CHAPTER 2 – LANDSCAPE PATTERNS AND BIODIVERSITY

LIST OF TABLES AND FIGURES

2.0 LANDSCAPE PATTERNS AND BIODIVERSITY

This chapter provides background and baseline information on biodiversity and sustainable forest management following a natural disturbance model. The chapter also provides a description of the FMA area, current human land use, and forest health -- in effect, a landscape assessment of the FMA area. Specific information on the application of forest management strategies on the FMA area will follow in Chapter 3.

2.1 DESCRIPTION OF FOREST MANAGEMENT AREA

NATURAL FEATURES

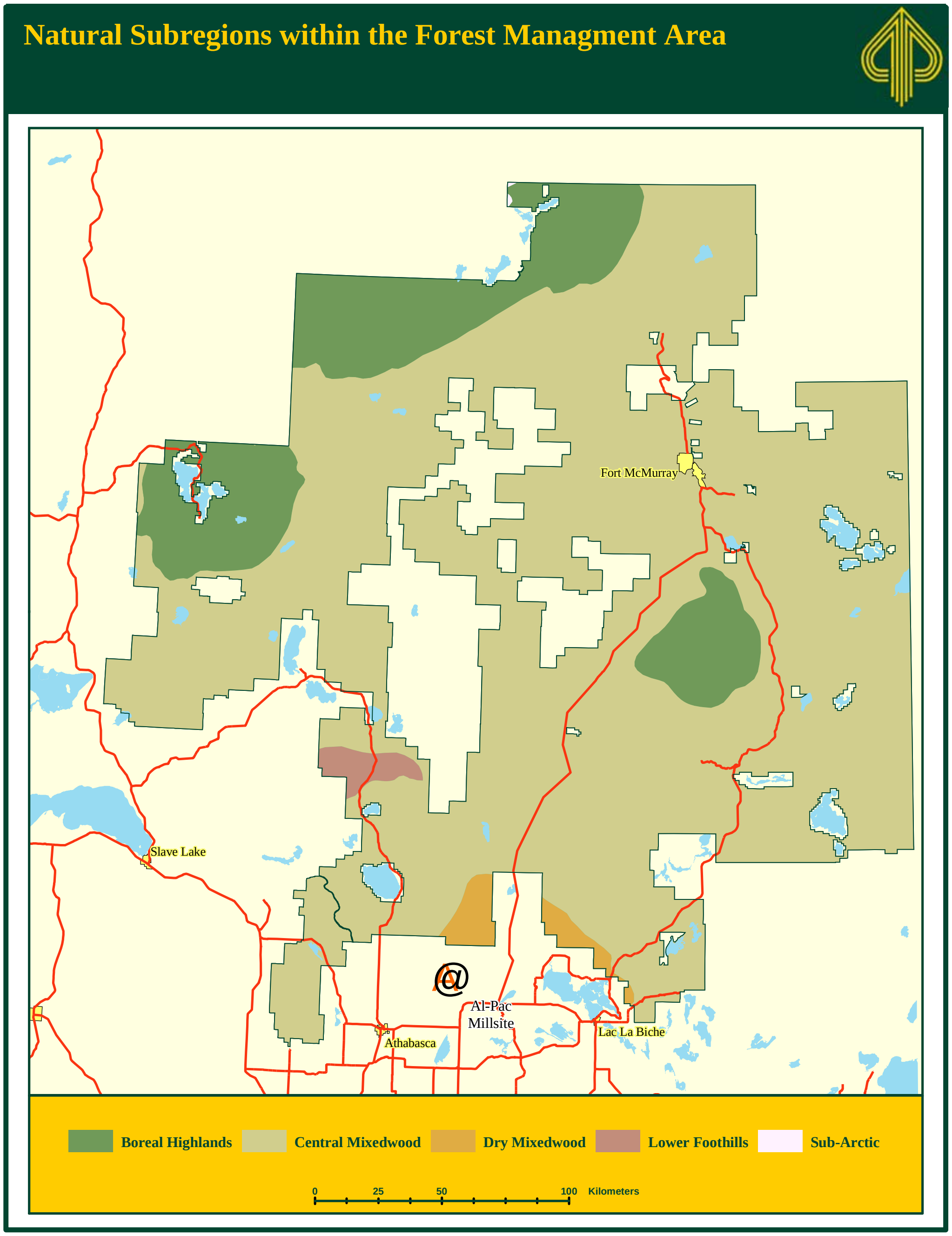
The FMA area's outer boundary encompasses a gross area of almost seven million hectares. East to west, it spans roughly 300 kilometres from the Saskatchewan border west to Lesser Slave Lake. South to north, the FMA area extends from the agricultural White Area around Athabasca and Lac La Biche to the Birch Mountains, a distance of about 340 kilometres. Figure 2.1 outlines the FMA area and shows its location within the province. The FMA area outer boundary is large, however, there are a number of exclusions within this boundary that are referred to as "doughnut holes." These exclusions are predominantly poorly drained and often forested with non-commercial stands of black spruce, larch and willow. They are, however, included in the scope of this document because the Quota Holders harvest conifer within the "doughnut holes" to fulfill quota commitments and also because the areas play an important role in Integrated Landscape Management. The "doughnut holes" comprise about 1.2 million hectares.

The FMA area lies within the Boreal Forest Region (Hosie 1979) and the Boreal Eco-province (Strong and Leggat 1992). The Alberta landscape has been classified and described as natural regions and sub-regions (Alberta Environmental Protection 1994). These divisions represent natural landscape patterns of similar vegetation, geology, climate, soil and landform features. Six natural regions have been delineated for the province of which two are represented within the FMA area. Natural subregions are areas with similar landscape patterns that are distinct from other subregions.

The Boreal Forest Natural Region encompasses over 98 percent of the FMA area. Natural subregions represented are the Central Mixedwood (approximately 84 per cent) and the Boreal Highlands (approximately 15 percent) with possible inclusions (less than 1 percent) of Sub-Arctic (Birch Mountains) and Dry Mixedwood (Wandering River-Lac La Biche area).

The remainder of the FMA area is represented by the Lower Foothills Subregion (less than 2 per cent), which is a subdivision of the Foothills Natural Region. The boundaries of these subregions in relation to the FMA area are shown in Figure 2.1.

Figure 2.1: Natural Subregions



PHYSICAL AND GEOLOGICAL FEATURES

The topography of the FMA area is characterized by large expanses of almost-flat terrain, interrupted by several hill complexes and river valleys. The elevation ranges from about 400 metres above sea level where the Athabasca River flows northward out of the FMA area, to over 900 metres above sea level in the Pelican Mountains. Other relatively high areas are the Birch Mountains, Trout Mountain, Stony Mountain and the Thickwood Hills. The major river drainages in the FMA area are the Athabasca and Clearwater in the central and eastern portions of the FMA area and the Wabasca in the northwest corner of the FMA area (see Figure 2.2).

In terms of bedrock geology, Devonian strata of limestone, dolomite, shale and evaporite underlie the area. Devonian and Cretaceous bedrock outcroppings only occur in the deep river valleys. The most notable Cretaceous feature is the McMurray formation consisting of oil-saturated sandstone and shale (the Athabasca Oil Sands). Figure 2.3 shows the extent of the Athabasca Oil Sands formation as well as the location of conventional oil and gas fields.

Surface geological features are primarily glacial drift of varying thickness up to 200 metres, left as a result of the melting of the Wisconsin ice sheet. Glaciation landform features such as glacial fluting, ice disintegration hummocks and potholes, eskers, glaciofluvial and glacial lake deltas are all represented.

Ancient glacial lake beaches have left extensive areas of fine sands that have been windblown in the eastern part of the FMA. Groundwater discharge that originates from deep geological formations is often high in dissolved salt content. Water may also be contaminated with organics from the Athabasca Oilsands formation.

Cold water mineral springs along the Clearwater River have salt content in the order of 3,000 to 20,000 parts per million (ppm), consisting of predominantly sodium chloride. These springs have a hydrogen sulphide smell and surface calcareous deposits. Salt springs along the Athabasca River and sulphate springs in the western part of the FMA area have also been identified and documented by the Alberta Research Council's hydrogeological surveys and reports.

Figure 2.2: FMA Main Features

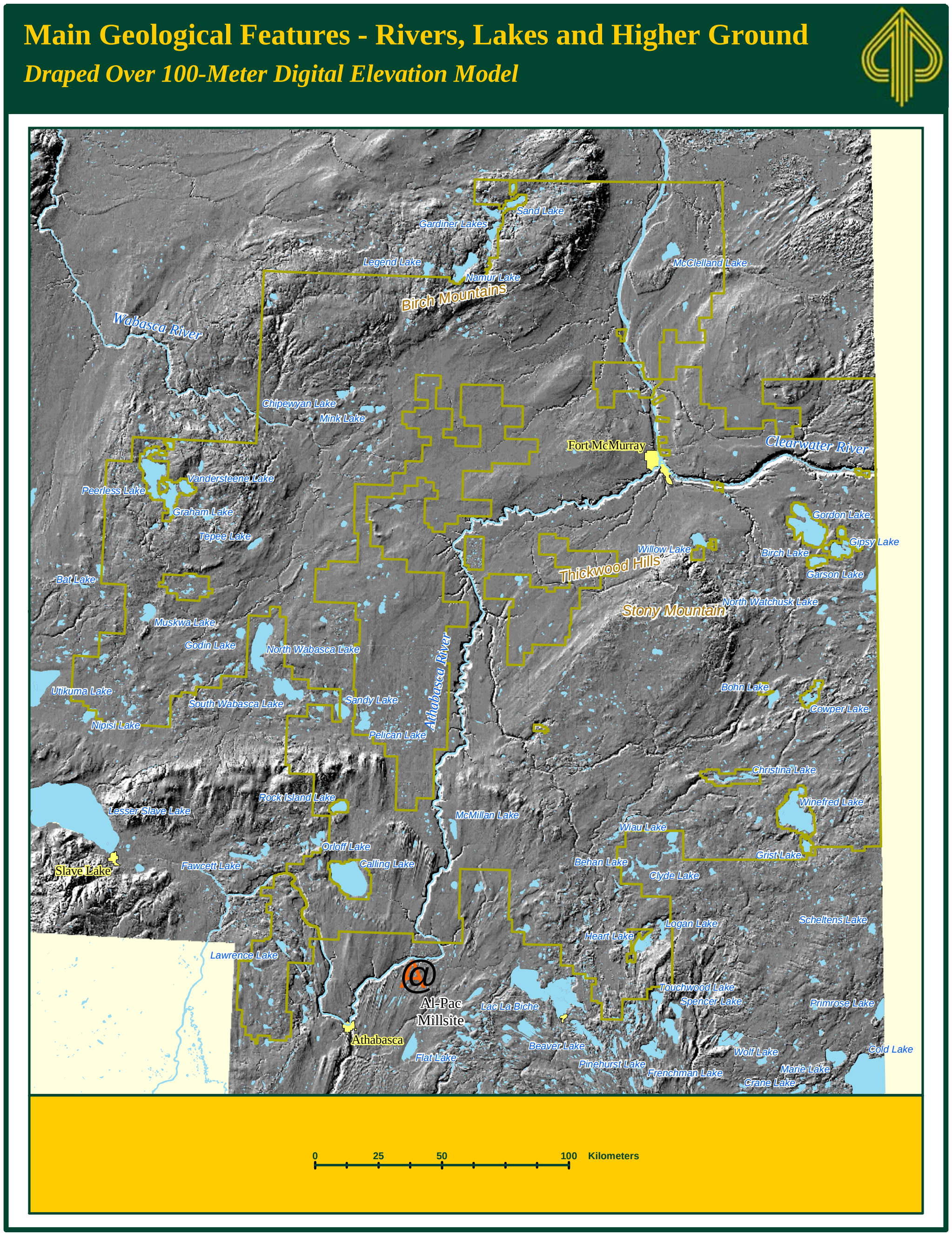
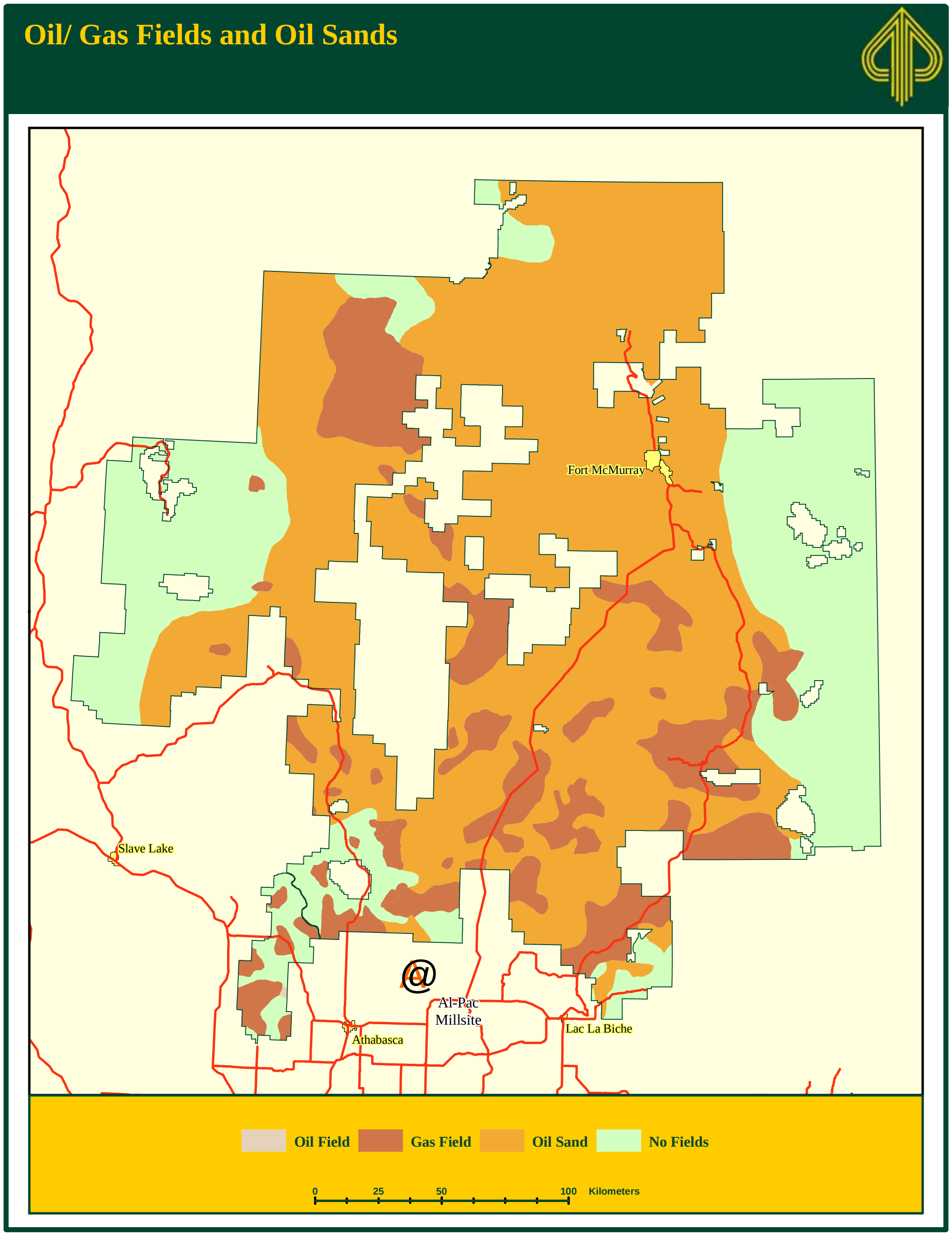


Figure 2.3: Oil and Gas Fields and Oil Sands within the Forest Management Area



Settlements and Features

The FMA is bounded on the south by agricultural settlement and the major towns of Athabasca, Boyle and Lac La Biche. The City of Fort McMurray falls within the outside boundary of the FMA, as do a number of communities and Indian reserves, including Janvier, Conklin, Sandy Lake, Heart Lake, Gregoire Lake, Fort MacKay, Peerless Lake, Trout Lake, Calling Lake and Chipewyan Lake. Just outside the FMA area are the Beaver Lake, Namur Lake and Wabasca reserves and the settlements of Red Earth, Plamondon, Wandering River, Smith, Atmore, Grassland, Buffalo Lake and Kikino (see Figure 2.4).

For the communities in and around the FMA area, the forest resources are vital in providing employment through the forest industry, trapping, guiding, hunting, tourism and fishing. The southern part of the FMA area lies within a three-hour drive from major population centres around Edmonton. Several lakeside summer villages are established along the southern edge of the FMA.

Lakeland Park and Recreation Area and the Cold Lake Air Weapons Range are also on the southeastern edge of the FMA. Lakeland Park and Recreation Area offers tourism and recreation opportunities and establishes a large reserve area with minimal harvesting. Cold Lake Air Weapons Range includes a military base that provides economic benefits to the area and the large training landbase may contribute to protected-area ecological values because of its very restricted use.

