Uneven-Aged Forest Management Strategies of North American Indigenous Groups

A Framework for Forest Management in British Columbia

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"Start with the rising sun and work toward the setting sun, but take only the mature trees, the sick trees that have fallen. When you reach the end of the reservation, turn and cut from the setting sun to the rising sun, and the trees will last forever."

-Past Menominee Tribal Chief (Davis, 2000)

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Abstract

The Menominee, and Salish and Kootenai indigenous groups of North America have implemented successful frameworks of uneven-aged forest management which pre-date European contact. Uneven-aged forest management strategies such as the ones practiced by these indigenous groups have been historically limited in North America due to a culture of even-aged forest management focused on short rotations and vast clearcuts. Academic recognition of methods utilized in uneven-aged forest management remains widespread in the Pacific Northwest. Environmental, social, cultural and spiritual acknowledgement of uneven-aged forest management in North America further implies the feasibility of replicating similar methods in British Columbia. With the inception of the New Relationship, a B.C. government – B.C. First Nations resource planning framework, applications of uneven-aged forest management based on the practices of the Menominee, and Salish and Kootenai should be strongly considered for implementation in B.C. forests.

Keywords: Uneven-aged forest Management, Indigenous, Menominee, Salish and Kootenai, First Nations, British Columbia.

Introduction

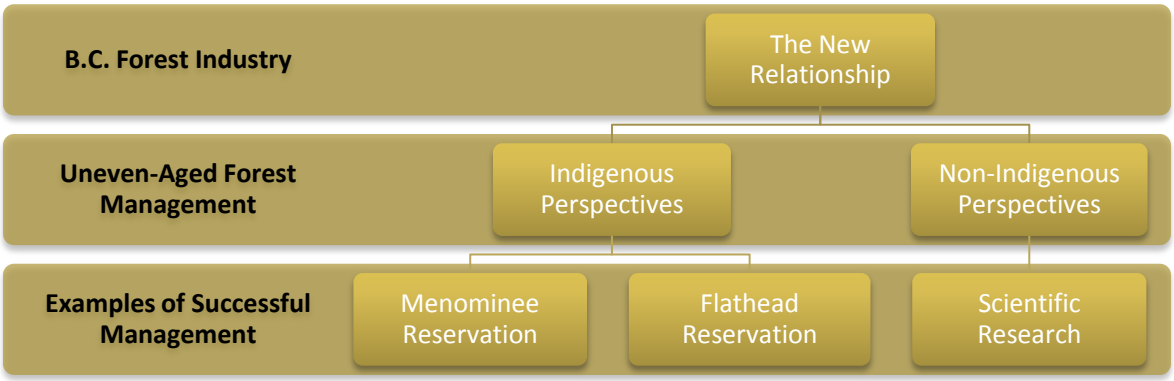
As British Columbia (B.C.) First Nations shift from stakeholders to shared decision makers with the inception of the New Relationship, opportunities for not only the recognition of rights and title, but also the potential for economic development will unfold. Established in 2005, the New Relationship was created to provide new processes for shared decision-making between the B.C. government and B.C. First Nations (Ministry of Aboriginal Relations and Reconciliation, 2009). While having no affect on existing provincial crown granted tenures such as Tree Farm Licenses and Timber Supply Areas, the New Relationship will continue to recognize the participation of First Nations as an authority which, along with the B.C. government will make decisions regarding land and resource use, as well as how resources

will be shared (Ministry of Aboriginal Relations and Reconciliation, 2009). Potentially one of the most significant consequences of this new government to government relationship is how the implications of the shared decision-making power will affect forest management in B.C. The current and historical trend in the B.C. forestry sector has primarily been the conversion of uneven-aged old growth and seral stage forests into even-aged second growth forests (Watts & Tolland, 2005). This extensive conversion to even-aged forests is not only causing an increasing loss of biodiversity but also contributes to a loss of traditional values of B.C. First Nations. As the B.C. forestry sector enters its worst downturn to date, the combination of economic, environmental and First Nations related issues provides the opportunity for new management opportunities and strategies to emerge.

The possibility of implementing a system of uneven-aged forest management within B.C. remains an option that to date has not been explicitly utilized. Uneven-aged forest management, as defined by Robinson (1988) is the limited cutting of timber on long rotations to be removed annually in perpetuity. The definition is further narrowed to include the practice of managing the timber through a selection harvest system that emphasizes the biological needs of the species involved while retaining the tree growth that is needed for managing all native wildlife and non-timber forest product values (Robinson, 1988). Coincidently, Robinson's definition of uneven-aged forest management is also what he refers to as excellent forestry. Based on this definition, this paper will effectively discuss the successful management of uneven-aged forests by North American indigenous groups. The Menominee of Wisconsin and the Salish and Kootenai Tribes of Montana, both demonstrate successful implementation of uneven-aged forest management, as illustrated in historical records that prove their strategies and practices. To compliment these examples of historically successful management, a review of scientific research regarding uneven-aged forest management, specifically in the Pacific Northwest will recognize the academic acknowledgement of the this management strategy. A link between the indigenous and non-indigenous perspectives will be provided in order to examine the viability of

applying a system of uneven-aged forest management to the B.C. forest sector. Figure 1 below provides a visual guide to linking these parameters to be discussed into a framework that seeks to apply the management strategies of indigenous groups to a new form of forest management in B.C. By utilizing the forest management practices of the Menominee, and Salish and Kootenai indigenous groups combined with scientific research throughout the Pacific Northwest and assessment regarding the adaptability to B.C. Forests, I will demonstrate how a system of uneven-aged forest management in B.C. will effectively compliment the implications of the New Relationship.

