed in Europe were transferred to North America (Kimmins 2004b). However, many of these European forestry practices were unsustainable **and led to a severe reduction of the forested areas in Europe during the 20th century.**

One example of this, the application of the sustained yield approach, led some European countries to intensively manage their forested areas expressly for a sustained production of timber. While this approach has been successful in increasing timber production, many of the harvesting methods, planting and silvicultural treatments have created homogeneous single-species even-aged stands. As a result, those European countries that have implemented such an approach have been confronted with the loss of biodiversity while becoming increasingly economically dependant on their forestry sectors (Nilsson 1997 as cited by Conard 1997). For example, in Sweden it is estimated that 1500 species are threatened by forestry practices (Berg et al. 1994 as cited by Haeussler and Kneeshaw 2003), and in Finland approximately 1000 or so forest dwelling species may become extinct due to past forest management techniques (Hanski 2000 as cited by Haeussler and Kneeshaw 2003).

Despite the European forestry experience and knowledge, the early development of the North American forestry sector has followed a similar path. Fortunately, this has not occurred to the same extent as in some European countries where former forested areas have been nearly completely cut down. For example, in many of Europe's strong naval countries, which exploited their forest resource for ship building, vast areas were denuded. In addition to the active removal of timber, the secondary human activities of grazing livestock, agricultural expansion and fire affected the regions after the trees were harvested. The British Isle's moors, for example, now an extensive area of infertile and marshy grassland, were once vast regions of forested land.

1500 - Late 1850s

The coming of settlers to North America -

The Forest has played an integral part in shaping indigenous North American cultures. It has always provided Aboriginal people with food, fuel, clothing, tools, shelter and sacred places; and spiritual and cultural needs (Ross 1995). Ross (1995) writes that when Europeans first arrived, forests were seen primarily as an impediment to settlement and agricultural activities. However, the forest also provided settlers with many of the necessities needed for survival and soon became a source of wealth as a small timber trade began to develop. This fledgling industry provided employment for settlers during the winter months. Large-scale timber trade exploded into the "unregulated exploitation" of forests for the British market in the late 1700s (due to repeated European wars and competing navies), and progressed from lumber to pulp and paper production, as early as the late 1800s (Burton et al. 2003).

1850 - 1920

Forests are inexhaustible

By the 1900s the forest was primarily being "exploited" for its timber resource and was the source of many local economies. During this time, loggers viewed the Canadian forest as "inexhaustible" and only focused on the forest as a resource of timber (Moore 2002). Cutblocks were large in size, continuous and even carried out through entire watersheds (Tappeiner et al. 1997 as cited by Parminter 1998). However, people eventually began to realize that the forest was not an infinite resource, that they had their limits. A conservation movement developed in Canada, spreading from the United States, to protect undisturbed and "old growth" lands from man's natural resource exploitation (Ross 1995). The concept known as "balance of nature", believed that forests remained in a steady-state of "old growth". There was a push for many forested areas to be protected and human activities to be prevented to preserve all species (Parminter 1998). This was the basis for the development of many parks, forest and wildlife refuges.

1920-1960

Forests have their limits

Foresters spent many years trying to find ways to maintain the Canadian forest (as discussed above), while at the same time utilizing them for their timber (Drushka 2003). This stage, as identified by Kimmins (1991 as cited by Burton et al. 2003) is known as the "administrative stage of forestry". Kimmins (1991 as cited by Burton et al. 2003, p. 9) defines this stage as;

> *"restrictions on forest harvesting and land-use conversion are devised and administered by the authorities; though still concerned primarily with logging rates, use may or may not be sustainable, depending on how effective the government is at constraining the rate or extent of unregulated exploitation, and how effective forest ecosystems are at self-renewal."*

During this time, due to the large demand for newsprint and paper products, large tracts of land were made available for pulp and paper companies. Timber licenses were granted based on the size of the pulp mill, with little regard for forest regeneration or sustainability (Reed & Associates 1978 as cited by Burton et al. 2003). During this time, many believed that the economic growth of the country would continue on forever, with little respect given to the conservationist idea that to maintain social and economic stability was through wise-use of the natural resource (Drushka 2003). With WWI and WWII, the knowledge of conservation/sustained yield gained and lost momentum during the pre and post times, many of the generation of foresters educated would go to war and not return and those that did were faced with an unstable, boom/bust economy or other circumstances. During this time, the idea was kept alive by professional foresters who were hired by industry to get the logs to the mill by the most efficient means rather than to manage the forest (Drushka 2003). Eventually, there was a slow realization by industry and government that the forest was not an inexhaustible resource. As stated by Mullholland from excerpts written in 1937:

> *"It is generally known among the well-informed that the forest is being over cut at a devastating rate in every forest province in Canada (Apsey et al. 2000, p. 9) ...The exploitation of visible supplies without regard for the future, involving 'devastation' is gradually changed to a policy of forest management for permanent production of 'sustained yield'. By this policy the forests are managed according to plans designed to secure reforestation, regulate the cut, provide sustained annual yields, and stabilize forest industries."* (Drushka 2003, p. 55).

Steady-state model

The ecological view of the forest environment was known as the "equilibrium model" and, when applied to forest environments, Parminter (1998) stated that natural communities then existed in a "steady-state", sometimes interchanged with the terms "climax" or "old-growth" (Oliver 1992 as cited by Parminter 1998). Essentially this approach held that the forest was at a constant with all of its systems at equilibrium and that natural disturbances and fluctuations within the environment were not important factors to the function of the system. As such, the interactions of competition between living elements and predator-prey relationships were thought to be the driving forces to bringing about the environment back to it original state after various types of disturbance occurred (Parminter 1998).

Under the equilibrium model forests were managed in order to maximize timber production as it was thought that forests would remain in a constant state forever. With this concept in mind, only the forested area and the timber to be harvested were managed, and the rest of the surrounding forested area and other aspects within were ignored. The forests were harvested in such a way that a portion of forest unit would mature each year, be harvested and then reforested. It was thought that, after some time, there would be a constant yield of timber which would be the optimum amount of timber that the unit could produce (Drushka 2003). Also, within the harvested area, attempts were made to suppress natural disturbances, however if they did occur, one tried to correct for them and bring the "managed" forest area back to stability (pers. Comm. Rick Bonar). Snags were cut in accordance to fire prevention and safety regulations, with no regard for the habitat requirements of different species of wildlife (Parminter 1998). It was thought there was a "need to better balance the age-class structure of wild forests (i.e. to equalize the area/volume in each age class, and to eliminate the older, less productive age classes) (Burton et al. 2003, p. 10), and it was also believed that with strong forest management, the other aspects within the forest would indirectly be managed for and their well-being sustained.

Concept of sustained yield

In the **1940s and 1950s**, the concept of sustained yield came to prominence and was legislated in the Prairie Provinces (Burton et al. 2003). This was a process of setting limits and entertaining the idea that, "*there would always be a constant supply of trees available to be logged*" (Moore 2002, p. 5), if managed on a sustained yield basis. Consequently, foresters would focus all of their efforts with "the question of setting limits" (Drushka 2003, p. 50) for the use and maintenance of the Canadian forest. The concept of a sustained yield was not a new one; the principles were borrowed from Germany where plantations were producing even-aged rotations of conifers **in the 19th century**. During 1943, the government of British Columbia called a royal commission to address "the establishment of forest yield on a continuous production basis in perpetuity"; Chief Justice Gordon Sloan defined sustained yield as:

> "*a perpetual yield of wood of commercially usable quality from regional areas in yearly or periodic quantities of equal or increasing volume. The objective of provincial forest policies, he wrote, must be: "To so manage our forests that all our forest land is sustaining a perpetual yield of timber to the fullest extent of its productive capacity. When that is accomplished all benefits, direct or indirect, of a sustained yield management policy will be realized...*" (Drushka 2003, p. 56).

This was further echoed by other provincial commission reports (i.e. Ontario in 1947 - the Royal Commission on Forestry (the Kennedy Report) and a provincial-federal conference in 1945 which stated:

> "*...forests, far from being inexhaustible, are being seriously depleted. There is growing realization of the fact that if our forest industries are to exist and expand, the forest must be handled as a crop and not as a mine, in other words must be managed on a sustained yield basis.*" (Drushka 2003, p. 57).

With technological advancements being implemented by the forestry industry and a steadily increasing demand for timber products, the area of forest logged increased to over 1,000,000 hectares by the mid 1990s (Drushka 2003). Much of Canada's timber products were exported abroad and the forest based economy boomed. Attitudes changed under the sustained yield concept, in that the annual allowable cut (AAC) was affected by the amount of young growth. Consequently, deforested land was promptly replanted in order to increase the AAC. Industries saw sustained yield policies as a great thing. However, as large areas of forests were being cut and forest industries were entering into previously untouched areas to meet this increased demand, there began to be competition with other forest users, such as cabin owners, tourism and recreation. This in turn, led to public attitudes becoming less indifferent. Nonetheless, in many areas, harvests were not reduced, and mills were not closed; a constant supply of timber was guaranteed.

There were flaws with the concept of sustained yield throughout Canada (Drushka 2003). The primary principles and policies of sustained yield were to maintain a constant domestic flow of timber. However, much of Canada's timber products have not been utilized within the national boundaries, but exported. This, combined with the fluctuation of export markets, fixed volumes were exposed, producing economic instability within Canada (Drushka 2003). Another flaw was that many sustained yield policies did not adequately take into consideration other forest values such as: fish, wildlife, water quality, and biological diversity. They focused solely on trees and timber production (Drushka 2003). In areas where forest fires were prevented and harvesting of specific species limited, large areas of very old growth developed which were susceptible to insects and disease. Since there was little to no growth in these forested areas, timber volumes declined (Drushka 2003).

Drushka (2003) writes that even though there were flaws with the concept of sustained yield, provincial policies brought an end of an era of unrestrained harvest and the misuse of forested land that had experienced harvesting, fire, pest or disease activities. There was a realization of the need to maintain the country's forest base, a knowledge that became a universal priority.

Is this in some ways similar to what happened to the Cod fisheries on the east coast? Some have compared clear-cutting to the large draggers; with better technology there is a reduction in labor force that exploits the resource (May 1998). Another parallel is that the demand for wood fiber has increased the harvest (AAC) of the forest resource, and more mills have been built, similar to the number of fish processing plants that were built as the cod catch increased.

1960-1980

Concept of multiple-use

In the 1960s through to the 1980s, as more and more people were participating in recreational activities, forests were recognized as a source of many other types of values, services and products and not just solely a timber resource (Moore 2002; Burton et al. 2003). Other uses of the forest, such as wildlife, fisheries, watershed protection, traditional cultural uses (Drushka 2003), cattle ranching, mining, transportation, hydroelectric generation, and petroleum extraction are justifiable components to be managed for (Pratt and Urquhart 1994 as cited by Burton et al. 2003). This became known as the "**multiple use**" concept and has been interpreted as a "commitment to maintaining habitat suitable for game animals and for recreational opportunities" (Burton et al. 2003, p.11). This concept helped guide management decisions, such as protecting soil resources, and preventing the damage of streams (Burton et al. 2003); however, the main priority was still focused on maintaining a "sustained yield" of timber (Ross 1995).

It was not until the 1970s that the provinces developed planning systems that would integrate the management of various resources and values present within the utilized forests (Drushka 2003). Within the planning process it was identified that public participation was essential, due to the increase in the public interest in the forests, and other agencies were also asked to participate because of their utilization of the forest (Drushka 2003). This approach was more "ecosystem" based, due to the defining and inclusion of more forest values in the management equation

(Burton et al. 2003). It helped address many environmental concerns that the public had issues with, particularly with soil conservation, stream protection, riparian zone management, silvicultural systems, cutblock size and arrangement and road allocation (Parminter 1998). However, management of forest wildlife focused more on cervids, such as elk moose and deer, than other less prominent species.

During this period, forests were intensively harvested and replaced with plantations (especially in BC). The plantation forests were homogenous in nature, simpler in structure and composition than natural forests. They lacked the diverse layers within the canopy, tree sizes, standing dead tree and the coarse woody debris (Parminter 1998). The landscape management involved linear (square) cutblock sizes in different parts of the country such as British Columbia and Alberta ranging from 8-16 hectares (Gillis 1990 as cited by Parminter 1998) and 5-40 hectares (pers. Comm. Rick Bonar) respectively, resulting in a large amount of forest fragmentation. The harvesting methods used usually resulted in all timber being removed from within the cutblocks, which resulted in a lower diversity of patch sizes compared to that created by natural disturbances. As discussed by Parminter (1998, p. 11), the fragmentation of large natural forested areas into a mosaic of young plantations, mature forests and non-forested land altered the habitat to the extent that, for some species such as forest-interior species, habitat may have been degraded or lost entirely. Indeed, it was believed that the plantations were incapable of supporting the variety of wildlife, plants, invertebrates or other organisms necessary for the functioning of an ecosystem, decreasing the productivity of the managed forest areas.

The multiple-use approach had potential to achieve sustainability in principle; however, it was rarely achieved, because of industries developments and attempts to maintain all values on each area harvested (Burton et al. 2003).

Forests are dynamic

Over time, it has been questioned if a mosaic of stand sizes and age classes ever reach equilibrium (Weir et al. 2000). More recently, there has been recognition that forest environments are dynamic with continual (sometimes unpredictable) change. Forest structure and species composition will change naturally over time depending on environmental fluctuations and the frequency, severity and size of natural disturbances, which indirectly affect environmental factors such as: nutrient cycling, heat, moisture and light intensity levels. Disturbance is an importance element in forests as well as in other systems, such as grasslands, shrublands, tundra and deserts (Pickett and White 1985). It has been identified that "*…a state of dynamic equilibrium can exist when an area is large enough to contain a mosaic of different communities and patches of mature vegetation, various successional stages, and recently disturbed areas*" (White and Bratton 1980 as cited by Parminter 1998, p. 7). Therefore, ecosystems are at equilibrium when there is continual change.

Late 1980s - present

Concept of sustainable forest management

Through the course of the late 1980s and 1990s, the public became increasingly critical of how forests were managed, due to the increased concerns of the Earth's sustainability, deforestation, forest fragmentation, old growth forest, global climate change and loss of biodiversity (Hunter 1993; Kimmins 2004b). This new public attention initiated new ideas in forest management. Simply put, this new concept looked at the forest as a holistic habitat for all species. This resulted in a shift of focus away from specific species, or classes of species, to maintaining the diversity of all species in the forest (Drushka 2003). Forest management in Canada changed from a multiple-use, sustained-yield management approach to an approach of sustainable forest management (Armstrong 1999). To define sustainable forest management (SFM), one must step back and discuss the beginnings of the consciousness of "sustainability" and/or "sustainable development".

What is sustainability?

The concept of **sustainability** began with the Brundtland Commission, also known as the World Commission on Environment and Development (WCED), which published the document, Our Common Future (1987) which defined sustainable development as:

> *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (WCED 1987, p. 43)

In addition to the sustainable development definition by the Brundtland Commission, Hediger (2000, p. 481) also stresses sustainable development "... implies sustaining the natural life-support systems on Earth...". Hediger (2000) also goes on to state that sustainable development can be more specifically defined as identified in WCED (1987, p. 46) as:

> *"a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations."*

Sustainability / sustainable development implies equity over all future generations (future generations will experience an "environment" that is similar to the one people currently enjoy); consideration of global "wealth" (wealth is not looked at just in the contextual sense of economic goods and services, but also in term of environmental assets and services that adds to our existence – market and non-market values); and the substitutability of constructed capital for natural capital to boost wealth (can parts of the ecosystem be substituted in response to the loss of species, cultures and knowledge and will they improve our broad concept of wealth and well-being?) (Adamowicz and Burton 2003). It asks *"for the modification of human activities to work in greater harmony with natural processes, and to reduce the potential for degradation or catastrophic collapse of natural systems. It puts a special responsibility on human beings to* *treat their fellows and the rest of the world in such a way as to avoid destruction of cultural and bio-diversity.*" (Gertler 2001).

In Rio de Janeiro, from 3-14 June 1992 (UN Conference on Environment and Development (UNCED) - Rio Earth Summit), the United Nations built upon their definition of sustainable development, pertaining to forests, and stated in a "Report of the United Nations Conference on Environment and Development" that,

> *"Forest resources and forest land should be sustainably managed to meet the social, economic, ecological, cultural and spiritual needs of the present and future generations. These needs are for forest products and services, such as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, carbon sinks and reservoirs, and for other forest products."* (DESA 1992)

The 2002 World Summit on Sustainable Development, reaffirmed the Rio Earth Summit sustainable development principles pertaining to forestry and developed an implementation plan.to build upon the previous principles. This plan builds upon how sustainable development can be achieved in respect to forest management,

> *"Forests and trees cover nearly one third of the Earth's surface. Sustainable forest management of both natural and planted forests and for timber and nontimber products is essential to achieving sustainable development as well as a critical means to eradicate poverty, significantly reduce deforestation, halt the loss of forest biodiversity and land and resource degradation and improve food security and access to safe drinking water and affordable energy; in addition, it highlights the multiple benefits of both natural and planted forests and trees and contributes to the well-being of the planet and humanity."* (DESA 2002, p. 35)

The understanding of the concept of sustainable development has be broadened and strengthened, specifically the linkages between poverty, the environment and the used of natural resources (USDA 2004). It is an important concept, particularly given the ever increasing human population and its dependency on, and misuse of, non-renewable and renewable resources, such as fossil fuels, minerals, forests, water, wildlife and air.

The concept of sustainability is also discussed in terms as the "**three pillars**" of sustainability (Schauer; Goodland 1995; Yamasaki et al. as cited by Adamowicz and Burton 2003). The "three pillars" are economic, social and ecological (environment) values. **Values represent what is important; they often reflect the outcome of an agency, resource sector or individual. Values are subjective; they will at times vary from one individual to another, from one society to another and from one time to another**. In general, values could be family, security, achievement, leisure time, personal growth, self esteem and so on. The values of society help management of industry and governments to establish goals and objectives, and in some instances indirectly shape management of the environment. Jischa (1998, p. 115) quotes a 1994 paper written by the Association of Chemical Industry that states,

"...In economic terms sustainability means an efficient allocation of limited goods and resources. In environmental terms sustainability means remaining within the limits of capacity of the ecosphere, preserving the natural conditions for life. In social terms sustainability means a high degree of equal opportunity, freedom, social justice and safety."

The "three pillars" are often identified "...as three interdependent goals of **environmental protection, social well-being, and economic prosperity**." (USDA 2004). The idea is that these values should be taken into consideration during the process of decision-making and actions, while still keeping in mind the needs of the present and future generations.

What are some things that are valued in respect to forestry?

As you will notice there will be a wide range of values identified. In practice, one tries to individually categorize each value, but in reality the complexity of these values and their interdependency make it hard to compartmentalize (Adamowicz and Burton 2003). Many values will overlap and can be found to have importance in respect to two or all facets; economics, social and ecological.

In the table below, many values have been identified. The table has been adapted from Moore (2002).

Table 1. Timber and non-timber values of forest ecosystems

Value	**Description**
Timber products	Products that can be produced from wood that is harvested from the forest
Non-timber products	Contains products such as mushrooms, medicinal plants, craft supplies (i.e. peat) that can be harvested from within the forest and sold for direct economic benefits.
Other commodities	This would include minerals found under or on the soil surface; also the value that pertains to livestock grazing.
Subsistence	Many people in rural areas obtain materials from the forest for survival. The forest may provide food, building materials, water, and so on.
Recreation/tourism	A range of outdoor recreation requires forested land, such as hiking, mountain biking, wildlife viewing, photography, etc.
Aesthetic	The viewing of beautiful landscapes.
Existence	Just knowing (having the knowledge) that wild spaces and species exist in natural forest ecosystems, even if they are not able to personally enjoy these things.
Ecosystem services	Also known as "life support values". The important value that forests provide in preserving the ecological processes necessary for life on Earth (CO_2 conversion to O_2, energy nutrient cycling).
Scientific/research	Research in undisturbed areas (ecosystems) provide benchmark results that allow for comparison with other research. Old-growth or forest dependent species can only be studied in undisturbed areas. Research on forests can also provide information on society.
Wildlife	Many species require large tracts of undisturbed forested and non-forested land to survive (i.e. caribou spp.). fish and wildlife products (meat, trophies, etc) consumptive
Biotic/genetic diversity	Forests have been identified as important reservoirs that preserve biotic (living

	elements) and genetic diversity.
Natural/cultural history	Forests can be used a teaching tool of the past, present and future. A place where people can observe the functioning of the living and non-living elements that interact together in a way that sustains life (functioning of the natural world). The presence of forests shaped a lot of North American culture.
Spiritual	Some people will go to forests to obtain spiritually or religious beliefs. Many people identify with natural ecosystem ways and functioning.
Character-building	Some programs, such as Outward Bound, will use forests as a way to improve a person's concept of self-worth.
Therapeutic	People involved in forested recreation find that their mental and physical outlooks are improved.
Cultural symbolism	Some species of wildlife of forested regions hold cultural significance, such as the bald eagle or salmon.
Intrinsic	Some people believe that forests have an inherent value, in addition to all the values listed above. This value, is the value of the forest in and of itself, without providing any useful means to humans (Rolston 1985 as cited by Moore 2002). All species were created for a specific purpose within the natural world and if lost can not be replaced.

If you were to look at the value of wildlife, it could fit into all three categories. It is important to note the commonalities, many of the economic, social and ecological values are integrated and each value builds upon the other. Economically, wildlife are a resource where activities such as hunting, trapping, wildlife viewing and photography will provide jobs, such us outfitting, food services, lodgings, and gas stations; people will spend a lot of money for participating in these activities, such as eating, traveling (gas and overnight lodging), purchasing proper clothing and buying cameras and film. Socially, having the knowledge that wildlife are present, can be found in the forest, and that they are being preserved through laws and regulation is mentally healthy. Also, many of these activities are socially acceptable and therapeutic. Many species are cultural symbols. Ecologically, wildlife are an integral part of ecosystems, and the removal of species (extinction) can have serious effects on other species and the functioning of the ecosystem. Therefore, proper management and regulations of many wildlife activities is carried out.

As stated by Adamowicz and Burton (2003, p. 46), "*Sustainability does not involve sustaining these three as separate components. It involves coming to terms with* ***tradeoffs*** *between values arising from our choices of management actions, or finding win-win solutions if possible, and recognizing the differences in values across individuals, regions, countries, and generations.*" Is this a good concept to have, to always make tradeoffs/compromises? To always outweigh or prioritize the advantages against the disadvantages.

In the early stages of forestry, the forests were valued for their jobs, revenues and economic stability, but as time progressed, and with people having more time of leisure to go out from the city to the forested areas to enjoy themselves, there has been a social shift to environmental well-being (Ross 1995). The economy is still an important factor, however, more emphasis has been place on the protection of soils, air, water, habitat for wildlife and plants, biodiversity and so on (Ross 1995). The value of the environment has only been identified to be of great importance in the last 25 years, with the realization of an ever increasing human population and the dependency and use of resources that are limited in the environment. Even Aldo Leopold proposed a similar idea, encompassing all three values (specifically the importance of the environment), 50 years or so ago, indirectly translating into the sustainable forest management (SFM) concept of today (Drushka 2003).

If you think back, only two of the "three pillars" have always been taken into consideration and driven the process of decision making; these "two pillars" were the economy and society. Many will state that the economic values, even today, are what drive the outcomes of society and the environment. However, is it that society puts the economic and ecological values into perspective? Conversely, many will state that without the resources, there cannot be an economy or social values. Are they right?