Management Subdivisions

The FMA area is subdivided into units to facilitate management of the forest resource and also subdivided into several sets of administrative and legal boundaries that are important to all forest management activities. Alberta is subdivided into administrative regions, and those that are forested are in turn divided into forest areas and sub-offices. The forest districts each administer a number of forest management units (FMUs).

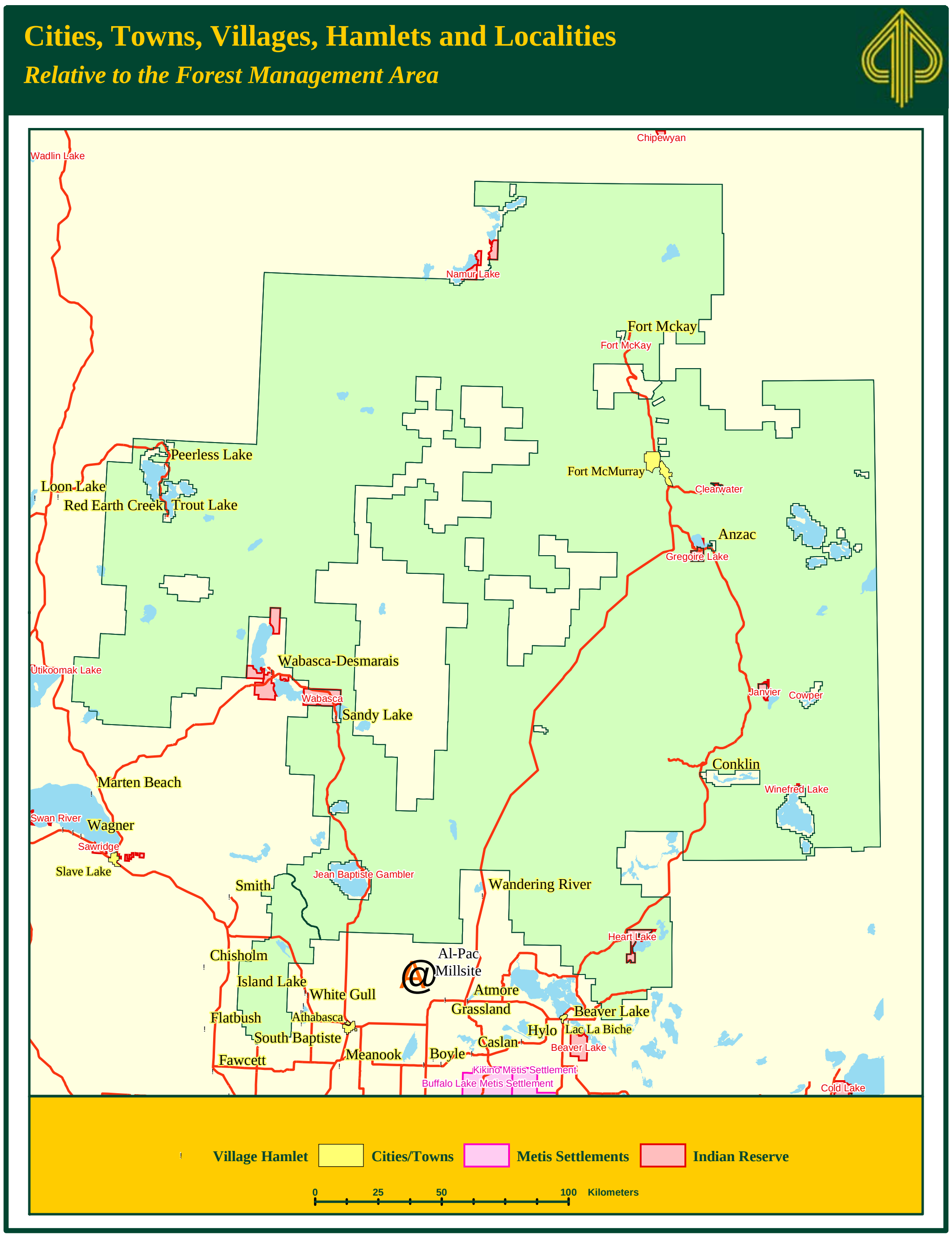
Appendix C of the Forest Management Agreement also subdivides the FMA into three zones that define Alberta-Pacific's coniferous timber rights for conifer and incidental conifer allocations. The zones are described by groupings of FMUs in Table 2.1.

Table 2.1: Alberta-Pacific Conifer Timber Rights Zone / Forest Management Units

Zone	Forest Management Unit
A	L11
B	A15, A14, S22,
C	L1, L2, L3, L8, S7, S11, S18

In Zone A, Alberta-Pacific has exclusive long-term coniferous timber rights, with the exception of 15,000 cubic metres per year retained by the Minister for miscellaneous timber use (MTU). In Zone B, coniferous cutting rights are shared between Alberta-Pacific, Quota Holders and MTU operators. Alberta-Pacific's rights in Zone C are limited to coniferous timber that is incidental to deciduous stands, and this must be offered to sawmill operators.[11] These zones are shown in Figure 2.5. Figure 2.6 summarizes the allocation of the gross FMA area.

Figure 2.4: FMA Communities



[11] *See Clause 19 of the FMA.*

Figure 2.5: Coniferous Rights Zones within the FMA Area

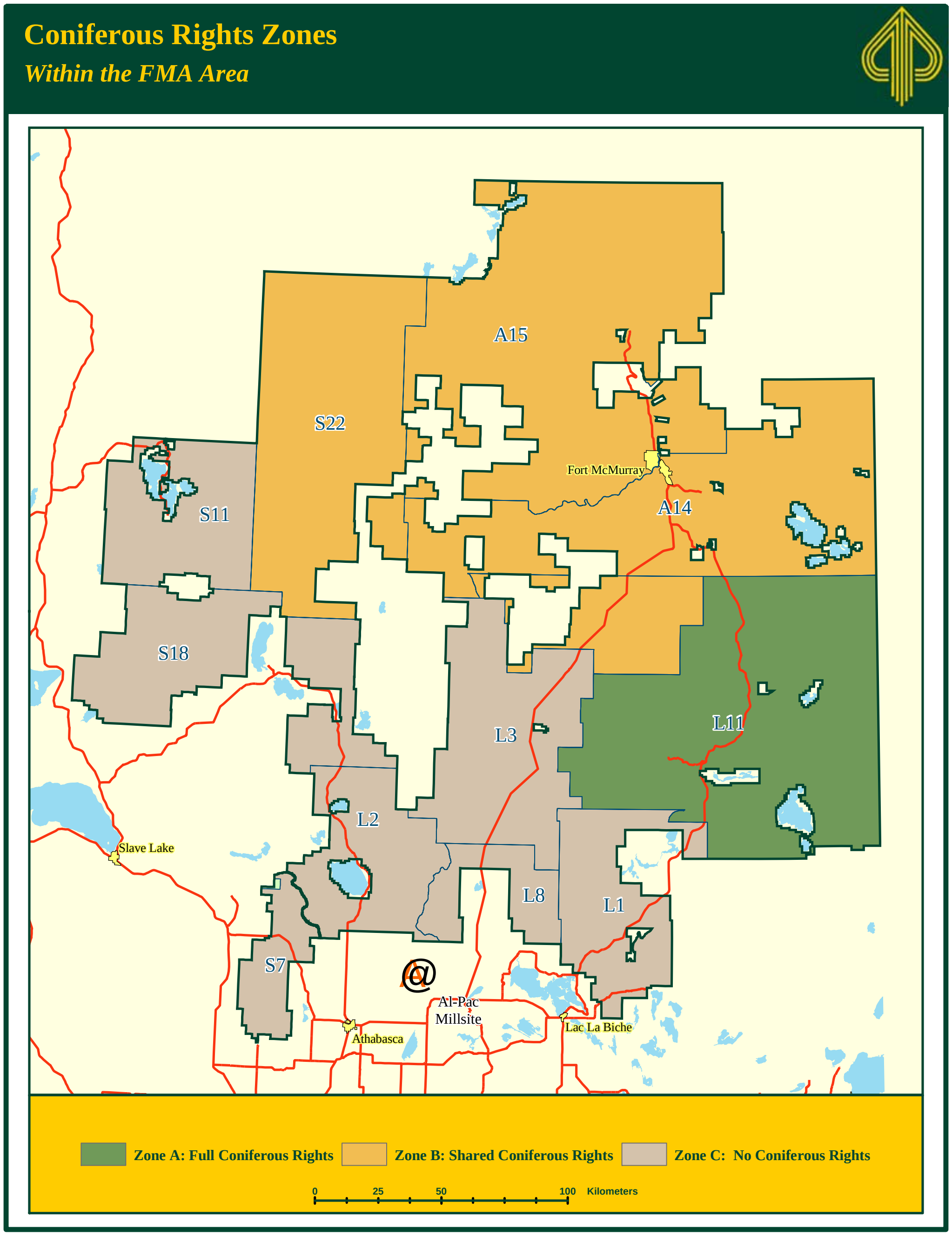
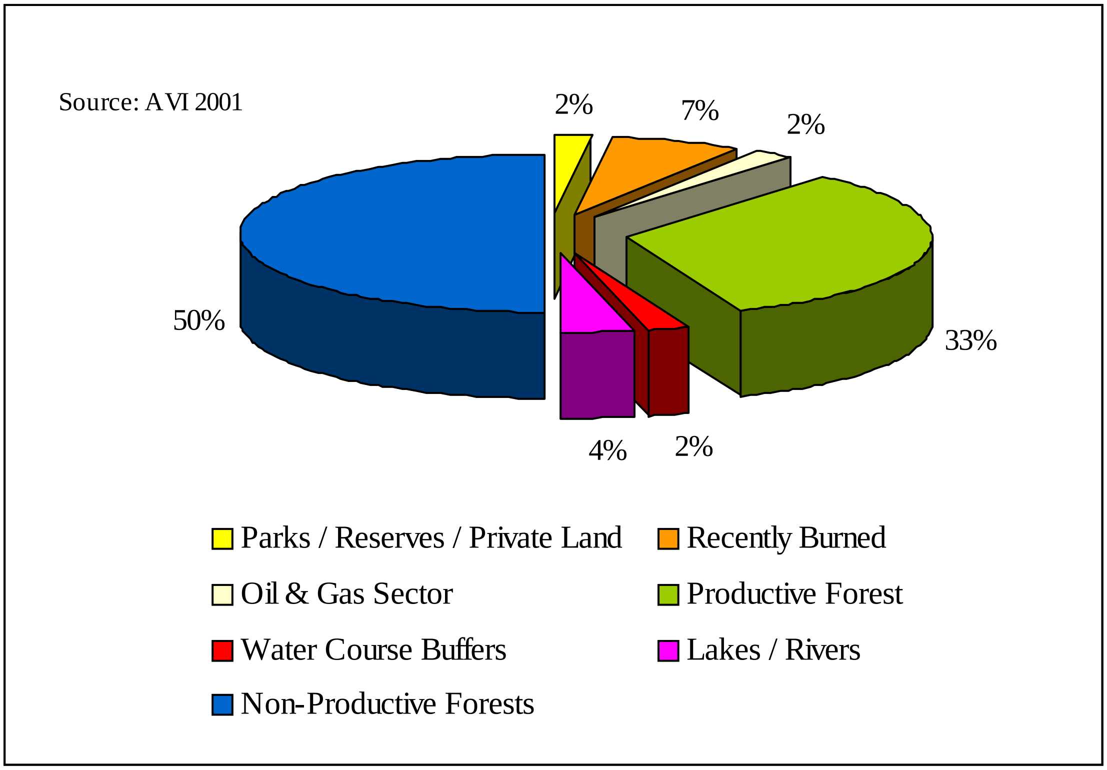


Figure 2.6: FMA Area Gross Landbase Summary (6.87 million hectares in total)



2.2 LANDSCAPE PATTERNS

At the scale of the landscape, whether the entire FMA area or the various forest management units, it is apparent that forest stands in the boreal mixedwood forest are arranged in a complex mosaic pattern. These patterns reflect a dynamic interplay between natural disturbance and forest succession, both of which are influenced by local site conditions. Understanding this interplay has encouraged the design of mixedwood management strategies within a sustainable forest management model. In this section we review the characteristics of this pattern, the processes that generate it, its importance to biodiversity, and thus, the desirability of mixedwood common landbase management (see section 3.6).

ECOLOGICAL PROCESSES

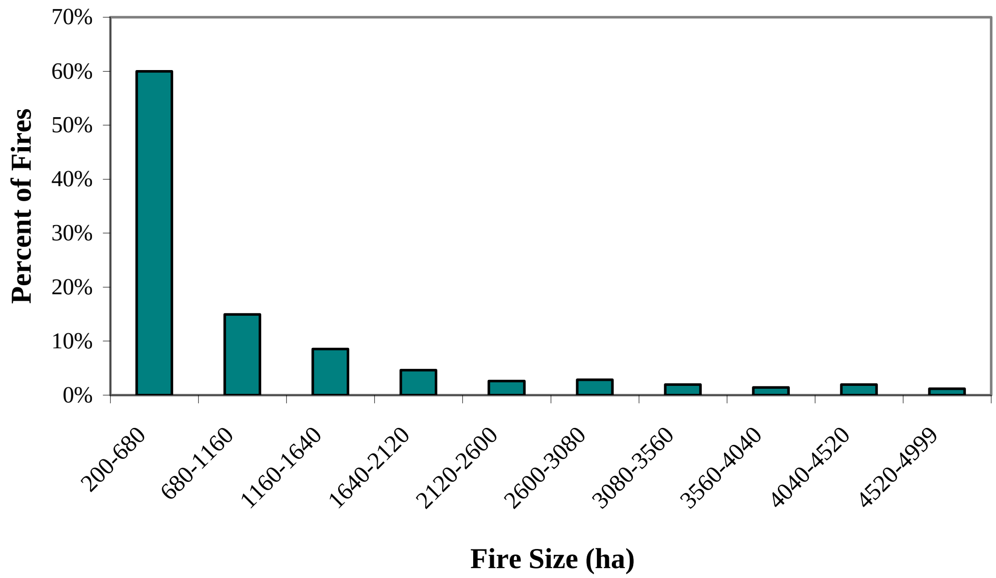
Fire is the dominant disturbance in the boreal mixedwood forest. Fires occur throughout the FMA area and surrounding areas and are described according to their variations in size (e.g., hectares), intensity, temporal variation (time) and impact on human activities. All these characteristics of fire and the landscape patterns that it generates require ongoing investigation to maintain natural disturbance as the basis of forest management activities.

DISTRIBUTION OF FIRE SIZE

The vast majority of fires in Alberta are small. Fires two hectares or less in area account for 74 per cent of all fires recorded in the provincial fire database from 1961 to 1998 (see Figure 2.7). However, while large fires are rare, they are responsible for the majority of the area burned (see Figure 2.8). For example, 98 per cent of the area burned in Alberta from 1961 to 2003 was due to only 5 per cent of the fires. These large fires, some of which have exceeded 200,000 hectares in size, play a dominant role in structuring landscape patterns. A pattern of decreasing frequency with increasing size is also evident in Class E fires (i.e., those over 200 hectares throughout Alberta; Figure 2.9).

Figure 2.7: Distribution of Class E Fires in Alberta, 1961 to 2003

Only fires 200-5,000 hectares are shown.

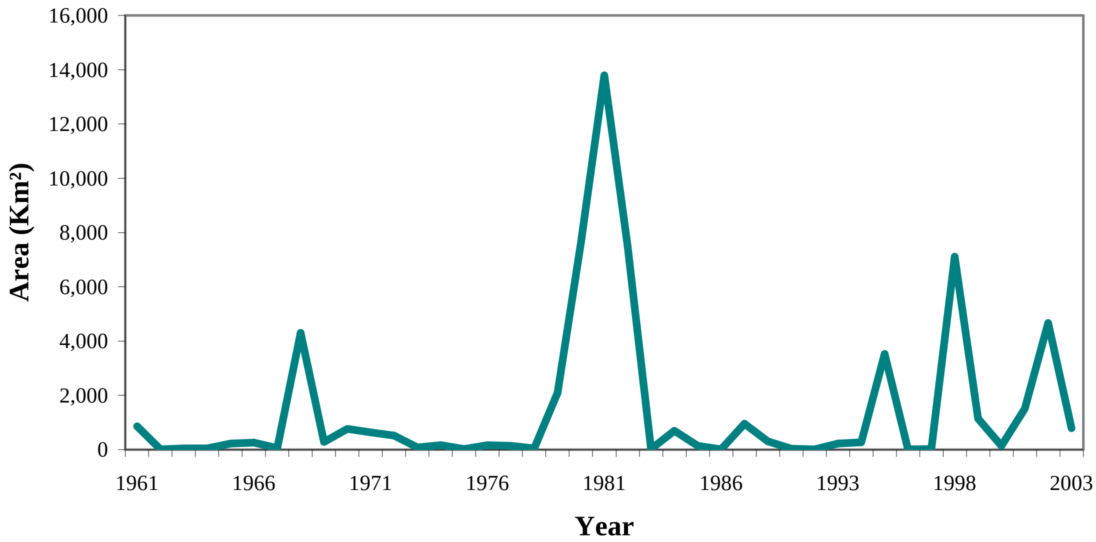


PATTERNS IN FIRE OCCURRENCE OVER TIME

Large fires are generally associated with "fire years" in which extreme climatic conditions, including extended periods of drought followed by hot and dry weather, make the forest highly susceptible to burning. During fire years multiple, extensive burns can occur within the FMA area and surrounding areas of Alberta. For example, in 1981 six fires occurred in Alberta that each exceeded 100,000 ha in size.