Figure 1: Framework for Applying Indigenous Forest Management to the B.C. Forest Industry



Frameworks for Success: Uneven-Aged Forest Management by North American Indigenous Groups

Whether or not they have had control of their traditional territory, indigenous peoples have always adopted the responsibility of caretakers for the land of their ancestors and children; their desire to maintain that connection and relationship with the land remains a dominant force (Trosper, 2008). This relationship with the land was further described by Wilson (2002) as being a romantic and simplistic one, but in the modern world, a relationship that is becoming increasingly accepted by academics (Trosper, 2008). While documentation on the forest management practices of many indigenous groups throughout North America is available, specific attention has been paid to the Menominee of Wisconsin and the Salish and Kootenai of Montana. This is primarily due to their long and unique histories of forest

management which have resulted in the successful and predominantly uneven-aged management of their reservation's forest (Davis, 2000 & Flathead Forest Management Plan, 2000). A review of the management strategies of these indigenous groups' forest practices will effectively provide a useful framework for uneven-aged forest management.

Menominee

Overview of the Menominee Indian Reservation

The Menominee people of Wisconsin's Menominee Indigenous tribe have successfully implemented a strategy of selection harvesting for uneven-aged forest management purposes since 1917 (Trosper, 2007). Located in northeastern Wisconsin, the Menominee Reservation's forested landbase of 220,000 acres or approximately 89,030 hectares (http://www.onlineconversion.com, 2009) is composed primarily of sugar maple, aspen, white birch, hemlock, red pine, white pine, swamp conifers (which includes white cedar, tamarack, black spruce and white spruce) and other hardwoods (Menominee Forest Management Plan, 1996).

Spiritual and Cultural Context

The connection between the Menominee people and the earth is sacred; they have always revered the entire forest as a spirit and respect it accordingly (Trosper, 2007). Marshall Pecore, a forest manager with Menominee Tribal Enterprises, the tribe's commercial enterprise, defines the sacredness of the land as the Menominee people's body and their cultural values as their soul (Pecore, 1992). These beliefs compliment the general management concept that Trosper (2007) describes as a strategy that emphasizes a larger and older growing stock of trees. Wood and Dewhurst (1998) continue that the Menominee management strategies themselves have been successful because of their roots in the cultural beliefs of the tribe. Perhaps the most fundamental statement about the Menominee land ethic and forest management policy was quoted from a past president of the Menominee Tribal Enterprises as saying: "[the land ethic] has always contained the three elements of a sustainable system. First he

[the forest] must be sustainable for future generations. Second, the forest must be cared for properly to provide for the needs of the people. And third, we keep all the pieces of the forest to maintain diversity" (Davis, 2000). This statement effectively describes the relationship between the Menominee's spiritual connection with the forest by personifying it as a being and honoring this by applying current definitions of sustainability. This connection can be utilized in similar forest management scenarios in B.C., where First Nations and sustainability values coincide.

Menominee Forest Management

Inventory

On the Menominee Reservation there is an annual cut of 30 million board feet, approximately 70,792 m^3 (http://www.onlineconversion.com, 2009) and based on a minimum harvest age of 200 years to promote an older standing stock of timber, the current volume of timber has increased since the first forest measurements were taken in 1954 (Trosper, 2007 & Pecore, 1992). With respect to the annual cut and minimum harvest age, the Menominee's Continuous Forest Inventory (CFI), established by the United States Bureau of Indian Affairs, is described by Pecore (1992) as the backbone of the forest management plan. Established to monitor the long-term impacts of the forest management strategies in place, the CFI system provides volume, growth and timber quality data which is essential to future management strategies such as silvicultural planning (Pecore, 1992 & Menominee Tribal Enterprises Forest Management Plan, 1996).

Silvicultural Methods of the Menominee

The silvicultural strategies in place are based on a series of prescriptions for the fourteen identified cover types which exist throughout the reservation's forest (Pecore, 1992). Stocking standards by species are based on the silviculture prescriptions for these cover types. Described as strict by Pecore (1992), the stocking standards prescribed by the Menominee are discussed by Trosper (2007) as being diverse with a large species mixture to effectively maintain biodiversity while also promoting non-timber

values and products. These non-timber values and products are outlined in the Menominee Tribal Enterprises Forest Management Plan (1996) as being quite extensive. As per the specific stocking standards, it is noted by Wood and Dewhurst (1998) that the strategy of implementing the CFI for stocking purposes is to utilize species which are ecologically suitable for certain sites and will yield higher quantities of higher quality timber than less suitable species. By regenerating a species stock that is ecologically suited to a certain site, natural, pre-disturbance diversity compositions are likely to be replicated, thus satisfying the Menominee's economic, social and spiritual values (Wood & Dewhurst, 1998).

Harvesting

In terms of timber selection for harvesting, the Menominee's foresters determine which trees and species are harvested, independent of the mills requirements (Trosper, 2007). This contrasts sharply with the concept of "high-grading", an increasingly common technique utilized in B.C. forests to harvest only the most economically valuable trees with no emphasis on biodiversity. Pecore (1992) goes more in depth when discussing the harvesting prescriptions, stating that the number of trees harvested depends on how many are considered excessive in fully stocked stands. The basis of only removing the excess trees is to ensure that it is the silvicultural prescription, not the timber requirements of the mill, that determine the volume removed (Pecore, 1992). While documents such as the 1996 Menominee Tribal Enterprises Forest Management Plan contain much more detailed accounts of tactical and strategic planning levels, the information which has been provided in this section is sufficient for discussing the implications of the Menominee's framework on uneven-aged forest management in B.C. as per the relationship displayed in Figure 1 above.