World examples of the "three pillars of sustainability" – unsustainable examples

Environmental – British Isles (18th and 19th century)

- environment was vastly exploited to the point that in some areas the forests have not grown back and are limited where they are present
- human economic and social values focused on human advancement and human activities exploited the forest resource for ship building for exploration and naval wars, tools and so on. No thought for the future. It did help to stimulate the industrial revolution, people had to look for new methods of manufacturing materials they needed for survival.

Social/Economic – Parks in Africa/South America (Brazilian Amazon) (beginning1980s but more emphasis 1990s to present)

- many lesser developed countries have been trying to put the environment first, the creation of nature/forest reserves for the maintenance biodiversity. However, many of the people in these countries are very poor and they do not receive or see the benefits socially or economically. Their values and focus is different than the governments, they are trying to provide food for their families survival, clothing and education for the present. Many of the resources in these reserves provide food for these people; vegetation or animals (bush meat conflict). These areas are sometimes cleared (slash and burn) so that the people can plant the land into food.

As you can see, sustainable development is a very important concept. As time has progressed, many definitions of sustainability and sustainable development have been used in many forest management concepts (Adamowicz and Burton 2003) ranging from the international, national and regional levels.

What is sustainable forest management (SFM)?

If you were to discuss the concept of SFM among a room full of foresters ranging from professionals to academics, you would get a lively debate on the definition of SFM. Each individual would provide a different definition, and are they wrong? No, there is no right answer, SFM is an evolving concept which is defined differently among different forests and different parts of a forest (Drushka 2003), administrative boundaries, regions, and countries. SFM is constantly changes/evolves as different human values change over space and time.

There are no set fixed rules or principles that apply to any type of forest (Drushka 2003). Universally, there is no agreed upon definition, a concept that is used throughout the world.

Since forests are a "dynamic" entity, what is perceived as sustainable today, will not necessarily hold true in 10 to 100 years from now (Drushka 2003). SFM is more of a way of thinking than a set of rules, principles and regulations.

What does the concept of sustainable forest management mean? Take a moment and write down a definition. Discuss this with your counterparts.

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As observed by Donald Floyd (2002 as cited by USDA 2004) that

> "*...trying to define sustainability* [or in this respect SFM] *...is like trying to define "justice" or "democracy." There are many definitions and some concensus, but agreement over the specifics is elusive. If sustainability cannot be specifically defined, does that mean it is of little value? Foresters know there are many useful yet ambiguous terms, like "multiple use," "forest health" and "ecosystem." We come to grips with any new idea through discussion and debate, and we are still in the process of debating and defining the meanings of sustainability.*"

Many terms are used interchangeably with SFM, such as forest sustainability, forest ecosystem management and ecosystem management; however they refer to the same basic concept. Helms (1998 as cited by USDA 2004) has identified that sustainable forest management is an "evolving concept" that has many definitions. It changes throughout the course of time, depending on human values. Helm (1998 as cited by USDA 2004 and SAF 1999) provides two definitions of sustainable forest management; the second one incorporates the seven criteria from the Montreal Process:

1. *The practice of meeting the forest resource needs and values of the present without compromising the similar capability of future generations – note sustainable forest management involves practicing a land stewardship ethic that integrates the reforestation, managing, growing, nurturing, and harvesting of trees for useful products with conservation of soil, air and water quality, wildlife and fish habitat, and aesthetics. (UN Conference on Environment and Development, Rio de Janeiro, 1992)*

2. *The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality, and potential to fulfill, now and in the future, relevant ecological, economic, and social functions at local, national, and global levels, and that does not cause*

> *damage to other ecosystems – note criteria for sustainable forestry include (a) conservation of biological diversity, (b) maintenance of productive capacity of forest ecosystems, (c) maintenance of forest ecosystem health and vitality, (d) conservation and maintenance of soil and water resources, (e) maintenance of forest contribution to global carbon cycles, (f)maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of societies, and (g) legal, institutional, and economic framework for forest conservation and sustainable management.*

The forest industry in Europe has been conscious of the importance of the forests and the need to manage them in a sustainable manner. The perception of sustainable management was once the continuous supply of wood. However, it has become more complex and considerations are made with respect to environmental, economic and social values. The Ministerial Conference on Protection of Forests in Europe (MCPFE) provides a definition on SFM as,

> *"stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant* ***ecological, economic and social functions,*** *at local, national, and global levels, and that does not cause damage to other ecosystems."* (CEPI)

Canada has been a leader in promoting sustainable management of the forests. The Canadian Council of Forest Ministers (CCFM) has promoted sustainable management of forests within Canada and in has implemented forest-related commitments made at UNCED into the national strategy. In "Sustainable Forests: A Canadian Commitment", a document of Canada's National Forest Strategy, sponsored by CCFM in March 1992, has defined SFM as,

> *"... to maintain and enhance the long-term health of our forest ecosystems for the benefit of all living things, both nationally and globally, while providing environmental, economic, social and cultural opportunities for the benefit of present and future generations".* (CCFM 1995)

As identified by Round Table on Sustainable Forests, "*SFM is a concept that that does not primarily view the forest as a source of a economic product or service (e.g. paper or recreation), but as an integrated whole*" (Meridian Institute). Further echoed by Floyd (2002 as cited by USDA 2004), the concept includes, "*managing the forest for more than outputs; it focuses on maintaining processes and seeking to sustain communities, economies, and all the elements of a forest.*" SFM is achieved by balancing a range of social, economic and ecological values/components of the forest (Figure 4).

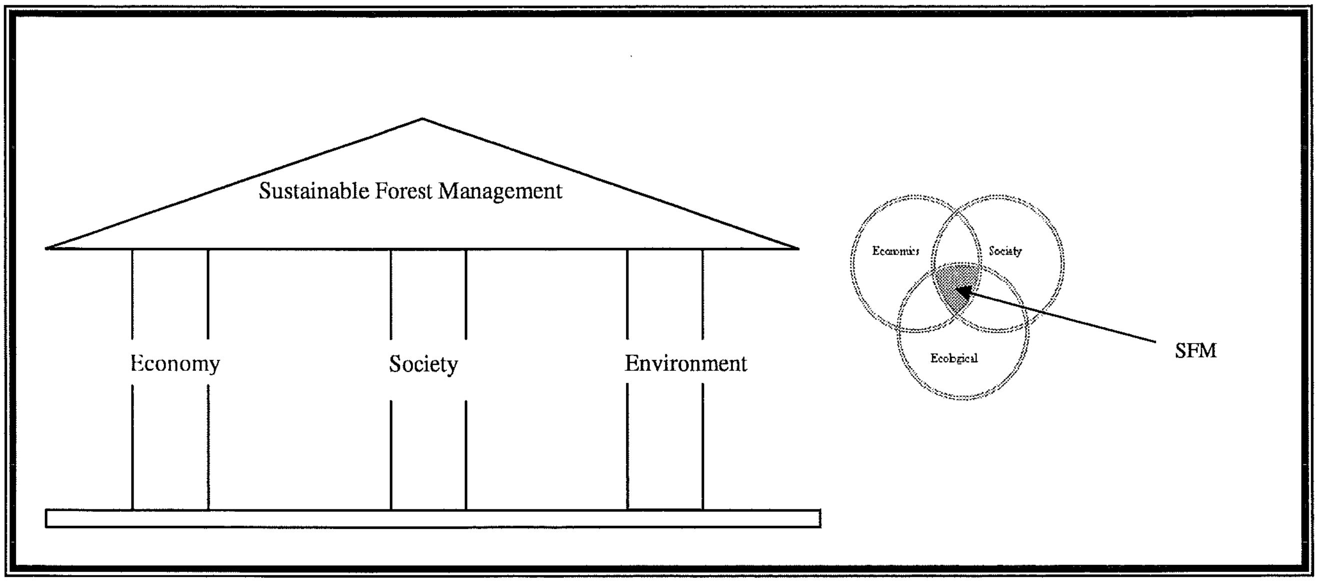

Figure 4. "Three pillars" of sustainable forest management

Obviously, achieving a balance among these diverse values is a challenge, which is why there is still a debate of what SFM really is, how to measure it and how to attain it (Meridian Institute). The concept has been given meaning through the development of criteria and indicators (C & I) (USDA 2004).

As discussed earlier, the concept of sustainable development and sustainable forest management began with the Brundtland Commission and was reaffirmed at many international conferences, and national commitments. In Canada the CCFM is a leader in promoting SFM. As part of its commitment, eleven model forests were established within the country's many different forested areas to be used for research in development for SFM. To identify if forested areas were attaining SFM, ways of measurement were needed. In 1995, Canada developed a set of C&Is to define SFM.

The development of Canadian criteria and indicators was by the CCFM. CCFM was established as a stimulator of policies and initiatives for strengthening the forest sector, and to provide the direction for stewardship and sustainable management (Rousseau 2003). The "*CCFM C&I provide a science-base framework to define and measure Canada's progress in the sustainable management of its forest.*" (Bridge et al. 2005, p. 74). Consideration of international criteria and indicators processes, such as the Montreal Process (temperate and boreal forests), was used to help develop the CCFM C&I framework, to allow for national and international compatibility (Rousseau 2003; Bridge et al. 2005). It has been identified that there is not one single metric that can measure the "well being" and therefore it is common to adopted several metrics as proxies for well-being, as illustrated in the CCFM C&I approach (Adamowicz and Burton 2003). The six criteria that have been identified within the CCFM C&I framework, have been frequently reviewed to maintain there relevance as society's values change over time. The "criteria" represent Canadian values, issues and concerns with respect to the sustainable use of the forest.

The six criteria were identified in the last review process of 2002 to be sufficient to encompass of environmental, economic and social aspects of SFM (Bridge et al. 2005). The C&I were reviewed again in 2005. Below are the six criteria in the CCFM C&I framework,

- Biological diversity
- Ecosystem condition and productivity
- Soil and water
- Role in global ecological cycles
- Economic and social benefits
- Society's responsibility

The six criteria have 46 indicators that identify scientific factors to assess the state of the forest and measure progress over time. Most indicators are measurable with available scientifically valid data and can be repeatedly measured. The C&I are not able to measure forests on a national scale, only in local terms.

What are some of the indicators for each of the criteria?

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Ecosystem health and ecosystem integrity (beginnings of NDM with EM/EBM – discuss the 1980s…)

Forestry has gone through a pendulum swing of shifting values, largely driven by social and economic issues. Depending on where you are geographically, some of the most recent approaches of forest management are ecosystem management (EM), ecosystem-based management (EBM) and sustainable forest management (SFM). The fundamentals of how we make decisions, such as measuring how much wood to cut, has not changed, things have just become more complicated and ecological accountability has become more prominent (Andison 2000).

Armstrong (1999) states that management objectives have changed from trying to produce the optimum mix of forest resource commodities and services (i.e. timber, wild, range, water and recreation), to maintaining the "ecological integrity" of the forest resource. With a healthy ecosystem, all values (commodities and services) of the forest resource could potentially be maintained at optimum levels. Some land and resource management agencies have adopted SFM, and have stressed the importance, "*…the maintenance of biological diversity and long-term sustainability of ecosystem processes in addition to traditional concerns for optimizing resource use and economic stability…*"(Haeussler and Kneeshaw 2003, p. 309).

The concepts of "ecosystem health" and "ecological integrity" have been hard to define and measure. An extreme situation would be if many large populations of species need to be tracked, and changes in the population could indicate the ecosystem health and ecological integrity

(Armstrong 1999). The interactions of these species with the environment is very complex and the relationship between ecosystem health and species populations is not really understood, also monitoring a large number of species at once would be very expensive (Armstrong 1999).

Many individuals and groups have many different definitions. Angermeier and Karr (1994 as cited by Haeussler and Kneeshaw 2003, p. 313) have simply defined ecological integrity as "*a system's wholeness, including presence of all appropriate elements and occurrence of processes at appropriate rates*". If a forest is managed in such a way that harvesting impairs the processes of the resiliency of the ecosystem from any type of disturbance, than the integrity of the ecosystem has been compromised (Kimmins 1995). Kimmins (1995) identifies that clearcuts will destroy the integrity of the old growth condition, however, if properly managed, without the problems of improper road allocation, construction, slope instability and erosion, regeneration will occur and return the area to forest. Ecosystems change on a continual basis, what one sets as a management goal must be clearly defined.

Kimmins (1995, p. 35) also provides an interpretation of ecosystem health,

> "*a forest is healthy if the structure, species composition and ecosystem processes are all within the historical range exhibited by the seral stage that the forest is in, or the stage that it is being managed for.*"

The Canadian Institute of Forestry (CIF) provides a more detailed definition,

> ***"Forest health*** *is the condition of a forest as it relates to its capacity to sustain its ecological functions and perpetuate the values conferred upon it by society. It is a measure of the forest's ability to maintain tree species composition, diversity of lower plants and animals, and age class distributions. It also refers to its ability to respond to and recover from forest harvesting, insect and disease attacks, climate change, and air pollution, to name a few. Forest health is the ability of the forest to accommodate our present and future needs for the values, products and services it provides."*

Kimmins (1995) provides two different management scenarios on ecosystem health. If one is trying to manage for old growth, "then many dead, diseased, broken and damaged trees, lots of canopy gaps, incomplete stocking, and lots of decaying logs may constitute a healthy ecosystem condition in some types of forest" (Kimmins 1995, p. 35). Conversely, if one is trying to manage the same area as an even-aged second growth, the features discussed above would indicate that the forested area is in poor health. If the objective was to manage the second-growth for an older seral stage, then it would be reasonable to find a few diseased, decaying, dying or dead trees. Seral stages have different characteristic conditions of good "health". In some instances, levels of pests and pathogens, play important roles in providing habitat for certain wildlife species, and are consistent with ecosystem health.

Natural disturbance approach

Over the last half century; people have become more critical of forest harvesting practices and the management of forests (Hunter 1993). As discussed earlier, recent issues with deforestation, forest fragmentation, climate change, carbon sequestration, emission trading and the loss of biodiversity – Earth's sustainability; has prodded forest managers, industry, government and scientists to look for new ways to manage the forest. As a result of trying to measure ecosystem health and ecological integrity over the years, the natural disturbance approach (NDA) was developed (Hunter 1993 as cited by Armstrong 1999). There has been a push toward forestry approaches being more naturalistic, so that a "lighter-footprint" is left on the environment. One such idea is that forest harvesting operation "*should be designed to imitate the natural disturbance regimes*" (Hunter 1993, p. 115), such as fire, windfall, insects and disease, which affect the physical and biological factors of the forest. These processes were once identified as disastrous, wasteful and were slowing human progress; but today are seen as important for the diversity and function of the forest ecosystem (Haeussler and Kneeshaw 2003).

Learning Step 2 Discuss the natural disturbance approach as the fundamental ecological component of sustainable forest management

NDA is one component of SFM; it is the environmental component of the "three pillars of sustainability" (Figure 4) which tries to maintain species diversity and ecosystems. Social and economical components of SFM must also be taken into consideration and will affect the degree to which natural disturbances will be emulated. NDA is not a simple and quick fix answer, it much more complex and requires more thought.

The maintenance of biodiversity has been one of the key modeling values for the NDA and is one approach of achieving SFM. Species provide a range of values, such as useful natural products, genetic material and can serve as ecological indicators (Burton et al. 1992). As identified by Hunter (1993) the underlying assumption to the approach of emulating natural disturbance is that organisms within an environment, such as the forest, have adapted and evolved with the natural disturbance regimes and therefore should be able to cope much easier with the ecological changes that correspond to timber harvest activities, if those changes closely resemble a natural disturbance.

Since the last ice age, plants and animals have adapted over time along with the surrounding environmental conditions. Because of this close association, most species are good indicators of the current conditions being experienced within the environmental region. Indeed, as discussed by Burton et al. (1992), plants and animals are better indicators than spot sampling techniques, because they are better able to integrate environmental conditions over space and time. Plants are usually good indicators of abiotic site conditions, such as nutrients, fire, and floods; animals are good indicators of atmospheric pollution (Burton et al. 1992). It is thought that if harvesting practices emulate natural disturbance, it will allow for better survival of the species, assure species resilience (minimal negative impact on the species – maintain biodiversity), and allow for the maintenance of the ecosystems' health and ecological integrity (Armstrong 1999). Species diversity is thought to be critical for the sustainability of an ecosystem.

Biodiversity (biological diversity)

Forests play a critical role in the maintenance of terrestrial biological diversity. Biodiversity refers to the variety of organisms present in an ecosystem. These may include plants, animals or microorganisms, and the ecological processes involved that make up the web of life. Biodiversity can be divided into three different areas, genetic, species and ecosystem diversity.

Genetic diversity refers to the diverse information contained within the genes and the gene variation that is within or between populations of plants, animals or microorganisms.

Species diversity refers to the variety of plants, animals and microorganisms present on the Earth. Approximately 1.4-1.7 million organisms have been identified and it is estimated that the total number of species on the Earth may be in the area of 5-100 million.

Ecosystem diversity refers to the variety of niches, habitats, communities and ecological processes present within an ecosystem. Ecosystem diversity is often indirectly measured by the diversity of species present.

Biodiversity is normally threatened when forested landscapes are denuded, fragmented and homogenized by the planting of single species creating even-aged stands (Kimmins 2004b). It is maintained within forested landscapes that contain vegetation of all ages and conditions that are within the natural range of variation (Kimmins 2004b). With the increased economic and cultural demands placed on the environment and its resources, plants, animals and microorganisms are suffering. These organisms play an essential role in the many processes of life on the Earth, which maintain the air, water, and land, in a way that promotes human growth. In short, biodiversity provides the essential elements needed in order to sustain life, and therefore the environment and resources must be properly managed and protected.

Emulation

Do forest management activities result in mimicking or copying "natural disturbance"? Kimmins (2004) suggests that if one takes a closer look at the definitions of copy and mimic, in the Webster's dictionary; copy "*suggests duplicating an original as nearly as possible, to imitate*" - following a model or a pattern but may allow for some variation; and mimic is "*to imitate closely, to simulate*". There has been a lot of discussion and a neutral term was introduced, the word was emulation (Kimmins 2004b). In the Webster's dictionary, emulation is defined as "*to equal or approach equality with*". This term was introduced because it recognizes that there are differences between human-induced (management) and nonhuman disturbance effects (Kimmins 2004b). Fuhrer (2000 cited by Kimmins 2004b, p. 521) states that "*the essence of emulation, then, is to try to equal the overall effects of natural disturbance through well-designed management disturbance*".

What is Disturbance?

Many have provided a definition of disturbance, but there has been rarely a consensus. One definition that has been put forward, by White and Pickett (1985, p. 7) is "*a disturbance is any relatively discrete event in space and time that disrupts ecosystem, community, or population structure and changes resources, substrate, or the physical environment*". Urban (2000) identifies that with this definition, it is important to note that "disturbances are *discrete* in time", opposite to "chronic stress or background environmental variability"; and that the change they do cause is noticeable. White and Pickett (1985) did identify that there are generally two kinds of disturbances, destructive events and environmental fluctuations, and that there are semantic problems with the meaning of disturbance. Therefore, it is important to define how the term is to be used (Kimmins 2004b).

The United States Department of Agriculture - Forest Service (Interim Directive, USDA Forest Service, 1994 as cited by Averill et al. 1994; Kaufmann et al. 1994 as cited by Averill et al. 1994) has defined disturbance as "*a discrete event, either natural or human induced, that causes a change in the existing condition of an ecological system*". They have identified that with this definition that there is a difference between natural and human-induced disturbances and that resource management activities can cause disturbance.

A *disturbance regime (process)* is all of the many types of disturbances (abiotic and biotic) that are found to affect the environment in an area (Urban (2000). There are many disturbance agents that affect the functioning and processes of an ecosystem. Some of the abiotic disturbance agents are fire, wind, floods, and snow and ice storms; and the biotic disturbance agents are insects and disease. For example, a multilevel disturbance regime for the boreal forest of Saskatchewan, could possibly consist of fire burned areas, spruce budworm, dwarf mistletoe, heavy snowfall and so on; each disturbance having its own characteristic scaling and spatial associations.

Characteristics of disturbances and disturbance regimes (processes)

The following provides a description of characteristics of disturbances regimes (Sousa 1984; White and Pickett 1985; Urban 2000). These characteristics are important in the study of disturbance regimes.

- *Magnitude* -- the size of the disturbance event, such as the size of a fire; which has the following components,
    - *Intensity* – the measure of the strength of the disturbance event itself, (i.e. fire temperature, wave velocity, flood stage, or wind speed);
    - *Severity* – the measure o the amount of damage caused by the disturbance event (e.g., percent mortality, or proportion of biomass removed);
- There are many terms that characterize the temporal scaling of disturbances:
    - *Frequency* - number of disturbance events per unit time;
    - *Recurrence interval* – the time between disturbance events.

    - *Return time* - the time that is expected to elapse before a disturbed point is again disturbed
    - *Rotation period* is the average time it would take to disturb an area in question (i.e. study area); It should be noted that within the area of question, some sites may be disturbed many times while other sites may not even be disturbed).
- *Predictability* - foretell on the basis of observation, or scientific reason, related to the variability of a disturbance event frequency or recurrence interval. Events with low variance are more predictable. Disturbances that are allogenic, external factors (i.e. floods, earthquakes, hurricanes) tend to be less predictable.
- *Synergisms* – interaction of disturbances, chronic stresses, or other factors (e.g., drought, pathogens, and fire) that may result in that the total effect is greater than the sum of the individual effects. This is rather common occurrence because vegetation already weakened by one agent are therefore easily more susceptible to other disturbance agents.
- *Spatial association* – the distribution of disturbance events are relative to climate regimes topography, soils, and so on.
- *Feedbacks* -- some disturbances either cause or prevent others. As an example, fire may orchestrate subsequent fires in frequency as well as patch boundaries; and in equal respect the lack of fire in an area can reaffirm a system's resistance to fire.

Dynamics over time and space

In nature, disturbances vary over time and space, and maintain various stages and community types of a forest (Noss 1983 as cited by Parminter 1998). Some disturbance patterns form cyclic patterns that may or may not be predictable or may be affected by the area's climate, topography, or prevailing species (Parminter 1998). Depending of where one is in Canada, some regions may be more affected by wind, landslides and flooding, and other areas are affected by fire, insects and diseases. Natural disturbances can be small or large in scale, such as individual tree death or hundreds to thousands. Disturbances will result in the release of nutrients, light, moisture, and space that will allow for new growth by the former species or by new species (Averill et al. 1994). The occurrence of these episodic events in ecosystems is relative to the lifespan of the biotic components and could happen fairly frequently, annually or every 50 to 300 years, depending on the biota, disturbance factor(s), and the ecosystems (Averill et al. 1994). When managing for diversity and the maintenance of relatively natural landscapes, this must be taken into consideration.

Small scale disturbance usually involves a small number of large trees dying or falling down, which results in gaps in the forest canopy (Parminter 1998). This can occur due to disease, insect infestation, structural abnormalities, snow loading, lighting strikes, fires and so on. Sometimes, these agents will interact together, such as insects and disease to determine stand dynamics. Insects will weaken the tree and enable a disease to kill it, which might otherwise not have occurred in healthy trees.
Large scale disturbance has been identified as catastrophic events which affect very large areas of both healthy and unhealthy trees (Parminter 1998). Such disturbance agents include wildfire, wind, landslides, snow avalanches, and flooding. Some of these disturbance agents can affect the stand by either returning the stand to an earlier seral stage or moving the forest towards a later seral stage.

Disturbances leave patterns

Human and natural disturbances affect landscape heterogeneity, leaving different forested patterns of composition and age. If you were to look out the window of an airplane over a forested area, one would observe a dynamic pattern of patches. To follow is a discussion on some of the agents responsible for forest disturbances (fire, wind, floods, ice storms, diseases and insects) as well as the patterns they create.