Based on the provincial database of fires greater than 200 hectares in size, an average of 0.4 per cent of the land area in northern Alberta has burned annually since 1961 (i.e., 4 hectares burned per year for every 1,000 hectares of land area). However, because of the impact of fire years, the rate of burning over time has varied tremendously (see Figure 2.8), making it difficult to accurately characterize the mean rate of burning.

Figure 2.8: Annual Area Burned From 1961 to 2003



Furthermore, studies of charcoal and pollen in lake sediments have demonstrated that the mean rate of burning has fluctuated over the centuries, likely in response to long-term climatic changes.

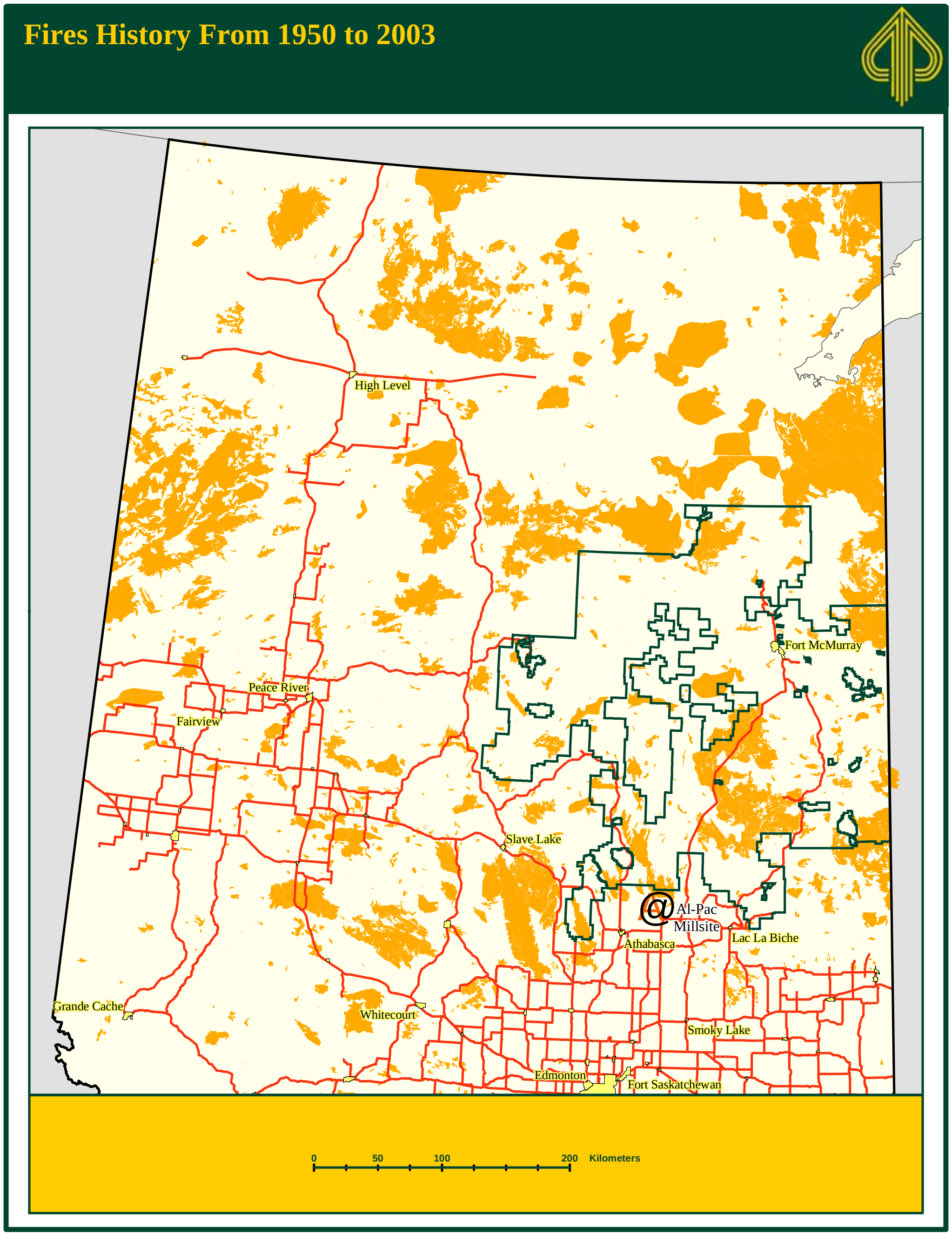
Since the 1950s, fire suppression efforts have steadily increased in terms of dollars spent. By 1971 a policy of total suppression across the entire province was in place. These efforts have not been accompanied by a decreasing trend in the annual area burned (see Figure 2.8). While there is some evidence that fire suppression has reduced the number of large fires when climatic conditions are not extreme, suppression does not appear to have been effective in stopping all large fire events. It appears that the large fires that occur during the extreme fire years account for much of the total area burned over time.

SPATIAL PATTERNS IN FIRE OCCURRENCE

At the provincial scale, the impact of large fire events is clearly evident in Class E fires (see Figure 2.9). While there is no clear pattern in the distribution of the fires, differences in the rate of burning throughout the province and the FMA area have been discerned through statistical analysis. Given the relatively low rate of burning in the past 25 years (except for 1981) there are many large regions in the province that have not been burned at all in the past 50 years. The patchy nature of the burns implies that substantial differences in forest age distribution (variable forest age-classes - i.e., large amounts of older forest and limited hectares of immature forest) will be observed at a landscape scale such as the FMA area or even an FMU.

At the landscape scale, fire patterns vary markedly. After an extended period of hot and dry weather, most types of forest are susceptible to burning and the broad patterns produced are primarily a function of wind speed and direction.

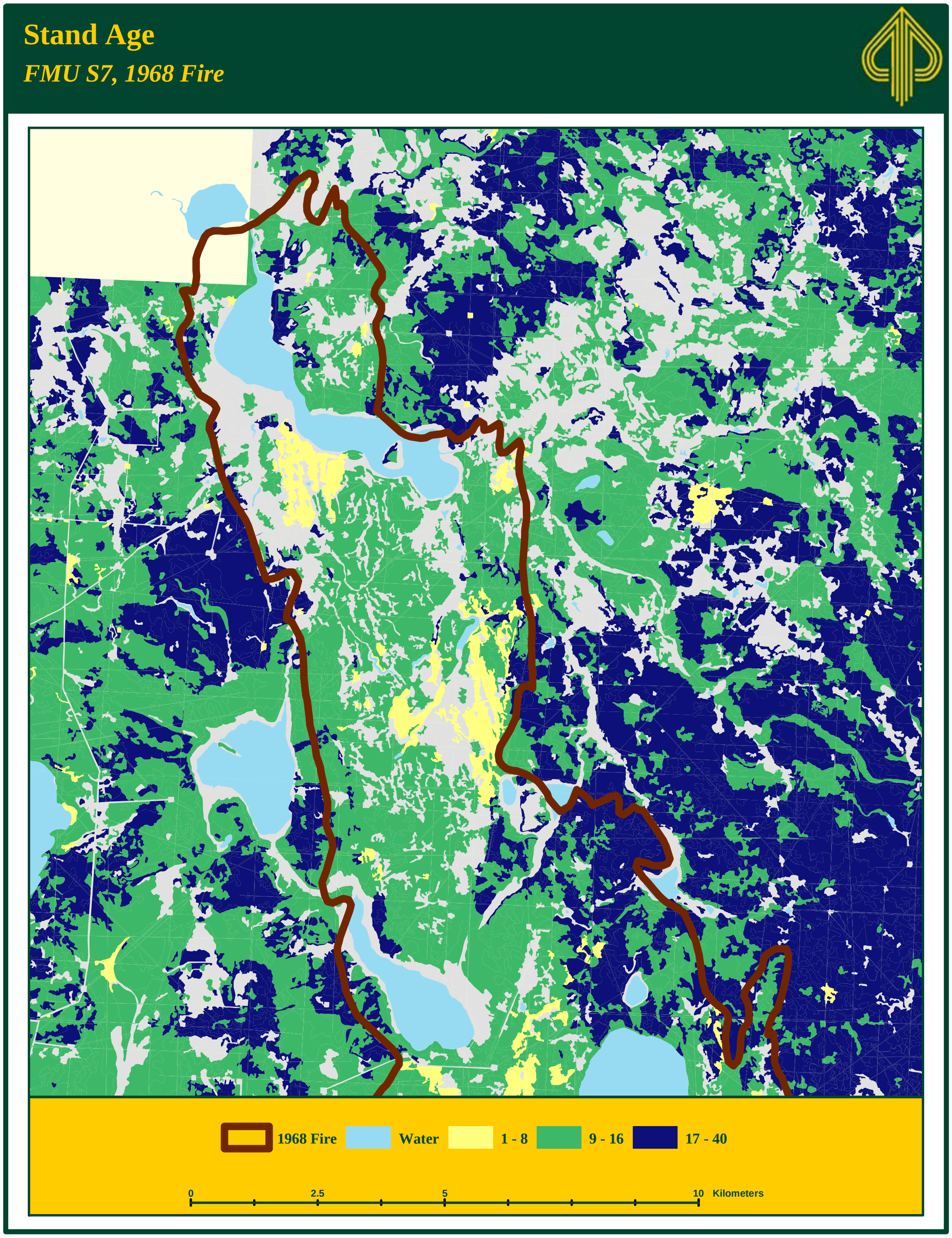
Figure 2.9: Fire History from 1950 to 2003



The intensity of burning varies spatially and the timing of burning also varies throughout a year in response to weather variables (e.g., precipitation and wind speed), physical features of the landscape (e.g., slope, aspect), stand type and suppression activities. "Green-up" of deciduous stands greatly increased their fire resistance. Many patches of forest remain unburned because they are downwind of firebreaks such as lakes, streams, and wetlands (see Figure 2.10). These are referred to as fire skips.

Figure 2.10: Stand Age After a Large Fire

Stand age structure following a large fire that occurred in 1968 in FMU S7. The fire (outlined in black) was 28,300 hectares in size, of which 9,100 hectares are shown. Note the arrangement of large patches of young forest produced by the fire (black) and the patches of older forest within the fire boundary.



Under less extreme climatic conditions, fires are often smaller and less intense, and physical features of the landscape have a greater influence on their behaviour. For example, a firebreak that produces an unburned island in an intense, rapidly moving fire might completely block the forward progress of a less intense fire. Furthermore, when climatic conditions are not extreme, forest stands will vary in their susceptibility to burning and thereby also influence fire behaviour.

Recent studies have shown that the probability of fire starting in aspen stands and the proportion of available aspen burned in large fires are both lower than in other forest types. Essentially, aspen is more difficult to burn, except under extreme conditions (e.g., Chisholm Fire in June 2001). This is especially true after "green-up" – from June to September – but aspen stands are somewhat more vulnerable to fires in the spring and fall.

FIRES AND THE CARBON BUDGET[12]

The fire cycle is a major factor in determining the "carbon budget" for the FMA area. Since suppression activities began in the 1950s, the burn rate has in general been reduced and hence the forests have increased in average age, indicating an increase in carbon storage. If the pre-1950 fire cycle resumed on the forest in place today, the result would be a reduction in the average age of the forest, and this would release more carbon into the atmosphere. Alberta-Pacific, Quota Holders and the government aim to continue reducing the frequency, area and intensity of fires, which would lead to a continued increase in carbon storage. The carbon is stored in live trees or in forest products. Lumber and panelboard products store carbon for a considerable time, while pulp and paper products are more disposable and result in more short-lived carbon storage However, there is no guarantee that future weather conditions will not lead to very large fires and a net reduction in carbon storage.

2.3 FOREST SUCCESSION

Natural succession in the boreal forest is dominated by the natural disturbance regimes: mainly wildfire, and to a lesser degree blowdown or windthrow, flooding (e.g., due to beaver activity), drought, insects and disease. These disturbance regimes have created two distinctly different boreal forest systems within the FMA area:

MIXEDWOOD SYSTEM ON MODERATELY MOIST (MESIC) SITES:

The primary tree species on all sites in this system are:

- Trembling aspen
- Balsam poplar
- White birch
- White spruce
- Balsam fir

[12] The carbon budget is the balance sheet of gains and losses (storage and release) of carbon in an area or ecosystem. The carbon budget determines whether it is a net "source" or "sink" of greenhouse gas emissions linked to global climate change.

PURE CONIFER SYSTEM ON WET AND DRY SITES:

The primary tree species in this system are:

- Black spruce (wet sites)
- Tamarack or larch (wet sites)
- Jack pine (dry, sandy sites)
- Lodgepole pine (dry, sandy sites)[13]

After fire disturbance, sites occupied by these conifer species will predominately return to the same species composition. The qualities of these sites do not normally allow for successional changes in tree species.

BOREAL MIXEDWOOD SYSTEMS

In the boreal mixedwood system, after fire or disturbance, the site will in most instances be occupied by the pioneer[14] and clonal[15] species -- aspen and balsam poplar. These pioneer species establish mainly through suckering (asexual reproduction from roots) but occasionally may colonize a site with seedlings (sexual reproduction from seeds). This only happens when a combination of favourable seed sources, exposed mineral soil, sunshine and available soil moisture all coincide.

With aspen or balsam poplar, only a small number of mature trees need to be present in the parent stand to maintain an adequate root system to allow for abundant suckering. Research in Canada has illustrated that 30-50 mature aspen stems per hectare are all that are required to ensure a sucker crop on a disturbed site (Navratil 1996). Thus, the mixedwood forest stand prior to fire or disturbance could have had any combination of conifer and deciduous tree species, yet the stand after the disturbance will not reflect the same composition as the parent stand. In all cases, the successional forest will be primarily composed of deciduous suckers.

In rare instances, deciduous regeneration is absent after disturbance. The absence of deciduous regeneration can be due to two main events: 1) a very hot fire that burned deeply into the soil and destroyed the deciduous roots, or 2) the absence of any aspen in the parent stand and thus no roots available. These sites can and will regenerate directly to white spruce if there is a spruce seed source and the seed fall onto a viable soil bed. In the absence of white spruce seed or a soil bed, the site will succeed into or go through a seral stage often identified as potentially productive (PP) on Alberta Vegetation Inventory maps, i.e., comprised of grass and/or herbaceous brush (willow, alder and/or hazel).

[13] There are limited occurrences of lodgepole pine in the FMA area.

[14] Pioneer species: Plant species that dominate in the early stages of succession.

[15] Clonal species: Species that can propagate by cloning, e.g., the genetically identical suckers of aspen and balsam poplar.

Aspen and poplar stands can remain pure or, depending on the presence of a white spruce seed source, move on towards a mixedwood stand composed of aspen and spruce, the next seral stage. Varying amounts of white spruce occur as an understory within the aspen, thus allowing succession to occur within the mixedwood ecosystem.

Currently, there is a forestry controversy as to whether white spruce establishes simultaneously (post-fire) with aspen, taking advantage of the exposed mineral soil, or if it recruits after a lag time to initiate the next crop of spruce.

There is mounting evidence that the main determinant in white spruce recruitment is whether or not there is mineral soil exposure immediately after disturbance and that delayed white spruce ingress in the site is not significant. Incorrect age measurements of small understory white spruce led to the belief that they were recruited after a lag time, when in reality they may be as old as co-dominant spruce in other stands with the same stand origin date. Individual spruce may have different growth rates due to different site conditions, e.g., aspen densities at the time of establishment. Additionally, research to date has shown that white spruce can survive under very poor conditions with minimal growth rates. The result is varying degrees of white spruce height and density in a mixedwood forest stand.

Aspen sucker densities can vary greatly after fire with the resulting maturing stands having varying degrees of stand density. Thus, mixedwood characteristics will also vary, ranging from stands that developed “true” white spruce understories with a vertical separation of crowns, to stands with co-dominant spruce and “salt-and pepper” stands (even numbers of mature aspen and spruce). These three mixedwood stand types may all occur due to similar disturbances (e.g., fires).

The extent of spruce and aspen interactions and densities dictates when the stand enters the next seral stage -- the stage when aspen dies out of the system due to old age and white spruce starts to dominate the stand. This stage generally happens after the aspen reaches 100 years. White spruce-dominated stands can then remain in perpetuity on the landscape, undergoing little change if a fire does not occur. The individual mature spruce can live upwards of 250 years old before succumbing to blowdown, disease or insects.