Management Concerns

The simplicity of the Menominee's model is demonstrated up by the historical success that not only can be seen in the forested landbase, but also in the data of the CFI which has been in place since

1950's (Trosper, 2007). One of the most significant aspects of the management plan is the direct connection between the Menominee's traditional and spiritual values and the sustainable management of the forest on an uneven-aged framework. Recent discoveries reported by Wood and Dewhurst (1998) indicate that limited fire suppression led to the loss of naturally occurring and planted regeneration. This has culminated in a compositional species change over approximately 60,000 acres, or 24,281 hectares (http://www.onlineconversion.com, 2009), and is not representational of pre-management species mixtures (Wood & Dewhurst, 1998). It is continued by Wood and Dewhurst (1998) that the primary issue resulting from this change is that species such as aspen, maple and pin oak are regenerating on sites that are best suited to pine; the maturing trees are therefore of lower quality than what the preferred species would have been. The initial issue with this undesirable feature cover regenerating relates to the competitive characteristics of sugar maple. Robinson (1988) describes the release of toxic chemicals from sugar maple roots that inhibit the growth of surrounding competitors. While Wood and Dewhurst (1998) recognize this issue, Huff and Pecore (1995) acknowledge it as a large problem potentially leading to large monotypes across the reservation's forests. To mitigate the distribution of undesirable non-site specific species and the potential establishment of monotypes, the Menominee Forest Management Plan (1996) enlists a "featured forest types" concept. This concept provides information on the species best suited for a particular site based on the potential for sawtimber, general biological and ecological suitability and relative competitiveness with other species (Menominee Forest Management Plan, 1996). Therefore, the restoration of sites with aspen, sugar maple, white birch, red maple, and pin oak when pine or other hardwoods are the featured forest type species is essential (Menominee Forest Management Plan, 1996). Regarding the restoration of specific species, the Menominee Forest Management Plan (1996) does state that when little or no featured cover types or species exist, for example, a monotype of maple on a white pine featured site, extensive silvicultural actions be applied to establish the featured cover type to the site through seeding and planting. The

extensive silvicultural actions referred to are generally clearcut, even-aged forest management, which will be discussed below with respect to the mitigation of restoring featured forest types.

Even-Aged Forest Management by the Menominee

The problem of restoring areas composed of unsuitable species back to featured cover types is that the species which have taken over these areas, primarily aspen and sugar maple across the reservation's forests, are shade tolerant and can regenerate quite easily without much disturbance (Menominee Forest Management Plan, 1996). As per these silvicultural characteristics, the most efficient means of converting these areas back to featured cover types is by essentially clearcut methods which create disturbance gaps much larger than uneven-aged forest management strategies generally call for. While undesirable by Menominee standards, clearcutting as a form of even-aged forest management is still commonly practiced in situations such as restoration to featured forest types (Menominee Forest Management Plan, 1996). The Habitat Type Management Key of the Menominee Forest Management Plan quite explicitly addresses the requirement for such a system for restorative purposes. For example, in the QV habitat type (Appendix 1, pg. 97 of Menominee Forest Management Plan, 1996), when pine regeneration is inadequate the management prescription requires clear cutting and converting to pine where site conditions permit. To compliment the field management guidelines outlined in the Menominee Forest Management Plan (1996), a decision support modeling system has since been implemented (Wood & Dewhurst, 1998). This support system will aid the Menominee in projecting future harvests which take into account the desire to restore these sites back to areas that fully maximize growth and biodiversity values (Wood & Dewhurst, 1998).

It is important to note that while the uneven-aged forest management plan utilized by the Menominee has been thus far successful, Trosper (2006) references the fact that the history of the Menominee Reservation intersected national policies regarding indigenous groups in different ways than other indigenous groups experienced. The primary differences occur during the allotment period

and afterwards, when, although the Menominee Reservation was one of the first to be terminated, it was also the first to be restored (Trosper, 2006). Most other indigenous nations in the United States were not subjected to this timeline of events, which, in the long term has aided the success of the Menominee people and the management of their forests (Trosper, 2007).

Salish and Kootenai

Overview of the Flathead Reservation

Perhaps one of the most thorough and comprehensive indigenous forest management plans belongs to the Salish and Kootenai Tribes of the Flathead Reservation. Located in the Flathead River basin in northwestern Montana (Becker & Corse, 1997), the Flathead Reservation is composed of the Salish, Kootenai and Pend d'Oreille tribes, whose organizational body is the Confederated Salish and Kootenai Tribes (Confederated Salish and Kootenai Tribes, 2000). The reservation's forested landbase of 459,408 acres, or approximately 185,915 hectares (http://www.onlineconversion.com, 2009) is composed of Ponderosa Pine, Douglas fir, western larch, lodgepole pine, grand fir, Engelmann spruce, subalpine fir, whitebark pine and alpine larch as the primary species (Confederated Salish and Kootenai Tribes, 2000). These species, as reported in the Flathead Forest Management Plan (2000), have been harvested as sawlogs since 1911 with an average annual cut of 29.1 million board feet, or approximately 68,668 m^3 (http://www.onlineconversion.com, 2009). Similar to the inventory reported on the Menominee Reservation, the volume of standing timber has also increased on the Flathead Reservation; however, it is presumed this is most likely attributed to fire suppression and increased stocking standards (Confederated Salish and Kootenai Tribes, 2000).

Spiritual and Cultural Context

The sustainable management of the Salish and Kootenai forests is not only of environmental and economic concern, but also cultural and spiritual; as the Flathead Culture Committee states: "[the land] is our Mother. We do not dominate Her, but harmonize with Her" (Confederated Salish and Kootenai

Tribes, 2000). This spiritual personification of the natural resources, similar to the Menominee peoples, reveals the deeply held beliefs of the Salish and Kootenai Tribes, and their diligence towards the land. With respect to the forest management plan, the forest-wide standards for culture emphasize the preservation and protection of all cultural, traditional, archaeological and historical sites (Confederated Salish and Kootenai Tribes, 2000). The management plan (2000) further discusses that the buffer zones placed on these sites will be site specific and determined by the tribal preservation office which consults not only with Salish and Kootenai elders, but also with a cultural committee.