Fires

Most regions within Canada, especially the boreal forest, are directly affected by wildfires which have a direct effect on landscape pattern and have therefore been studied extensively. The boreal forest has been found to burn frequently, and most areas have totally burned within 300 to 400 years (Johnson et al. 1998). Depending on fuel load, moisture content, frequency of ignition sources for the season, vegetation community, aspect, elevation, and local weather conditions will affect the intensity (crown or surface) and size of the fire regime, resulting in different landscape patterns (Sousa 1984; Averill et al. 1994). Research has found that within the boreal forest that most fires are small in size (less than 100 ha), but large fires account for most of the total area burned (Johnson et al. 1998; Andison 2001). Fires do not break up the landscape in a linear, check-board fashion similar to cutblocks, road corridors, seismic lines and agricultural activities, but are at the landscape level a mosaic of fingers, bays, unburnt islands (circular-shaped polygons), and irregular edges. Research has generally found that the landscape-age mosaic created in the boreal forest by wildfire is generally one of smaller, older forest patches embedded within a matrix of large, younger patches (Johnson et al. 1998). This provides evidence that wildfire patterns are a result of infrequent large fires, where small residual patches of old forest are a result of previous large, infrequent wildfire activities (Johnson et al. 1998). Small fires play a very limited role in shaping the landscape-age mosaic, since they account for a small proportional amount of total area burned.

Wind

Most terrestrial ecosystems are affected by wind. It is an important agent of disturbance where it creates gaps ranging in size in the forest and forest canopy by blowing down: large branches or large trees that are old in age and affected by diseases such as root rot; and trees that are on the exterior edges of pre-existing gaps which will succumb to the effects of wind over time displaying progressive mortality (Sprugel 1976 as cited by Averill et al 1994; Sousa 1984; Marchand et al. 1986 as cited by Averill et al. 1994; Averill et al. 1994). It is a major force in "patch dynamics" of some ecosystems (Averill et al 1994). Gap size relates to the way in which a tree, or large branches falls and if multiple trees fall (Sousa 1984).
In the boreal forest, tornados occur very rarely. Areas that experience tornados result in extensive damage that has a pattern of destruction which is typically narrow and linear with trees twisted and broken off (Wright 2005). As stated by Wright (2005), tornados are found to be associated with large convective storm tracks and obtain wind speeds that are greater than 200 km/hr.

Plough winds occur with much greater frequency in the boreal forest than tornadoes do. These winds are straight-line downbursts of rapidly moving air, attaining speeds of 100 to 150 km/hr or more, which are found within thunderstorms (The Weather Network 2005). Typically, the pattern of destruction caused by plow winds in forested areas is either somewhat linear or a starburst configuration (Wright 2005). These winds have been found to affect areas greater than 10 km^2, but are usually localized in nature (Wright 2005). Apart from plow winds and tornados, severe thunderstorms alone may attain wind speeds that are sufficiently high to cause localized and scattered tree damage, especially in old growth forests in which many of the trees may be experiencing stem rots which pre-dispose the trunks to breakage (Wright 2005).

Areas along or near coasts where high-velocity wind storms are prevalent will also experience extensive damage. This damage usually correlates with the elevation, aspect and vegetation make-up particular to any given location (Foster and Boose 1992 as cited by Averill et al. 1994). The amount of crown sway, and thus, crown support is also critical in determining how susceptible to blowdown a particular tree will be (Averill et al. 1994).

Floods

In the boreal forest, floods are associated with the seasonal changes in water levels, such as the spring thaw, or rainstorms and beaver activity (Wright 2005). As such, flooding of areas is usually localized and contained within the river and stream valley or lake edges.

Rivers and lakes usually experience seasonal flooding during the spring thaw or when other increased amounts of water flow into the flood zones of streams, rivers or along lake edges. This periodic flooding tends to prevent the establishment of woody vegetation, such as trees and shrubs, in these flood zones (Wright 2005). Also, large river valleys may experience spring ice jams and this ice action will tend to remove vegetation along the banks, and create alluvial sites by depositing sediments (Wright 2005). Sometimes flooding is induced by storms, such as heavy rainfall over the time of a few hours or days, which can cause flash floods in small streams or rivers (Wright 2005). These flash floods can move large amounts of soil, rocks, and vegetation; and can restructure valleys of streams and rivers. Our little national animal of Canada, the beaver, can also have a significant affect on small streams and rivers. Through their damming activities, they can induce localized flooding.

Ice storms

Ice storms occur when supercooled rain freezes on contact with surfaces that are at or below the freezing point, causing ice to accumulate on those surfaces (The Weather Network 2005). This process usually occurs when "a warm, moist winter front passes over an area after the ground level temperature falls well below freezing" (The Weather Network 2005). These ice storm events are relatively common in the eastern part of Canada, from Ontario to Newfoundland, and past ice storm events have been known to affected over 10,000 km^2 of area (Wright 2005). Trees usually break or topple over due to the weight of the ice and/or the force of the wind on the ice-covered branches (Wright 2005).

Diseases and Insects

All terrestrial ecosystems experience disturbances caused by disease and insects, and frequently these disturbances occur at the same time. Averill et al. (1994) state that it has been widely observed that pathogens of disease and insect species within ecosystems are site specific. However, some are more general in nature and can be found in many different ecosystems interacting with different species. While insects and pathogens create disturbance by attacking healthy vegetation, some may only affect host vegetation that is already weakened by other disturbance agents. In either case, acting alone or in tandem with other disturbance factors, these disturbance agents are important creators of small gaps and in some instances can cause disturbance over very large areas. For example, in the west part of Canada, widespread disturbance in the western lodgepole pine forests has been caused by the mountain pine beetle (Averill et al. 1994), and in the east, disturbances in the balsam fir, blue spruce, white spruce, red spruce, and hemlock forests is frequently caused by spruce budworm infestations (NRC).

Synergism

Some natural disturbance agents may interact to affect natural processes of forest ecosystems. For example, insect defoliation may harm trees to the point of mortality; however this allows for the potential of other disturbance processes (Rykiel et al. 1988 as cited by Radeloff et al. 2000), such as fire, which may increase in frequency because of increased fuel load (Stock 1987 as cited by Radeloff et al. 2000).

Ecological differences between the effects of wildfires and clearcut harvesting

In the boreal forest, wildfire has been identified as the principle large-scale disturbance agent. The current concept of emulating natural disturbances seems to be the best and logical approach for achieving sustainable forest management practices and the maintenance of biodiversity. The fact that plants, vertebrate and invertebrate species are able to recover from a natural disturbance, leads to the conclusion that they should therefore be able to cope with the ecological changes due to timber harvest activities if those changes resemble that of a natural disturbance (Hunter 1993). Also, with our limited knowledge of forest ecosystem processes and disturbance regimes, emulating natural disturbances provides a conservative basis from which to develop forest management strategies (Perera and Buse 2004). However, there are many differences between forest harvesting practices and natural disturbances which begs the question, why are we doing it??? Below is a table summarizing the differences between wildfires and clearcut harvesting (traditional) (adapted from Park et al. 2005).

Table 2. Comparison of wildfires and clearcut harvesting

Wildfire	Clearcut harvesting
Fire is a chemical process that affects the environmental and biological processes – burning of fine woody debris and changing of the chemical makeup within the soil = release of nutrients such as nitrogen, potassium, magnesium and calcium…., affects the microclimate – light, humidity and wind	Mechanical process – that leaves a "mechanical footprint" – soil erosion due to removal of ground cover, compaction, rutting - the break down of the woody debris and release of nutrients when exposed to the sun (20°C) is much slower
Variability in fire sizes – 0.1 ha to 1.4 million ha	Usually one consistent size (British Columbia = 8-16 hectare and Alberta = 5-40 hectares) and none represent the largest or smallest of fires.
Fire leaves biomass – dead and scorched standing trees (snags)	Traditional clearcutting removed all standing trees (did not take into consideration forest interior species). However, new management prescriptions call for a percentage of snags.
Fires leave coarse woody debris (CWD)	Up to 90% of CWD can be removed during the first clearcut and further reduced during following rotations.
Fires are very irregular in shape and leave residuals island remnants within large burned areas	Clearcuts leave few forest islands or peninsulas
The effects of fire are softer; the edges blend with the surrounding live forested area. The ratio of edge habitat to the area burned is lower in clearcuts.	Clearcuts patterns are very sharp and distinct - traditional clearcuts were patterned in a linear, check-board fashion. The amount of edge affected is 10 times greater than that affected by wildfires.
Natural disturbances create a diversity of patch sizes – results in a low proportion of fragmentation, provides refuges and travel corridors (connectivity) for many species	Forests are fragmented into patches that fairly homogeneous size. Fragments large habitat areas into small blocks - good for cervid habitat (elk, moose, deer) - possible negative effects on forest-interior species
Fires are not associated with linear patterns such as roads that allow for increased assess to hunters and fishers	Large networks of roads are built across the landscape, which allows for increased access to wildlife. Increases the stress of the wildlife and adds additional dangers, such as traffic noise and vehicular collisions.
Forests will reflect a mosaic of age classes – and a percentage of old growth forest will be older than the mean fire-return interval	Forest age classes are manipulated, to allow for rotational harvesting. Stands that are older than the rotational age are removed, resulting in a forest where nothing is older than the rotation interval.
Most stands will naturally regenerate to former species composition, some have adapted to fire (i.e. coniferous stands – cones from standing dead trees will release a large amount of seeds, such as a million seeds per hectare)	Clearcut areas may be converted to different stand types that were present pre-harvest; such as a pure coniferous stand being converted to a mixedwood or hardwood stand. May induce changes to forest composition in the long-term – affecting species that rely on or have a strong preference for a specific stand
Fire kills pathogens, such as disease and insects within the burnt and surrounding area, via the fire and smoke	Harvest operations often result in introduction of exotic species into the forest. Seeds may piggy-back onto forestry equipment that is brought into the harvested area. Non-native species compete with native species.
Fires may burn within riparian areas or skip over the wet areas	Buffers of variable sizes are place around water bodies depending on their importance to protect the riparian habitat

Landscape level management practices

Landscape level management practices attempt to emulate the natural conditions typically found in an area. At this level one tries to emulate historic age distribution by adopting variable rotation ages across the landscape by emulate natural patch size, species composition, patch location on the landscape, and minimize negative effects of edge through harvest planning. Also, this type of planning tries to maintain habitat connectivity, especially by protecting riparian areas, minimizing and reclaiming roads, and attempting to maintain species assemblages across landscape (forest inventory provides basis for species assemblages).

Stand level management practices

Stand level management practices take into consideration microhabitat elements, such as standing and downed woody debris, live trees, fine woody debris and so on. One of the most critical objectives of stand-level management is to provide adequate habitat for wildlife, specifically those that require cavities. These species are of particular concern because traditional forestry practices tended to eliminate the microhabitat elements for those species by removing snags and dead trees, etc.

Stand level management objectives can be accomplished by retaining both live trees and snags; retaining trees of different sizes and species, even if damaged or diseased; and, retaining snags of different sizes, species, and decay classes. Also the arrangement of retained trees and/or snags should be considered. Should these retained elements be isolated or placed in clumps; how close should they be from the edge of the cut? Also to be taken into consideration is which downed woody materials should be retained, along with the different species, size and decay classes. Furthermore, the edges of cut blocks should be made irregular, in order to minimize the edge effect, and natural successional pathways should be approximated: adopt ecological rotation instead of economic rotation (White spruce-aspen vs. white spruce-white spruce).

It is very important to understand the disturbance regimes in one's region, as well as the process and resulting patterns resulting from these disturbance regimes, which can be used as a guide to developing ways to emulating those disturbances. This is important in management planning at the landscape and stand level, as there is a need to know if natural disturbance patterns are able to provide guidance and are feasible in the process of attaining SFM. Consequently, harvesting and silviculture systems will vary, depending on the spatial and temporal characteristics of the natural disturbances you are trying to emulate. For example, at the stand level, small harvest units, tens of hectares in size, may be placed throughout large areas to simulate gap dynamics caused by insects and/or disease, snow loading damage and so on, that have various time scales, ranging from years to decades (Barten 2001). At the landscape level, large-scale harvesting units, hundreds to thousands of hectares in size, attempt to emulate low frequency disturbances such as fire, extreme storms (ice damage or tornadoes), and severe insect and disease outbreaks (Barten 2001). There are many variables to take into consideration (forest environment, production requirements, transportation costs, and community preferences) and, therefore, many forest companies are incorporating both approaches (Barten 2001). As stated by Barten (2001, p.

4), it is "*like an investment portfolio, common sense argues for a diverse range of holdings and diligent performance monitoring.*"

Risks

It is obvious that for every action that we carry out, there is a certain level of risk associated with it. This risk element is, by far, one of the most significant and ignored elements of sustainability (Adamowicz and Burton 2003). Simply put, there is never a 100 percent certainty that a harvesting activity or plan will be sustainable or not, due to the natural and sometime unpredictable fluctuations within ecosystems and socioeconomic systems, and our limited knowledge of these systems. The risk element must be considered at all levels of planning: strategic, tactical and operational. Given that there are always unknowns about future preferences for forest products and ecological services (Adamowicz and Burton 2003), there is a need for a better understanding of risks, the degrees of risk, and risk analysis. As stated by Colberg (1996 as cited by Andison 2003, p. 439) "*planning cannot reduce risk, but it should identify and quantify it, and then decide on a course of action that has the greatest chance of success.*" Unfortunately however, people are not in a habit of identifying or presenting this information with stakeholders or management (Marshall 1986 as cited by Andison 2003). The process of adaptive managements allows for some leeway, by allowing for continuous learning and improvement of SFM approaches.

Natural range of variation

There are several questions raised when considering the natural range of variability (NRV), including: what is the past history of the landscape; do we and can we know its every detail; and, what is natural? Establishing the NRV requires careful assessment...discuss this with your counterparts.

What is natural?

Defining what should be considered 'natural' is critical to determining the NRV. As such, 'natural' includes those natural activities, such as fire, wind, floods, disease and insect outbreak, which occurred prior to human presence or influence. Unfortunately, it is frequently difficult to distinguish between natural and human-caused environmental change. For example, it is known that Aboriginal peoples were actively using fires, to maintain the land and drive animals, over 6000 years ago (SERM 2001). Also, as previously discussed, early European settlers removed forest for settlement and agriculture by way of fire and logging. As such, in terms of what is "natural", it seems it would be hard not to include human influence as a natural disturbance on the landscape (SERM 2001). However, the last half century has seen a great human influence on the landscape, large tracts of land being cleared for road corridors, settlements, harvesting and suppression of fires and disease. Therefore, SERM (2001) has identified "natural" to be pre-industrial (prior to the 1940s).

What is NRV (or RNV/RONV/HRV)?

Kimmins (2004a, p. 11) defines NRV as

> *"It describes both the historical and the present range of disturbance patch sizes, the landscape-level pattern of disturbance patches and events, and the range in disturbance severity, and thus describes the variability in plant community composition and structure. Social, cultural, and economic considerations are then used to select the acceptable portion of this range. A comparison of the natural range of variation with the socially selected range of desired conditions alerts managers to the neglected portion of the natural range of variation (and its associated values)."*

The question then is: can we know every detail? The short answer to this is: probably not. For example, in many instances regional inventories, records, and aerial photos are either incomplete or inaccessible. Because of this, many have rejected the NRV approach. Also, as discussed by Andison (2000), there are many additional reasons why many do not use the NRV approach. Some of these are due to the four factors of: research; understanding; unknown territory; and, policy framework (Andison 2000).

> *"1) Research.*
> *Natural pattern research is happening, but slowly, and in a piecemeal fashion. Studying natural disturbance patterns and processes is a new area of study that requires unique methods and often unusual and expensive datasets. Nor does it always fit the standard scientific method very well. We very likely do not even know all of the questions we should be asking. It will take us time to adapt, learn, and develop the appropriate expertise, data, and methods.*
>
> *2) Understanding.*
> *Conceptually the NRV model is quite different than anything we have dealt with to date. It takes time to consider and absorb the merits, assumptions, advantages, and disadvantages of adopting it. Skipping this step and simply agreeing to adopt an NRV approach to management because others are doing so will not change the fundamentals of the current system, only the numbers of rules it has.*
>
> *3) Unknown Territory*
> *We understand even less about the potential implications of using an NRV approach to forest management operationally, strategically, and politically. What policies does it affect? At what planning levels and scales? Is new training required? What tools will we need - reports, workshops, modeling, gap analysis, or others?*
>
> *4) Policy framework.*
> *By definition, the NRV model means change must be understood, embraced, and employed. Ranges and distributions must be used at small, medium, and large scales instead of maximums and minimums. The current forest management*

planning framework relies heavily on setting and monitoring deterministic performance measures. The transition will not be a simple or logical one. For instance, is the question we should be asking "how do we change the groundrules?", or is the more important question "is groundrules the appropriate vehicle?". By asking the former, we may be trying to jam a square peg into a round hole. By asking the latter question, we can explore more appropriate planning and monitoring delivery mechanisms." (Andison 2000)

As identified by Andison (2000), these are good reasons to "proceed slowly and carefully". Andison (2000) also provides some relevant solutions to these concerns: start talking with others; change is natural; avoid getting caught up in the idea that NRV is the answer for everything; and, make researchers answer practical questions.

> *"1) Begin talking about it – Now.*
> *First and foremost you have to be comfortable with the concepts of using NRV as opposed to other strategies of achieving EBM* (SFM/EM or whatever you want to call it). *There is a wide range of opinions out there, so take advantage of it and ask and listen. Put the scientists on the spot first, and then work your way through those who claim to understand it. Find out about the strengths and weaknesses, and move forward only if and when you are convinced. If you are not convinced, you are not likely to convince others, and defend your words and actions.*
>
> *2) Get used to the idea that change is natural.*
> *As easy as it is to say that landscapes change over time, it is quite another thing to understand what this really means. Natural pattern research – all of it – tells us that nature is probabilistic. Averages and even medians have little or no meaning since they are by definition static. Ranges and confidence intervals are better than averages, and distributions better still. Historical and empirical data can be used to generate these metrics for everything from edge densities to patch size to interior forest percent.*
>
> *However, even after they are generated, there are at least four questions that should be asked:*
>
> > *a) Are we now, or in the future staying within the "natural range of variation"? This is a simple yes/no "red flag" comparison of existing or projected levels of a given metric at one point in time against the historical range.*
> >
> > *b) Are we representing the full range of variation over time – or just hanging around the bare minimums? If the historical amount of old-growth forest is found to be between five and 25%, we want to make sure we manage for the full range over time, and not just "high grading" NRV by keeping it at the 5% minimum over the long-term.*

c) Are we representing the full range of variation over space? Another high-grade check to make sure that NRV is being fully represented across the landscape. For instance, if NRV of percent area in island remnants is zero to 80%, then leaving 3% area in every cutblock is not an appropriate use of the NRV model.

d) Are we considering a complete list of natural patterns.........or just a select few? The number one fear of ENGO's, environmentalists, and members of the public. Can't blame them either. I've seen examples of (unnamed) companies taking large blocks in the name of "emulating nature", but they are not willing to leave island remnants behind. Clear case of high-grading / cherry picking.

3) Use NRV as the guide, not the master.
We cannot mimic all aspects of natural disturbance. Harvesting removes biomass, compacts soils, and only disturbs mature forests. As a largely indiscriminate chemical process, fire does none of the above. Nor do we always want to emulate natural disturbance. For instance, although it may be physically possible to create very large harvest blocks, there are valid social reasons why we may not want to. NRV is therefore an excellent starting point for management choices, but NRV cannot dictate them. To take best advantage of the NRV guide, it is useful to develop a process.

a) What is the natural pattern in question, and how much do we know about the impacts?

b) What is the current pattern?

c) What are the (cultural, economic, or ecological) reasons for the differences?

d) With this in mind, choose a desired future forest condition.

e) Re-evaluate, defend, monitor, and adapt to this standard.

Having a process has not only created a final solution that makes best use of historical information, but has allowed us to learn and move forward over time, improve wildlife protection, and respect other values.

4) Make researchers answer practical questions.
We have a lot yet to learn about natural patterns and processes. Given the nature of scientific investigation, we should not even assume that we know all of the questions to ask. What we can do in the meantime is try to make sure that the

inevitable scientific investigations will lead to practical answers." (Andison 2000)

Which historical period should be the baseline for NRV?

Managers spend a significant amount of time trying to determine what the "natural" disturbance regime, and the resulting mosaic of patterns of species composition and age, of an area actually is (Weir et al. 2000). When managing, there is a tendency to set a specific number as a target, such as the amount of retention that should be left within a cutblock when harvesting. However, when looking at a landscape over time and depending on the disturbance regime, such as wildfire, the percentage of vegetation that survives changes on a year to year basis. Therefore, by trying to emulate natural disturbance, a manager should be asking, "Where should we be within the NRV?" As such, a manager must not pick a specific number within the range, but try and manage for that range over time (pers. comm. with Rick Bonar on April 18, 2005).

For example, the primary natural disturbance regime on your landscape area, that you are trying to manage for forest harvesting for the next 180 years, is wildfire. If, over the past 200 years, the average amount of area within an event that has burnt is 65%, and the range of area that has burnt over the 200 years is between 44-95%, you would not want to say, "Every time that I go to harvest, I will harvest 65% of the event area". What you would want to say is, "Every time that I go to harvest, I want to harvest between 44-95% of the area, and I would like the average to be 65% over the next 180 years". Therefore, depending on where one is harvesting each year within the landscape area, where various physical factors may limit or increase the amount of trees harvested, the area cut will range between 44-95%. A manager should always keep an account of the amount of forest landscape that has been harvested, because if harvesting primarily towards the high or low end of the range of the scale (i.e. 44-95%), the next harvest year(s) must be adjusted in order to maintain a harvest average of 65% over 180 years. Also, you want to make sure that you are not always harvesting in the middle of the range (pers. comm. with Rick Bonar on April 18, 2005).

Many have a problem with this concept, because as stated above, there is a tendency to want specific numbers, such as averages, when establishing a management regime; and if one is a regulator, every year there is no fixed target. Regulators invariably ask, "How do you measure NRV?"; "How do you set the target each year?"; "How do I tell if the target is or is not being achieved each year?" While it is possible that these questions can be addressed, this will require that both regulators and forest harvesting companies sit down together to identify what the outcomes each are looking for, and whether or not a different approach can achieve these outcomes (besides the standard approach of measuring specific distances on the map and the ground each and every day). Additionally, both parties must trust one another and carry out a great deal of monitoring after the fact, not necessarily before hand (pers. comm. Rick Bonar on April 18, 2005).

As previously discussed, Andison (2000), provides some advice for determining the desired future condition by using *"NRV as the guide, not the master"*. Andison (2003) has developed four rules for one to check to see if one is carrying out NRV properly (Box 1.).

Box 1. DAVES' 4 GENERAL RULES for practicing NRV

RED FLAG CHECK
Are we now, or in the future, staying within "natural range of variation" benchmarks, *at any one point in time*?

TEMPORAL HIGH-GRADE CHECK
Are we representing the full range of natural variation *over time*? ... or just hanging around the bare minimums?

SPATIAL HIGH-GRADE CHECK
Are we representing the full range of natural variation *over space*?

CHERRY-PICKING CHECK
Are we *considering* a complete list of natural patterns.........or just a select few?

OVERALL
How different/similar are the natural/managed forests going to be? Have you increased similarity compared to the "old way"? Has this increased chances (lessend risk) of success? How will you know - do you have a monitoring/improvement plan in place? What about "fine filter" values? e.g. species at risk

Coarse-filter approaches

The coarse-filter approach of maintaining the NRV of forest age, seral stage, and ecosystem conditions is thought to provide a better result of maintaining biodiversity and values across the landscape, particularly when our knowledge of that landscape is ecologically limited (Kimmins 2004b). This approach takes into consideration a broad array of attributes within a forest, such as snags, coarse and fine woody debris, and age classes at the landscape level, and makes available these attributes, in the hope of providing suitable habitat, for most of the forest species (Park et al. 2005). The thinking is that, by supplying habitat at macrohabitat level, this should result in providing the microhabitat elements which are essential for many organisms.