Balsam fir, a very shade-tolerant species, can start to recruit into the understory of mature spruce. Depending on senescence (aging), disease, blowdown or other mechanisms that create gaps in the stand, white spruce can also be once again recruited and thus lead to the development of uneven-aged white spruce stands.

Pure aspen stands usually become decadent at about 100 years and due to the species’ clonal characteristics will start to break up in patches. Aspen suckering can initiate a multiple-age-class stand. Grass and brush species such as alder, willow and hazel may invade the site. This grass/brush stage is limited in time and area; according to Alberta-Pacific’s forest inventory, few hectares of this type can be found on the FMA area.

All the various stages of tree growth and death described above represent various differing points along a 250-year, mixedwood forest stand life cycle. Unfortunately, the relative frequency of occurrence of these points and life cycle trajectories at large spatial scales has not been defined. Such lack of understanding limits our ability to interpret and predict landscape patterns.

Although the intensity of burning within and among fires is variable, the large fires responsible for most burning generally kill most aboveground vegetation but still leave some "islands." The immediate effect of large fires is a homogenization or simplification of the landscape. This simple mosaic does not persist, however, because the regeneration of the forest is influenced by local site characteristics (e.g., moisture and nutrient regime; soil type) and by seed availability and suckering.

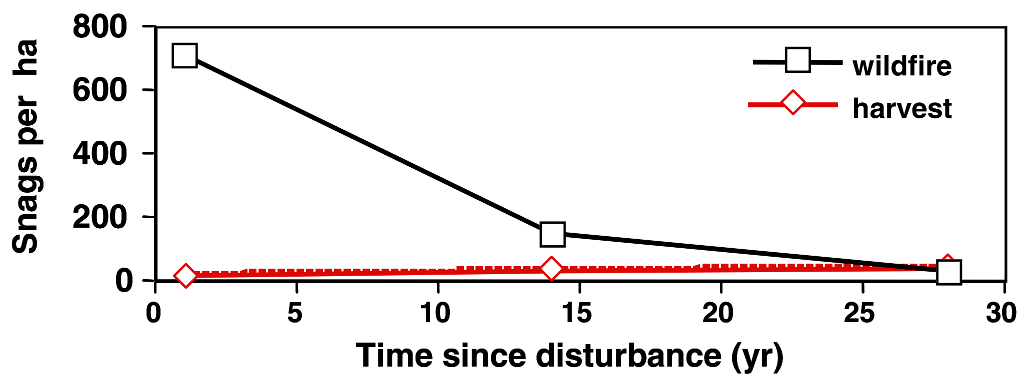
The result is that the large post-fire patches rapidly differentiate into smaller forest stands (a complex mosaic) that differ in vegetation composition and life cycles.

2.4 FOREST STRUCTURE AND PATTERNS

STAND STRUCTURE

Structure is the physical form of the forest. Features of structure include live merchantable trees of all types and ages, standing dead trees (snags), downed woody material (dead logs and branches), and non-merchantable vegetation (e.g., shrubs and grass). After a fire, the structure usually contains a large number of snags that over time will fall, contributing to an increase in downed woody material. This falldown usually occurs after 14 years. Thus, as stands age, the amount and type of structure changes. Researchers have found that forest structure developed from fires and structure left after logging tends to converge over time and become similar (see Figure 2.11).

Figure 2.11: Young Forest Stand Structure Over Time: Fire vs. Harvest.



(Note: Densities of snags (standing dead trees) greater than 10 centimetres diameter at breast height within wildfire and harvest stands (1-28 years) (Lee & Crites 1999).

Young stands represent the biological legacy of disturbance and typically contain a substantial amount of structure, including snags. Structure is generally carried over from the pre-disturbance stand according to the characteristics of the disturbance. Features found in pre-fire forests can be found post-fire in the form of residual materials. In time, the older trees that remain in the young stands will begin to fall, creating gaps in the canopy and allowing light penetration, which stimulates increased understory growth. There will be a large number of snags remaining after a fire and over time these snags will fall, contributing to an increase in large downed woody material.

Mature stands are relatively simple in structure. The majority of snags and downed woody material present in the young stands have decomposed. The canopy is closed, resulting in relatively little understory development. The trees are relatively uniform in spacing, height, and diameter.

Old or over-mature stands have many features that are unique to their age class. As stands age beyond the mature stage, the canopy begins to break up as older trees die and fall, allowing more light to reach the ground. Increased light levels result in the formation of an understory layer in the resulting gaps. Mortality of canopy trees continually adds to the amount of snags and downed woody material. Tree canopy and understory variety is highest in old stands and lowest in mature stands. Old stands also exhibit a deeper organic soil layer.

AGE DISTRIBUTION

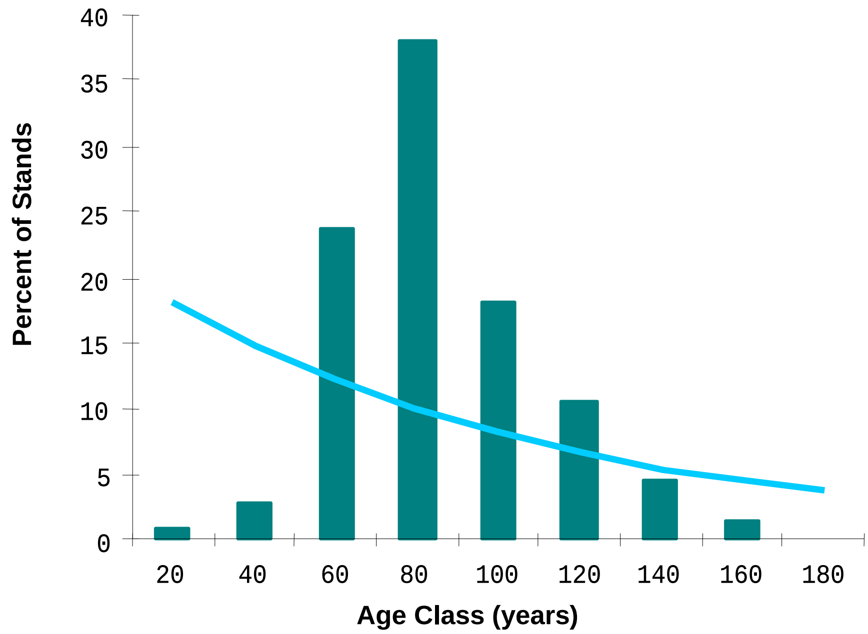
If forests burned at a constant rate in a random pattern then the age class distribution of stands would follow a curve similar to that shown in Figure 2.12. The slope of the curve depends on the mean rate of burning; however, two features are constant: young stands outnumber old stands, and there is an extended “tail” reflecting that, through chance, some stands escape burning for very long periods (resulting in over-mature or old stands). The actual age distribution of forest stands rarely follows the conceptual line, as illustrated by the bar graphs for all forest stands in Forest Management Unit L1 (290,000 hectares, see Figure 2.12).

The main reason for the discrepancy between the line and the bars is that most burning occurs in pulses, associated with fire years (see Figure 2.8). Furthermore, most burning is spatially clumped as a consequence of large fires (see Figure 2.9). Because of these processes, the age distribution of the forest is more a function of the variability in fire occurrence than it is to the mean rate of burning.

As shown in Figure 2.12 for L1 -- an FMU that has a fairly representative age-class distribution for the entire FMA area -- the majority of forest stands are in the age class of 60-100 years. There are a small component of young stands. This is most likely the result of extreme fire years in the early part of the 1900s.

Figure 2.12: Theoretical Age Distribution (assuming a constant rate of burn) for Forest Management Unit L1.

(Bars = current age-class structure; Line = theoretical distribution)



STAND SIZE

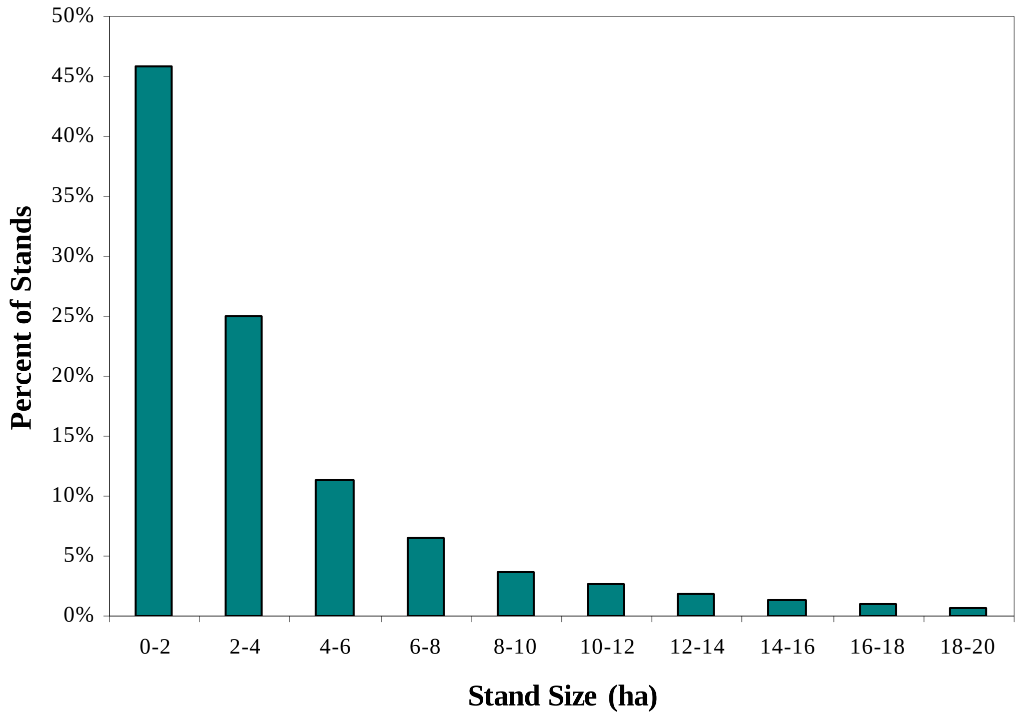
Historically, the distribution of stand sizes reflects the interplay between fire and forest succession. Large fires produce large homogenous patches, albeit with many small unburned islands, and succession differentiates the forest into smaller units in response to differences in site characteristics and seed availability. Thus, stand size decreases over time as different species react to the site variables and create varying microclimates over time. The net result is that stand size is only vaguely distributed in a pattern similar to forest fire size (see Figure 2.13). On average, forest stands over time are substantially smaller than the original fire disturbance patterns.

Stand size is sensitive to the system used to classify the landscape. An increase in the number of categories or the resolution[16] of interpretation results in a decrease in the average size of stands. Highly detailed inventories, such as the Alberta Vegetation Inventory (AVI), virtually preclude the existence of stands greater than 100 hectares. Stand size must be considered when comparing landscapes and when developing size targets for management based on natural disturbance patterns.

[16] Resolution of interpretation: The amount of small detail visible in an image; low resolution shows only large features, high resolution shows many small details.

Figure 2.13: FMU L1 Stand Size Distribution

Size distribution of forest stands in FMU L1. Stands larger or greater than 20 hectares are not shown. (Source: AVI)



SPATIAL ARRANGEMENT

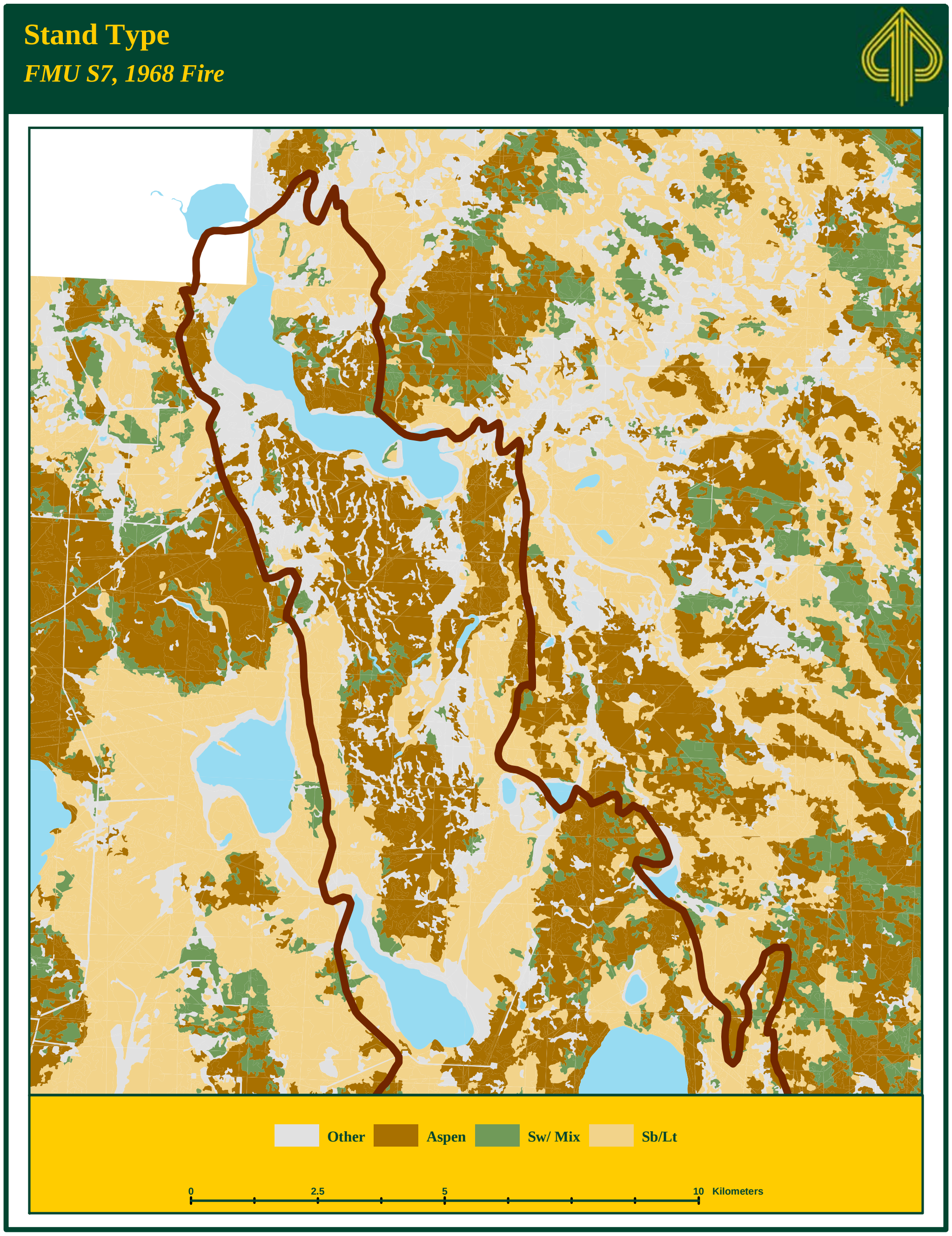
The arrangement of forest stands reflects the legacy of differences in fire characteristics and local and regional site conditions. As a consequence of infrequent large fire events, stands of the same age are typically aggregated together (see Figure 2.12). Within the matrix produced by these large fires lie islands of older forest, representing fire skips, and patches of newer forest arising from more recent small fires.

Aggregation is also apparent from the perspective of vegetation type (see Figure 2.14). This is largely a consequence of regional patterns in site conditions, especially moisture regimes. Although most of the FMA area's boreal region is relatively flat, there are nevertheless significant differences in moisture regime expressed at a variety of spatial scales up to several kilometres.

These differences in moisture regime are in turn linked to different assemblages of vegetation. Fire also plays a role in aggregating stands in that it promotes the establishment of aspen and mixedwood stands at the expense of pure conifer stands.

Figure 2.14: Stand Type

Stand type for the same region illustrated in Figure 2.10 (Page 15 of 49). Note the aggregation of similar stand types at a scale of several kilometres. Abbreviations: Sb/Lt = Black spruce/Tamarack Larch; Sw/Mix = White spruce/Mixed deciduous and conifer; other = Pine and non-forest.