Salish and Kootenai Forest Management

The extensiveness of the Flathead Forest Management Plan can be attributed to the historical trend of forest practices in the area, which, due to fire exclusion and other practices has shifted from a quilt-work mosaic of tree age diversity to a uniform blanket of even-aged stands (Confederated Salish and Kootenai Tribes, 2000). The cornerstone of this management plan is the concept of restoring diverse and sustainable forest conditions that existed prior to European contact (Becker & Corse, 1997) by mimicking natural processes and functions (Confederated Salish and Kootenai Tribes, 2000). On the Flathead Reservation, these natural processes and functions involved the role of fire to create a heterogeneous mixture of tree species, heights and sizes; when these processes did not naturally occur, fires would be lit by the tribes, a strategy pre-dating European contact (Confederated Salish and Kootenai Tribes, 2000). Since the Salish and Kootenai view natural disturbances as both integral and beneficial to the ecosystem, modern forms of replicating them are outlined in the Flathead Forest Management Plan (2000). While the restoration of fire regime mimicking forests is generally not a common technique of uneven-aged forest management, the objective of recreating a mosaic of tree age diversity through a selection system is consistent with Robinson's definition of uneven-aged management of forests.

Inventory

As with the Menominee Reservation, the Flathead Reservation is also subject to Continuous Forest Inventory. The data provided by the CFI however is re-grouped into a seral class system established to provide for management units that are based on size and age of trees, as well as species composition, relative closeness to each other and layering (Confederated Salish and Kootenai Tribes, 2000). The seral class management units were re-classified into smaller functioning units called seral clusters; twelve in total were distinguished for the entire forest landbase (Confederated Salish and Kootenai Tribes, 2000). As explained in the Flathead Forest Management Plan, these seral clusters are established based on their reactions to disturbances such as fire or harvesting. These seral clusters are typically harvested by either a single tree or a group selection system (Becker & Corse, 1997), consistent with Robinson's (1988) definition of uneven-aged forest management. Although discussed below, it should also be mentioned here that where favorable, even-aged forest management by clearcut is also used to harvest these cluster. As was discussed with regards to the uneven-aged strategies applied by the Menominee, emphasis will be placed on discussing the principles of the Flathead Forest Management Plan rather than the operational level planning and activities.

Silvicultural Methods of the Salish and Kootenai

The general forest practices of the Flathead Forest Management Plan are outlined under the Forest-Wide Standards for Timber Management section. These forest practices are subject to what is described as reference variability, the naturally occurring range of variation recommended management variability, simply a narrower range of reference variability; and how they relate to the desired condition (Confederated Salish and Kootenai Tribes, 2000). These terms are the basis for the Flathead Forest Management Plan's Ecosystem Management concept (Confederated Salish and Kootenai Tribes, 2000 pg. 16), which is remodeled in Figure 2 while still reflecting the essential components from the Flathead Management Plan. The reference variability represents the pre-European condition shown in Figure 2,

the state of the Flathead Reservation's forests prior to impacts from fire suppression and even-aged forest management. Recommended management variability is in place to re-focus the reference variability to account for not only modern management strategies and techniques, but also to implement site specific plans for varying ecosystems (Confederated Salish and Kootenai Tribes, 2000). The final management objective to be applied to the Flathead Forest Management Plan is the desired condition. As shown in Figure 2, the desired condition represents the eventual target stand that best upholds the reference variability and recommended management variability of key forest values such as tree species diversity or wildlife habitat (Confederated Salish and Kootenai Tribes, 2000).

Figure 2: Flathead Forest Management Plan Ecosystem Management Framework

Source: Hierarchy and information acquired from Flathead Forest Management Plan (2000, pg. 16)

Harvesting

Listed under the Forest-Wide Standards for Timber Management in the Flathead Forest Management Plan (2000), the list of general forest practices provides extensive objectives which act as the standard operating procedures for the reserve's landbase. The chosen silvicultural systems for certain seral clusters will seek to achieve and maintain the desired condition of the specific seral cluster as per the recommended management variability's (Confederated Salish and Kootenai Tribes, 2000), the relationship of which is displayed above in Figure 2. As with most forest management plans, indigenous or not, the Flathead Forest Management Plan (2000) may deviate from the recommended management variability when forest health issues override management objectives. Prescriptions for harvesting type and size are based on the fire regime class of the seral cluster involved while taking into account the most effective methods to compliment regeneration of the desired species within the ten year stocking standard period (Confederated Salish and Kootenai Tribes, 2000). One of the specific management objectives that are outlined within the Flathead Forest Management Plan (2000) that sets their management plan aside from that of the Menominee is the focus on salvage operations. Forest practices standards regarding salvaging include removing no more than 50% of salvageable forest products that have been damaged fire, insect, disease, or windthrow within six months of damage detection (Confederated Salish and Kootenai Tribes, 2000). Further, to capture the best value, high value sawlog trees recently killed or damaged from the above disturbances will be salvaged only when the appropriate amount of snags and recruitment trees are available to maintain wildlife objectives (Confederated Salish and Kootenai Tribes, 2000). Specific emphasis should be put on the management plans (2000) assertion that salvage operations are not to be undertaken in old growth stands unless it maintains or enhances the ecological objectives for the area.

Management Concerns

It is noted in the Flathead Forest Management Plan (2000) that large areas of forest on the reservation are composed of lodgepole pine. The natural silvicultural properties of lodgepole pine as outlined by McDowell (1998) include the rapid regeneration after large scale disturbances such as fire into vast even-aged stands. This implies a problem for the Salish and Kootenai with respect to their desire to implement uneven-aged forest management. While the Flathead Management Plan (2000) illustrates the requirement for managing areas of lodgepole pine under even-aged conditions as per natural fire regime patterns, a greater risk exists with the presence of the mountain pine beetle on the reservation. Attacking primarily lodgepole pine, the mountain pine beetle was recognized as a problem and a risk to the Salish and Kootenai forests in the 2000 Flathead Forest Management Plan. Management of the mountain pine beetle has historically been similar to methods applied in B.C.: large scale clearcuts; accumulated ecosystem knowledge however has modeled into management strategies which seek to increase the presence of specific seral clusters of non-pine species to eventually mitigate the risk by the year 2089 (Confederated Salish and Kootenai Tribes, 2000). By implementing specific strategies such as regenerating sites with several different seral clusters, the Flathead Management Plan (2000) ensures that current even-forest management practices which are larger than generally desirable will assist in protecting forest health in the future.