Fine-filter approach

There is concern that spending time on a species by species basis, the fine-filter approach, where one or a group of species benefits, may inadvertently result in negative effects for other species (Kimmins 2004b). As there are hundreds to thousands of plant, vertebrate and invertebrate species within a forested area, managing on a species by species basis, in the context of forest management, is impossible (OMNR 2001). Furthermore, such an approach results in far too many values to effectively manage, and leads to the problem of who decides which species are given priority within the management scheme. However, the fine-filter approach is necessary for managing those species which are specialists requiring specific habitat requirements, such as "species at risk" or species vulnerable to disturbance. This approach ensures that no species fall through the cracks because of their specific habitat requirements (OMNR 2001). It focuses on the microhabitat that some species may require, for example the tree cavities used for nesting, and therefore the density of snags per hectare will be taken into consideration. Below is a table that is adapted from Parker et al. (2005) and OMNR (2001), which provides considerations for the coarse-filter and fine-filter approaches.

Table 3. Material considered in the coarse and fine-filter approaches

Coarse-filter	**Fine-filter**
Composition of the forest - retain a variety of forest habitat that is within historic limits	**"Species at Risk" – Endangered, threatened or vulnerable** - patch size – caribou spp. need large undisturbed areas that provide lichen spp., such as old growth forests and the tundra
Forest age-class structure - retain a variety of age-class that are found under the disturbance regime	- site specific habitat – nesting sites for bald eagles (large snags or trees with dead or broken tops), peregrine falcon - landscape-level habitat supply – caribou – need large undisturbed (old growth) homogenous areas that are populated with a primary food requirement - lichens
Characteristics of forest patches - variability of sizes and shapes - different age classes grow adjacent of one another - fire salvage - prescribed fires	**Keystone species** - deer yard management plan - site-specific habitat protection – fish spawning areas, great-blue heron and cormorant nesting areas (large snags or trees with dead or broken tops), mineral licks, osprey nests, moose aquatic feeding areas
Residual patches - riparian buffers (?) - composition, size and placement of peninsular and island patches in wildfire burnt areas	- landscape-level habitat supply – marten, pileated woodpecker
Residual trees - snags, fine and coarse woody debris - live trees	

Forests of Canada

Canada contains one-tenth of the forested area in the world (Burton et al. 2003). As would be expected, the forested regions across Canada are very diverse, depending on climate and geography. There are common traits though, with many areas affected by similar primary dominant disturbance agents, such as wind, fire, mountain pine beetle, and spruce budworm. There are, however, other disturbance agents, such as other diseases (i.e. root rot), insects (i.e. bud worm spp., defoliating spp.), ice storms, drought, snow load, and so on, that are also important factors in forest environments.

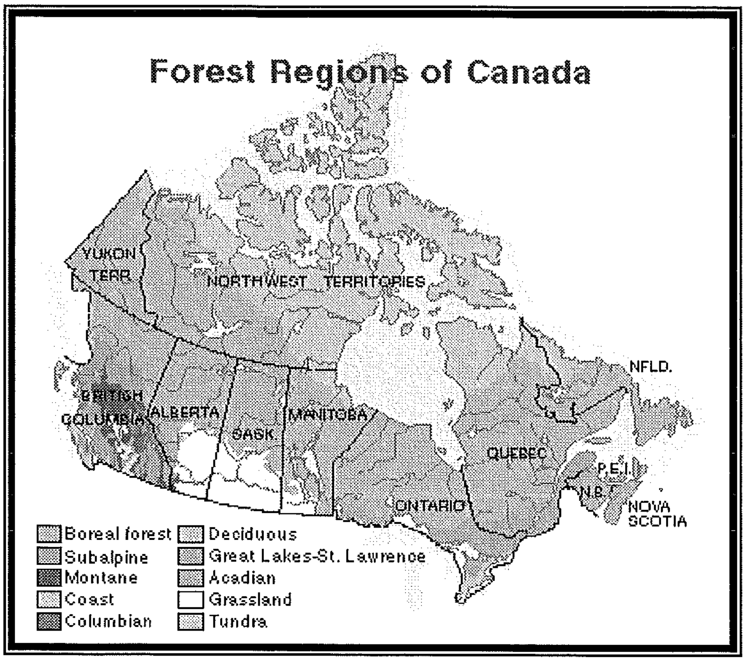

Figure 5. The forested regions of Canada (NRC 2004)

If we begin on the west coast, in the province of British Columbia, we find a very diverse region where forest harvesting activities occur in the boreal forest, coastal, and interior forested (columbia, montane, subalpine (isolated patches on Vancouver Island)) regions. Tree communities vary in each region, with the size and shape of the trees dependant on the temperature, moisture conditions, and terrain. In the Columbia region, the slopes where trees grow are exposed to moist, blowing, air from the Pacific, which precipitates as it tries to rise above the Rockies (Drushka 2003). This results in these forests being large in size and similar to the composition of forests along the coast. Along the coast, trees are large in size and very old which makes this region is the most productive and economically valuable area in British Columbia. In the subalpine region, trees are much smaller due to the short growing season and cool temperatures. In the montane region, trees are smaller than along the coast or within the Columbia region, due to the area being relatively dry. Trees in the boreal forest are not as large as in the other regions as growth is limited due to a shorter growing season and cooler temperatures.

There is significant forest variation in British Columbia with each region principally affected by different major disturbance agents. The coastal forests are very distinctive in that they never experience fire; wind is the major disturbance. The southern interior forest will experience fire very frequently, every 5 – 15 years, and areas along the Rockies within the montane region, containing lodgepole pine forest, experience damage caused by the mountain pine beetle. (pers. Comm. Andy)

The boreal forest in Canada stretches all the way from the west to east coast (BC, YK, NWT, AB, SK, MN, ON, QUE, NFLD), experiencing fire as the major disturbance agent, every 20 - 300 years (MNR 2001). The boreal forest makes up approximately 76% of the forested land in Canada (Drushka 2003) and, not taking into consideration non-timber products, generates approximately 60% of Canada's economic activity in forest products (Burton et al. 2003). The boreal forest is an important biome in Canada, providing habitat for a large number of invertebrate (insects) and vertebrate (birds, fish, amphibians and mammals) species; plants (trees, shrub and herbs); consists of diverse landscapes united with lakes, rivers, streams and wetlands. Consequently, significant research and development has been undertaken within the boreal forest, pertaining to natural disturbance regimes that are different across the country.

As you move further east to Atlantic Canada, spruce budworm is more of a major disturbance than elsewhere. Spruce budworm is a primary disturbance of balsam fir, but it also causes damage to blue spruce, white spruce, red spruce, and hemlock (NRC). The Acadia (Nova Scotia, Prince Edward Island, and southern New Brunswick) forests are affected by fire and wind. Situated at the tail-end of the Atlantic hurricane zone, there have been instances when large areas of timber have been blown over (Drushka 2003).

Depending on climate and geography, the forest regions are different across the country. Therefore, management will be different regionally, recognizing the different disturbance and climatic regimes, and geological factors that shape the ecosystems (DeGraaf and Healy 1993).

Learning Step 3 Discuss the advantages and disadvantages of using the natural disturbance approach for forest management

There are many advantages and disadvantage to the natural disturbance approach that have been identified for achieving SFM. Tradeoffs have been assessed in respect to environmental, social and economic values. In some instances it has been found that the natural disturbance model has not given a clear picture of what to do. In light of this, discuss the advantages and disadvantages of using the natural disturbance approach with your counterparts. What are the tradeoffs? What instance(s) has the natural disturbance approach not provided a clear picture? Below is a table for you to fill in as you are having your discussions.

Advantages	Disadvantages

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A short review will begin the day, to discuss any unanswered questions or misunderstandings from the previous Learning Outcome 1. Also, we will spend a few minutes going over the main points from day before, highlighting on the principles of Natural Disturbance.

Learning Outcome 2 Compare and contrast natural disturbance based approaches to traditional approaches to forest management

Learning Step 1 Discuss the principles of natural disturbance to forest management issues

There are many reasons why many new harvesting approaches have been proposed, due to, among other factors, increasing public interest in the forest resource and the loss of biodiversity, as previously discussed. Given these factors, there has been a great demand for harvesting practices to be more 'natural', with particular attention given to changing from the practice of clearcutting.

During this learning step, you will be shown a multitude of images at various scales, from different regions of Canada of different forest harvesting practices of the past and present, along with an example of a forest disturbance agent, which will be displayed as illustrated below:

agents	vs.	what we have been doing ('traditional' harvesting) + agents	vs.	different harvesting approaches that are currently being carried out which are similar to what the agent has done + agents

Compare the patterns of forest disturbance agents, to forest harvesting practices that we have been doing ('traditional'), to the harvesting practices that are currently being carried out. How well do the forest harvesting practices address the principles of natural disturbance? How do all of these pieces fit in terms of why you want to do them – such as to achieve SFM.

Learning Step 2 Evaluate the consistencies and/or inconsitencies between concept and practice

All provinces are carrying out emulation of natural disturbance albeit to differing degrees and in different ways. Where some provinces are stringently providing regulations for the emulation of natural disturbance's patterns, others are putting the onus on the companies to provide the solutions. These very different philosophies, in terms of how things are carried out on the ground, seem to lead to similar end results - the practice of sustainable forestry.

Some of the questions to consider are: Theory to practice... does it work at all scales? Does it work for heavily disturbed landscapes that have existing footprints? What are some of the problems and resolutions, if any? What are the advantages and disadvantages? Are there many tradeoffs? These are just some of the questions you should be thinking about as you work through the real-world case studies.

A number of case studies are provided for illustration to determine if there is consistency between concept and practice. These case studies range from across Canada, applying different forest harvesting practices and address many different principles of natural disturbance. The following are questions that were addressed for the case studies:

- What was your objective with respect to using or integrating natural patterns?
- Why did you think this was important?
- Did this need arise from policy direction from within your organization, strategic commitments in higher level plans, regulatory requirements, or? other?
- What scale(s) or level of planning was affected?
- Describe the initiative - exactly how are natural patterns now more integrated into FM planning?
- Who initiated the idea?
- Who was involved in developing the idea?
- Was there public input? Was there other agency input?
- Did it turn out as hoped, or were compromises necessary along the way?
- What were some of the issues and road-blocks along the way?
- In the end, does it achieve the desired objectives? If not, why not, and how might it be done differently next time?
- What are 3 key lessons learned from this experience?

Case Study #1

Stand Structure and Residuals
Alberta-Pacific Forest Industries Inc.

Alberta-Pacific Forest Industries Inc. (Al-Pac) has been operating in northeastern Alberta since the early 1990's. The Al-Pac Forest Management Area (FMA) consists of approximately 6.9 million hectares within the boreal forest of northeastern Alberta.

Describe the initiative - exactly how are natural patterns now more integrated into FM planning?
Sustainable forest management principles were implemented at the onset of Al-Pac operations and included application of a natural disturbance model. Early on in operations Al-Pac began to incorporate residuals and stand structure within cutblocks and developed guidelines for retaining stand structure within harvest areas. The guidelines help operators understand the principles of stand structure and provide guidance for deciding how to incorporate structure within harvest areas. One version of the guidelines is available in "An Operator's Guide to Stand Structure" (Al-Pac 2000). The guidebook instructs operators to leave an average of 1% of merchantable volume scattered throughout the cutblock (consisting of an average of 8 single trees (small clumps of three or fewer trees) and one clump per hectare harvested). On average was retained and 1% of live merchantable conifer trees It also provides examples of where and what kinds of structure that should be considered for retention, for example, all non-merchantable vegetation, mixtures of forest types and sizes, a few largest trees, wolf trees, nest trees, downed logs, all snags, understory associated with canopy gaps, and more clumps on step slopes, north-facing slopes and in wet areas.

The operators are provided with the opportunity to decide where the residual material is left, with the goal to be highly variable among cutblocks and within logistical constraints or ecological conditions that determine where structure should be left. Tools to guide the operators, in addition to the guidebook, include annual training workshops and ongoing evaluation/audits.

Based on ongoing research the stand structure protocols are revised and updated. For example, further increases in retention volume, as implemented in the 2006 Forest Management Plan, include an increase in retention of conifer structure to 5%.

What was your objective with respect to using or integrating natural patterns?
To maintain biodiversity in a working forest. To maintain old growth characteristics in regenerating stands and ensure old growth attributes in second rotation forests. From the Al-Pac website: "The goal [of using a natural disturbance model] is to minimize the effects of Al-Pac's harvesting operations and restore the ecological benefits of fire by approximating this natural disturbance as closely as possible".

Why did you think this was important (to do / initiate)?
We need to manage forest for all values and maintain habitat for species associated with structure and unique habitat characteristics.

Did this need arise from policy direction from within your organization, strategic commitments in higher level plans, regulatory requirements, or? other?
The direction came from biologists and the environmental group within Al-Pac.

Who initiated the idea? Who was involved in developing and integrating the idea?
The impetus was industry driven. We were exposed to the idea of a natural disturbance model primarily from work in the Pacific Northwest (Franklin and others). An initial draft of stand structure protocols was developed around 1993 with the understanding that they would receive input from the operators. These were used as a basis for discussion and were presented to the contractors/operators in terms of what the company wanted to do (i.e., emulate natural patterns) and asked for feedback. Based on input from operators/contractors the protocols were refined over the next 2 to 3 years. The protocols continue to be reviewed and updated.

What scale(s) or level of planning was affected?
Cutblock/stand level

How much of a shift was this for the organization, how did it differ from the pre-initiative process or practice?
Strategically, there was no shift required since incorporating stand structure into cut areas was done from the onset of operations. The only resistance came from older operators/contractors and that a shift in thinking was required from them to create buy-in for the initiative.

Was there scientific knowledge in existence to support the initiative (if relevant)?
In the beginning there was no specific information available on what to do, but the principle of retention as a natural featured was recognized. The protocol was changed in 1995 and 2006 as more scientific information became available.

Was there public input? Was there other agency input?
There was/is public input through two processes. First the idea was brought to the Forest Management Task Force which represented a number of public interest groups (First Nations, trappers, outfitters, hunters, conservation groups, government agencies, etc). Secondly, through annual open houses where they present their annual harvest plans and operations. The government was not involved in initiating or developing the idea although they were presented with the idea and Al-Pac worked with them through numerous meetings and reviewing of plans to ensure their concerns were addressed.

What were the primary concerns of the contractors/operators and other stakeholder groups?
The public provided the most positive reaction overall. They saw it as a departure from what was being done and it broke up the cut areas, especially the homogeneous, flat areas. Some of the members of the public initially thought that leaving stand structure was a waste of wood or that it looked ugly but once they understood the ecological rationale for it, it is was accepted. The government also had concerns around wasting wood (utilization standards), contravening ground rules, overcutting, and worker safety around snags and single trees. The company met with the government on these issues a number of times. There was about a year worth of meetings and plans to resolve the concerns.

The operators initially thought the company was nuts. They were paid by how much wood was in the pile and the more wood and larger wood the better. What helped create buy-in for the concept was that there were a lot of new, younger operators who may have been more open to the idea than some of the older operators where the historical way of cutting was very entrenched. The operators also had some concerns with the operability of the initiative, for example maneuvering in a cutblock is much easier if all trees are taken down. Initially there was some difficulty in getting the operators to leave trees in areas however they saw that this could be used to their advantage (i.e., situate leave areas in areas which were more difficult to access). Followup was a bit of an issue and getting contractor buy-in was very important since they could provide immediate feedback and correct behaviours.

There were also concerns from the softwood quota holders. They were concerned with leaving trees within the cutblocks, especially spruce. Some are on board, but there is still some resistance.

What were some of the challenges, issues, and road-blocks along the way?
One potential setback was the current legislation. The methods they were proposing were contrary to Alberta legislation. Based on the existing regulations at the time, the company would have been penalized for not utilizing all merchantable volume. However, Al-Pac was granted an exception to move ahead with the initiative.
The government was also concerned with worker safety with the presence of standing dead and live trees in the cutblock. These had been concerns in other jurisdictions where structure was being left (i.e., BC) and logging was done by hand. In Al-Pac operations, cutting was mechanized and workers were protected in cabs of equipment. The safety of tree planters was somewhat of a concern and they were instructed to avoid areas of potential hazard. Al-Pac had numerous meetings with the government to address their concerns on safety. Overall, the effort to transition to this type of harvesting was iterative, and took several years of meetings and discussions.

Did it turn out as hoped, or were compromises necessary or disappointments along the way? In the end, does it achieve the desired objectives? If not, why not, and how might it be done differently next time? How was success measured or monitored?
The company strongly felt that the initiative was successful. Two measures of this are the fact that monitoring shows that the cutblocks meet the objectives set for the initiative and secondly the initiative influenced change in the government. A broader perspective of success is the social awareness among forest professionals of the importance of structure.

Not sure what they would do differently if anything. The only negative was the length of time and amount of effort it took – although that may just be the nature of implementing change.

Success is monitored through the audit program. In the beginning an evaluation form for every cutblock was completed by an Al-Pac person. However, as the performance/behaviour improved, the contractor did evaluations on block by block basis and an Al-Pac person did spot checks. The audits/evaluation allow feedback to be provided to the operators.

What are 3 key lessons learned from this experience?

1. Need for continual monitoring and improvement for such an initiative. A monitoring/reporting system is important: do, measure, communicate
2. The buy-in from the harvesting contractors was critical to the successful implementation of the initiative. Al-Pac kept on preaching/educating the operators and contractors, and have a reward program for performance. They have annual startup meetings with contractors and operators to introduce the concepts of the program. They also physically go to examples of successful cutblocks and some not so successful cutblocks and discuss potential challenges of retaining structure.
3. The shift in responsibility of decision-making was significant. Operators became much more empowered.
4. Two way communication (both giving information, and careful listening) is required to all people, at all levels, multiple times before there is buy-in.

What are the research/knowledge requirements? (i.e. to do this better or to implement at a larger scale)

In a perfect world, Al-Pac still has a few outstanding questions.

1. It is not clear how much structure is required from an ecological perspective.
2. Need a more thorough understanding of green tree retention naturally - within wildfires.
3. Need long-term monitoring of stand structure – how is it used, the amount of structure is related to what you start with i.e., the diminishing amount of structure with subsequent rotations.

What are the policy / regulatory requirements? (i.e. to do this better or to implement at a larger scale)

Provincial Ground Rules have changed since operations began, the new ground rules state that you must leave structure in cutblocks, whereas the previous ones stated you must get every piece of wood out.

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Case Study #2

Forest Management Guide for Natural Disturbance Pattern Emulation Ontario Ministry of Natural Resources

The Forest Management Guide for Natural Disturbance Pattern Emulation (the "Guide") was released in 2001 by the Ontario Ministry of Natural Resources. The Guide outlines both stand and landscape level standards and guidelines for crown land forest management designed to emulate natural disturbance patterns from fire. The development of the Guide was driven by two different government processes which took place in the late 1980s and early 1990s. The first was the Class Environmental Assessment hearings for timber management, which produced the recommendation for a set of guidelines to govern the size and distribution of clearcuts. A second consultation process sought opinions/advice from the public and experts to improve forest management on crown lands. As a result of this consultation process the Crown Forest Sustainability Act ("CFSA") (1994) was implemented, with one of the clauses of the Act requiring that forest management emulate natural disturbance patterns. In response to this clause the MNR undertook the development of standards and guidelines to direct a natural disturbance pattern system of forest management.

What was the objective for using or integrating natural patterns?
The objective as stated in the Forest Management Guide for Natural Disturbance Emulation ('the Guide') is to "provide a coarse ecological filter that will help to conserve biological diversity" (OMNR 2001a)".
There was concern that the previous approach of featured-species management may not be effective in maintaining biodiversity. Therefore, influenced by the popular ideas at the time (i.e Hunter and subsequent local analysis), a coarse filter/fine filter approach to maintaining diversity was supported/being considered in Ontario which involved landscape level management and a diversity of patch sizes (McNicol and Baker 2004).

What was the impetus for the initiative? (strategic commitments in higher level plans, regulatory requirements, other?)
Under the Ontario Crown Forest Sustainability Act there is a statement to emulate natural disturbance patterns. The Act was brought into effect in 1994. In addition there was the Class Environmental Assessment, which was completed in 1993. During the Environmental Assessment hearings clearcuts were a big concern. MNR supported that clearcuts should exist as a range of sizes similar to what would happen naturally. There was some concern at the time that the board would just pick a number for the size of clearcuts, so MNR supported a range of clearcut sizes and committed, if accepted by the board, to develop natural disturbance guidelines.

(from OMNR 2001a): In fact, the development of the guide is in response and in support of a number of government directives:

- *Class Environmental Assessment by the Ministry of Natural Resources for Timber Management on Crown Lands in Ontario* (1994) mandates the creation of a guideline to provide direction on forest management relating to clearcuts. It further states that clearcuts should be in a range of sizes to emulate natural disturbance;

- *MNRs Policy Framework for Sustainable Forests* (released in 1994) stated that forest practices must emulate natural disturbance patterns; and
- *Crown Forest Sustainability Act* (1995) - one of the guiding principles states that forest practices should emulate natural disturbances and landscape patterns.

Who was involved in developing and integrating the idea? (A brief timeline may be helpful in highlighting milestones from initiation of idea through implementation and monitoring)
The Guide flows from CFSA, which states that the Ministry will develop guides, which then become legal instruments. Government, industry, and NGO representatives were involved in crafting the guidelines. The Provincial Technical Committee is an appointed body that looks at the review and development, if necessary, of new guidelines and includes representation from industry, environmental groups, academia, and government. In the case of the natural disturbance guidelines, because a lot of the expertise sat on the committee, a subcommittee/writing team was struck to undertake the development of the guidelines.

(from McNicol and Baker 2004 and OMNR 2001a)
1988-1994 – Class Environmental Assessment hearing and report
1992-1993 – Forest Policy Panel public consultation and forest policy framework
1994 – Implementation of the Crown Forest Sustainability Act
1997 – Historical fire analysis results to support Guide
2000 – Draft Guide
2001 – Release of draft NDPE guide for 60 day public review
2001 – NDPE guide ver 3.1 released
2003 – Begin to apply stand level standards and guidelines with forest management plans scheduled for approval
2004 – Full application of the guide beginning with plans scheduled for approval
2004 - MNR developed action plan to assess the effectiveness of the guide directions and recommend scientific studies to address knowledge gaps (as per Condition 39c of the 2003 Environmental Assessment Declaration Order instructs MNR to determine whether the NDPE guide directions for forest harvest are effective (i.e., represent natural fire regime characteristics)

What scale(s) or level of planning was affected?
Landscape (harvest layout) and stand (cutblock)

Describe the initiative - exactly how are natural patterns now more integrated into FM planning?
Summarised from OMNR 2001a:
The NDPE Guide provides both standards (mandatory) and guidelines (more flexible) for landscape harvest patterns and residual stand structure. The guidelines and standards apply primary to clearcuts but have some applicability to shelterwood systems as related to stand level residuals and regeneration height requirements.
Landscape Level

- Standard - create a more natural landscape pattern (towards a more natural frequency distribution of disturbance sizes)
- Standard - in the boreal forest 80% of clearcuts and in Great Lakes-St. Lawerence region 90% of clearcuts should be less than 260ha.