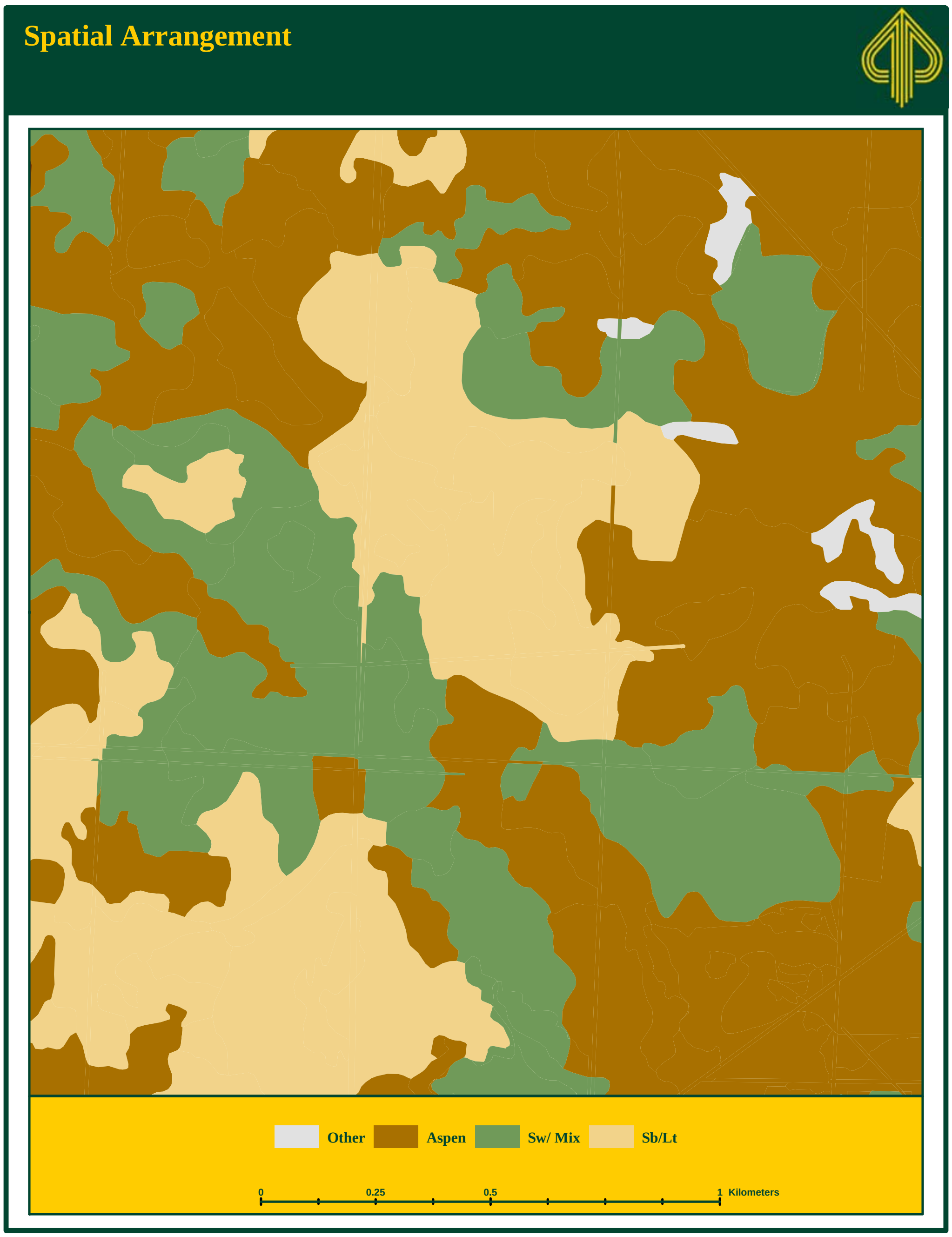


In spite of the existence of large-scale aggregation, the spatial arrangement of stands at the local level is often highly complex (see Figure 2.15). This complexity reflects local variations in site conditions, seed availability, successional stage, and the irregular boundaries of past fires.

Aquatic features such as rivers, lakes and wetlands also have an important influence on landscape patterns. Because they often act as firebreaks, there is a greater probability of finding older forest stands in the vicinity of these features than in the remaining landscape. Furthermore, the moisture regime, soils, and even microclimate in the vicinity of aquatic feature are often unique, leading to distinct assemblages of vegetation in these areas.

Figure 2.15: Spatial Arrangement

This illustrates one example of the kinds of spatial arrangements of forest stands encountered when viewed at a small scale.



CONNECTIVITY AND FRAGMENTATION

Ecological theory emphasizes the importance of landscape configuration in determining the persistence of populations. However recent reviews indicate a lack of consistent empirical evidence of fragmentation effects on populations (Harrison and Bruna 1999).

Recent studies in the Al-Pac FMA indicate that corridors may not improve the conservation value of small reserves for most boreal birds (Hannon and Schmiegelow 2002), while habitat loss rather than fragmentation appears to be responsible for most population declines observed due to forest harvesting (Schmiegelow and Mönkkönen 2002).

When considering landscape fragmentation (or its inverse connectivity) it is important to consider that this depends on the perspective of the organism in question. What appears to be fragmented or connected to human eyes may be less relevant for different boreal species. Connectivity can occur without specific corridors, as some organisms are able to use the matrix between preferred habitat patches, while other species appear to not easily traverse recent cutblocks. Fragmentation by the forest companies is probably not a foremost issue when 65% of the Al-Pac FMA is unavailable for forest harvest. For, although the habitat value of these non-commercial forest areas, muskegs and aquatic areas is unknown for many species, it is most likely that these areas make a significant contribution to landscape level connectivity.

In the absence of detailed information about the response of a suite of species, the following are important and emerging components of an ecosystem program that attempts to maintain landscape connectivity within the Al-Pac FMA. These components are addressed in chapter 3.

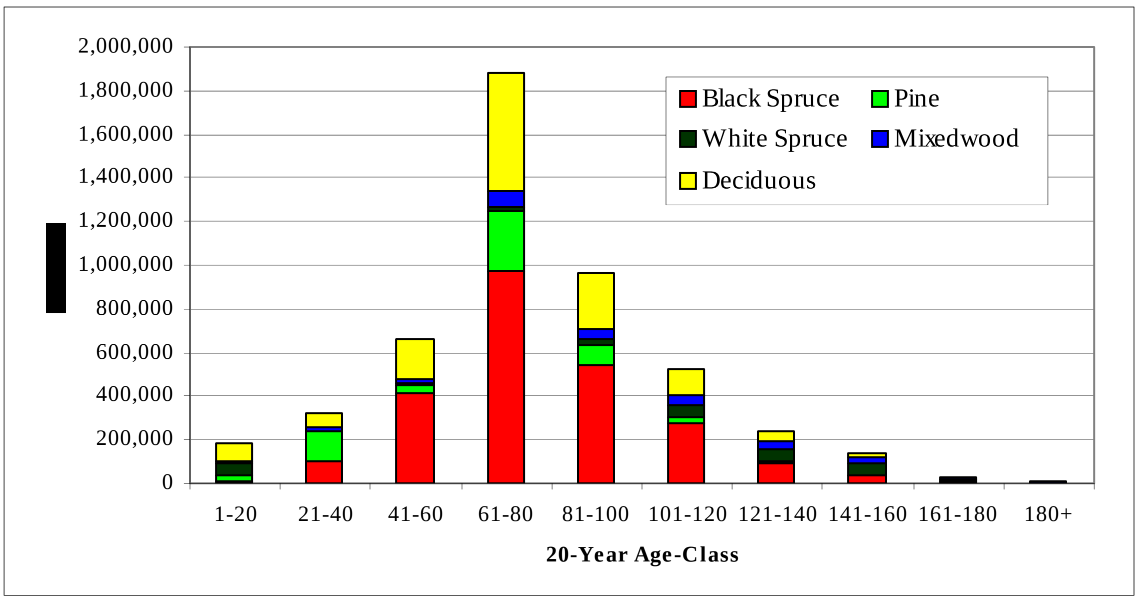
- Develop harvest plans that will maintain landscape pattern and structure.
- Retain residual material within all cutblocks, in addition to non-merchantable material.
- Retain riparian buffers on all permanent and intermittent streams.
- Minimize roading requirements through integration with other disposition holders (ILM program) and develop aggregated harvest plans.
- Support long-term monitoring to determine potential long-term effects of landscape fragmentation, particularly after two-pass harvest activities (Chapter 4).

Additionally, there needs to be continued landscape based research into the development of practical targets for forest companies' patch sizes and distribution that better imitate the natural landscape pattern.

2.5 FMA AREA FOREST COMPOSITION CHARACTERISTICS

Baseline measures of the FMA area forest such as age-class distribution and cover type distribution can be to some extent managed by the forest companies. Figure 2.16 presents the current age-class state of the gross FMA area forest (includes the Non-FMA areas[17]). However, the boreal forest does not provide a stable age mosaic due to the effect of historical disturbance regimes (large fires in particular), physiographic and natural forest stand dynamics (i.e. insects, disease, wind, flooding). Thus the current FMA area age-class distribution follows "a natural pattern where large areas can be dominated by a single seral stage and the overall landscape is a dynamic mosaic of large-scale patterns created by what fires burn and leave behind as unburned residuals" (Cummings et al. 1996).

Figure 2.16: Forest Age-Class Distribution of the Gross FMA Area Landscape (AVI 2006)

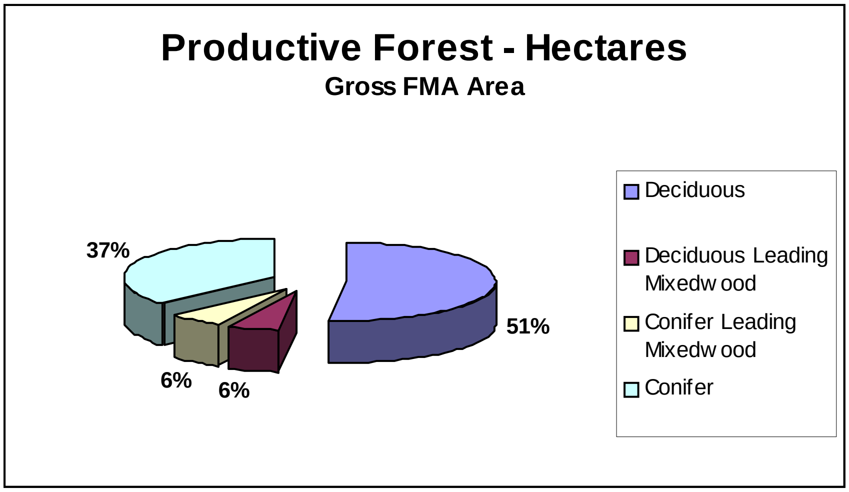


As illustrated in Figure 2.16, 54% of the forested area is in the 40-80 year age classes.

The forested pattern of the FMA area can also be simplistically shown by the broad cover-type distribution. These broad groups are: deciduous leading stands (D), mixedwood leading stands (DC and CD) and conifer leading stands (C) composed of white spruce, black spruce and pine. Figure 2.17 illustrates the four broad-cover groups' distribution for the 2.2 million hectare productive forest landbase (net landbase).

[17] The FMP also pertains to the areas inside the FMA area (donuts) and FMUs outside of the FMA; "non-FMA FMUs".

Figure 2.17: Major Forest Cover-Groups of the Productive Landbase (%)



Forest companies only conduct harvest operations within the productive forest landbase (net operable landbase) – 33% of the 6.8 million ha gross FMA area. The remaining portions of the FMA area are composed primarily of continuous wetland units to highly variable upland-wetland complexes. Lakes, ponds, rivers and streams also compose a significant portion of the FMA area (see TSA Appendix). Both areas contribute significantly to biodiversity and ecological connectivity and mutually play an essential part in sustainable forest management.

2.6 WATERSHEDS AND DISTURBANCE ASSESSMENT

Identification of watershed areas within the boreal plain of the gross 6,800,000-hectare FMA area is extremely challenging. The Ducks Unlimited Canada and Al-Pac cooperative "Boreal Conservation Project" (BCP) has as one of its goals to identify watersheds and/or landform boundaries to enable effective watershed conservation planning for the entire FMA area. Until the BCP defined watershed or landform boundaries are identified, a complete watershed assessment to help direct forest management objectives and strategies is not available for this FMP. The BCP will provide the groundwork for future landscape watershed assessments of the FMA area.

EFFECTIVE DRAINAGE AREA OF THE INCREMENTAL DRAINAGE AREAS OF THE PRAIRIE FARM REHABILITATION ADMINISTRATION WATERSHED PROJECT

To assist in the coarse-filter natural disturbance approach and provide a very broad level watershed assessment, the Prairie Farm Rehabilitation Administration (PFRA) coverage, called the "Effective Drainage Area of the Incremental Drainage Areas of the PFRA Watershed Project"[18] was used to determine relative impacts of fire events at this relatively coarse watershed level assessment.

Figure 2.18 delineates the PFRA defined watersheds for the FMA area.

From the PFRA analysis, the average (mean) basin size within the FMA area is 195,000 hectares. A full listing of the PFRA watersheds is provided in Appendix 2.

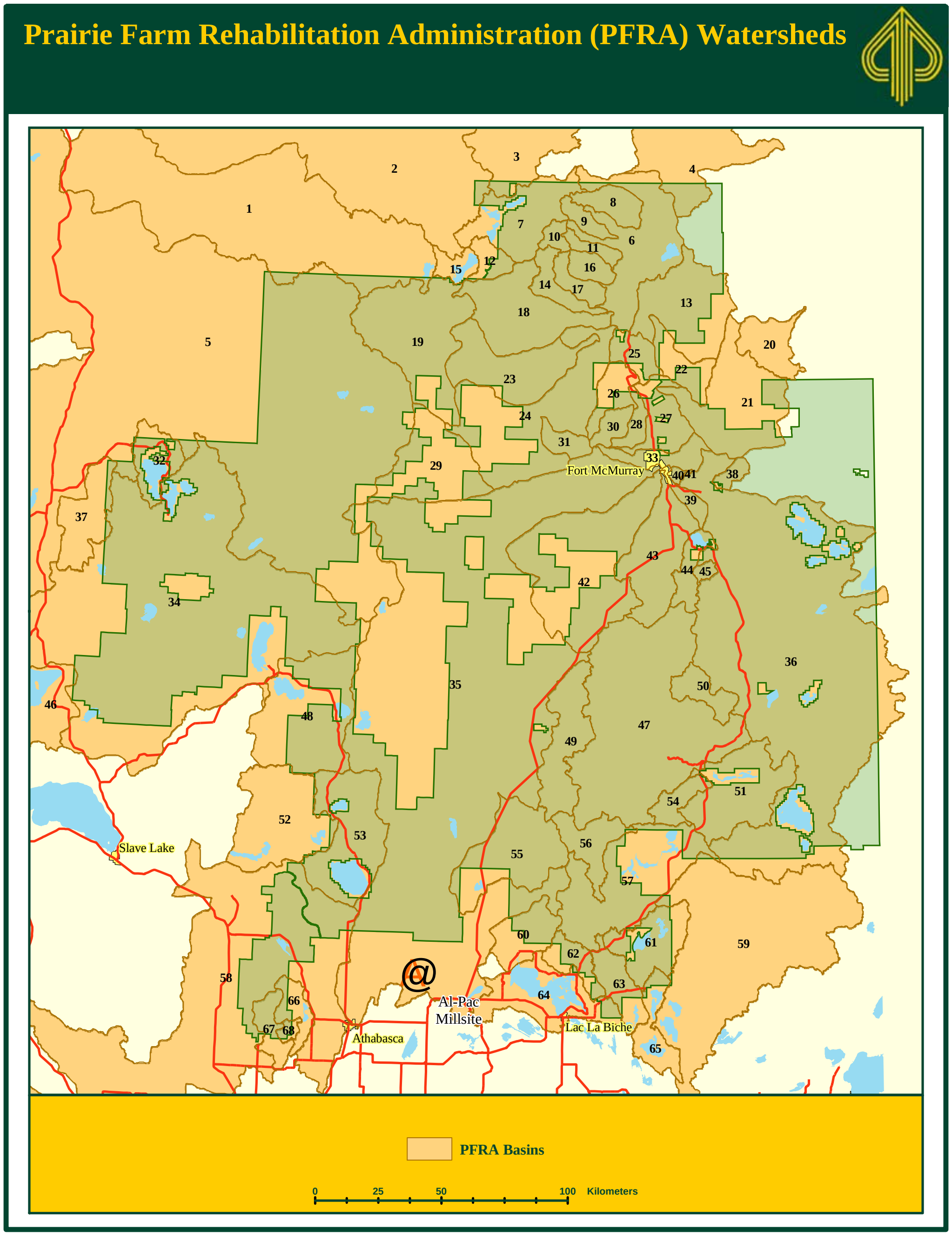
Within each watershed, the past 40 year (1960-1997) fire history was overlaid on the PFRA watershed map. A five-year window around each year was calculated to estimate the total natural disturbance over any 10-year period. Burned area, as a percentage of total watershed areas are calculated for each PFRA watershed. Based on empirical data:

- The mean maximum watershed disturbance by fire during any 10-year period was 38% of any watershed.
- For some watersheds, disturbance was 100% during some ten year periods and as low as 0% for other periods.

What this demonstrates is that disturbance patterns within the FMA area boreal forest are extremely variable, and that catastrophic natural disturbance of significant portions of watershed units is a common occurrence. Thus it is appropriate that the forest companies follow a natural disturbance model approach and manage within the range of natural disturbance of a watershed.