Even-Aged Forest Management by the Salish and Kootenai

It is important to note that the Salish and Kootenai tribes, like the Menominee prefer uneven-aged forest management over even-aged clearcutting. Both indigenous groups however recognize the need to replicate natural disturbances; the Salish and Kootenai specifically, try to mimic fire disturbances as discussed above and will often create very large even-aged clearcuts to replicate high intensity fires over a large landscape (Confederated Salish and Kootenai Tribes, 2000). Besides mimicking fire regimes, even-aged forest management implemented by the Salish and Kootenai also

seeks to remedy immediate forest health issues in what the Flathead Forest Management Plan (2000) refers to as uneven-aged restoration management. As per the discussion of even-aged forest management of the Menominee, it is essential to recognize the use of both systems, with preference being given to uneven-aged methods whenever possible. Therefore, explicit discussion regarding uneven-aged forest management of the Salish and Kootenai was established for discussion through the remainder this paper.

The Flathead Forest Management Plan provides an exceptional framework for a system of uneven-aged forest management that focuses on historically natural processes such as fire regimes to be replicated in silvicultural systems to convert the Reservation's forest back to an uneven-aged mosaic of tree species, size and age. Although the Salish and Kootenai Tribes seek to implement a strategy different from that of the Menominee, the nature of the silvicultural systems and forest practice strategies parallel in their commitment to the relationship between the forest and the environmental, economic, cultural, and spiritual goals and values of their respective indigenous groups.

Uneven-Aged Forest Management: Non-Indigenous Perspectives

While the breadth of discussion thus far has focused solely on the uneven-aged forest management strategies and practices of North American indigenous groups, it is also essential to understand the non-indigenous perspectives of this management system to understand implications for B.C. forest practices. A brief discussion on the history and concept of uneven-aged forest management in North America followed by descriptions of scientific research will provide the necessary acknowledgement from academic sources to legitimize the development of this form of management in B.C.

Uneven-Aged Management in North America

History and Development

The concept of uneven-aged forest management was introduced from Europe in the early 1900's (O'Hara, 2002). It is also revealed by O'Hara (2002) that despite the many definitions of uneven-aged forest management, the common concept continues to be essentially based around a selection system of silviculture which compliments Robinson's (1988) definition provided in the introduction. Historically, uneven-aged management in North America has followed a cyclic pattern; but as further research is conducted and a better scientific understanding is generated, the popularity, as with the methods of implementing it, has evolved (O'Hara, 2002). This current revival seeks to replicate natural multi-aged stand structures (O'Hara, 2002), a strategy which is most likely rooted in a reflection of the modern era of environmentalism. North American uneven-aged forest management has generally followed a trial and error model of implementation. In one example, O'Hara (2002) discusses the faulty management of coastal Douglas-fir, a shade intolerant species, which, under a selection system of silviculture regenerates poorly. The above model is typical of North America with respect to uneven-aged forest management where Emmingham (2002) reveals that the primary reason for lack of implementation is due to the absence of North American foresters experienced with this form of management. However, similar to the indigenous perspectives previously discussed, it is also held in academic circles that uneven-aged forest management can create a diverse forest that provides socially and culturally acceptable sustainable alternatives to current trends of even-aged clearcutting (Emmingham, 1998 & Ralston et al, 2004). The better understanding of uneven-aged forest management and its current acceptance rely heavily upon not only trial and error management, but also research, which provides the scientific base for implementing this management strategy at operational levels.

Scientific Research

Efforts to better understand the concept of uneven-aged forest management with hopes to establish effective implementation on the ground have been provided in research by Nyland (2003), O'Hara and Gersonde (2004), Guldin (1991) and Ralston et al (2004). The results provided by these academics effectively encompass several aspects of uneven-aged management ranging from the conversion from even- to uneven-aged forests stands (Nyland, 2003), to appropriate stocking levels (O'Hara & Gersonde, 2004), to methods of regulation (Guldin, 1991), and finally to the potential for growth and yield (Ralston et al, 2004).

Conversion from Even- to Uneven-Aged

Perhaps the most relevant aspect of uneven-aged forest management in North America is the conversion of the even-aged forests which currently exist over most of the forested landbase to an uneven-aged structure. Nyland (2003) addresses the challenges, requirements, and implementation of such a conversion. The primary challenges discussed by Nyland (2003) include dividing the harvest of older trees in order to maintain the mature or seral component of the stand; establishing new cohorts at regular intervals to allow for a multi-aged composition; protecting tree species diversity, specifically older trees which may be prone to health or vigor issues; guarding each age class during selection harvesting; and, regulating the amount and dispersal of trees within each cohort throughout stand development. Challenges to shifting requirements for successful management strategies focus heavily on stand structure. To ensure the vigor of each tree is best utilized and growth is not impeded, ensuring a multi-aged cohort allows for sunlight to reach lower canopy species through the upper canopies (Nyland, 2003). While the stocking specifics based on desired and ecologically suitable species is also discussed, this will be reviewed as per O'Hara and Gersonde (2004) to follow. Nyland's (2003) findings dictate that the overall conversion can be completed by undertaking either a regularly scheduled partial cutting system, or periodic patch cutting system to establish either a shelterwood or group cluster

dynamic which will eventually lead to either a single tree or group selection management strategy respectively.