- Guideline - Clearcuts greater than 260ha can occur under a variety of stated conditions related to defragmentation, habitat strategies, addressing public concerns.
- Standard – documentation of rationale for clearcuts greater than 260ha
- Standard – temporal separation of clearcuts (20 years or 3m in height) or spatial separation if the temporal standard cannot be met (guideline)
- Standard – movement towards estimated natural forest condition relating to forest composition objective for forest management units.
- Guideline – within or movement towards the estimated range of natural forest condition as defined within the Guide
- Standard – establishment of a benchmark of natural forest condition based on specified sources (guideline)
- Standard – estimation of natural variation for forest parameters within acceptable bounds as specified by standards within the Guide.

Stand Level – Residual Patches

- Standard – distribution of residual patches to reflect fire pattern (size distribution and location consistent with fire)
- Guideline – retention of insular patches: 2-8% of planned area based on cover type
- Guideline – retention of peninsular patches: 8-28% of planned area based on cover type
- Standard - retention of all internal patches and 50- 75% of peninsular patches; 50% of peninsular patches available for harvesting after regenerating trees 3m or one pass removal of 50% of volume in 50% of exterior edge

Stand Level – Individual Residual Trees

- Guideline – leave individual trees based on species, fire tolerance, silvicultural requirements and wildlife value
- Standard – minimum of 25 well spaced trees per hectare (including 6 large-diameter living cavity trees and snags)
- Guideline – leave trees and snags based on species and silvicultural treatments as specified in Guide
- Guideline – creation of snags during mechanical harvesting

Stand Level – Downed Woody Material

- Guideline – creation of coarse woody debris and fine woody debris based on harvesting systems and site conditions as specified in the Guide
- Guideline – burn woody debris that cannot be redistributed on site

Stand Level – Silvicultural Treatments and Fire Salvage

- Guideline – prescribe burning as silvicultural treatment
- Guideline – maintain natural proportion of uneven-aged forests through guidance as specified in the guide
- Guideline – avoid fire salvage in some areas to maintain post-fire habitat
- Standard – maintain minimum residual standard as per guide for fire salvage areas and minimizes unburned area included in salvage

How much of a shift was this for forest management, how did it differ from the pre-initiative process or practice?

Going back to the 1950/60's, there were no guidelines regarding clearcut size. There appeared to be very large clearcuts in some areas (eg 1,000 – 20,000 ha, one was noted as being as large as PEI), however many of the cuts were not as large as originally thought.
Management guidelines originating from the 1980s were focused on maintaining habitat for a few different species such as deer and moose but also including endangered-vulnerable species (McNicol and Baker 2004). For example, in the boreal moose guidelines drove forest management for cut sizes of between 80-120 ha. In central and southern Ontario deer habitat guidelines drove forest management with even smaller cut sizes than moose.

The summary document of the NDPE Guide (OMNR 2001b) provides a comparison of "old-style clearcutting" and the new "harvesting guidelines"

- Pattern: previously generally regular, small blocks vs more natural pattern
- Size: previously many small clearcuts vs random sizes of cut areas (small, medium, a few large cuts
- Roads: previously extensive road network required vs wider spacing between blocks
- Roads: previously network maintained for later harvests vs roads maintained for shorter periods
- Residual: previously most merchantable timber removed vs leaves standing live trees, snags, and islands/peninsulas

There were a few companies that had already been thinking or incorporating ND in their forest operations. Tembec in NE Ontario had incorporated natural patterns in their FMP in terms of shape, distribution, and relative size of cutblocks (i.e., lots of small, few large clearcuts). Also about 10-15 years ago, a company in NW Ontario (now Abitibi Consolidated) started to incorporate some ND.

Was there scientific knowledge in existence to support the initiative (if relevant)?
There was a belief to retain residuals – individual trees and clumps. The problem was there was not much science to understand why residuals should be left. There was some work done during development of the guidelines to look at the range of fire size in the province for different ecoregions.
They had proposed a variation in cut sizes from the fire information. A large number of small cuts and a small number of large cuts, where justified. The guidelines were developed as a means to get underway. It was quasi-adaptive management – to implement guidelines and then learn if appropriate.

From McNicol and Baker 2004 and OMNR 2001a
Analysis was undertaken by OMNR on mapped fires greater than 200 ha from a 30 year period (1920-1950). The maps were digitized and analyzed based on site regions. Residual stand structure guidance is based on analyses of aerial photos from 42 fires (from 1920 – 1960) ranging in size from 54 ha to 52,772 ha (median fire size 1,327 ha). Information is provided in Forest Management Guidelines for the Emulation of Fire Disturbance Patterns – Analysis Results (OMNR 1997). The problem with that was that earlier fires were burned over by more recent fires, which made it [fire delineation] difficult.

Was there public input? Was there other agency input?
There was public review at two stages. The first public consultation attempt involved the first approach [first draft] of the guidelines which was to take guidance literally from fire history dataset, from the size frequency distribution with the lower limit of a range of cut sizes at 10 ha and the upper limit at 10,000 ha with a lot of small cuts but the bulk of the area clearcut form a few large disturbances. There is a requirement for all guidelines to undergo a 30-60 day public review. In the case of the natural disturbance guidelines the review period was 60 days. There were a lot of comments in response to the [first draft of the] guide and most of them (about 98%) were negative with most of the concern around large clearcuts. Many of the comments received were form letters [developed] by environmental groups and forwarded to MNR from the public. Industry did have some concerns as well and at the end of the day pulled their support for the frequency by size class approach. They were concerned with the foreign perception and industry's image with regards to clearcuts and forest certification etc. Although MNR did initially have the political support of the guide (i.e., following through on a legal requirement), the politicians did not really know what natural disturbance meant. Once the public review comments were received there was no longer the political support for the guidelines. The guidelines were revised and a second approach was developed which did take part of the natural paradigm but did not explore the full range of sizes that natural disturbance would suggest and was therefore not as good as it could have been. The revised approach was to have 80% of clearcuts <260ha in the boreal region and 90% of clearcuts <260 ha in the Great Lakes region. The second approach went to the public and negative comments were received primarily from environmental groups in regards to there not being an upper limit of clearcuts sizes. However this second approach was accepted and the guide was implemented.
In addition to the public review process preparation of draft guidelines by MNR was assisted by the Provincial Forest Technical Committee – with representation from MNR, industry, environmental community, academic community and other interest groups. (OMNR Aug 2001).

What were the primary concerns of the stakeholder groups?
There were numerous (thousands) comments from the public review process. Most responses were critical to the *idea* of clearcuts, not necessarily the size of cuts. But the government had to be true to the Crown Forest Sustainability Act and knew that there was little they could do to get around the controversy. They tried to make it clear that clearcuts would be incorporated but residuals would be added; further the cuts would not replace fires (there would still be large fires on the landscape) but could emulate small to medium sized fires. Another concern raised was that fire is a chemical process and harvesting is a mechanical process. Some [stakeholders] also supported the precautionary principle that they should not do large cuts since the effects were unknown. The NGO's in particular had quite a bit of concern with the first version, they did not want to be promoting large clearcuts. One NGO actually quit. Industry then became concerned with the issue as well, primarily in terms of being able to gain certification, etc. The draft was revised and changed quite a bit in terms of the distribution of cut sizes.

Some of the companies who had already been incorporating ND patterns in their forest management thought that the Guide was just an extra layer of process to go through. However, the government needed a consistent approach for all companies.

What were some of the challenges, issues, and road-blocks along the way? Did it turn out as hoped, or were compromises necessary or disappointments along the way?
There were some challenges in implementation of the Guide. Industry understood what and why and supported the concept of NDE but there were some problems in translating the direction of the Guide on the ground. Some of the questions related to the planning and how much detail to put in the FMP, how much documentation is required in FMP, how to report ND guidelines in FMP. The FMP planning process remained the same as previous, during development of the Guide they tried to make sure the direction was similar to the original process. The government did suggest additional tables which may be included relating to the guide (eg, to track residuals). There were some operational problems in implementation. For example, the guide deals primarily with incorporating ND patterns into clearcuts. However most of the harvest systems in the Great Lakes - St. Lawerence (GLSL) forest region are selection cutting, shelterwood and some clearcuts. The industry had some questions around how much of the Guide needs to be applied in GLSL and how to implement the Guide when using selection cutting and shelterwood systems. In most cases the government was able to come up with solutions or compromises in order to live within wording of Guide but also provide a solution that industry could live with as well. One aspect of the Guide the government could not move on was the 80/20 clearcut size ratio. That standard was needed in the Guide in order to sell it to the public.
Overall, there was some disappointment with the final result, it was a big departure from the original natural disturbance approach.

In the end, does it achieve the desired objectives? If not, why not, and how might it be done differently next time?
Not sure if the initiative was/is successful. In terms of the goal to improve biodiversity it is still too early to tell. They tried to bring as much science as they could into the development, however at the end of the day it is the political will that will prevail. It was successful in terms of creating awareness and getting the companies to think about ecological processes. In terms of long term social benefits and changing company behaviour it was successful. In general the companies have seen it as positive. At the time, there were some people in industry thinking about the concept but they were not sure where to go from there (eg, Tembec, Weyerhaeuser, Domtar).
If had to do things over would likely:

- Do more science first
- Do more consultation around the uncertainties – need to recognize the uncertainties upfront and communicate this/interact more
- Develop a plan to assess if the guide was effective early on. For the current initiative this was not done until after the fact.
- Would have broader consultation.

How was success measured or monitored?
The effectiveness of the guide will be assessed in two ways by 1) assessing the effectiveness of the Guide's directions (are the directions correct?) and 2) assessing the effectiveness of the outcome of the Guide's directions (were the expected results achieved?). The action plan (Nov 2002) was designed to assess the directions, from an ecological perspective) of the Guide and the

effectiveness of the outcomes will be assessed through other plans (OMNR 2002). To determine if the guidelines are good science the Ministry has undertaken a program (initiated 2 ½ years ago) to look at direction in guide regarding size and residuals (why and where to leave them) and rationale for leaving individual trees. The study includes empirical data from a number of fires and simulation modeling. There is also compliance monitoring as part of the FMP process where the companies need to report on what was done (post harvest).

What are 3 key lessons learned from this experience?

1. With regards to the multidisciplinary writing process, need to be aware that there are agendas out there and regardless of how much science is available, at the end of the day, political will usually wins.
2. What made it work was that aside from the legal mandate to implement the Guide they had support of senior managers and the Minister. This was key in allowing the completion of the guide, particularly when there was resistance from the public.
3. Getting a large number of people involved early on is key and making sure there is supporting science for the initiative and in lieu of science, expert opinion.

From McNicol and Baker (2004):

1. Ensure interactive and adaptive public consultation – ensuring ongoing interaction and consultation during the analysis and development of guide to expose evidence and promote broad agreement.
2. Develop a monitoring program to evaluate policy effectiveness – to evaluate impacts of implementation of new policy.
3. Address possible inconsistencies in policy consequences – for example using natural disturbance to emulating the patterns of natural disturbance on the landscape and not the process of fire.
4. Communicate proactively about new policies – for example communications plans that better help the public understand ecological processes and scientific knowledge.
5. Strengthen stakeholder partnerships – long-term ongoing knowledge and consultation with the industry, public, and nongovernmental organizations to understand impacts and mitigation of risks and reach compromise.

What are the research/knowledge requirements? (i.e. to do this better or to implement at a larger scale)

As stated in the Guide (OMNR 2001a) the effectiveness of the Guide needs to be tested through formal rigorous monitoring through an adaptive management process in order to assess its effect on featured species (i.e., for which there are fine filter guidelines for the protection of).

What is the current status of the initiative? What are the plans for the initiative in the future?

The guide was released in 2001 and has begun being implemented with full implementation 2004. One of the problems industry faces is that there are a number of guidelines from government and they often provide contradictory advice among management or guidelines for specific species (i.e., guidelines for management of marten vs moose). It makes it confusing for

planning teams and there should be one guide - the landscape management guide – which deals with the larger picture instead of focusing on individual species. The creation of the landscape guide will supplant individual species guides and the natural disturbance guide. It will be at the landscape level but include stand and site level management. It should be complete fall of next year.
They will now also incorporate the guide into a landscape level guide that will include stand and site direction – it will change and be incorporated into larger initiative. There is an advisory group, including scientists, to develop the new guide. The project has proceeded fairly well although there are some delays in getting the science done. The public participation through the committee has been good – there is a lot of back and forth between the steering group and the science on what will be done.

References/Additional Information Sources

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McNicol, J.G. and J. A. Baker. 2004. Emulating Natural Forest Disturbance: From Policy to Practical guidance in Ontario. Chapter 21 *In* Emulating natural disturbances: concepts and applications. Perera, A. H., Buse, L.J., Weber, M.G. (eds).

Comments from case study researcher:

The Ontario Ministry of Natural Resources Forest Management Guide for Natural Disturbance Pattern Emulation provides direction on emulating natural disturbance both at the stand and landscape level for public lands in the province. Although guidelines or standards are broad, there is some allowance for deviation from the stated guidelines if supported with appropriate rationale and regional data.

Based on the input from the interviewees, the guide represents a compromise between the concept/science of emulating natural disturbance and the public/environmental opposition to clearcuts. The public opposition to clearcuts was significant despite the apparent high degree of acceptance for the natural disturbance approach during the Environmental Assessment Hearings and the CFSA. Compromises were necessary to balance the legal requirements to emulate natural disturbance and limit the size of cuts, particularly to address the perception that natural disturbance emulation would allow for very large cutblocks. Based on comments from one of the interviewees, he did not believe that more science would have led to greater acceptance of the Guide. Another comment from one of the interviewees was that things in Ontario are over *regulated; there is no allowance for industry to try different approaches (for example, unlike Alberta where there is more flexibility and a greater opportunity to learn from experience).*

In addition to the challenges stated in the above text another challenge alluded to in McNicol and Baker (2004) is that the public is invariably suspicious whenever government tries to change public opinion, regardless of the supporting evidence. Therefore government driven initiatives may face additional challenges during development and implementation. Furthermore government initiatives require the support of a very broad stakeholder group, which includes the general public. As mentioned by one of the interviewees, when the directive was set for forest management to emulate natural disturbance, the politicians who set the directive may not have had a good grasp on what 'emulating natural disturbance' meant.

Although the Guide has been released there appears to be a lot of work required to implement the Guide. These include difficulties in the interpretation of the Guide; government representatives mentioned that some companies interpret the guide exactly whereas others are more flexible. Most of the interpretation issues are dealt with on a concern-by-concern basis between government personal and industry. Still remaining in the ongoing development/implementation of the Guide is the revision/incorporation of the Guide into the new Landscape Guide and the development and implementation of the assessment and monitoring plan.

Despite the challenges, the Guide does provide relatively straightforward guidelines and standards, albeit broad, for incorporating natural disturbance pattern while providing a background rationale for the concept and understanding of emulating natural disturbance and limitations. Further, the rationale and plan for the development of the Guide is well documented both in government publications and the literature. There are a number of sources of readily available information to support this case study including summary documents, technical reports, numerous backgrounders, and published literature.

Case Study #3

Keeping Forests Healthy While Harvesting Timber
Manitoba Model Forest/ Tembec (Pine Falls Division)

CASE STUDY INFORMATION:
Background
The Manitoba Model Forest case study project involves the development and implementation of guidelines for wildfire based harvesting at two different scales: landscape design guidelines and cutblock guidelines. The Manitoba Model Forest project began with the initiation of research in the late 1990s to develop guidelines based on natural disturbance (wildfire) patterns. Wildfire research was undertaken and guidelines were developed over the next few years. Information for development of the guidelines included: previous research on post-fire and post-harvest effects on plant communities and regeneration (Ehnes 1998); fire history records and mapping/analysis of six wildfires with a combined area of 75,000ha (landscape level); and data from permanent sampling plots (cutblock level). Based on the guidelines, trials were implemented in Tembec's forest management area, over a period of three years (1999 to and 2001); five-year monitoring of the trials is scheduled for 2006.

What was your objective with respect to using or integrating natural patterns?

There seem to be three elements to this initiative; 1) to develop (provisional) stand and landscape level natural pattern guidelines, 2) to test the ability of those guidelines to emulate subsequent natural patterns and processes, and 3) to incorporate all new knowledge into a new provincial planning standard. (although no one worded it quite this way during the interviews).

Why did you think this was important (to do/initiate)?

The Manitoba Model Forest vision of sustainability involved encouraging a more "natural" footprint, but the linking of guides with responses was unique. The company saw that natural disturbance patterns seemed to be the way of the future. The project was a good opportunity to put scientific knowledge into practice. The project also represented a non-threatening approach to informally assess how things were currently being done.

Did this need arise from policy direction from within your organization, strategic commitments in higher-level plans, regulatory requirements, or other?

The idea, workplan and budget came from within the MMF as one of their original commitments. As a partner of the Manitoba Model Forest, Tembec was supportive of, and involved with the project from the beginning, and the operational trials occurred on their land base. Note that this research was also the PhD thesis of an individual with the MMF.

What scale(s) or level of planning was affected?

Landscape and harvest block scales.

Describe the initiative - exactly how are natural patterns now more integrated into FM planning?

There are two stages to this project. The first is the development, implementation and monitoring of wildfire based guidelines in four trial areas. The second is the ultimate incorporation of the guidelines into Tembec's and the province's forest management. While the guidelines are specific to the ecological region for which they were developed, the principals and ecological objectives are applicable to most of the boreal forest.
In the trials, natural disturbance is incorporated in fundamentally different ways at the operating area and cut-block levels of planning and operations (i.e., landscape and stand to site spatial scales, respectively). At both levels, the overall objective is to conduct timber harvesting so that its effects approximate those of a large wildfire.
At the operating area level, the guidelines are a planning exercise. When designing an operating area (i.e., at the landscape spatial scale), cutblocks, roads and other types of disturbance are located in the same places that fire typically burns while retention areas are located in the same places that fire typically skips over.
At the cutblock level, the guidelines largely relate to how harvesting, site preparation and regeneration operations are conducted. Here the objective is to have the cut-block look, feel and operate like a natural forest as quickly as possible. Some large initial differences between the effects of harvesting and a large wildfire are unavoidable, however, the objective is to eliminate these differences as quickly as feasible.
With regard to the ultimate incorporation of the trial guidelines into company operations and provincial regulations, the intent and practice is to involve the provincial agency in every step of the trials and make the results available to them. Ideally, the provincial government will be influenced by this information and make adjustments to current policy and regulations. Until this occurs the company will only conduct these operations on a trial basis with government permission.
The guidelines are documented and summarized in various reports/papers including "Harvesting to regenerate a natural forest: Guidelines for landscape design and cutblock operations" ECOSTEM 2004

At the landscape level, planning operating areas is specified by 10 steps/tasks, which include delineation of operating area, incorporation of macro-site variables, mapping of wetlands, mapping of undisturbed corridors and wetland and upland islands, and location of roads and landings.
At the cutblock/site level, harvesting guidelines are based on macro-site type and include both harvest and site prep guidelines. (The first five steps relate to lay-out of cutblocks with respect to sensitive ecosystems and seasonal areas). Steps six to eight relate to guidelines designed from wildfire effect, as follows:

6. *Harvest using method appropriate for macro-site type.*
   a) *Clear-cut with about 5% scattered retention. Retain aspen except on harvest trails. Cut all balsam fir and tamarack;*
   b) *De-limb and top at stump;*
   c) *Disturb only litter layer on mineral soil. Do not rut organic soils;*
   d) *Leave snags standing where possible. There may be Workplace, Safety and Health regulations that prohibit snag retention in chain-saw operations.*
7. *Site prepare and regenerate harvested sites as soon as possible based on macro-site type prescriptions.*
   a) *On mineral soil, disturb only the litter/lichen/moss layer. Do not disturb organic soil*
   b) *Target recruitment density for age 3 is about 75% of fire density for the macro-site type with a species mix that reflects typical post-fire tree species composition for the macro-site type.*

8. *Kill any residual trees that are still alive at age 10 so that an even-aged community develops.*

Was there scientific knowledge in existence to support the initiative (if relevant)?

From the MMF project and PhD thesis.
There is a fair amount of information and research done specifically relating to the project and the study area to develop the guidelines; including post-fire and post-harvest recovery (PhD thesis), landscape level analysis of disturbance, additional post-harvest recovery for local area and the differences between wildfire and harvesting are and the mechanisms for the differences.

How much of a shift was this for the organization, how did it differ from the pre-initiative process or practice?

Several – for example:

a) The nonproductive landbase (i.e., alder, shrubby areas) is where roads would typically be constructed however under the ND prescription these areas do not burn as much therefore we should reduce disturbance in these areas and roads and landings should be constructed on the productive landbase; and

b) on wetter sites (i.e., black spruce swamps) the natural pattern indicates that these areas do not burn as much and should not be disturbed as much, however the company traditionally fully utilize black spruce on these sites.

c) It is best management practices to retain/avoid damage to regenerating understory (i.e., white spruce, balsam fir), however the harvest prescription directed that these shade tolerant species should be eliminated by knocking them down or killing them, since they would not have occurred immediately post-fire (Ehnes and Keenan 2002).

As described in ECOSTEM 2004, the main differences between the design and current practice are, based on the design guidelines:

1. More pine and less spruce are harvested.
2. Roads and forwarding occur within harvested rather than retention areas.

3. Regeneration methods place more emphasis on creating natural recovery pathways for understory species composition and soil processes.

At landscape level, the design guidelines changed the normal cutblock layout in the following ways:

- Some commercially viable forested peatland areas were left undisturbed in corridors or islands;
- Some sites with rough, rocky terrain were in cut-blocks because fire usually burns all of these areas (however some of these sites were not cut under the guidelines due to inaccessibility or safety issues); and
- Changes in the scheduling of operations due to placement of roads (i.e., under the design guidelines roads were placed on the interface between mineral and organic soils rather than through frozen, untreed wetlands).

Who initiated the idea?

Incorporating natural disturbance into forest management was part of the first Manitoba Model Forest proposal in 1992. Members of a Model Forest working group focused this broad goal into a particular project. But the main driver was a single individual who had the vision for his PhD work prior.

Was there public input? Was there other agency input?

Public input was primarily through the Manitoba Model Forest members which include industry, first nations, municipal governments, unions, NGOs, trappers, and provincial government (Manitoba Conservation), all which would have had input/knowledge of the project. Several workshops and public meetings were held to introduce the concepts and guidelines to interested people. Scientific expertise was gained through the PhD process, and a group of technical experts from Manitoba, Alberta and Finland was assembled to review the initial guidelines and related documents and attend local workshops. A provincial workshop was held so that people from government, industry and environmental organizations could review the principles and guidelines and discuss how they might be implemented in their regions.

Did it turn out as hoped, or were compromises necessary along the way? What were some of the issues and road-blocks along the way?

Major difficulties with implementation of the trials arose during the site preparation and regeneration stages. Several methods were tested over three years but none achieved the target levels. From the start we anticipated that it would be difficult to achieve dense regeneration of post-fire pioneer trees species and rapid convergence of post-harvest and post-fire ecosystem parameters. For that reason, more than one cutting, site preparation and regeneration method was proposed for each trial area. Prescribed burn was thought to be the best site prep technique to meet the regeneration objectives but weather conditions and fire indices prevented this technique from being implemented.

Some of the guidelines contravene current provincial regulations. For example, due to the location of the Pine Falls operation and visibility one of the desires of Manitoba Conservation is to harvest and then get out (i.e., roads) so some prescriptions (i.e., max cutblock size, green up) are not being done and are modified to meet other values (i.e., aesthetic).

In other cases there were some changes to the prescriptions as written in order to balance other/conflicting values. There will likely be necessary changes if the prescriptions are to be implemented / accepted on a larger scale.