[18] In 1970, as part of an International Hydrological Decade study, the PFRA Hydrology Division undertook the tasks of delineating and of measuring the areas of gross and effective drainage for catchments tributary to active and discontinued hydrometric gauging stations in the prairies. The results were intended to provide the basis for updated regional flood and runoff studies. In 1975, at the request of the Prairie Provinces Water Board, PFRA formally agreed to delineate gross and effective drainage basin boundaries and also to provide a set of standardized drainage area maps (1:250,000 scale). Available online at http://www.agr.gr.ca/pfra/gis/gwshed.htm

Figure 2.18: Prairie Farm Rehabilitation Administration (PFRA) Watersheds



Integrated Forest-Watershed Planning and Assessment Model: ECA-Alberta [19]

The hydrologic effects of forest harvesting in the Alberta-Pacific Forest Management Area (FMA) was simulated using the ECA-Alberta hydrologic model (Silins, 2000). The objectives of this analysis were to estimate changes in mean annual stream flow, Equivalent Clear-Cut Area (ECA), and the time for hydrologic recovery for the 11 Forest Management Units (FMU) in the FMA area.

The focus of this analysis was to evaluate the hydrologic effects of harvesting operations at a strategic level (large scale) within the FMA area. An analysis was conducted at the FMU (11 in total) and the FMA area scale by simulating the effect of applying the proposed annual allowable cuts (AAC) by species as an even flow harvest rate in each management unit.

Changes in streamflow were simulated based on the area harvested (determined from the proposed AAC hectares) in each of 11 FMUs and over the entire FMA area, rate of forest re-growth (based on provincial average yield curves for unmanaged stands), and long-term average climatic conditions specific to each management unit. To evaluate the effect of an even-flow harvesting scenario (area based) and illustrate the rate of hydrologic recovery of this landscape (re-establishment of landscape level forest water use) simulations were projected for 100 years (50 years of harvesting at the proposed harvest rate indicated by the AAC, followed by 50 years of no harvesting) based on average precipitation and stream-flow conditions in the region.

- ECA-Alberta simulations of even-flow harvest in the region predict increases in mean annual water yield (stream-flow) during the first 35-50 years after which no further increases in stream-flow are observed because the rate of harvest is balanced by the rate of hydrologic recovery of stands harvested earlier in the scenario, followed by a decline in water yield with simulated suspension of harvesting activities:
  - A maximum increase in average annual water yield of 2.4mm or 2.86% occurred from 2046 to 2055 for the FMA.
  - ECA for the FMA peaked at 3.13%, from years 2053 to 2055.
  - Hydrologic recovery for the FMA (the time for increased water yields to approach zero upon suspension of harvesting) was 39 years.
- Some variability in projected increases in average annual water yield following harvesting was projected in individual FMU's:
  - Maximum increases in water yield ranged from 1.45% in A14 to 6.06% in S11
  - 8 of the 11 units had projected water yield increases of less than 4%.
  - Smaller FMU's experienced the largest simulated yield increases.
  - ECA for the FMUs ranged from 2.54% in L11 to 4.48% in S11.
  - 8 of the 11 units had ECAs less than 4%.

[19] The ECA-Alberta model has been provided by UofA's Centre of Enhanced Forest Management, Department of Renewable Resources.

- Hydrologic recovery for each of the FMU's was variable and ranged from 35 to 42 years.

The results from this analysis indicate that projected increases in annual yield and ECA at large landscape scales (FMU/FMA) are quite low when considered against the natural range of variation in steam-flow produced by fluctuation in annual climate in the region. Based on the scale of this analysis (FMU/FMA) and the assumption of an even spatial distribution of harvest, the projected increases in average annual yield are probably not significant and are likely below the measurement detection limit using standard hydrometric techniques.

However, actual water yield increases will probably be larger than simulated in this analysis if harvesting effects were evaluated at a smaller scales (township or catchment scale). It should also be noted that the ECA-Alberta model projects average stream-flow changes over time assuming average climatic conditions. While this allows for the evaluation of the incremental hydrologic effects of forest disturbance over and above that produced by climatic variation, it is important to note that actual water yield increases produced by disturbance co-vary strongly with variation in annual climate. Stream-flow increases in wet years may be significantly higher than those presented here. Conversely, actual yield increases in dry years may be significantly less or non-existent.

The ECA model also predicts changes in annual yield based on average provincial rates of stand growth. Therefore, actual stand growth and regeneration lags will affect actual yield increases and ECA's. Appendix 3 provides the complete ECA model formulations and analysis.

The ECA model provides a gross approximation of water yield at the landscape level. Within this modeling environment, large variances will occur at the sub-basin and watershed scale. To identify those areas susceptible to water yield sensitivity, Alberta-Pacific has collaborated with Ducks Unlimited Canada and University of Alberta researchers as part of a comprehensive conservation planning project - the Boreal Conservation Project (BCP) (see below). The BCP is designed to develop sensitivity models and planning tools that will identify risks to water yield. Additionally, the program will attempt to provide harvest planning recommendations for avoidance of at-risk sites.

BOREAL CONSERVATION PROJECT (BCP)

Alberta-Pacific and Ducks Unlimited Canada (DUC) signed a memorandum of understanding (MOU) in 2002 to establish a watershed-based conservation partnership for 115,000 square kilometres of northeastern Alberta - an area of land including the Al-Pac Forest Management Agreement (FMA) area. The signing of the MOU marked the beginning of the Boreal Conservation Project (BCP) – Al-Pac FMA Area, a common sense, practical conservation and management project.

The partners have developed a number of principals to guide the partnership development:

- Conservation of wetlands, as well as water quality and supply, is of vital interest to the public and a responsibility of government and users of the land base
- Conservation of wetlands requires the active participation of industries whose activities affect watersheds

- Watershed conservation of the Al-Pac FMA area is critical to the achievement of informed decision making, and

- Watershed-based conservation of the Al-Pac FMA area is consistent with Al-Pac's operating guidelines

Watershed-based conservation of the Al-Pac FMA area will demonstrate the potential to maintain the watersheds of the boreal forest as healthy ecosystems, consisting of a vast mosaic of lakes, forests, rivers, and wetlands. The BCP can achieve ecosystem health, and sustainability of development, through a comprehensive watershed-based conservation program that will define and implement best practices in protection, special management of designated priority watershed features, and use of a Conservation Plan based on sound science and traditional knowledge.

The knowledge-based approach to collaboration by Al-Pac, DUC, other industry partners, universities, government, Aboriginal partners, and other stakeholders should significantly increase our understanding of boreal forest watersheds, their values for waterfowl and other wildlife, cultural and ecological significance, high conservation value forest, and the effects of various industrial activities. This information will be used to increase societal awareness of the value of the western boreal forest (including those values defined through traditional knowledge), promote sustainable integrated land management and assist in maintaining the ecological integrity of the WBF.

As a result of these standards, future land use activities in the boreal forest will be able to respect the function, value and importance of restoring and maintaining watershed integrity. Cooperation of other industrial land users, governments, other stakeholders and Aboriginal partners in watershed-based conservation will ensure that the boreal forestlands of the Al-Pac FMA area will support healthy ecosystems on a sustainable basis. Human use of the Al-Pac FMA area will be in better harmony with the land through conservation of its vast cultural and ecological heritage. Priority watershed features and high conservation value forests, representing areas of cultural or ecological significance, will be clearly identified and conserved. Industrial activity will be carried out in a manner that achieves and sustains the long-term health of the ecosystem.

Goals of the Boreal Conservation Project

The following are the seven goals that the BCP is tasked in achieving over the initial five-year project period.

Goal 1: Inventory of the Watershed Features

Information that is currently being collected and analyzed includes an inventory of watershed topography, hydrology, ecology, and history of disturbance. This information will be used to identify and describe initial priority areas for special conservation measures, based on cultural, traditional and ecological significance as well as vulnerability to disturbance and immediacy of threats to ecosystem health.

The BCP has contributed to the development and implementation of directed academic research to determine the hydrological cycle within the boreal forest. Dr. K. Devito of the University of Alberta directs this research project, termed Hydrology Ecology and Disturbance (HEAD). The objectives of HEAD are to: 1) understand the natural variation in linkages and pond characteristics to establish a framework for conducting, interpreting and extrapolating effects of disturbance on wetlands, 2) investigate and characterize waterbird ecology, 3) determine the ecological and hydrological processes controlling wetland structure and, and 4) derive and automate indices for inclusion into a GIS-based Conservation Plan.

Goal 2: Develop a Conservation Plan in Support of Watershed-Based Conservation

The Conservation Plan will be comprised of two components:

1. Current and future research programs will be used to assess the variation among watershed features and the associated sensitivity to and significance of existing disturbance.
2. Outputs of this research will provide inputs into the development of GIS-based conservation planning tools, which in turn will be used to assess current landscape capacity as well as model the potential affect of development scenarios.

Goal 3: Implementing Watershed-Based Conservation - From Plan to Program

The BCP - Al-Pac FMA Area Conservation Plan is being developed in parallel with Al-Pac operational planning. The benefit of parallel conservation and operational planning is that the Conservation Plan will be fully integrated into operational planning, thereby streamlining the implementation process and permitting the Conservation Plan to become integral to Al-Pac's core business.

Goal 4: Realization of Environmental Benefits

Through development and deployment of the Conservation Plan, Al-Pac and other land users in the area will be able to plan their respective activities consistent with recommended conservation practices. This practice will decrease the rate and effect of anthropogenic disturbance on the Al-Pac FMA area and increase the effectiveness of reclamation.

Goal 5: Demonstrate the Potential for Application of Proactive Watershed-Based Conservation Technology

Inform others of the benefits of conservation planning. Stakeholders in other areas will be encouraged to adopt any methodologies, technologies and practices that may prove to be transferable. The transferable watershed-based conservation technologies, developed through the partnership, will establish global benchmarks for integrated land and resource management.

Goal 6: Verification of the Value-added Through Watershed-Based Conservation

The economic, environmental and socio-cultural value of the Conservation Plan will be measured objectively and publicly recognized globally, through the media, as “state-of-the-art” and “one-to-emulate” in integrated land and resource management. The value of the ecological goods and services delivered through the Project will be documented and confirmed.

BOREAL CONSERVATION PROJECT (BCP) - 2007 STATUS

Presently, there is a lack of information regarding resource extraction activities impacting/interacting with hydrologic processes in the FMAA area. The BCP model for the boreal plain is still being developed to define the risk of interaction based on a hierarchical approach beginning with climate, geology, organic content and finally topography. The ECA Alberta model (page 54) fell short of identifying the variability of potential hydrologic response in the boreal plain and would only address water yield with poor accuracy.

The hydrological risk approach will not only address water yield (quantity) but quality and ecological integrity of connected hydrologic systems.

PROGRESS TO DATE

Research by Dr. Kevin Devito (University of Alberta) and the Hydrology, Ecology and Disturbance (HEAD 2001-2005) project and the WBF Hydrology Group (ongoing) showed that hydrological models based on pronounced topography (e.g. foothills or mountains) and shallow soils (e.g. boreal shield) do not adequately address hydrology and watershed management in the boreal plain. Models based on major landform units (surficial geology) would provide more accurate outputs. The boreal plain's low-relief landscape and elevation / topography models can not be used to identify drainage or catchments, and thus hydrological connectivity.

Landforms that consist of fine-grained clay materials (e.g. clay plains, clay-rich tills) support horizontal, shallow ground water or surface water flow and are therefore easily affected by such land-use as road building. Understanding the relationship of landform and hydrology allows industry to assess ecological and operational risk.

Currently the team is developing hydrological risk maps in relation to road building and wetlands conservation. These maps will identify hydrological connectivity (recharge/discharge) and to-date have completed a pilot version of the risk map in the 83p map sheet of an area approximately 8,000 km^2. In the pilot area, we assessed how data such as surficial geology, DU's enhanced wetland classification layer, streams, road problems, and other data can be used to identify risk in disrupting hydrological connectivity. Field verification of our risk modeling will occur in 2008.

The hydrology component of the research is focused on the Utikuma Region Study Area, URSA. This is located on public (crown) land near Utikuma Lake, approximately 500 km north of Edmonton, Alberta, where the researchers from the University of Alberta, including the Western Boreal Forest Hydrology Group under the direction of Dr. Kevin Devito, have been undertaking hydrology, ecology and disturbance research since the 1990s. The region was chosen because of the representative nature of the region for the climate and diversity of wetland types in the boreal forest, and its accessibility. This region is the location of site specific, focused research on the processes involved in the hydrologic cycle in the boreal forest.

A second research area, the "Al-Pac Catchment Experiment" (ACE) was established in 2005 on an active portion of the Alberta-Pacific Forest Management Agreement Area in Township 70, Range 14, W 4 (70-14), on a site where forest harvesting and road construction began in 2006. The purpose of this site was to conduct more extensive experiments based on the URSA research to capture the impacts of forest harvesting and road construction on a greater area, under normal harvest operations.

The third research area consists of the 1:50,000 scale Map Sheet 83P, which includes most of Al-Pac's 70-14 harvest unit. This are has been used for developing the prototype risk prediction maps, because of the availability of surficial geology mapping information, the overlap with the harvest unit, and the familiarity of the researchers with the ground conditions in this region. One example of ecological risk may be the disturbance of drainage or flow. Another example of operational risk may be building roads where high maintenance is required.

2007 BCP PROCESS

Based on the BCP research, Al-Pac is developing a hydrological risk assessment process that helps planners to avoid operational high-risk areas when placing roads or harvest areas (Spafford & Devito,2005, Al-Pac in-house report – See Appendix 3). For the planning stage the "Patchworks" model is being tested for use as a predictive tool to assist Al-Pac in selecting roads for the least environmental and long-term cost. Specific sensitive features can be identified beforehand and minimize costly interactions with subsurface water. For example, an important issue, "road icing" which is caused by horizontal water flow over fine-grained soils that prevent drainage. Road icing is not only an operational cost but also a safety issue. The problem is associated with surficial geology and soils, and understanding and mapping these landforms can therefore be used to identify hydrological risk areas and apply best management practices. Based on landform and predicted risks, best management practices may include winter operations, strategic road placement, bridges instead of culverts, increasing culvert size or number, avoidance and/or new, innovative approaches. In 2008 a program synthesis report will be made available to all stakeholders.

BCP - 2008 - 2010

Al-Pac will incorporate the updated hydrological risk assessment into its planning and operational best practices that allow for cost-benefit analysis of a) avoiding these high-risk areas (cost of building more kilometers of road) versus b) road maintenance and high safety risk (cost of time of reduced speed and risk of accident).

Since surface and groundwater movement are largely related to geology and soil types, mapping these features will help to address landscape management issues related to wetland and hydrology conservation. The BCP is working with the Alberta Geological Survey to assess surficial geology data, and how these data can be used in landscape management in the different climate regions in Alberta's boreal forest. Further, geological data can be used in conjunction with other data such as Ducks Unlimted's enhanced wetland inventory to assess hydrological connectivity and appropriate management practices.

BCP COMPLETION TARGETS

- The 83p map sheet hydrologic risk map is now complete (field verification in 2007/2008)
- The FMA hydrologic risk map will be completed by 2010
- The hydrologic cost model ("Patchworks") will be functional in 2008 and if successful be applied to the whole FMA in 2010

2.7 Biodiversity and Sustainable Forest Management – Background Concepts and Rationale

Biodiversity in the FMA Area - What is Biodiversity?

Biodiversity means, in its broadest sense, the distribution and abundance of living organisms and the ecological complexes of which they are part. This includes three types of diversity, as described by the Canadian Council of Forest Ministers[20] and elaborated in Alberta-Pacific's 2000 Detailed Forest Management Plan:

- Genetic diversity, within species[21]
- Species diversity, the number of species and their population levels
- Ecosystem diversity, the variety and relative abundance of ecosystems across a landscape

Biodiversity of all forest ecosystems changes over time (Kimmins 1991). A mature forest may change very slowly as individual trees die and create small gaps. Young, vigorously growing forests will change more quickly. Disturbances from forest fires, wind, insects or disease can cause rapid change, affecting small to extremely large forest areas. In the boreal forest, where these larger scale disturbances are common, species and ecosystem diversity undergoes a continual change across the landscape.

The understanding and approximation of natural disturbance processes (fire patterns, stand structure, succession) in forest management activities acts as a mechanism to conserve biodiversity. The ecosystem management approach suggests that by managing aggregates (i.e., communities, ecosystems and landscapes), the components (species and habitats) will be managed as well (Jensen and Bourgeron 1993). If an ecosystem management strategy is based on plant communities and natural disturbance processes at the landscape level, it is assumed that the associated species will be protected through time as a consequence of the persistence of plant communities, patterns and processes.

Examining existing and past ecosystems provides a means of assessing the historical range of variability of ecosystem characteristics. This is used as a baseline reference for assessing the present condition or health of existing ecosystems, and as a guide for implementing sustainable forest management practices that are designed to maintain biodiversity.