Stocking and Regulation

One of the challenges of implementing uneven-aged forest management in North America as discussed in most of the reviewed literature is associated with stocking species that grow well in multi-age stand structures. As per basic silvicultural characteristics, the regeneration in uneven-aged forests is directly correlated with the shade tolerance of the particular tree species. Since shade tolerant properties are determined on a desired site by site strategic level for uneven-aged forest management (Robinson, 1988), the scientific discussion regarding stocking will focus mainly on recognized regulation methods for use in determined sustained yields and annual cuts. While O'Hara and Gersonde (2004) describe four approaches to controlling tree stocking, focus will be put on the q-factor, or BDq approach as it is the most common concept in North America. The BDq method is fairly simplistic in that the desired stand structure is described using a negative exponential, or reverse-J shaped diameter distribution (O'Hara & Gersonde, 2004), the slope (q-factor) of which is the ratio of trees in a given diameter class to the number of trees in the next highest class (O'Hara & Gersonde, 2004). The BDq approach is composed of basal area, B, which represents the total stocking, is combined with the maximum diameter class, D, to form the full BDq approach (O'Hara & Gersonde, 2004). With respect to forest practices, the BDq approach attempts to push the uneven-aged stand to a target diameter distribution, which achieves sustainability once trees exceeding the target diameter are harvested (O'Hara & Gersonde, 2004). While several assumptions are made with respect to the negative exponential function which this approach is based on, O'Hara and Gersonde (2004) along with Guldin (1991) discuss that in practice, variations in the form of surpluses or deficits in some diameter classes require minor deviations based on economic risk and operability of the stand. While this general equation for balancing out a specific target diameter distribution limits the size classes to occupy equal

growing space, the q-factor can be adjusted to promote more or less larger or smaller trees with differing occupancy of growing space (O'Hara & Gersonde, 2004). In terms of stocking standards for different forests based on management objectives, O'Hara and Gersonde (2004) suggest that adjusting the basal area factor, B, will effectively increase or decrease the total stocking. The main appeal of the BDq approach is the simplistic structural distribution of diameter it creates while also being able to allot growing space and control stocking levels (O'Hara & Gersonde, 2004).

Similar to approaches to stocking control, there is more than one way to regulate the cutting cycles of uneven-aged forests. In compliance with the BDq approach used above, the correlated regulation method as recognized by Guldin (1991) is structural regulation. The advantage of implementing a structural regulation system is that it considers the entire stand rather than specific components such as sawlog quality timber (Guldin, 1991). Allowable cut determination in uneven-aged forests managed for structural regulation is described by Guldin (1991) as being the cumulative difference between the observed pre-harvest stand and the BDq synthesized target stand. The allowable cut for each diameter class is determined first by subtracting target stand parameters from the original pre-harvest stand; when this difference is positive, it represents the allowable cut for that diameter class (Guldin, 1991). Determination of the stand level allowable cut is simply the sum of each diameter class allowable cut (Guldin, 1991).

Growth and Yield

While historical yield data is limited, a 2004 report by Ralston et al examines a 200 year projection of growth and yield based on the WestPro modeling software. Keeping with the BDq approach, the inputs used in WestPro include the diameter distribution of the pre-harvest stand, the diameter distribution of the target stand, the cutting cycle and any relevant costs (Ralston et al, 2004). The outputs of stand state, yield, tree size and species diversity indices and net present value were modeled to view the affects of each input on the eventual outputs listed (Ralston et al, 2004). Varying

the inputs of cutting cycle length, and changing basal area, diameter, or q-factor targets to promote either a light, medium, or heavy BDq had essentially no effect on the overall productivity and financial returns (Ralston et al, 2004). Through these examples, Ralston et al (2004) concluded that uneven-aged forest management is economically competitive with even-aged forest management.

Further Incentives for Uneven-Aged Forest Management

The scientific research reviewed above provided relevant information for the technical implementation of uneven-aged forest management with respect to sustained yield rates and annual cuts. It was also concluded from growth and yield studies that uneven-aged management can compete at an economic level as well when compared to even-aged management. Robinson (1988) however, recognizes the qualitative properties of this form of management. One aspect of uneven-aged forest management Robinson (1988) acknowledges is the increased timber quality that is produced through extended rotation ages that are typical of forests managed under this practice. Another key attribute of uneven-aged forest management is that it effectively acts as a method of fire hazard reduction (Robinson, 1988). Having reviewed the methods of mimicking fire regimes practiced by the Salish and Kootenai on the Flathead Reservation, it can be established that by performing such disturbance replicating management practices, the forest can exhibit characteristics of natural progression while capturing the value of a timber resource which may be lost to fire or other disturbances.

While the relative amounts of academically reviewed research articles are substantial, it is interesting to note that only a few recognize the uneven-aged forest management strategies of North American indigenous groups. Even Robinson fails to link his concept of “excellent forestry” to the management applied by indigenous groups. Whether these academics disagreed with the actual practices of groups such as the Menominee, and Salish and Kootenai can only be speculated on, however, it remains essential to the breadth of this article to recognize the link between indigenous

traditional knowledge of this method of management and the in depth technicalities presented by the academically reviewed research articles.

A Viable Management Strategy: Uneven-Aged Forest Management and British Columbia Forests

Although there is a historical lack of uneven-aged forest management in B.C., several of the trends relating to either indigenous perspectives or non-indigenous perspectives of forest management in North America which have been reviewed in this article effectively overlap. Where there is overlap, an examination of the possibility of applying these trends to the B.C. forest industry must be discussed in order to create a framework relating to Figure 1.

Implications for Uneven-Aged Forest Management in British Columbia

Comparing Ecosystems and Species

Prior to discussing the trends of uneven-aged forest management between indigenous and non-indigenous groups and whether the application of these systems to the B.C. forest industry is possible, a brief examination of operational and ecological level characteristics is essential. The ecosystems and tree species present on the Menominee and Flathead Reservations are compared with the species composition of specific areas of B.C. As discussed below, there were many positive correlations established.