At the landscape level the design was okay but the site guidelines/prescriptions were harder to apply and implement. There were conflicting views/values of various stakeholder groups with regards to some of site guidelines/prescriptions. For example in order to attempt to achieve the very high, post disturbance stand density, a prescription which was attempted directed the operators to evenly space the 5% of merchantable standing trees. However there were a number of different views of this prescription from the various stakeholders:

a) Operational concerns included how do you logistically leave trees in the manner described and how do you replant (although initially the prescription was time consuming, the researcher was able to work with the operators to simplify the process and once the operators had adjusted it did not affect operator productivity);

b) Public - aesthetically the harvest areas did not look nice, clumps of trees would be preferable; and

c) Trappers were not on board, as they saw no value in the prescriptions.

At the single tree scale, the company has simply not doing it as prescribed.

Some internal concerns related to a change in operations as a result of the prescriptions. For example, leaving quality wood (black spruce) behind on the wetter sites to parallel natural patterns was a hard sell for the company.

The substantial cost of setting up the trials was a concern as is the cost associated with the ongoing monitoring, particularly since there is currently no commitment for longer term continuation/funding for the project beyond this last year (2006).

One of the companies concerns was that under the guidelines clumps of small trees were harvested which would normally be left and where these were common they could affect operator productivity as factored in wood supply analysis. Some adaptations were made during the implementation and a number are recommended for future implementation, primarily around achieving retention targets and regeneration/recruitment density of black spruce and jack pine.

Another company concern was that the implementation took planning out of the hands of the planners. Initially the operators were having problems implementing some of the harvest rules which increased the time required for harvesting; however, the researcher did spend some time in the field with the operators to ensure that the operational guidelines could be implemented more efficiently. This was in reference to the spacing of residual/leave trees

Broadcast burning was initially proposed as one of the site preparation methods; however provincial approval was not received until the sites were 1-2 years post harvest so broadcast burning was not included as a site prep method. This resulted in four trials: two seasons and two site prep treatments (mechanical and none). There were also some complications with setting up the trials, which included timing of harvesting, subsequent sampling effort, implementation of harvest design (winter harvest areas), and limitations of site preparation methods (ECOSTEM 2004, Ehnes and Keenan 2002).

One of the prescriptions, to destroy white spruce and balsam fir during harvesting, was in conflict with current best practices and therefore difficult to change the mind set of the operators who would previously had protected this regeneration, further it was impossible to differentiate between white and black spruce while on the harvester, so white spruce would often get protected anyway (Ehnes and Keenan 2002).

In the end, does it achieve the desired objectives? If not, why not, and how might it be done differently next time?

It is uncertain if desired biological response objectives were met. The trials were initiated in 2000 and next year will be the 5 year remeasurements. Following remeasurements then they will get first good impression if it is actually working. Unfortunately, the failure to achieve one or two ecological objectives can have cascading effects in an ecosystem. Since dense regeneration is thought to be necessary for the restoration of natural levels of many ecological functions, the inability to achieve relevant targets in the trials means that this is an area that needs to be the key focus of future efforts.

It is not entirely clear whether or not the objectives were financially viable either. A detailed economic analysis has yet to be completed.

The implementation of the landscape design appeared to go quite well. However based an initial assessment of the implementation of the cut-block design guidelines from ECOSTEM 2004, it was more difficult to implement, primarily related to the success at post-harvest recovery pathways (i.e., regeneration): Some guideline implementation issues at the cutblock level were:

- Initial substantial decline in productivity of operators due to being too conscientious in deciding which/where to leave trees (this was quickly corrected).
- Diameter distribution of retention trees were skewed towards small trees.
- Actual retention levels varied substantially from target levels.
- Post-cutting decline in retention tree density was more rapid than desired

What are 3 key lessons learned from this experience?

CON:

1. Generating cutblock post-harvest ecosystem recovery that approximates post-fire recovery may require several successive trials because (1) we understand so little about how ecosystems operate, (2) a long time is required to determine whether modified practices are working, (3) there are some large initial differences that cannot be eliminated if industrial harvesting is to remain commercially viable, and (4) to date we have been unable to devise a way to approximate the chemical and physical effects of fire on soil and the forest floor without prescribed burning.
2. When trying to approximate wildfire's effects, a measure that promotes one ecological objective often decreases the likelihood of achieving another ecological objective (e.g., scarifying a site creates suitable seedbeds for seeding but destroys some advance regeneration).

IND:

1. The prescriptions took the planning out of the planners hands – to implement on a large scale work between planners and researchers would be of value i.e., workshops.

2. Need agreement on what is happening at the site level
3. Need to make operational at the landscape level (i.e., landbase is 40% non productive) – many of the prescriptions were not practical when rolled up to the larger landscape area. Trials were established in areas which may not be representative of the entire landbase.

What are the research/knowledge requirements? Regulatory requirements?

1) If the goal is for timber harvesting to approximate the effects of natural disturbance then the first thing needed to design guidelines is a good knowledge of natural patterns at multiple spatial scales and a good understanding of the mechanisms that generate those patterns. This is especially true of the stand and site scales. Longer-term results from the trial are necessary and information from permanent sampling plots.

2) Before implementing at a larger scale, the province will have to look at guidelines i.e., maximum cutblock size, single trees. There are some aspects/areas where the ND strategy may contravene current practices/regulations. A forest practices group (including Manitoba Conservation and industry) are working to develop and revise policies/guidelines. They just started on terrestrial guidelines so project will likely change policy.

3) The guidelines document lists a number of issues not addressed in the current iteration of guidelines which include: riparian areas, access and road decommissioning, linkages between uplands and lowlands, etc. As indicated by industry, one of the impediments to implementing the design to the broader landscape level is that the trial sites were not typical of the region. This is also mentioned in the ECOSTEM 2004 with regards to the two winter harvest trial areas, which were considered unusual for the area.

References/Additional Information Sources

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Comments from the case study researcher:
To date, the project has been implemented on a trial basis and monitoring still needs to be done to determine if the project achieved the objectives. Initial impressions indicate that the prescriptions were relatively easy to implement at the landscape design scale but more challenging at the cutblock/site level.

The guidelines appear relatively straightforward and were based scientific information; however, the objectives that they were trying to meet at the cutblock level may be difficult to achieve in the short term. For example, to meet the objective set for regeneration, the level of site preparation and effort, which may be required, may be impractical. Appears that the objective of the guidelines was to emulate the effects of fire (i.e., high density regeneration) rather than the post-fire pattern. Trying to match the effects of fire through harvesting would likely be much more challenging than trying to recreate the post-fire pattern, especially in the short-term.

One of the differences between this initiative and others (eg, HWP, Alpac) is the use of static targets as opposed to a range or variability. Prescriptions which are set within the range of natural variation may allow the operators more flexibility and have a greater chance of creating a wide range of habitat conditions in addition to reflecting the highly variable natural of fire. However, from the fires studied for development of the guidelines there was little variability in the percentage of area of disturbed patches, corridor patches, and island patches (ECOSTEM 2004).

Based on the information gathered to date, I would summarize that the guidelines appear to be based on a reasonable amount of scientific information and knowledge specific to the project and the local area. Based on the consultant's responses to the question of who initiated the idea and the question of public/agency input, the initiative appears to have good exposure/input from the scientific community and technical experts, however it is not clear from the response to date how much involvement industry had in the design of the guidelines. There are numerous documents describing detailed research and project summary information related to the initiative.

Case Study #4

The Mistohay Experiment

Mistik Management Ltd., Saskatchewan

Mistik Management Ltd. manages a 1.8 million ha Forest Management Area (FMA) in the boreal mixedwood region of west-central Saskatchewan. In the late 1990's they initiated work on a harvest plan, within an 11,000 ha operating area, which would emulate a natural disturbance event.

Describe the initiative - exactly how are natural patterns now more integrated into FM planning?

Taking what we know about wildfire patterns, the idea is to redesigned the harvesting operations within an 11,000 ha planning compartment as a clustered one-pass system, with a few very large harvest "blocks" surrounded by several smaller ones, and leave behind a wide range of sizes, shapes, and types of undisturbed residual material. The plan would also compress all disturbance activities (road building, harvesting, silviculture) into about a 20-month period (instead of 15 years over two passes). After completion, almost all roads were rolled up. The company will not be returning to the area of the main event for 40-50 years, although some small portions will be accessed in 10-20 years.

Compared to a traditional planning scenario, the resultant patterns are quite different. The natural disturbance experiment harvested the same area in 31 blocks compared to 129 blocks in the traditional planned area, resulting in larger patches and less edge (i.e., average patch size of 84 ha vs 21 ha and edge of 167km vs 326 km in the traditional planning scenario). The total final length of roads were 50 km as opposed to the traditional planning scenario of 122 km, with roads being retained for much less time than the 20 years of scheduled activity within the traditional planning scenario (Burton et. al. 2003). After all disturbance activities ceased, the road length is now only 5 km.

What was your objective with respect to using or integrating natural patterns?

To see if it was logically possible, economically feasible, and socially acceptable to emulate some or most aspects of a natural disturbance "event" pattern through harvesting over space and time. Also, to create such an event as a demonstration of a concept that for some was difficult to translate into a "real" plan.

Why did you think this was important (to do / initiate)?

The company was doing a more traditional style of harvesting (i.e., multipass), but there was a movement in industry and the scientific community for natural disturbance emulation. Mistik strives to be a leader in sustainability, and this was a natural progression of the idea of integrating natural patterns. However, since no one had done it before, there were many questions (cost, practicality, wood quality, public opinion, etc).

Did this need arise from policy direction from within your organization, strategic commitments in higher level plans, regulatory requirements, or? other?

At the time, creating "natural" disturbance events was a novel idea, and arose purely from a desire within the company to try to change the way they do business on the ground – based on the science of natural patterns.

What scale(s) or level of planning was affected?

Operational / tactical.

What were current operating/regulations which would have affected project implementation?

There was nothing in the regulations that said we could or could not implement a different way of harvesting. The open nature of the regulatory framework was a significant factor in the development and ultimate successful completion of this concept.

Who initiated the idea and when?

It was a convergence of ideas, knowledge and opportunity. The "disturbance event" concept originated in 1998 with a consultant working for Mistik at the time who specializes in natural pattern research. Implementation of the plan began in 2001 and was completed over a 3-year period.

Who was involved in developing the idea?

Support for the "natural event" concept (see above) was very high from Mistik, and Mistik staff went to tremendous measures to find a way to make it happen. The conversion of the concept into a practical plan took place over a period of two years, and included several field visits, many presentations, and focused meetings with government regulators and local land users. Government representatives were involved early in the planning process, and highly supportive. They recognized early on that this was something that Saskatchewan may want to consider as a conceptual model for provincial forest management policies.

Was there public input? Were regulators involved or other agency input?

Mistik has a long history of effective consulting. One of the initial concerns of the company was whether this type of plan could be implemented with all the other interests in the area, particularly outfitters (primarily deer and to a lesser degree bear). Representatives from

Saskatchewan Environment were brought in relatively early in the planning process. They weren't just presented with the idea, but the company continued to work with SE throughout the planning. During development of the plan, Mistik worked closely with the outfitters, government and advisory board (a community-based group representing local interest including conservation and historical interests). It was key to get these people involved early on so that they were on board before the plan was fully developed. The Saskatchewan Environment representative was involved continually throughout the process, and interacted directly with the scientific lead on the project.

What were the primary concerns of stakeholders, if any?

Local Saskatchewan Environment (SE) staff consists of regulators, fisheries staff, and wildlife biologists. The greatest concern initially was that the plan introduced some fundamentally new concepts – although the idea was not new, no one else in Canada had done this before. However, thanks to a tremendous communications effort, in the end, there were few concerns. One of their concerns was how the plan would affect trappers and outfitters operating in the area (but see below). The wildlife biologist had some concerns with the idea early on but once the concept was grasped he was fully supportive once he understood that operations were in and out of the area quickly. Otherwise, SE did not impose any additional monitoring or reporting on the company as a result of the initiative.

Local outfitters were also interested in the plan. The bear outfitter was less involved since there was less overlap with bear habitat. The deer outfitter was interested and once he realised that he had input into the plan, he came on board.

Was there scientific knowledge in existence to support the initiative (if relevant)?

At the time (1998), the theory of using natural pattern as management guides was alive and well, but the scientific community was still largely gearing up to study the specifics of natural disturbance patterns. Although there existed no local, specific understanding of natural wildfire patterns at that scale in Saskatchewan, the work of the Foothills Model Forest (FMF) Natural Disturbance (ND) Program provided a strong foundation (and the link here was that the consultant responsible for the ND program was the same one working for Mistik at the time). More specifically, this was the first known operational plan in Canada that adopted the disturbance "event" concept, which expanded the spatial language of disturbance patterns considerably beyond its previous limits.

Did it turn out as hoped, or were compromises necessary or disappointments along the way?

Overall, it was a tremendous success as an experiment / demonstration of if / how natural pattern knowledge might be used at operational scales. First, there were many win-win outcomes, some predictable, and some not. For example, here were cost savings, a minimal road network (when completed), widespread public support, and no obvious serious disappointments. Second, the Mistohay to this day represents a tremendous leap forward as the first true "event" planned and installed in western Canada. It attracted a lot of attention from other agencies within and beyond Alberta. Tours from other companies and governments, the aerial pictures are well used in presentations by many people, and the project is now featured in several published peer-reviewed articles.

Having said that, in hindsight, there were many other natural pattern attributes that could have been brought to bear. However, given the degree to which this plan departed from the traditional plan, it is highly unlikely that any of these issues could possibly have been addressed. There was a "walk before we run" attitude.

What were some of the issues and road-blocks along the way?

There were no real concerns from the operators although there was a bit of a learning curve with respect to leaving structure within the cutblocks. But this was addressed as a cooperative process where they went through the cutblocks and noted areas where improvements could be made. They worked with the operators to achieve the goals. The operators were on board because the plan represented cost savings and saved time, because they stayed in one area longer. Getting the skidder operators on board was also a bit challenging since they wanted to knock everything down (i.e., leave trees). It took some educating and a bit of time for them to change.

The road costs were lower in terms of construction and long term maintenance. However, road maintenance costs in the short term, while in operation, were greater due to the heavy traffic use. The large amount of traffic on the roads was only possible because it was a dry summer, if the weather had been wet the increased amount of traffic would not have been possible.

In the end, does it achieve the desired objectives? If not, why not? How might it be done differently next time?

They overachieved the government objective for structure retention, the road network was lower than what would have been done traditionally, and the road construction and maintenance costs were lower. There was no formal report on costs but they did keep track and found the greatest savings in road building and maintenance costs.

The initiative was also well received by all stakeholders and there has been a lot of interest and reference to the project, including tours from companies and regulators from other provinces. The government thought its success was largely due to the initial consultations with stakeholders including outfitters, trappers, and recreational users. They also believed that the closure of the roads, after the initial harvesting, was important to the project's success/acceptance. The project has had an impact on the way forestry is done in Saskatchewan today (and beyond).

As far as doing this type of thing again, they are occurring, but we did "cherry pick" that site, so subsequent areas may be more challenging and may have to be done differently. Specific conditions are needed relating to homogenous structure of the forest, trapping/outfitter interests, and consideration of softwood/harwood product mix. It would also be nice to integrate a few more key natural patterns; more irregular shapes for residuals, more feathering or partial disturbances, and so on.

How was success measured? What were targets or benchmarks?

Mistik is required to monitor a subset of the blocks for variables such as vertical structure, road network, and a number of landscape metrics. The company is now at the tail end of their 20-year forest management plan and are now using/developing a GIS-based operational decision-support spatial pattern model (NEPTUNE) for analysis of larger disturbance events. This analysis is part of their new 20-year forest management plan where they need to measure and report on a number of criteria including values, objectives, targets and criteria and indicators.

When compared to the traditional harvesting plan for the area, the natural disturbance harvest plan resulted in half as much disturbance edge and less than half the length of roads needed with much less fragmentation within the planning area (Burton et. al. 2003). We also know from the NEPTUNE runs that the total amount of residual, the sizes of the disturbed patches, and the shapes of the event and disturbed patches were all well within the natural range. The proportion of island remnant to matrix remnant was a bit low relative to a wildfire.

What are 3 key lessons learned from this experience?

1. It is not only possible to design "natural" disturbance events, but quite possibly better. It proved more economical, and more socially acceptable.
2. A group effort was required. The consultant for pushing the concept and providing expertise along the way, the support and involvement Sask Environment, and the commitment from Mistik to the idea, and the subsequent effort made to involve stakeholders were all critical to the Mistohay happening as it did. The regulatory agency felt it could have been more of a partner in the consultation process.
3. Flexible regulations were required.

What are the research/knowledge requirements? (to do this better / properly)

Specific local knowledge of wildfire event patterns in the boreal mixedwood (which has now been completed – and the work was due largely to the need demonstrated by the Mistohay in fact). It would also be advantageous to link "natural" efforts to some directed fine-filter research output on the effect of natural event patterns.

What are the policy / regulatory requirements?

The system has to somehow allow for creative and adaptive (to local conditions) planning and encourage the natural range of patterns without giving away the bank. So hard rules will not work. But no rules will not work for some companies either. The concept of a "results-based" system seems ideal, but there is a long way to go to work out those details before everyone is comfortable. In the meantime, perhaps the regulatory system should be designed to change every year or two – to anticipate new knowledge and higher levels of understanding of natural patterns.

What is the status of the initiative?

Similar natural disturbance projects are implemented on Mistik's landbase whenever possible. However there are a number of constraints which limit the application of ND including considerations of previous harvesting, summer and winter harvest areas, balance between hardwood and sofwood areas, limitations as to the intensity and size of harvest areas, and consideration for various outfitters in each of the areas. In areas where there is not much industrial forestry, incorporation of concepts from the Mistohay experiment is the norm.

References

No published information is available on the project aside from the brief one-page note on the project comparing the traditional planned harvest scenario and the experimental natural disturbance harvest scenario in:

Andison. 2003. Chapter 11 in: Burton, P.J., Messier, C., Smith, D.W., Adamowicz, W.L. (Editors). 2003. Towards Sustainable Management of the Boreal Forest. NRC Research Press, Ottawa, Ontario, Canada. Page 450.

Comments from Case Study Researcher

Overall the initiative appeared successful. One of the contributing factors noted was that the stakeholders were engaged early on in the project and their concerns were addressed. Further, the initiative appeared to be a win-win scenario i.e., meeting the objectives of the company in terms of emulating natural disturbance and without additional costs.

Case Study #5

FireSmart-ForestWise Communities Project
Jasper National Park

The FireSmart program is an initiative developed by Partners in Protection, a non-profit, multidisciplinary partnership organisation. The focus of the program is to provide individuals and communities with the necessary tools and information to work towards reducing the risk of fire losses from wildland / urban interface (WUI) fires. Information provided through the program includes strategies and techniques relating to assessment of issues and hazards, mitigation, emergency response and training and education. The FireSmart program is implemented in communities across Canada for the purpose of protecting homes and communities, within the wildland urban interface (WUI), from wildfire.

The FireSmart-ForestWise Communities program in Jasper, Alberta is an adaptation of the FireSmart program with a goal "to develop, implement and assess innovative, ecologically-based methods for managing forest fuels in ways that reduce wildfire risk but also optimize or improve ecological conditions, wildlife habitat and aesthetic qualities in the narrow fringe of forest lands located immediately adjacent to the Town of Jasper and other major developments" (Parks Canada 2003). The implementation of FireSmart-ForestWise in Jasper is a partnership between Parks Canada and the Foothills Model Forest.

What was your objective with respect to using or integrating natural patterns?
FireSmart-ForestWise has dual objectives relating to both fire protection goals and ecological goals. As stated in the environmental assessment the project would contribute to two of Parks ecological goals; "to contribute to ecological restoration directly by improving ecological conditions regarding forest structure and landscape pattern, and to indirectly contribute to ecological goals by facilitating the restoration of fire as an active natural disturbance process in surrounding areas of the park" (Parks Canada 2003).

Why did you think this was important (to do / initiate)?
FireSmart – ForestWise involved the two parallel goals of mitigating wildfire threat to communities, and restoring the natural structures and composition of the forest. However, to some stakeholders the creation of "natural" forest conditions was still just something nice to have, and the primary goal was to protect the WUI from wildfire.

Did this need arise from policy direction from within your organization, strategic commitments in higher-level plans, regulatory requirements, or? other?
Along with the mandate for protection, the reintroduction of fire into the ecosystem was well grounded in Parks policy. Parks policy in the mid 1980's identified a need to restore fire which was also strengthened in the National Parks Act (late 1990's). FireSmart-ForestWise was an opportunity to reintroduce fire into the system.

Who initiated the idea? Who was involved in developing and integrating the idea? (A brief timeline may be helpful in highlighting milestones from initiation of idea through implementation and monitoring)

The concept and the leadership for this initiative came largely from one park warden, although it attracted a large number of partners. The original FireSmart committee for Jasper began meeting in 1999. This gave rise to the FireSmart-ForestWise initiative which was to merge ecological goals with protection goals – which also subsequently became the subject of the park warden's M.Sc. thesis. The project was developed over a three year period from 2000-2003 although there were some demo sites established as early as 1999. Local stakeholder groups like the Edith Lake Residents Association became involved in 2001 after a presentation on the concept. The town of Jasper became involved around the same time. The presentations described the state of the surrounding forest and the risk of forest fire. Following the presentations, the residents of Edith Lake formed a fire protection committee and following the preliminary risk assessment began to implement the FireSmart-ForestWise program around Edith Lake with the main goal of reducing the risk of wildfire. The Jasper townsite workplan was much the same. Soon after, the Foothills Model Forest became a sponsor of the project in 2002. At this point (around 2002/03), neighbourhood "work bees" began to thin the first stands, and work, presentations, and tours continue today.

What scale(s) or level of planning was affected?

Stand level and landscape level. Most of the treatments or prescriptions are undertaken at the stand level however at the larger scale the objective is to reintroduce fire into the landscape.

Describe the initiative - exactly how are natural patterns now more integrated into planning?

We know that the montane landscape historically experienced much more frequent, low intensity fires that kept the forest open and somewhat complex in structure. Due to the huge diversity of forest types (ages/species) present now, there are 15 different prescriptions. All of them to some degree reduce forest canopy density, vegetation, and fuel on forest floor. The forest is selectively thinned, retaining fire adapted species and thinning out fire sensitive species. This will result in lower intensity fires (prevent crown fires) and increase ability to suppress fires. These measures alter fire behaviour but do not eliminate fire.

It is anticipated that after FireSmart measures have been implemented they are able to use natural disturbance more effectively. There will be a big emphasis on prescribed burning – some are planned and some are random ignition fires that can be managed within constraints.

How much of a shift was this for the organization, how did it differ from the pre-initiative process or practice?

Historically there was a singular mandate for fire suppression. However in the mid 1980's the concept of restoring fire was introduced into Parks policy. The expansion of the FIRESMART concept to FireSmart-ForestWise was unique, but consistent with Parks policy.

Was there scientific knowledge in existence to support the initiative (if relevant)?
There was a lot of research from the Foothills Model Forest on disturbance patterns and some earlier research related to frequency of fire, intensity, size, timing and species adaptations. This information lent to the understanding of what a natural forest would look like.

Was there public input? Was there other agency input?
There was a federal requirement for an environmental assessment [in order to implement the program]. As part of the environmental assessment there was a requirement for public input. We reached out to national, regional and local environmental groups, local residents, and the local business community. The Jasper Interface Steering Team (JIST) facilitates formal communication and spokesperson roles where members become advocates and provide important links to the community at large. Partners and stakeholders include: Jasper Tourism and Commerce, Lake Edith Fire Prevention Committee, Outlying Commercial Accommodation Association, Jasper Hotel Association, Jasper Volunteer Fire Brigade, Jasper Environmental Association, Town of Hinton, ATCO Electric, Fairmont Jasper Park Lodge, RCMP, Foothills Model Forest, Alberta Sustainable Resource Development, and Parks Canada. In addition to stakeholders, JIST members include decision makers, opinion makers, interest groups and industry (McFadden 2005). The success of the initiative has been due, in part, to the comprehensive partnership and participation in JIST which groups with a wide range of interests including some opposing interests. Although somewhat difficult we also tried to take the visitors perspective into account.