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[20] Criteria and Indicators, published originally by the Canadian Council of Forest Ministers in 1995, subsequently revised and updated as *Defining Sustainable Forest Management in Canada: Criteria and Indicators 2003* (Natural Resources Canada, Ottawa, 2003).

[21] There is little information available regarding the levels of diversity for species at the genetic level on the FMA area. It is assumed that the coarse-filter approach, combined with fine filter-research and management of species such as caribou, will conserve species by protecting their habitat, and this in-turn should ensure the genetic resources are also conserved.

BIODIVERSITY IN THE BOREAL FOREST

The composition of plant and animal communities in young, mature and old aspen mixedwood stands is described in the landmark publication "Relationships Between Stand Age, Stand Structure, and Biodiversity in Aspen Mixedwood Forests in Alberta" (Stelfox 1995). This study identified a rich biota[22] in pure aspen, spruce, and mixedwoods, including (but not limited to):

- Lichen species
- Mosses
- Liverworts
- Fungi
- Horsetails/cattails
- Club mosses
- Ferns
- Herbs
- Shrubs
- Major tree species (9)
- Amphibians
- Birds (76 species)
- Mammals (33)
- Insects and arthropods (numerous)

RELATIONSHIP BETWEEN STAND AGE, STRUCTURE, AND BIODIVERSITY

Forest wildlife species vary widely in their habitat requirements, reflecting diverse strategies for obtaining nutrition, avoiding predation, and meeting other requirements of life. Many have specialized requirements reflecting physical and behavioural adaptations designed to minimize competition with other species.

For example, the unique beak of the red crossbill, designed to efficiently pry open pinecones and extract the seeds therein, links this species to patches of forest with a high density of pinecones. Because of such habitat specialization, the overall diversity of forest species is dependent upon the diversity of habitat features, which is in turn a consequence of the combined actions of disturbance events (e.g., fire) and succession.

[22] Biota: The plant and animal life of a particular region.

The greater the structural complexity of the stand, the greater the number of species it can support at higher relative abundance. Mature stands exhibit lower spatial heterogeneity and are less structurally complex than are young or old or over-mature stands. It has been shown that in general, mature stands contain lower levels of biodiversity than the other two age classes. Old stands contain the highest level of biodiversity; followed by young stands, then mature stands.

An important observation is that species richness (the number of species present) does not change significantly when over-mature or old stands are compared to young stands. Species that are often considered "old-growth species" are often found in young stands, although density of individuals may be lower in the young stands. These species may be present because of the presence of the structural features (i.e. standing dead trees) retained from the pre-disturbance, structurally complex, old stand. This theory is supported by evidence that these species are often not found in mature stands that have lost the majority of their structural heterogeneity. A similar pattern has been demonstrated among a wide range of organisms, including both vascular and non-vascular plants, insects, birds, and mammals.[23]

2.8 SUSTAINABLE FOREST MANAGEMENT (ECOSYSTEM MANAGEMENT) GOALS

As stated in Chapter 1, sustainable forest management (ecosystem management) means the careful and skilful use of ecological, economic, social and managerial principles in managing human activities within forest ecosystems to produce, restore, or sustain ecosystem integrity and desired conditions, uses, products and services over the long-term. The essential goals of ecosystem management or as commonly called, sustainable forest management are:

- Maintain biodiversity, productivity, structure and function of ecosystems within historical ranges of variability (the "coarse-filter" approach).
- Maintain the optimum sustainable flow of renewable resource products and values to meet the current and future needs of society.

BASIC THEMES OF SUSTAINABLE FOREST MANAGEMENT

The following eleven themes capture the basic rationale for sustainable forest management and characterize the initial components of the approach (Overbay 1992; Grumbine 1994).

1. Multiple uses of lands and resources depend on sustaining the diversity and productivity of ecosystems at many geographic scales. A focus on any one level of the biodiversity hierarchy (e.g., genes, species, populations, stands, ecosystems, landscapes) is not sufficient. When working on a problem at any one level or scale, managers must seek the connections among all levels. In short, what is done at any scale will depend on what is known about all geographic scales.

[23] For more information about the link between forest structure and biodiversity, see "Ecological Basis for Stand Management: A synthesis of ecological responses to wildfires and harvesting" (Song 2002) and "Relationships Between Stand Age, Stand Structure, and Biodiversity in Aspen Mixedwood Forests in Alberta" (Stelfox 1995).

2. Recognition of natural dynamics and complexity of ecosystems suggests future conditions are not easily predictable and that any ecosystem offers many options for uses, values, products, and services, all of which can change over time. Sustainable forest management, as envisioned here, requires maintenance of options for the benefit of future generations.

3. Descriptions of desired future conditions for ecosystems at various geographic scales should integrate ecological, economic and social considerations into practical statements that can guide management activities.

4. Management planning and actions must span sufficient periods of time to ensure maintenance of the evolutionary potentials of species and ecosystems.

5. Effective management requires working across administrative and political boundaries (e.g., forest management units, provincial parks, national parks) and defining ecological boundaries at appropriate scales. Co-ordination of plans and management actions is essential to the success of sustainable forest management.

6. Ecological classifications, inventories, data management and analysis tools should be utilized in the integrated management of lands and resources.

7. Sustainable forest management requires research and data collection (e.g., habitat inventory/classification, disturbance regime dynamics, baseline species and population assessment) as well as better management and use of existing data.

8. Monitoring and research should be integrated with management continually to improve the scientific basis of sustainable forest management. Managers must track the result of their actions so that success or failure can be evaluated quantitatively. Monitoring creates an ongoing feedback loop of useful information.

9. Adaptive management will be employed. Adaptive management assumes that scientific knowledge is provisional and focuses on management as a learning process or continuous experiment where incorporating the results of previous actions allows managers to remain flexible and adapt to uncertainty.

10. Humans are an integral part of ecosystems. Humans can have a significant influence on ecological patterns and processes, and are in-turn affected by them.

11. Regardless of the role of scientific knowledge, human values can play an important role in forming sustainable forest management goals.

The design of a sustainable forest management plan, its principles and objectives, could follow the steps outlined in Table 2.2.

Table 2.2: Possible Steps for Designing Ecosystem-Based Land Evaluation and Planning

Step	Explanation (and examples of related activity)
1. Ecological Capability	Describe the ecological capability of the analysis area for meeting stated societal needs. Such descriptions must include the following items: a description of the range of conditions required to maintain long-term ecosystem sustainability, a description of current conditions, and a description of desired landscape conditions that achieve societal needs (complete vegetation surveys, determine sustainable annual allowable cut, conduct landscape analyses under various management scenarios).
2. Social Needs	Determine the desires and requirements of the people who will be influenced by the planning outcome (the local community meetings held by Alberta-Pacific at various stages of a project).
3. Public Consultation	If desired landscape conditions fall outside the range of conditions that are required for long-term ecosystem sustainability, the affected public needs to be informed of this fact. Public awareness of ecosystem potentials is critical to the development of achievable "desired future condition" strategies for land management (Forest Management Task Force).
4. Implementation Design	Once a socially acceptable, sustainable vision of landscape conditions is achieved, it is then contrasted against available technology to determine if it can be implemented. Factors such as system design and equipment availability are considered to determine if it is technologically feasible to move the existing landscape to some desired set of conditions (harvest planning and scheduling, understory protection).
5. Reality Check	Economic factors are also used to determine what parts of the stated human desires can be fulfilled. If resources (economic and/or technological) are not available to implement management of desired landscape conditions, the affected public should be notified and alternative strategies developed. Avoid trading off long-term ecological and human values for short-term economic benefits.

SOCIETY'S NEEDS

Sustainable forest management must reflect social values. People are an important part of forest ecosystems, influencing ecosystem processes in many ways – as they have to some degree in the FMA area for the past 10,000 years. Society's values play an important role in developing sustainable forest management objectives. These values are diverse and often conflicting. They include industrial values in timber and access to oil and gas resources, wildlife, trapping, hunting, fishing, aesthetics, cultural, traditional use, spiritual, recreation, wilderness and other values. It is important to realize that sustaining these social values requires a management program that ensures the maintenance of biodiversity.

Sustainable forest management, to properly reflect social values, requires the ongoing input and meaningful participation of concerned groups and individuals. Careful planning must be jointly undertaken to integrate and balance values across the whole of the landbase. Societal values can change over time and the planning process must be responsive to new needs.

2.9 COARSE-FILTER APPROACH

Maintaining biodiversity is a primary goal in the implementation of sustainable forest management on the FMA area. The basis for accomplishing this goal is a coarse-filter approach to sustainable forest management following the natural disturbance model. This is a preventative approach to maintaining biodiversity (Hunter 1991). It assumes that maintaining vegetative communities and landscape patterns and processes within the limits of natural variability will result in the maintenance of the full complement of native plant and animal species. In a coarse-filter approach, timber harvesting must be designed to regenerate the diversity of structure and vegetation within forest stands, and the patterns of forest stands on the landscape that could be found in natural disturbance regimes. Maintaining these critical features of the forest will provide the variety of habitats needed to support the diversity of living organisms (both seen and unseen, known and unknown) found under the diversity of natural disturbance regimes. Important components of a practical coarse-filter approach include:

- Harvest activities that approximate the range of sizes, shapes and intensities of natural disturbance events. (See Chapter 3, Sections 3.6 – 3.8)
- Retention of residual structure within cutblocks that approximates the green-tree residual pattern left by natural disturbance such as fire. (See Chapter 3, Sections 3.6)
- A realistic older-forest (over-mature) management strategy that maintains older-forest stand types in all major forest strata throughout the FMA area, within the range of natural variability. The strategy should also account for projected landbase losses due to natural disturbances and other human activities such as oil and gas exploration and production. (See Chapter 3, Sections 3.16)
- Maintenance of some post-fire habitat types that are difficult to simulate through fire salvage harvesting activities; retention of early or young post-fire habitats, stands or blocks that have variable and dynamic levels of retained live and dead trees. (See Chapter 3, Sections 3.3)
- An assertive Integrated Landscape Management program to minimize road construction and persistence in harvested areas, since roads have no parallel in nature. (See Chapter 3, Sections 3.4)
- A system of ecological benchmarks, free of industrial activity, supported by the Alberta government and other industrial sectors, that will act as reference areas to compare with the landscape managed under the coarse-filter approach. (See Chapter 3, Sections 3.12)

The implementation of the coarse-filter approach is an important component of the Triad approach to ecologically sustainable forest management. However, the coarse-filter approach is relatively new. Although strongly supported by research and current understanding of boreal forest ecosystems, there are many uncertainties with regard to our knowledge of biodiversity and natural disturbances. Coarse-filter harvesting strategies might affect biodiversity differently than natural disturbances.

Therefore, the forest companies will implement a monitoring program (see Chapter 4, Section 4.2) that will focus on species groups that may be adversely affected by harvesting strategies. This fine-filter monitoring will supplement the coarse-filter approach and provide a basis for possible modifications to harvesting strategies and improved management of individual species (particularly species at risk and species associated with older forest).

EFFECTS OF CONVENTIONAL FOREST HARVESTING

Forest harvesting often falls outside the range of disturbances naturally occurring in a forest, particularly in terms of the size and shape, severity and frequency of disturbances. In Alberta, the required harvesting system can result in a landscape with a uniform quilt-like pattern of cut and uncut areas. When this type of harvest regime is applied over large areas, it reduces the natural variability in landscape and vegetation patterns and has the potential to reduce the biodiversity of a region. Fragmentation of the natural forest matrix also reduces the availability of interior forest habitats, leading to an increase in abundance of those organisms associated with forest edges and a decrease in those requiring large intact tracts of interior forest habitat.

Conventional harvesting ground rules, utilization standards and safety regulations generally require that most standing live and dead trees be removed from the sites (although in mixedwood stands it was common for the deciduous trees to be left standing when there was a limited market for them). Silviculture standards and practices have the objective of regenerating these sites into stands that are relatively uniform in terms of tree species, age, size and spacing. Such stands do not have the range of diversity found in natural stands, where multi-layered canopies, diverse tree sizes, abundant snags and fallen trees are common. Biodiversity within stands therefore tends to be reduced by conventional practices.

Conventional forest management also attempts to maintain maximum fibre production from the available productive landbase. To accomplish this, all forest stands would be harvested in a "rotation" before their average growth rate slows down. Eventually, after all stands are brought into rotation, there would be an absence of old stands (110+ years) in the productive landbase, with the exception of creek buffers and other reserve areas. This would have an adverse affect on species that require the greater structural diversity of older forest types.

SUSTAINABLE FOREST MANAGEMENT APPROACHES TO FOREST HARVEST

Harvesting, following a sustainable forest management approach, should approximate the historical structure and pattern of vegetation at the regional, landscape and stand levels. Logging of aspen and coniferous timber is designed to create effects similar to those of natural fire, with respect to patch size, age, stand structure and landscape pattern. The coarse-filter approach assumes that biodiversity will be maintained if landscape and stand patterns and processes are maintained. Patches are cut following natural stand boundaries and stand types, so that natural patch size, shape and landscape patterns are perpetuated. Fragmentation will not be increased and, with patches of various sizes, substantial amounts of interior habitat are kept intact. Social constraints on cutblock size must be recognized (i.e., public perception of large cuts); however, there will be an increase in variation of patch size and shape that should approach the naturally existing variation on the landscape. Retaining structure and varying patch shape may eventually demonstrate to the public that larger cutblocks are acceptable, or even desirable options.

At the stand level, fine and coarse woody debris, residual conifers, shrubs, snags, layered components of aspen, individual trees and/or clumps of single species or mixed stands can be left within harvested blocks. This material emulates the gaps, skips, and standing dead trees that are left after fire passes through a stand. As harvested sites regenerate and grow through successional stages, the material left on each site adds structure and complexity to the stand, and will ultimately produce natural gaps in the canopy (by residual trees aging and dying), prior to the next rotational cut. The intent is not to emulate exactly the patterns left following fire, but rather to reduce the time required for convergence of post-fire and post-harvest communities. Structural diversity thus occurs earlier in the regenerating stand than would be the case with conventional practices.

In addition, leaving conifer within harvested aspen stands helps the forest to retain its natural mixedwood character, and not become a simplified, stratified landscape. Understory protection during harvest and alternative silviculture systems after harvest are additional means to maintain conifer in mixedwood stands.

Several technical and social issues must be addressed when using ranges of natural variability as the basis for ecosystem management (Swanson et al. 1993). Such issues include:

- Limits to our abilities to interpret past ecosystem variability;
- Effects of management measures (such as fire suppression) on ranges of natural variability;
- Gaps between the state of naturally occurring ecosystems of the past and desired future conditions (e.g., large fires vs. socially acceptable limits to the size of harvest areas).

2.10 FINE-FILTER ISSUES

Biological research and management have traditionally focused on individual species and their relationship to their habitat. The extension of this species-level thinking to biodiversity and sustainable forest management is called the fine-filter approach. The application of this approach would involve collecting and using extensive knowledge of all the organisms in the affected ecosystems to design forest management activities that would maintain biodiversity. Realistically, it is not feasible to study and understand all of the species in our forests. The fine-filter approach instead assumes that a smaller number of “indicator species” will represent the full spectrum of organisms present. Research, management and monitoring then focuses on this select group of species.

Most experts agree that sustainable forest management based entirely on a fine-filter approach is unlikely to succeed. A multitude of individual species and habitats would require detailed and costly scientific analysis. Most existing fine-filter models of persistence of species are based on expert opinion and conjecture derived from estimation of habitat requirements. Despite large amounts of recent Sustainable Forest Management Network (SFMN) research, there have been few thresholds or concrete prescriptions as to the habitat needs of individual species (Hannon and McCallum 2002).

Additionally, a forest management program based on fine-filter programs essentially pits selected species habitat against other species' habitat requirements. This could lead to arbitrary selection of "winners and losers" among species and habitats.

Even if all the necessary information could be collected, what criteria would be used to manage the conflicting and very complex needs of individual species? What species would be favoured and where? Because of such uncertainties, sustainable forest management must follow a coarse-filter approach augmented, where required and appropriate, by fine-filter strategies to address human-caused effects on some species. Fine-filter strategies are utilized where species are at risk, potentially for species with high social value (see Chapter 3) and as part of an overall monitoring program (see Chapter 4). This blended approach appears to be the most effective way to maintain biodiversity in the boreal forest.

Ongoing monitoring programs sponsored by Al-Pac and other forest companies to test the efficacy of the coarse-filter approach include vegetation monitoring (Alberta Vegetation Inventory and permanent sample plots), bird community monitoring, trapline monitoring, mammal tracking, lake fisheries monitoring, and wetland and waterbird monitoring (see Chapter 4). Studies initiated in 2003 have been examining the effects of salvage logging on early post-fire communities. The Alberta Biomonitoring Program (ABMP)[24] has the potential to integrate biodiversity monitoring at large scales, and Al-Pac is committed to the development of these protocols within the FMA area. Monitoring results from all programs will be used to help guide changes to land-use practices among all land users.