Menominee and British Columbia Ecosystems

The Menominee Reservation of Wisconsin was described in the Menominee Tribal Enterprises Forest Management Plan (1996) as being composed of sugar maple, beech, aspen, white birch, hemlock, and white and red pine as the major species by area. Perhaps the closest Biogeoclimatic (BEC) zone in B.C. to exhibit similar species compositions is the Interior Cedar-Hemlock zone (McDowell, 1998). While the primary species of the Menominee Reservation are hardwoods, typical of the Great Lakes region,

Hemlock, Aspen and Birch are all common and often dominant species within the Interior Cedar-Hemlock zone (McDowell, 1998).

Flathead and British Columbia Ecosystems

Examining the BEC zones of B.C. against the ecosystems of the Flathead Reservation reveals a high potential for application into B.C. The primary species existing on the Flathead Reservation, as outlined in the Flathead Forest Management Plan (2000) are ponderosa pine, Douglas fir, western larch, lodgepole pine, grand fir, Engelmann spruce, subalpine fir, whitebark pine and alpine larch. Important climatic properties of include sites that exist on either hot and dry, south and west-facing slopes, or cool and dry ridges (Flathead Forest Management Plan, 2000). Common plant species also described in the 2000 Flathead Forest Management Plan include wheatgrasses, pine grass, fescues and snowberry. While not a complete match, several of the species present on the Flathead Reservation are also found on low elevation zones of side valleys in the Ponderosa Pine BEC zone of B.C. (McDowell, 1998). With the Ponderosa Pine zone occurring on lower elevations side valleys, McDowell (1998) describes the domination of Douglas fir and lodgepole pine on the lower to mid elevation slopes within the Interior Douglas fir zone. Both of these species, are listed as occurring on the lower to mid slope regions of the Flathead Reservation as well (Flathead Forest Management Plan, 2000). It is also noted by McDowell (1998) that Engelmann Spruce and subalpine fir in the Engelmann Spruce-Subalpine Fir zone of B.C. occur on higher elevation zones.

Comparing Management and Regulation

Management

Further implications in linking the discussed uneven-aged management strategies to the B.C. forest industry are apparent in the management philosophies of not only the Menominee, and Salish and Kootenai, but also in the findings of the scientific research reviewed. With respect to the perspectives of the two indigenous groups, the primary aspect of their strategies is based on an adaptive

management. This is quite similar to the Forests and Range Practices Act (FRPA) of the B.C. Government (B.C. Ministry of Forests and Range, 2002). FRPA (2002) allows foresters to manage land on what is considered a result based code. The scientific research based on the non-indigenous perspectives revealed similar findings regarding the lack of knowledge and experience with uneven-aged forest management and therefore obtaining results through "trial and error" was unavoidable. Regardless what it is called (i.e. results based or trial and error), each source utilizes strategies that evolve through the success and failure of the forest management practices.

Regulation

The role of government, whether it is provincial, state or federal plays a major role in forest practices in North America. With B.C. forest practices being highly regulated at provincial levels through FRPA, an interesting correlation exists between the regulation of practices in B.C. and those of the Menominee and the Salish and Kootenai. Management strategies of the Menominee and the Salish and Kootenai, while regulated through the United States Bureau of Indian Affairs, include a similar concept with regard to legislation: each of the plans, although distinct in their own way, are all bound by federal and state laws governing forest management and environmental protection. Therefore, by applying methods similar to those used on reservations in the United States, provincial and federal laws can be applied relatively simply to uneven-aged forest management strategies.

Social, Cultural and Spiritual Implications

The final key parameter to be discussed in applying uneven-aged forest management practices to B.C. forests is the possible social, cultural and spiritual implications to both indigenous and non-indigenous communities that will be impacted. Studies by Lewis and Sheppard (2005) and Lewis (2008) accurately establish the perceptions of both communities with respect to landscape level changes, specifically, forest management. The effectiveness of examining these particular research articles lies not only in their specific community scopes, but in their focus on B.C. communities. Broader

perspectives on the implications forest management may have on communities is also provided by Donoghue and Sturtevant (2008), who assess socio-economic impacts with respect to forest resources.

Indigenous Communities

Lewis and Sheppard (2005) focus on the Cheam First Nation community of B.C.'s Fraser Valley. Results for this study were based largely on quantitative analytical methods that tested perceptional responses to visual images of resource management possibilities (Lewis & Sheppard, 2005). The basis of these tests was to provide an understanding of the impacts related to resource management and the protection of cultural and spiritual values (Lewis & Sheppard, 2005). With this objective in mind, Lewis and Sheppard (2005) discovered a theme of spiritual landscape values through their tests. Relationships between landscape features and legends were noted as playing a large role in land management (Lewis & Sheppard, 2005). As was discussed in the above sections regarding the Menominee, and the Salish and Kootenai, respect for the land and its spiritual condition were ranked high in Lewis and Sheppard's (2005) study. With respect to forest management specifically, computer rendered images showing current conditions, a partial cut and a clearcut of the same landscape feature was met with positive feedback for current conditions, predominantly positive feedback for the partial cut and all negative feedback for the clearcut (Lewis & Sheppard, 2005). While Lewis and Sheppard (2005) admit to several biases that may be present in their study techniques, they remain conclusive to the fact that identifiable landscape features having cultural and spiritual value must be maintained in order to ensure the continuation of their respective traditions.

Non-Indigenous Communities

Similar to the study provided by Lewis and Sheppard (2005) regarding indigenous communities views on forest management, Lewis (2008) also provides results from a study focused on non-indigenous communities in the Skeena Valley of Northwestern B.C. It is pointed out that while alterations to the landscape for such management uses as timber harvesting may seem necessary and

harmless to forest managers, considerable damage may in occur from the perspective of a community's regular use of the landscape (Lewis, 2008; & Donoghue & Sturtevant, 2008). A similar research method as provided by Lewis and Sheppard (2005) was enlisted for the Skeena Valley study by Lewis (2008). An interesting difference between Lewis (2008) and Lewis and Sheppard (2005) was the background of the test subjects; while the indigenous community members sampled from the Cheam had little experience with forest practice and logging, community members from the Skeena Valley study drew upon knowledge of forestry in their responses (Lewis, 2008). This background knowledge of forestry was reflected in results provided by Lewis (2008). While many of the test subjects acknowledged dislike for images representing clearcuts, many other values were questioned beyond environmental impacts. Specifically, several test subjects expressed concern for social and economic impacts of lighter harvesting techniques (Lewis, 2008).