The public was also engaged in the project through demonstration sites and work bees. Hundreds of people were involved with the work. Although it [the work bees and education] was an investment it was the best way to engage people. Demo sites of about ½ acres were established in neighbourhood areas and many people who were not involved in the work bees could see and understand the mitigative measures for wildlife. There was lots of positive feedback and the sites helped to quell fears and concerns.

What were some of the challenges, issues, and road-blocks along the way?
There were some initial concerns with the program.
Most of the concerns of the various groups related to damage to habitat, impact on wildlife directly, soil erosion, and how species will respond to the prescriptions.

One of the biggest issues related to this was the selling of wood generated from the program to support the program. However, it was established that full-scale logging would not occur and the value of any wood would go directly to the program and not into Park Canada general revenue. There were also concerns included the initial concern with mechanical logging in the Park. However, people were well prepared for the logging and it left little impact and turned out to be quite successful. Concerns were addressed through the environmental assessment.

The project is expensive. There seems to be never ending funding for fighting fire but not so much for preventing fire. Although it was a huge asset the cost was quite high, including a tremendous communications component.

But communicate with people was critical, which was resolved through involving them in the development process, showing them what they were doing and getting them involved on the ground.

Smoke was somewhat of a concern initially. It was much more than originally thought. However, Parks began altering the timing of the burning based on the weather and the communication got better so it began less of an issue.

There were initially some safety concerns as well as timing - why it had taken so long to get to this point. Thanks to the communications effort, both issues were addressed and action was taken.

There was not much conflict between balancing ecological objectives and protection objectives. Although the principles of FireSmart direct that the closer you are to buildings or urban areas the more intensive thinning should be, as you move further away the thinning need not be as intensive. There is also latitude in requirements to remove downed woody material and snags. However, some criticism of the program offers that the removal of wood is not natural and deprives the ecosystem of nutrients and carbon. There was also criticism that instead of the natural process of burned downed wood remaining on site following fire the trees are harvested and removed from the site and sold to cover the costs of thinning. There were also concerns expressed that the project may not achieve its objectives in the end, i.e. act as a fire guard due to thinning and the width of the fire guard. (AWA 2004).

(From McFadden 2005) In conflict with wildfire protection were some municipal bylaws and architectural guidelines implemented to control structural appearance (eg, the use of wooden shakes required for new developments in order to ensure that they are consistent with Jasper's identity. However, the Review Committee of JIST and town administrators have been involved in reviewing and adapting specific bylaws for wildfire risk.

Did it turn out as hoped, or were compromises necessary or disappointments along the way?

The program was successful. It heightened peoples' awareness on the issue of fuel loading and changed peoples' attitudes with respect to fires. The program also heightened the awareness of safety and offers some level of protection from fire. The program also created awareness that more still needs to be done.

From McFadden (2005) "The FireSmart-ForestWise Communities project in Jasper has enjoyed strong public buy-in from the outset. Its dual goal: to restore ecological conditions for wildlife and reduce wildfire threats to residential and commercial developments within the park, commenced with lots of public information and a series of small-scale demonstration site (Foothills Model Forest 2004). The FireSmart-ForestWise project is considered by most in the industry as the 'ideal' type for FireSmart success. It has been able to combine research, restoration, education and stewardship to reduce the risk of wildfire and to restore local forests"

In the end, does it achieve the desired objectives? If not, why not, and how might it be done differently next time?

The initiative was successful in terms of meeting objectives of both ecology and hazard reduction, probably would not do anything significantly different. Every year we think the enthusiasm for the project will lessen but it does not. Most of the cottage holders are involved in the program. 95% of the 50 cottages responded to the program and carried out the recommendations, which were made through the initial assessment. Participation in the program was high, for example there were 75 volunteers who helped with the first demonstration site. McFadden (2005) comments that the success of the FireSmart-ForestWise Communities initiative in Jasper has been due, in part, to the comprehensive partnership and participation in JIST which include groups with a wide range of interests including some opposing interests.

What is the current status of the initiative?
Over the past three winters they have treated 300 ha of forest around the townsite and surrounding developments. Of the 18-20 accommodation areas around Jasper all but one or two have undertaken FS-FW. There are still 300 ha to complete which they hope to complete by next winter. They have done some prescribed burning in the thinned areas – three areas have been burned to date.

How was success measured or monitored?
There is some monitoring information available. From Al's thesis data there is information on pre-treatment conditions and one-year post treatment responses. Permanent sampling plots have been established so that additional/long-term monitoring is possible should funding be available.

What are 3 key lessons learned from this experience?
AW:

1. Communication and gaining public support were critical. They found it was best to deal with concerns upfront. The project needs to be presented in the right way and the community has to respond. From a communication/education perspective, the selection of the location of the test plots turned out to be important also. The more central the test plots were to town the more interest there was and the greater the impact they have with respect to education. There was far less interest/involvement in the test plots further from town.
2. There is significant overlap in the requirements for ecological forest and protection/risk reduction. Both objectives can be accomplished simultaneously.
3. They found that, as they utilized forest contractors for the mechanical thinning, it was relatively easy to adopt practice to meet the special needs of the project in WUI. Learned from industry that adaptable, low impact logging on a smaller specialized scale can work.

What are the research/knowledge requirements? (i.e. to do this better or to implement at a larger scale)
Need monitoring information. They have baseline conditions but long-term monitoring is required to track changes in vegetation, songbirds, small mammals and large mammals.

The program worked for the size of the town of Jasper but if implemented on a larger scale, would probably need to deal with test plots differently, ie over a longer time period such as a weekend.

What are the policy / regulatory requirements? (i.e. to do this better or to implement at a larger scale)
Nothing really required for this project, however based on the experience of FireSmart-ForestWise they have written a few more chapters for the FireSmart manual on how to implement FireSmart in a more ecological way.

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Comments from Case Study Researcher

The FireSmart-ForestWise program appears to have been successful based on the input from interviewees and documented information. Some of the key points of the program noted include: involvement of the community in work bees and demonstration sites and involvement/buy-in from the stakeholders and residents created by communication and involvement (including the Jasper Interface Steering Team). From the stakeholders interviewed, the presentation of the issues and the program by Alan Westhaver was important to their involvement in the initiative.

Although the buy-in and implementation of the program appears to have been highly successful, monitoring is required to ensure that ecological goals are met and implementation of large wildfires and the effects of these will not be apparent for some time.

One of the largest concerns raised involves the selling of the wood generated for the program. Although proceeds from the sale of wood are allocated directly back into the program, the idea of selling wood/resource extraction within the park is controversial.

At this stage in the program, the program appears to be focused quite heavily on the issue of protection from wildfire and less on the reintroduction of natural disturbance into the landscape.

However, I think that creating awareness and generating a program of action to address the need for protection against fire through the FireSmart program may help to create awareness for the broader issue of fire/natural disturbance and some of the issues in the park due to years of fire suppression.

Case Study #6

Old Growth in Alberta

Hinton Wood Products (Formerly Weldwood)

Hinton Wood Products (formerly Weldwood of Canada) managed a 1 million ha Forest Management Area (FMA) in the foothills of Alberta. The following contains information for the case study of HWP old forest strategy. The strategy was developed over a number of years beginning in the mid 90's and was incorporated into HWP's 1999 Detailed Forest Management Plan.

Describe the initiative - exactly how are natural patterns now more integrated into FM planning?

The HWP initiative involved management for a variable amount of old forest within the historical range of natural variation as opposed to a fixed amount of old forest that was common practice at the time. Research was undertaken through the Foothills Model Forest in the mid to late 1990's to determine historical disturbance patterns and define the natural range of variability for different seral stages and forest types at multiple scales on the landscape. Raw data included a pre-industrial stand origin map (based on 1955 aerial photographs) and tree ring analysis. These data, in addition to probabilistic levels of fire frequency and fire size, were simulated in a stochastic spatially explicit landscape disturbance model LANDMINE, to create multiple landscape possibilities of fire occurrence and spread over time. Simulations were summarised into four broad age classes and four forest types and the percentage of area in each class and type were recorded at different landscape sizes ranging from 30,000ha to the Natural Subregion Area. Results of the simulation and analysis provide a frequency distribution of the percentage of each forest type/age class for each area. This information was used in HWP's Forest Management Plan to forecast expected forest dynamics in response to a proposed harvest level at three different scales: the entire Forest Management Area, three Natural Subregions, and 38 Natural Variability Units (approx. 30,000 ha each). Based on the proposed harvest level, forecasts of the proportion of each forest type/age class forecast at each scale are compared to the simulated results for median and range of natural variation.

What was your objective with respect to using or integrating natural patterns?

To conserve old forest over time by approximating historical old forest dynamics over time and space at the regional / landscape scale.

Why did you think this was important (to do / initiate)?
The initiative arose from a need to conserve old forest to meet stewardship commitments to conserve biodiversity. Secondarily, we wanted to know how much we needed, and how to do it. The shift in strategy arose from an understanding from Foothills Model Forest research that old forest is naturally highly dynamic in both time and space. This was in sharp contrast to the static old forest strategy that was commonly used to this point. The other principle borrowed from natural old forest dynamics was the inclusion of the whole landbase in the strategy, not just the working part of the forest.

Did this need arise from policy direction from within your organization, strategic commitments in higher-level plans, regulatory requirements, or? other?

It was internally generated. We were ahead of the government and most other industry at the time with our thinking. Our thinking was influenced by the ND work coming out of the US Pacific Northwest in the early 1990s.

What scale(s) or level of planning was affected?

Strategic, long-term planning at the forest (FMA) scale.

Who initiated the idea? When?

It was an opportunistic convergence of ideas, needs, and tool development. Beginning in 1991, the PhD research of David Andison involved developing the computer model LANDMINE and the use of it to generate historical range of variation for seral-stages on landscape scales. In 1995, HWP staff began looking for alternatives to a static old forest model, and thinking that some sort of natural pattern approach might be the answer. The combined efforts of everyone created the output and presentation methods in 1996 over several months.

Who was involved in developing the idea?

Hinton Wood Products (company), Foothills Model Forest (facilitator), and Bandaloop (expertise / research consultant). The Alberta government became involved during the 1999 forest management planning process.

Was there public input? Were regulators involved? Was there other agency input?

There was public input through the regular Forest Resource Advisory Group (FRAG) of HWP. The FRAG was very enthusiastic about the concept and strongly supported it. Even the ENGO community supports the approach, although there is still disagreement from some ENGO groups on details.

Government senior forester was involved in natural disturbance pattern discussions with HWP and FMF in 1997 / 98 with respect to discussing/planning alternative approaches to forest management. Government interest was to stay in tune with what the company was doing and ensure that the proposed strategy was in line with regulations.

How receptive was the government to the initiative? What were the government's primary concerns? How were these concerns addressed?

The government realized that some of the current practices and policies needed to be reconsidered or revisited for example, distribution of seral stages (overmature wood), size of cutblocks and planning areas, and leave trees. However, there was some concern that the strategy proposed a different approach to forestry and current government policy of even flow, over two rotations. Discussions were ongoing, but in the end the proposed strategy was supported as an initiative for forest management planning.

There were a number of questions shared by government and industry in terms of the concept of natural disturbance. These included high level questions such as what natural disturbance meant, how would this approach balance/conflict with other resources values (i.e., recreation), what would the long-term impact be on wood supply (i.e., leave residuals forever, would cut drop), how would this approach impact watercourse buffers which were untouched.

Was there scientific knowledge in existence to support the initiative (if relevant)?

HWP was at the time (and still is) an industrial partner in the Natural Disturbance (ND) program at the Foothills Model Forest. This long-term program is designed to identify, quantify, and understand natural disturbance pattern at all scales of planning, and help develop integration tools. The old growth question was the first major project assumed by the ND program, and the background research was completed in 1997 / 98. This was a tremendous advantage, and likely a significant reason that it succeeded.

Did it turn out as hoped, or were compromises necessary or disappointments along the way?

Overall, the initiative was a success, and in fact became a turning point for old forest management in Alberta. Several companies have since emulated this technique across and even beyond Alberta.

One of the biggest surprises was the contribution of the "non-contributing" forest to old forest dynamics and targets. Traditional forest management analysis identifies the "non-contributing landbase" (which won't experience timber harvest) and then ignores it. We added it back in to see what the forest as a whole would look like – a novel approach at the time. What became apparent was that there would be plenty of old forest over time (always above the median of NRV) but that most of it would eventually wind up in the "non-contributing" landbase and there wouldn't be much in the "contributing" landbase. So our initial outcome was positive (we would have lots) but we recognized we needed to work on the pattern (more in the contributing, less in the non-contributing) over time if we wanted to more closely approximate natural forest dynamics. This work is now being done.

What were some of the issues and road-blocks along the way?

There wasn't much selling (of the concept) needed at any level, because it addressed a need that was widely recognized. From a company perspective we showed that we had a good old forest conservation plan at virtually no "cost" to the company. Management for old forest on the "contributing" landbase was a bit of a sell internally, but by the time that came up the overall concept was well endorsed, and other factors helped to garner uptake. Still, there were several concerns along the way.

- It was a challenge to put the output in a simple format that still allowed for natural levels of variation, and satisfied the regulatory needs (something to measure).
- It also became clear that it was impossible to meet "natural" old forest targets under the existing policy framework because of some other rules that were in conflict. For example, old spruce in riparian zones always extends beyond NRV because of watercourse buffer rules. This recognition actually generated a considerable debate and further research on the issue of riparian management. Traditional riparian management consists of protected buffers, and the ND model suggests that disturbance is a better way to approach riparian management. This is controversial with some sectors and individuals and is still a work in progress.
- We had to find a way of dealing with the "gap" between natural and cultural disturbance regimes. For example, fire control is imperfect, so we know natural disturbances will influence old forest levels (downward). Also, it may be that a higher than "natural" level of old forest is chosen because that is the desire of the public.
- We made some simplifying assumptions about the landscape, and about old "growth". For example, we just picked an age at which forest became "old". We did not call it "old growth", but the implication was there. But in the end, I think the simplification helped us. The fewer details there are, the more people can focus on the results.
- Some folks are leery about the ND concept in general, believing that it is more costly and/or no better than traditional approaches. Some in this camp come around to supporting the approach as their level of understanding increases, but there are still plenty of folks who are unconvinced.

What were the primary concerns of the various stakeholders/stakeholder groups?

There were no concerns at the time from neither the public nor the ENGOs. However since then some environmental groups have raised concern about the age class definition used for "old forest". There were some initial concerns by the company that the results may suggest lower harvest levels.

There were also some internal concerns include growth and yield implications of partial age class and implications of disease. These are being addressed by an internal multidisciplinary plans and practices group.

In the end, does it achieve the desired objectives? If not, why not, and how might it be done differently next time? If so, how might you do things different next time?

There was unanimous agreement that it achieved the objectives and the success and extension of the approach elsewhere is testament to its veracity. One suggestion for improvement is the amount of resources and time devoted to the project. It would have been good to improve data, documentation, and communication. Work is progressing now on these fronts, and HWP is preparing for the second series of NRV seral-stage runs for their upcoming FMP.

One of the criticisms of the exercise was that it did not specifically identify the size or location of old forest. Although the work was not designed to do this, it was an excellent demonstration of the danger of using isolated pieces of NRV knowledge or tools, and the need to package NRV tools and knowledge together.

What are three key lessons learned from this experience?

1. It is possible to capture and integrate natural patterns at landscape scales (this was the first work of its kind).
2. The Foothills Model Forest "model" of active partnerships worked – it produced good science, but also a valuable tool for partners. Maybe this type of partnership is particularly important to have when a new science is emerging? The unique model was a collaboration of managers who had specific questions they wanted answered with researchers who were committed to getting the information. This approach bridges the gap between knowledge and applications, and shortens the continual improvement cycle.
3. The project worked largely through the initiative, drive, openness, and working relationships between a few key people. Every successful project has a few dedicated champions who keep it going and put their soul into the outcome. For example, the lead HWP planner was steadfast in his communication with the government foresters - he saw the challenges in government and brought them in to create government buy-in through discussions, which included consultants, despite the expense to company. The development team was also highly multidisciplinary.

What are the research/knowledge requirements? (to do this better / properly)

Access to the model(s) that generate the data for this exercise are widely available, so that is not really an issue. However, it is quite possible that the output from a more sophisticated / complicated model, or a set of simulations that involved a larger number of assumptions, or a higher level of detail in terms of output would not have been nearly as well received. The simplicity of the explanations, assumptions, and summaries was a strength.

Part and parcel of using a simulation model is that you need someone who knows how to run, calibrate, and interpret the output from the model.

The last requirement is data and knowledge. We were also fortunate to have exceptional historical data for this area, and a dedicated research program and the FMF. It would be difficult to do this type of analysis with poor data and / or knowledge of the natural disturbance regime. Many Forest Management Areas in Alberta have multiple disturbance regimes – particularly in the foothills. Borrowing or extrapolating from knowledge of other areas is not recommended.

Overall, it is safe to say that at least a part of the reason for the success of this project was the direct link between the research and the management application.

What are the policy / regulatory requirements?

There were no policy requirements *per se*, but this sort of departure from the norm could not have happened within a more rule-based regulatory system. There are two major areas where regulations will be challenged. First, every landscape will be different. A "one size fits all" solution is not going to work. For others to use the same model, any new "rules" will have to be flexible enough to suit natural variation and local conditions. The second shift was away from a model of uniformity towards one of embracing variability. This also has tremendous regulatory implications.

Whether it was by chance or otherwise, it helped that the chosen disturbance scenario parameters generated levels of old forest that were well within the ability of HWP to create. In other words, there were no allowable cut implications. This may not always be the case with others though.

Also have to be aware of interactions with other old forest requirements. For example, the boreal FSC requirement allows for a baseline of plus or minus 25% around an estimated average old forest level. Provincial policies require protection of riparian zones, which we found will eventually spiral well beyond NRV for old forest.

It was also felt that while this was an excellent first attempt, the need for more research still exists – as much for the concepts as the details. Such changes in thinking involve a huge learning curve and it is an evolving science. When the research gets better, the application is always better.

What is the current status of the initiative?

Since this model of old forest strategy was created, six other agencies in Alberta, and two beyond have used it. The original FMF ND program partners (HWP and ANC) are preparing for the second generation of simulation NRV results for their next DFMP's. The likely improvements will be to introduce more detail, and more of a spatial component.

Has the initiative been evaluated or is it being monitored? If so how?

In terms of overall evaluation, the fact that the Alberta government has accepted this as a legitimate old forest strategy for (now) six different agencies represents tacit approval. The objectives established in each case are being measured on a regular basis, and compared to the predicted ranges.

References/Additional Information Sources:

Bonar, R.L., H. Lougheed, D.W. Andison. 2003. Natural disturbance and old-forest management in the Alberta Foothills. Forestry Chronicle 79(3): 455-461.

Comments from Case Study Researcher

There appears to be overall consensus that the initiative was successful and innovative at the time. There appeared to have been little concern (internal of external) with the strategy, which may have been a result of having a multidisciplinary team and involvement from various stakeholders early in the process (i.e., government and local interest groups). Further, since the strategy was relatively simple/easy to understand (although not particularly easy to simplify) may have contributed to the acceptance of and the natural disturbance concept of management within the strategy.

The success of the initiative appears to be the result of a number of contributing factors, which in addition to those stated above may include:

- *Based on the results, it appeared that HWP could feasibly manage for the projected amount of old-forest with the proposed approach. This probably helped with the company to buy-in to the idea.*

- *Since the research was done specifically to suit the needs of the forest company it did not need to be 'adapted' or interpreted, the link between scientific information and application was already made. There are often problems with interpreting or adapting science that was undertaken for one purpose and using it or applying it for a different purpose. This certainly would have made the approach more defendable.*

- *Also the government had realised that some of the current policies and guidelines needed to be revisited so they were open to alternate strategies i.e., the climate was right.*

Learning Step 3 Review how are management scenarios generated?

There is a general pattern to forest management planning that is followed in Canada, and it generally proceeds in the following matter (Tittler et al. 2000 as cited by Burton et al. 2003):

1. the provincial government, which owns the rights and controls the natural resources, passes forestry acts and regulations, and develops policies;
2. the policies and those of other departments (agriculture, fish and wildlife, environment) are used to generate regional land-use plans;
3. forest inventories are carried out by the government / industry
4. timber rights are granted to industry by various methods; such as in the form of a license, forest management agreement (FMA), timber quota or other area-based or timber volume-based tenure arrangement; and
5. the industry then must develop and implement a strategic (i.e. 20 year), tactical (i.e. 5 year), and operation (annual) plans, which specific government agencies will monitor and inspect these operations.

As you can see, the planning pattern is hierarchical in context; each planning level must be consistent with the one above it. It is important to consider that forest management activities must be planned at various temporal (several months to more than one forest rotation) and spatial scales (one cutblock size to forest management area) (Harvey et al. 2003). A good strategic plan will allow for re-current evaluation, such as every five years, to allow for modification of management strategies depending on the feedback analysis from the field which may indicate changes in forest conditions or socio-economics (Harvey et al. 2003). This process is not just between the government and industry, there is input by other stakeholders, such as the public, aboriginal community, outfitters and so on.

Forest management plan

The underlying philosophy of forest management has changed from being nearly completely concerned with extracting the raw resources, to one of sustainable forest management which focuses on the multiple-use of the forest resources, the economy and society of today and future generations and the health and integrity of the forest resource (Murphy et al. 2002). However, as in previous management approaches, sustained yield still remains a primary consideration (Murphy et al. 2002). Managing the forest has become much more complex as is illustrated in the table below, the 'compilation of forest inventory data', which is just one step in the process towards SFM planning.