Fine-filter strategies employed for species at risk include:

- Special guidelines for operations in caribou habitat (see Chapter 3)
- Management guidelines for operations around trumpeter swan lakes (see Chapter 3)

Additionally, within the FMA area, other species and species groups have been identified as important wildlife species. These species are studied through the research program. A brief description of these highlighted species follows:

AQUATIC RESOURCES

The FMA area's mixedwood boreal forest is characterized by low relief and a relatively dry climate. Lakes and streams in this region tend to be isolated due to the lack of aboveground flowing water. Apparent isolation is complicated by the important role of groundwater. Water quality in the region is variable, but the tendency is towards eutrophic (nutrient-rich) systems. Soils are relatively phosphorus-rich, and thus runoff and groundwater also tend to be rich in phosphorus. This situation is compounded by the fact that bottom sediments found in this area do not bind phosphorus. The naturally high phosphorus content can influence all levels of the aquatic food chain. Increased nutrient content can lead to kills of fish in both summer and winter.

[24] The Alberta Biodiversity Monitoring Program is being developed by natural resource management and research organizations in Alberta to help government and industry meet commitments to report on the status and trends of biological diversity. Coordinated implementation is intended, with participation of the natural resources sector (government and industry) and National Parks. For further information and updates, see http://www.abmp.arc.ab.ca/ Chapter 4 also provides more details.

Riparian areas are the land areas adjacent to water bodies and wetlands. These areas are distinct from uplands in vegetation type and result in a large variety of habitats for many species of plants and animals. Fires and floods have a role in shaping riparian areas. Riparian areas depend on fire to restart the cycle of disturbance creating the diversity of habitat needed to maintain all their unique features. However, there is a greater variability in fire return intervals in riparian areas as compared to areas not associated with water bodies. Some riparian stands are burned right to the shore, whereas others escape for long periods of time.

Presently there is little information on the effect of land use and forest-clearing activities on aquatic ecosystems in the mixedwood boreal forest. Research is currently underway to look at new ways of understanding and protecting aquatic systems (see Appendix 3 attached to this document or http://www.alpac.ca). In 2002, Al-Pac signed a Memorandum of Understanding with Ducks Unlimited Canada to develop the Boreal Conservation Project, a watershed-based conservation plan for the FMA area.

FOREST BIRDS

Birds constitute 72 per cent of all vertebrate species in the FMA area. Among vertebrates, birds generally exhibit the greatest degree of specialization relative to environmental diversity. The birds within any geographic area consist of species suited to various niches presented by that environment.

Because of the boreal forest's characteristically complex pattern of stand age, species composition, and structure, the entire boreal mixedwood (deciduous and coniferous components and associated wetlands within the FMA area) offers a diverse array of habitat niches that provide the breeding habitat for 190 species of birds (30 resident and 160 migratory). An additional 43 species (7 in winter and 36 in summer) use the area for foraging and staging during annual migration to and from arctic nesting grounds. Forty-eight of the breeding species are associated with lakes and wetlands, while the remaining bird species nest and forage in a wide variety of upland situations (Stelfox 1995).

The regulated hunting of game birds provides recreational opportunities and contributes to local and regional economies. Subsistence hunting continues to contribute to the traditional lifestyles of Aboriginal communities in the area. There are about 22 species of geese, ducks and grouse that are hunted in the FMA area. The populations of grouse species (ruffed, sharp-tailed, and spruce) follow natural fluctuations and provide substantial hunting opportunity during years when numbers are high.

FURBEARERS

Technically, the term furbearer includes all mammals, all of which possess some form of hair.[25] Typically, however, wildlife managers use the term to identify mammal species that have traditionally been trapped or hunted for their fur.

[25] True hair is found only in the Class Mammalia, and there is really no such thing as an absolutely hairless mammal. Even whales (at least some of them) have rudimentary hairs here and there.

Furbearers are a diverse group, including both carnivores (meat-eating predators) and rodents (gnawing mammals). Most are adaptable species ranging over large geographic areas. A few animals that are normally hunted or trapped primarily for their meat or to reduce agricultural or property damage may also be considered furbearers if their skins are marketed.[26]

In the FMA area boreal forest, trapping of furbearers is traditionally of economic and social value. Many of the 392 traplines found within the FMA area provide trappers with a supplementary income as well as a traditional lifestyle. The 15 species of commercial furbearers found throughout the FMA have very diverse habitat requirements and timber harvesting will influence different species to varying degrees. Alberta-Pacific supports a trapping management program (see Chapter 1). A furbearer-monitoring program has been ongoing in the FMA area for the past 10 years and will continue throughout the life of this plan. (See Section 3.5)

UNGULATE SPECIES

The ungulates found within the FMA area include woodland caribou, moose, white-tailed deer, mule deer, elk and bison. Although ungulates represent a tiny fraction of the biodiversity of the boreal mixedwood forest, they traditionally receive special management consideration. This is due to the fact that large ungulates are valuable to humans both for viewing purposes and for subsistence and recreational hunting. Their populations are also easier to monitor than other wildlife species. Large-bodied mammals may also be indicators of important ecological conditions, such as habitat fragmentation at larger scales.

WOODLAND CARIBOU

In northeastern Alberta, woodland caribou are found in small groups (generally less than 15 individuals) within peat-land complexes that contain significant areas of lichen producing forested bogs and fens. Caribou densities are typically very low (0.02-0.07 caribou per square kilometre). Caribou in northern Alberta do not exhibit seasonal migrations; rather they are quite nomadic within their ranges.

Unpredictable patterns of movement (daily and seasonal) by caribou makes searching by predators inefficient. Due to these adaptations such as habitat use, and low density, caribou are only an incidental food source to their major predator, the wolf.

However, any process that fragments the landscape, restricts movement of caribou and makes them more predictable in space and time has the potential to make caribou more vulnerable to direct mortality losses.

Woodland caribou rarely produce twins and this, combined with the fact that females are often 2½ years old before first breeding, accounts for their relatively low reproductive rate. In order to maintain populations at constant levels, the characteristic low recruitment must be matched by low adult mortality rates. The low productivity of woodland caribou populations makes them vulnerable to many types of direct mortality. Woodland caribou populations in northeastern Alberta range from stable to declining. Recreational hunting of caribou in Alberta ended in 1981, and woodland caribou are currently listed as threatened under the Alberta Wildlife Act.

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[26] Definition from "Trapping and Furbearer Management: Perspectives from the Northeast" published by the Northeast Furbearer Resources Technical Committee (NEFRTC).

The forest companies support wide-ranging caribou research throughout the FMA area and are also partners in provincial caribou research and monitoring initiatives (see Appendix 6). The companies support practical changes in operational practices that reflect new information derived from research. Section 3.5 articulates strategies with respect to woodland caribou.

MOOSE

The primary factor determining moose population levels throughout North America is related to the quantity, quality and availability of food, which consists largely of woody browse of a variety of plant species. In northeastern Alberta, moose are under significant influence from three additional limiting factors:

- Predation by wolves and black bears
- Recreational and subsistence hunting, and poaching
- Periodic winter tick infestations (e.g., winter of 1998-1999)

Moose occur throughout the FMA area, and are a pioneer[27] species, well suited to sites where forest succession has been set back by fire or logging, creating abundant shrub production. Colonization and efficient use of burned or logged areas by moose are influenced by the time since disturbance and the type, amount and proximity of mature forest cover for shelter. Optimal moose habitat may occur where sufficient forest cover has been retained to maintain connectivity among important habitat features (conifer cover, shrubland or newly generating forests, wetlands, and riparian zones).

Moose are likely the most valued wildlife species in the FMA. They are the most important focus of Aboriginal subsistence hunting throughout the boreal forest, providing a source of meat and raw materials for clothing, crafts, and other articles. This historic relationship is the basis for strong cultural and spiritual associations with moose. Non-native people also place special value on moose. In practical terms, moose have high viewing value and considerable value related to recreational hunting (including meat, hides, recreation and employment in the guiding, outfitting and retailing businesses).

Given that the primary human factor limiting moose populations is hunting mortality, a co-operative moose management process developed by the provincial government may be an effective approach to conserve moose populations within the FMA area. Through the forest companies' ability to manipulate habitat and access opportunities, the forest companies will be active participants in such programs. Responsibility for initiating a co-operative moose management program lies with those with responsibility over moose harvesting – the provincial government and First Nations leadership. The moose management process should address issues of habitat manipulation, human access, and moose harvest to help sustain plentiful moose for the enjoyment and use of subsistence and recreational hunters, as well as non-consumptive users of this important wildlife resource. (See Section 3.5)

[27] Pioneer species begin colonizing a site during the first stages of ecological succession.

OTHER WILDLIFE SPECIES

Research has been conducted on many other wildlife species within the FMA area (i.e. Black bear, marten). Please consult the Appendix 12 for an account of biodiversity studies within the FMA area.

2.11 HUMAN LAND USE FEATURES ON THE FMA AREA

CURRENT SITUATION

A variety of human land use features are embedded in the forested landscape of the FMA area. The activities associated with this "human footprint" demonstrate the economic and cultural reliance that people have on the natural resources of northeastern Alberta. Many of the industrial sectors and human settlements have stated or potential growth mandates and the trajectories of growth are not clearly defined. Thus, the footprint with respect to human features on the landscape is clearly dynamic. We present here the current situation of human features on the landscape. Table 2.3 provides the size of the human footprint on the FMA area.

Table 2.3: Human Land Use Deletions from the FMA Area (1997-2003)[28]

Number, length and area of Alberta-Pacific FMA area deletions (legal FMA area of 5.8 million ha).

Type of Human Landuse	Length (kilometres)	Area (hectares)	Notes
Town/City/Rural Residences		2,363	
Agriculture		1,802	
Wellsites (# - 19,289)		15,516	1
Industrial Plants		5,929	
Seismic Lines	72,368	41,082	2
Pipelines	8,906	22,258	3
Roads – Major (primarily highways)	1,533	19,237	4
Roads (LOC)	39,209	31,367	5
Railways	226	450	
Power Lines	560	2,800	
Total		**134,561**	

1. Based on average wellsites of 90 x 90 metres
2. Based on 5-meter seismic lines (this is very conservative as many historic lines were between 5-8 meters)
3. Based on average pipeline right-of-way width of 20 metres
4. Major roads widths used were 40 metres
5. Road widths used were 8 metres; includes, pipeline agreement roads, License of Occupation (LOC) roads, and wellsite access roads

[28] Caution: These metrics are from a dynamic landscape. Disturbances are continually happening throughout the FMA area landscape. Linear features such as roads and pipelines were buffered to remove the possibility of double-counting features. As such, the numbers above can generally be viewed as a conservative estimate of today's footprint. The oilsands areas are excluded from this table, as they are not part of the FMA area. The "donut" holes are excluded from this table, as they are not within the Alberta-Pacific FMA area.

Not shown in Table 2.3 are features that are not considered permanent (or long-term) deletions from the FMA area. Some seismic lines, in-block roads and landings, and cutblocks are temporary disturbances that regenerate to forest on various growth trajectories. Seismic lines have various regenerative trajectories depending on their subsequent re-use by industrial or non-industrial human users. From a forestry perspective, conventional 5-8 metres wide seismic lines tend to put the regrowth out of phase with the surrounding forest. New technology in the seismic industry may provide opportunities to reduce the impact of seismic lines from both a forestry and ecological perspective (see Section 3.11 on Integrated Landscape Management for more details).

The oil and gas industry is the dominant industrial activity on the FMA area in terms of area disturbed and economic impact. It creates a large number of jobs and business opportunities relating to oilsands bitumen extraction, natural gas and crude oil exploration, resource development and pipeline work (see Table 2.3). The oilsands extraction is concentrated near Fort McMurray. Oilsands project areas are not included in the table as they are not part of the FMA area. Steam-assisted gravity drainage (SAGD) heavy oil operations are currently a relatively small component of the energy sector in northeastern Alberta, but are expected to become a major contributor to industrial activity in years to come. Oil and gas industry roads, wellsites and pipelines are common in many areas, and approximately 70,000 kilometres of seismic lines criss-cross virtually all of the FMA area.

Coniferous and deciduous harvesting from within this FMA area is well established, with long-term timber quotas being held by eight companies and individuals, and supporting several sawmills and one panel board plant.

A number of guide-outfitters work in the area, and the FMA area is covered by registered traplines. Recreational hunting is prevalent in the fall, and there is a bear hunt in the spring. Large lakes, rivers and streams provide recreational fishing and some commercial fishing opportunities. Recreational fishing, hunting and vacation lodges are found throughout the FMA area. There are also several recreational trails of historic significance on the FMA area, including the Trans Canada Trail that crosses the southwest corner of the FMA area near Smith.

People of Aboriginal ancestry use the land for hunting, fishing, trapping, harvesting and gathering, as well as for spiritual and cultural activities. Traditional Land Use and Occupancy Studies (TLUOS) document how Aboriginal people rely on the land for hunting, fishing, gathering plants, trapping and generally living and traveling in the forest (Robinson et. al., 1994). Alberta-Pacific has supported several TLUOS studies within the FMA area (e.g., Wabasca-Desmarais, Anzac-Janvier, and Conklin).

Within the FMA boundaries there are a number of provincial parks, protected areas and exclusion zones such as major lakes. These areas have been deleted from the FMA landbase. Linear transportation corridors such as provincial highways, railways, electrical utilities and pipelines also affect the FMA area's landbase. Table 2.4 identifies the protected areas in or around the FMA area (not including linear deletions):

Table 2.4: Protected Areas in Northeastern Alberta

Name	Total Area (Ha)
Birch Mountains Wildland Park	130,882
Crow Lake Wildland	1,462
Gipsy Lake Wildland	17,667
Grand Rapids Wildland	25,720
Gregoire Lake Provincial Park	1,401
La Biche River Wildland	16,436
Lakeland Provincial Park and Recreation Area	60,609
Maguerite River Wildland Park	188,435
Otter-Orloff Lakes Wildland	4,225
Poachers' landing Provincial Recreation Area	1,706
Stony Mountain Wildland	12,123
Whitemud Falls Wildland	4,726
Wood Buffalo National Park (Alberta Portion)	2,053,597
SUB TOTAL *(Does not include Wood Buffalo National Park)*	**465,392**
GRAND TOTAL	**2,618,989**

2.12 INSECTS AND DISEASE

Both forest diseases and forest insects are natural processes and play a major role in forest sustainable forest management and boreal forest succession. Forest health is the primary responsibility of Alberta SRD[29], and the Forest Companies co-operate in Alberta SRD forest health programs aimed at continued healthy forest conditions in the FMA area.

From a forestry perspective, forest health is a desired condition of the forest in relation to management objectives. In a forest health program, biological, physiological, and environmental factors that have an adverse effect on the health of the forest are carefully monitored and/or managed. Maintaining forest health is accomplished through detection, surveying and monitoring, assessment of risk, and the implementation of various management programs in forest stands.

[29] Further information on Alberta's Insects & Disease program can be found on the Alberta Environment website (http://www.gov.ab.ca/env/forests).

As of 2003, there were no major outbreaks of insects or diseases in the FMA area. Over the previous 20 years there have been spruce budworm and tent caterpillar outbreaks. Budworm infestations have in the past resulted in increased cutblock sizes and early removal of second pass stands to eradicate the problem. There have been no major actions to mitigate tent caterpillar outbreaks on the FMA area.

Alberta-Pacific, the Quota Holders, and Alberta Sustainable Resource Development will remain pro-active in a combined approach to identify and manage forest health challenges.

INSECTS

Direct control of insects in the FMA area's forest is usually not necessary, because the impact of most insects has not been critical to fibre supply.

As with diseases, maintenance of a well-stocked stand and protection from mechanical wounding is perhaps the most practical method of coping with insects in the boreal forest. However, four main insects are identified as potential hazards:

Insect	Host
Tent Caterpillar (*Malacosoma disstria*)	Aspen and Poplar
Spruce budworm (*Choristoneura fumiferana*)	Spruce and Balsam Fir
Satin Moth (*Leucoma salicis*)	Aspen and Poplar
Aspen Tortrix (*Choristoneura conflictana*)	Aspen and Poplar

DISEASES

Although many diseases attack aspen and conifers, relatively few kill or seriously injure living trees. The common deciduous leaf diseases, in general, are widely distributed throughout the range of aspen, whereas there are subtle differences in distribution between the important decay fungi, and apparently entirely different areas of distribution of major canker causing organisms. However, there still are large gaps in knowledge of the disease organisms and their influence on natural and regenerated stands. These knowledge gaps are being addressed through government and industry research and monitoring initiatives and programs throughout Alberta. Three main diseases are identified as potential hazards:

Disease	Host
Armillaria (*Armillaria ostoyae*)	All commercial tree species
Shepherd's Crook (*Venturia* species)	Aspen and Balsam Poplar
Aspen Trunk Rot (*Phellinus tremulae*)	Aspen and Balsam Poplar