While these two communities differed slightly in background knowledge and values, many indicators remained congruent: concern for the multiple values offered by the forest. Whether these values were cultural or spiritual (Lewis & Sheppard, 2005), or social and economic (Lewis, 2008), concern over the impact of forest management practices was acknowledged.

Communities and the Forest

While Lewis (2008), and Lewis and Sheppard (2005) focus specifically on testing small populations of two different communities, Donoghue and Sturtevant (2008) provide an extensive source of the broader community sense of forest management. The recognition of people and communities existing as part of the forest ecosystem introduces the relationship between forest management and community wellbeing (Donoghue & Sturtevant, 2008). From the perspective of communities of varying sizes, from rural to regional to provincial, Donoghue and Sturtevant (2008) establish that growing environmentalism movements in North America, and the physical and spiritual enjoyment of non-timber forest values all play a key role in the how forest management is viewed and understood. Donoghue and

Sturtevant (2008) also admit the role of economical support required for communities and establish that a requirement for socially and environmentally sustainable management is paramount.

Given the visual quality, social, cultural and spiritual indicators tested by Lewis (2008), and Lewis and Sheppard (2005) in conjunction with the overall values reviewed in Donoghue and Sturtevant (2008), sustainably proven process of uneven-aged forest management has high potential for community approval.

Conclusion

Discussion of the uneven-aged forest management strategies of the Menominee, and Salish and Kootenai indigenous groups revealed historically successful management methods that provided a link with the land from which they are deeply connected to and a means economic and environmental sustainability. The results of the management strategies implemented by these indigenous groups have resulted in quilt-work patterns of uneven-aged tree species and plant communities that represent the naturally desired conditions on their respective reservations. The frameworks provided by the management strategies which have resulted in this quilt-work appearance were then compared to other perspectives on uneven-aged forest management in an attempt to link the strategic application of these methods to B.C.

The incorporation of results from several academically reviewed scientific articles provided the necessary recognition required to effectively establish a system of forest management that is highly regulated. With respect to the calculations of annual allowable cut, forest management in B.C. seeks to administer levels of regulation that implement acceptable methods of determining harvest levels for example. By establishing the legitimacy of regulating uneven-aged forest management as determined in

academically reviewed scientific articles, speculation towards a similar, regulated B.C. system can be made.

Examination of the ecological, regulatory, social, cultural and spiritual aspects of uneven-aged forest management revealed three dispositions: habitat types based primarily on dominant tree species on the Menominee and Flathead reservations are congruent with many areas of the B.C. interior; infrastructures of management and regulatory frameworks currently established on the Menominee and Flathead reservations seem comparable in scope and focus to B.C.'s FRPA; and finally, social, cultural and spiritual assessments in the United States Pacific Northwest and B.C. exhibit specific values which are seemingly incorporated in the strategies of uneven-aged forest management.

Strategies of implementing uneven-aged forest management which have yet to be discussed include opportunities with B.C. First Nations. While an in depth discussion on the issue is not essential, mention of an example framework which has thus far proven successful assists in the promotion of management strategies developed by First Nations. The Nuu-Chah-Nulth of Western Vancouver Island's Clayoquot Sound developed a forest management plan in conjunction with the Clayoquot Sound Scientific Panel, or CSSP (1995), a committee composed of highly recognized academic figures. Much like the management plans of the Menominee, and Salish and Kootenai, the CSSP held the integration of Nuu-Chah-Nulth traditional knowledge into the forest management practices to be considered for the area above all else (Clayoquot Sound Scientific Panel, 1995). While the Nuu-Chah-Nulth were not established as the primary managers of the area, it is important to note that the major consideration of their cultural and spiritual values was successfully integrated into the forest management practices in Clayoquot Sound.

While the implications discussed remain to be relatively positive, there are several limitations that must be noted with respect to implementing a system of uneven-aged forest management in B.C.

These limitations correlate highly with those faced on the Menominee and Flathead reservations; managing for species that are undesirable for regeneration based on their inefficient use of growing space and low timber quality, and concerns regarding the management of lodgepole pine. Management for these two concerns must also be carried out in B.C. as it is on the respective indigenous reservations, through even-aged clearcut methods. Although undesired species management may occur on relatively small areas of forest and only require smaller clearcuts, the continuing mountain pine beetle epidemic in B.C. is managed using extensive clearcut systems. Perhaps then it should be noted that as per the Menominee and Flathead forest management plans, while the preferred strategy remains to be uneven-aged management of B.C. forests, even-aged methods must be employed where necessary to mitigate risks and apply the silvicultural prescriptions necessary to re-establish the desired composition. The primary limiting factor regarding implementing uneven-aged management methods in B.C. however are operational constraints. Due to the characteristic steep topography of the B.C. coast, the applicability of uneven-aged management is mainly directed towards the B.C. interior. Despite these constraints however, coastal harvest methods involving single tree removal, primarily by helicopter may be considered forms of uneven-aged management by some, however, based on the lack of research and studies, consideration was not emphasized in this paper.

As proposed in the introduction and framed in Figure 1 the soon to be released New Relationship between the B.C. government and B.C. First Nations will provide to be determined amount of shared decision making power. The shared decision making power of First Nations from this relationship will potentially provide indigenous governments in B.C. with the power to allow or veto forest management on their traditional territories. The implications therefore of the framework presented in Figure 1 outline the opportunity to manage forests in B.C. using successful, economically viable, and socially, culturally and spiritually recognized strategies that are based on the traditional knowledge of First Nations.

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