Table 4. The complexity of Weldwood's inventories for SFM (obtained from Murphy et al. 2002; p. 50)

1960 forest management plan: "sustained-yield forest management"	1999 forest management plan: "sustainable forest management"
Forest inventories (for calculation of sustainable AAC) ➢ Permanent sample plots (Continuous Forest Inventory) ➢ Inventory listing all forest types, based on the Continuous Forest Inventory ➢ Age classes of the forest	*Forest Inventories (for calculation of sustainable AAC)* ➢ Permanent Growth Sample plots ➢ Inventory of forest types based on Alberta Vegetation Inventory ➢ Age classes of the forest ➢ Regenerated stand inventory ➢ Ecological site classification

Additional Inventories for the 1999 Forest Management Plan "Sustainable Forest Management"

Visual landscape inventory

- Basis for developing "visual quality objectives" (similar to B.C. visual landscape inventory)

Cultural/historic inventory

- Basis for protecting sites of unique historic or cultural value

Seral Stage/ Forest Type classification

- Basis for "Natural Forest Management" program
- Basis for broad scale/ coarse filter habitat supply

Riparian corridor inventory

- Basis for special management zones
- Physical landform (active channel, floodplain, terrace, fluvial slopes, etc.)
- Site sensitivity (high, medium, low)
- Management access
- Management history pre-1956
- Basis for appropriate silviculture design

Regional Hydrology Study

- Catchment basin hydrologic characteristics
- Hydrologic "triggers" – i.e. threshold limits of management activities
- Hydrologic operations manual (Foothills Model Forest)

Fish and Stream Inventory

- Identify streams with fishery management concerns
- Primary use for operational planning

Wildlife Inventory

- Species grouping of 153 habitat-related species into 17 "habitat associations"
- 30 representative species selected for habitat supply analysis spanning all 17 groupings
- Development of Habitat Suitability Index (HIS) models for 18 species linked to habitat associations
- Preparation of habitat inventory from Alberta Vegetation Inventory (AVI)
- Habitat yield and change forecasting
- Habitat supply analysis models (Critter-cruncher, Wild-weasel, Tribble)

There is an "integration of resources and values, and the results of public input [that] are brought together" in a forest management plan (Murphy et al. 2002, p. 42). Below is a general schematic framework for the process of a strategic forest management plan obtained from Harvey et al. (2003 as cited by Burton et al. 2003);

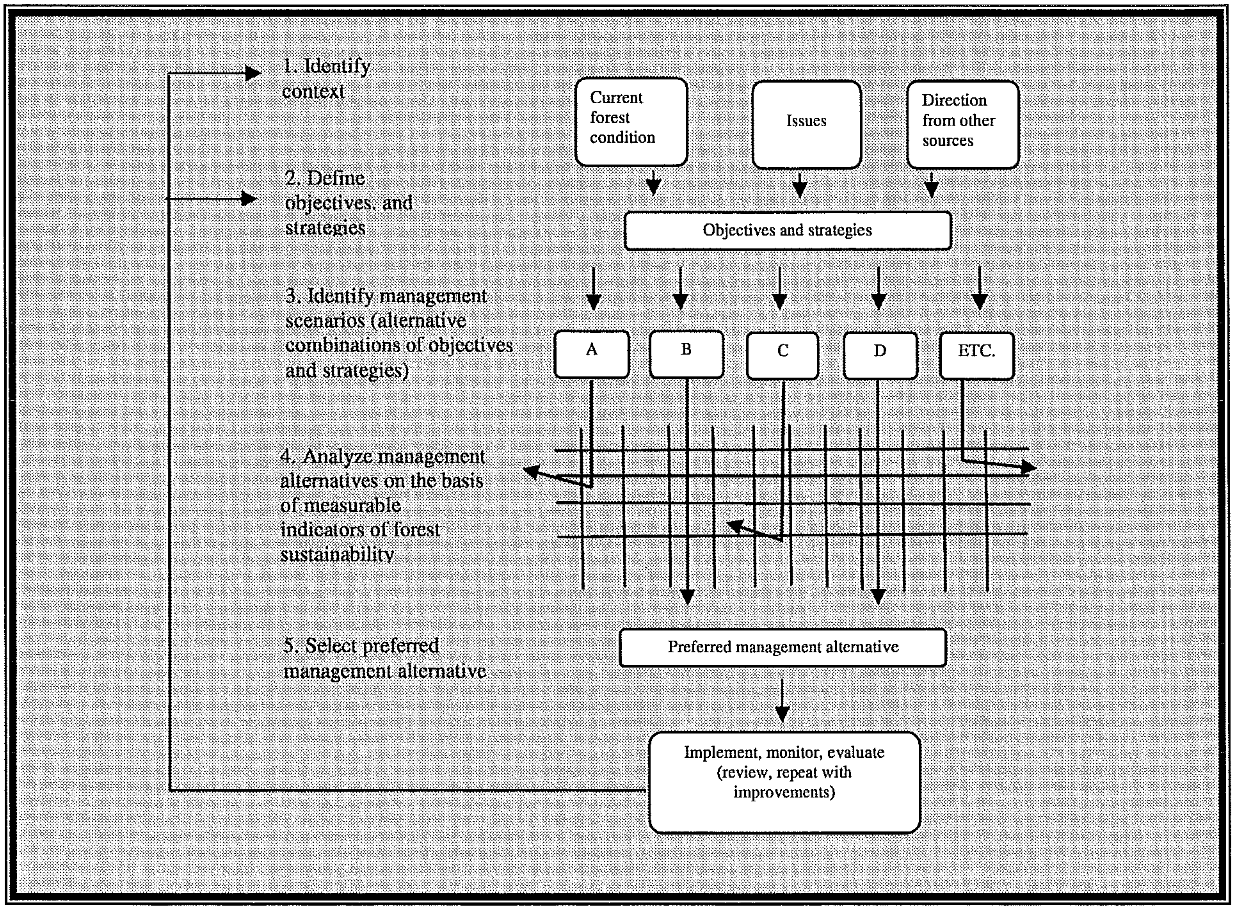

Figure 6. Generalization of a strategic forest management planning process

Where are we now?

The first step towards developing a forest management plan is to determine the current forest condition, the forest age structure, its composition, and so on. The management plan also requires a description of the other land uses and the socio-economic background of the area in question. It is also important to identify who the other players are in order to evaluate if there will be any issues arising when determining what to harvest. Since the land base, the boreal forest, is mostly publicly owned, much of the inventory requirements (forest age and composition, ecosystem classification, wildlife and so on) can be obtained from many of the provincial resource departments.

"...[I]*nventories may take on a variety of forms but generally include a mix of remote sensing technologies – from aerial photography to satellite imagery – and a range of field inventory techniques...essential for validating or "ground-truthing" the interpretation of remote images of ecological units within a landscape or region*" (Harvey et al. 2003; p. 403). They provide information of the current forest and provide the basis to project the future forest conditions (Harvey et al. 2003). They can also provide information on important timber (old growth or mature stands) and non-timber forest values (berry and mushroom patches, water bodies, bear dens and raptor nests, endangered or rare species, and so on). Inventories are essential... "[t]*hey provide the knowledge and data about resources and values that influence management decisions*" (Murphy et al. 2002; p. 42).

What is Mother Nature doing in the particular forest you are dealing with?

In order to develop a natural disturbance based forest management strategy, it is important to identify the natural disturbance drivers of the forest management area. As such, the historical natural disturbances, their roles and effects on the forest ecosystem (individually or synergistically), must be documented early in the planning process (Harvey et al. 2003). As discussed earlier, natural disturbances can range in size, from the death of a single tree to hundreds, can affect the landscape annually or every 50, 75 150 years and so on (must be considered in the context of NRV), and involve a range of disturbance agents such as fire, wind, floods, insects and diseases.

Natural disturbances significantly affect forest dynamics by causing environmental changes through direct physical influence on vegetation (Harvey et al. 2003). As such, natural disturbances affect the forest's natural regeneration cycle which leads to a variety of forest types at any given time and in any given area. Knowing which attributes, particularly those of propagation and establishment, and the processes that generate them, allows for the development of a forest management strategy that focuses on the maintenance of the health and integrity of the forest ecosystem (Harvey et al. 2003). In addition, a key to the development of a successful natural disturbance based forest management strategy, and the development of various models to predict the effects of natural disturbance on timber and non-timber values, is that there must be an understanding of how natural disturbances affect the attributes and process of the forest ecosystem (Harvey et al. 2003). It must be asked "*What are the resource objectives in different parts of the landscape, and what landscape patterns are necessary to accomplish them?*" (Diaz and Bell 1997; p. 259). This is dependant on what resources are present in the forest management area, or use of those resources, which may be dependant on the 'landscape pattern' such as forest interior species, clean water, timber production, aesthetics, tourism, recreational activities, big game and so on – "*what patterns need to be in the landscape, and where do they need to be?*" (Diaz and Bell 1997; p. 259).

Where do we want to go?

Identifying what the desired future forest, and the values that are to be sustained, is a very important and conflicting step in the process of the strategic forest management plan. This step provides the framework for which all decisions and additional plans are designed. Prioritizing which objectives should receive the most attention may at times correspond with current social values and definitions of the function of the forest ecosystem for today and in the future: however there are times of conflict with deciding what is economically best for the company. Also, this step is usually limited by higher levels of decision-making, provincial and federal legislation and policies. Initially when all of the benefits, which society and the company obtain from the forest ecosystem are considered, the list will be long. Below is a list of some subject areas that should be taken into consideration when defining objectives:

- "timber objectives (coniferous/deciduous/mixedwood management, sustainability, harvest priorities);
- silvicultural objectives (reforestation, growth rates, yields);
- forest protection objectives (fire and fuels, insects and diseases);
- ecological objectives (biodiversity, forest connectivity, ecological integrity);
- watershed management objectives (water quality and quantity, erosion, siltation, flooding, riparian zone management);
- fish and wildlife objectives (habitat access);
- aesthetics and recreational objectives; and socio-economic objectives (commercial opportunities, social benefits)" (AEP 1998 as cited by Harvey et al. 2003; p. 408).

Unfortunately, as things are prioritized it will emerge that some objectives are complementary and others are conflicting. Dealing with incompatible objectives is challenging, but can be resolved by using either a point system or zoning compatible values; depending on provincial or regional forest management strategies (Harvey et al. 2003).

As objectives are prioritized, assumptions must be made in respect to stand and forest dynamics for the long term, and the silviculture treatment effects on these dynamics, to assist in the development of tactical and operational planning. While it is difficult to determine if the decisions and assumptions that we make today are sustaining the forests for tomorrow, there is no way of getting around in making assumptions: uncertainty and risk are inherent realities of long-term forest management planning process (Harvey et al. 2003). Adopting the concept of "learning and modifying as we go", adaptive management, may provide some leeway to modify the plan/practices to ensure the sustainability of the forest environment and corresponding values.

During identification of the objectives, questions concerning what should be monitored will arise: "Which processes?", "Which indicators of integrity?" The criteria and indicators developed by the CCFM will provide direction on what should be monitored and measured. As discussed previously, the "criteria" represent Canadian values, issues, and concerns, with respect to the sustainable use of the forest; most indicators can be compared with available scientific valid data and can be repeatedly measured. For example, if a desired amount of an area to be occupied by a forest type, such as old growth, is identified, a natural disturbance based forest management plan should establish a range of desired targeted values for the criteria within their historical NRV, such as: a level of connectivity and fragmentation; and, a minimum population levels and changes in selected species or species guilds (Harvey et al. 2003). (As discussed earlier, Andison (2003) has developed four general rules, questions that one should be asking when they are using the NRV). Therefore, as previously discussed, it is important to identify the natural disturbance regimes in the area, to provide information on historic patterns (spatially and temporally) of natural disturbances. As such, to evaluate management objectives and the effects of forest management practices, a network of natural benchmarks should be set aside to serve as a reference of sorts (Harvey et al. 2003).

What are some of the different ways of getting there and what is the best way of getting there?

Once the strategic plan's policies, goals, and objectives are identified, the next step is to develop forest management strategies that enable these objectives to be met (Harvey et al. 2003). These strategies will then be translated into tactical activities, to implement the strategic goals and objectives, which in turn are developed into specific operational actions on the ground (Andison 2003). As stated by Harvey et al. (2003) there is more than one way to attain an objective, and an evaluation of the impacts of the different alternatives on the resources and management activities, must be carried out. It should be noted that an important part of this step is to identify which strategies can feasibly be carried out with the use of different harvesting and silvicultural methods and to plan where, when, and how, these methods should be applied (Harvey et al. 2003). Also, it is assumed that there will be policies, guidelines or other directions regarding resource objectives for the landscape already in place (Diaz and Bell 1997). Since forest management unavoidably involves making decisions about trade-offs (ecological, social and economical), modeling is a useful tool for creating different scenarios, making comparisons between these scenarios, and deciding which of them are best suited for the task at hand.

It must be identified that designing management scenarios requires consideration of all levels of forest planning: strategic (long-term); tactical (landscape); and, operational (stand-level). While stand level activities need to be planned in detail at the operational scale, because they are the principle means of carrying out goals and objectives on the ground, they also need to be considered in the tactical and strategic scales. As an example, you may want to know which areas going to be harvested during the next 10 years. Below are some ways scenarios can be generated to make management decisions of where harvesting activities may be in the next 10 years:

1. small scale strategy – cut all of the old growth forest first;
2. look for the largest areas where merchantable timber is clumped, thereby avoiding unnecessary road building; or,
3. look at fire risk and decide to put disturbance activities in an area where it is going to reduce the landscape fire hazard (pers. comm. David Andison, March 23, 2005).

Simply put, the current practice is to leave the development of management plans up to the particular company which is responsible for a given forest management area. They do this primarily by taking into consideration merchantable timber, minus road areas, riparian buffers, wildlife habitat needs (salt licks) or species at risk, trails or scenic buffers for fishermen and so on. Whatever is not included in the aforementioned considerations is what they will cut (pers. comm. David Andison, March 23, 2005). This is one way to obtain a forest management plan scenario (noting that they have specific people to generate and analysis all of the data and input it into geographic information systems (GIS) and spatial-and temporal based decision models).

In the future, we may move beyond this approach to work with and consult individuals who are experts in 'natural patterns'. These individuals will likely be asked by companies to provide three or four different scenarios, based on how the primary disturbance patterns occur on the landscape. As an example, if a plan is to be based on how fire patterns occur on the landscape, the consultant would have to come up with a design of what the landscape might look like if a fire burned through the area and provide the company with three or four possible outcomes. These would then become the scenarios from which the company's forest planners would work backwards, by looking at ecologically sensitive areas, areas that cannot be accessed by roads, other players, and so on, to identify within the scenarios areas that cannot be harvested.

The end result may be a creation of two scenarios that may be similar, but which differ fundamentally due to the processes which facilitated plan development and design – created through two different pathways and ways of thinking (pers. comm. David Andison, March 23, 2005).

Did we get there?

The final important step in the planning process, after the strategies and a scenario has been chosen and implemented on the ground, "*is to keep track of what is actually happening in the forest*" (Murphy et al. 2002; p. 81). It is vital to continually monitor, using established criteria and indicators, observe the changes taking place, and analyze them to make certain that the practices are achieving the desired goals, objectives and predicted results. If the implemented practices are achieving the desired outcomes of the company, this "*provides a measure of learning by the experience, and gives assurance that the approach is on the right track*" (Murphy et al. 2002; p. 81). If they are not achieving the desired results as expecting, the method of practice should be reassessed, modified and adapted in order to obtain the desired results (Murphy et al. 2002). The ability to correct or adapt management practices, provides a way to measure additional knowledge that we are gaining about the forest ecosystem and its management (Murphy et al. 2002).

Learning Step 4 **Identify information and data needs required to choose between natural disturbance based approaches to traditional approaches**

Identifying inventory and research requirements, as discussed previously, is an essential first step to developing a management scenario, and provides information about the forest management planning area and values that will influence management decisions. Also, it aids in identifying who the other stakeholders are and what areas can be most easily harvested, with little or no conflict arising from it.

Just a few of the questions asked when developing a forest management plan are: how might we do this; what would be the costs; what would be the acceptance of the management scenario? In order to answer these questions, the right information and data are needed.

As part of the learning process, you will be divided into 4 groups. Each group will be given a mini-management scenario, which you must work through to identify a list of inventory and research requirements that will be needed to carry out a forest management plan based on the Natural Disturbance Model.

Once you have worked through your mini-scenario, one member from the group will present and discuss:

- what information was given
- what assumptions were made
- the challenges that were faced
- what worked and did not work and how this might compare to the other scenarios
- provide the list the inventory and research requirements for the mini-management scenario that would aid in choosing between alternative management scenarios
- How could this scenario be carried-out better? (policy or modified policy)

Learning Step 5 **Discuss the advantages and disadvantages of traditional and natural disturbance approaches**

In this learning step, you be divided into 4 groups to debate the merits of traditional forest practice approaches and natural disturbance approaches. Also to be discussed are the disadvantages of each of the different approaches. You will be given the criteria to guide the debate.

During this exercise, you should recognize that the there are negatives to every approach, even the natural disturbance approach, but there are too many positives to not take the natural disturbance approach into consideration. Even if it changes your way of thinking in terms of the process of forest management planning and of how we are doing things, such as the type of harvesting methods, silvicultural methods, salvaging and so on; then this exercise has been worthwhile.

<u>Criteria</u>

1. Please identify if you support traditional forest management approaches or 'new forestry' such as the approach of emulation of natural disturbances.
2. Once placed in groups of 4-6 people, you will argue the side that is contrary to your own beliefs. (This is to help to clarify your own ideas and to deepen your understandings of the issues)
3. You will have 20 minutes to prepare your arguments
4. Each group will debate their case for 10 minutes.
5. After each group has stated their case, 10 minutes will be given to prepare for rebuttals.
6. 5 minutes will be given to each side for rebuttals.
7. After rebuttals, there will be group discussion to summarize the important issues of the debate.

Some things to think about in terms of the NDM approach and traditional forest management practices:

- Tenure arrangement
- Salvage logging after a wildfire
- Riparian zones
- Costs (management, harvesting and roads)
- Knowledge of disturbance regimes
- How do you know when you have done a good job?
  - 2 levels of verification:
    - 1. things that can be measured – patterns – how much structure was left
    - 2. functional ecological response – conservation of biodiversity
      - Does this take care of cavity nesting wildlife, economic important species (i.e. moose, beaver)
- How would you compare what you have now, to what you used to do?

Some things to think about in terms of the NDM approach:

- ND concept allows for better ecological outcome, but a worse economic outcome.

- Is it beneficial to use the coarse-filter approach (vs. the fine-filter approach)?
    - Did this plan provide for conservation needs of 'species at risk'
- Is the approach of using the NDM more than managing using ND patterns and creating patterns on the landscape?;
- What might be a merit in one disturbance regime, may be a disadvantage in another
- Is it more than a bunch of rules - is it a way of thinking of "what it is your are managing, about how you are managing the forest, and about how the systems to do it are set up to plan, manage and monitor?";
- Is it an approach of having respect for the system you are managing and understanding that it is its own system and can function very well without us?; or
- Is it a useful tool that may allow one to:
    - obtain public support,
    - involve more partners in the planning process (i.e. environmental organizations, oil and gas, outfitters),
    - talk to the public,
    - interact with researchers who are doing research on the landscape area, and
    - obtain certification and make things more efficient.

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A short review will begin the day, to discuss any unanswered questions or misunderstandings from the previous Learning Outcome 2. Also, we will spend a few minutes going over the main points from the day before.

Learning Outcome 3 Design and evaluate natural disturbance based management scenarios

Learning Step 1 Design scenario management plans

This portion of the course is intended to give participants an opportunity to put together a natural disturbance based management plan, as well as to obtain feedback on the plan from the group and the facilitator(s). The objective is to have people to work together in addressing natural disturbance modeling issues. The course instructor will facilitate the exercise and provide direction or advice as needed.

The class will be divided into 4 groups. The plan description, with management objectives, regulation, inventory and data, assumptions, and targets, will provide the background needed. The scenario is to be designed primarily at the landscape level (strategic planning scale); however, since it is impossible to separate tactical and operational planning, each component must also be taken into consideration.

Materials that will be available for the groups include:

- overview of scenario
- forest management area
- transparency paper
- grease pencils, colored markers
- masking tape
- calculators, note paper, dot grid
- one large table per group

Learning Step 2 Interpret designs in context of current practices

When the plans are ready, each group will present their plan to the whole class. Presentations will be limited to 10-15 minutes. Presenters can be questioned about their plan. After all of the groups have presented there natural disturbance based management plans, each group will compare and contrast what they have done (designs), and compare their plan with what is currently being implemented.

Some things to think about in terms of comparing NDA to current practices:

- How would management controls change under natural disturbance management?
- What are the policy implications?
- What is the effect on timber supply?
- What is the effect on rate of cut?
- Is NDM more expensive?
- Docs NDM provide more protection for wildlife species?
- Docs NDM provide more protection for wildlife habitat, riparian habitat and so on?
- What is the effect on salvage logging?
- What are the economic, ecological, and social considerations?

Learning Step 3 Discuss challenges for implementation

As with any approach there will be challenges. Discuss the challenges faced with implementing the natural disturbance model with your counterparts. Are you currently trying to integrate the NDM into your management practices? If so, what are your challenges?

Some things to think about in terms of the challenges in implementing the natural disturbance approach:

- tradeoffs in terms of competing values, goals and objectives of:
  - the company
  - the province
  - and society

(think back to the '3 pillars of sustainability' - economics, society and the environment).

- riparian zones
- aesthetics
- public perception
- salvage logging after a wildfire
- regulatory framework - what are the current challenges in implementing NDM with the current rules?
- costs (harvesting, management, roads)
- data requirements
- modeling capacity (whether or not have the appropriate models available and the data to drive in order to design, run the scenarios and evaluate the outcomes)
- annual allowable cut
- non-timber values
- what are some of the physical limitations to what one can accomplish
- tenure system

<u>List of examples for facilitator for LO1 LS3 -</u> *Discuss the advantages and disadvantages of using the natural disturbance approach for forest management*

- will "climate change" change everything?
  - do we use the past for the future

- What is 'natural' (NRV)
  - how far back do we go for benchmarks
  - how much variation do you account for

- If we build it, will the come
  - assumes that there is a direct relationship between patterns and ecological responses
  - we can never emulate natural disturbance – chemical vs. mechanical

- Harvesting removes the biomass and no matter what we do, we will never be able to fully emulate nature – so why are we doing it? = reduce risk

- We cannot mimic Mother Nature (i.e. 100,000 ha)
    - so why bother
    - assumes that coming close is better
    - riparian zones

- Does not give a clear picture – riparian zones, BC coastal areas
    - research has found that forest fires burn through riparian zones on a regular basis. In the past have harvested riparian zones extensively, but did do a lot of damage to the soil, aquatic habitat, water quality and therefore resulted in buffer zones.
    - the NDM justifies that the riparian zones should be disturbed, however harvesting activity leaves a mechanical footprint – biomass is removed, different than wildfire activity, where most of the biomass is left

    - magnifies the difference between fire and mechanical harvesting

    Problem – what does one do? NDM says one should be harvesting, but harvesting may not be the answer

- makes regulating difficult, because of flexibility and variability in nature
    - ND are unpredictably and do not do the same thing every time, regulator may have to give more decision making power to forest management companies
    - Everyone has to trust everyone a bit more

- Although quantifiable, it is in a form that is not currently "regulation friendly"
    - our whole management system is not set up to support ND
    -

Infrastructure and communities are fixed - realities - communities/mills
    - commitments have already been made/fixed, cannot move infrastructure

- Endless amount of material; Data intensive initially to understand landscape - (I don't have all the info, too much to know therefore I am not going to do it)
    - necessary to know all in detail

- NDA – complex, requires more thought, not as safe (snags, residuals), more expensive, yields less $$$, less cubic meters of wood, increase in training of staff ($$$), however less roads corridors (less $$$/km for road to be built) which decreases amount of disturbance within the forest – soil compaction, erosion, human activity that can affect the wildlife

- FM is not the only player
    - perceived as the one to manage the landscape
    - could still end up with an unnatural landscape
        - in the East - ON, NB - 50% private woodlots

- Not always the right answer
    - riparian example

- Everyone SAYS that they do it - Natural Pattern strategies
    - all examples provided are an example of the NDA, but at different levels - then do you accept them all or set standards - no requirement to validate the approach one has taken
    - does one have to meet all aspects of ND or achieve parts of it?
    - need to discuss tenure
        - if patterns already set on the landscape - cultural patterns - What do you do? (i.e. oil/gas, agriculture)

- ND is the most ecologically important driving force.
    - species have evolved and adapted since the last ice age to the terrestrial environments, better equipped to survive if disturbances similar in nature to ND
    -identified to maintain biodiversity
    - less roads are built

- Emulate disturbance – leaving more snags and coarse woody debris, live clump – possibly result in decrease in AAC, $$$, jobs which could weaken the local economy and compound into the provincial and federal economies

- Aesthetically may not be pleasing if harvest larger cutblocks – society will not allow

- Operational and safety issues – simpler and safer to clear cut, leaving little to no residuals. Cheaper too, yielding large returns.

- Good for the boreal forest, burns on a regular basis, but how can it be used as a guide in places where fire is not the major disturbance, such as the coastal forests in BC where the forests are primarily old growth. Anything that you do will change the ecosystem considerably.

Forest certification increases access to 'green' markets = premium pricing

What about the non-contributing landbase - steep slopes? Most consider what you are going to do, what about if don't disturb (Brad Hawke has examples)

NDA very flexible - operator responsibilities