

Alberta-Pacific Forest Industries Inc.

Landscape and Stand Level Structure Monitoring Vignette



March 2018

Landscape- and Stand-Level Structure Monitoring

The boreal forests of northeastern Alberta evolved over thousands of years through continual cycles of disturbance and renewal. Fire was the dominant disturbance agent, with far greater impacts than other causes such as insects, disease, and wind. Evidence from tree rings, lake sediments, historical records, aerial photography, and other sources shows that historically there were many small fires and a smaller number of very large fires that accounted for most of the total area burned. Fires varied widely in scale and intensity. The effects were not uniform, and fires typically left patches or “islands” of unburned and partially burned forest. The biological diversity of the landscape—all of the animal and plant species, from microbes and worms to trees, birds, and large animals—adapted to these dynamic processes of fire and recovery. The result was a mosaic of forest ecosystems, large and small, at various stages of disturbance, regrowth, and maturity.

Ecosystem-Based Management

Alberta-Pacific endeavours to use these natural disturbance patterns as the basis for its forest management. This approach, known as ecosystem-based management (EBM), aims to approximate the effects of natural disturbance and thus maintain the distribution of habitat types within their natural range of variability (NRV). The assumption is that biological diversity will be maintained if the natural range in types of habitats, and the species associated with them, are present in the landscape. A key indicator is the distribution of forest species and age classes (described in Al-Pac’s 2016 Forest Inventory monitoring vignette).

EBM addresses a large majority of habitat types for species and minimizes the need to design harvest activities to meet the specific requirements of most individual species. The effectiveness of the approach is monitored through studies of selected species and their habitats, and further verification comes from periodic grid-pattern surveys for a wide range of species by the Alberta Biodiversity Monitoring Institute (ABMI).

Since the beginning of operations in 1993, Al-Pac has applied EBM at the scale of individual forest stands* by varying the size and shape of harvest areas and leaving an average of 5 percent of merchantable trees as “structure”—individual live and dead trees and clumps, similar to those remaining after fire. During the first decade of operations, average harvest block size was about 24 hectares, and block size seldom exceeded 200 hectares.

In the early 2000s, scientific research and forest management trials in Saskatchewan showed that EBM could and should also be applied to much larger areas. Landscape-level harvest design, adopted in Al-Pac’s 2006 Forest Management Plan (FMP), approximates more of the effects of the larger fires that historically accounted for most of the natural disturbance in the boreal forest.

* A **forest stand** is a contiguous community of trees sufficiently uniform in composition, structure, age, spatial arrangement, site quality, condition, or location to distinguish it from adjacent communities.

At the landscape level, in planning units that can range from 10,000 hectares to 30,000 hectares, the target for residual retention is between 10 per cent and 50 per cent by area, including non-merchantable trees and muskegs, bogs and fens.

This vignette summarizes how the spatial aspects of EBM—harvest layout and structure retention—have been implemented and monitored in the Al-Pac Forest Management Agreement (FMA) area in northeastern Alberta.

Stand Structure Retention

Stand structure in harvest areas plays a variety of temporal and spatial roles for biodiversity. Residuals (patches of live trees, as well as scattered live and dead trees) may produce structural conditions that are more similar to those created by forest fires than those resulting from traditional clear-cut harvesting, especially as the forest regenerates. Residual structures positively affect microsite conditions to help establish the new vegetation community. Residual patches may also act as “lifeboats” that give various species fuller use of the disturbed area and permit more rapid recolonization of its interior by plant and animal species characteristic of later successional stages.

For Al-Pac, stand structure retention is a critical component of the ecosystem management approach laid out in its government-approved FMP and the current approved Operating Ground Rules (OGRs). Al-Pac started implementing the concept of residual stand structure retention when operations commenced on the FMA area in 1993. The original guideline was simply to leave an average of 8 stems per hectare. Protocols evolved over the years, but the target on Al-Pac harvest blocks since 1998 has been to retain an average of 5 per cent of merchantable trees as single stems and clumps of various sizes and species of trees.*

By definition, retained stand structure consists of live single trees, dead snags, and clumps of merchantable and non-merchantable trees of all ages that will provide seed sources and contribute over time to an increase in downed woody material in the harvest block. Gap dynamics (the effects of light-admitting gaps opening and closing in the canopy) can also benefit from structure retention. Al-Pac’s stand structure strategy has evolved towards leaving more patches within a larger range of block sizes.

The retention of single trees, snags and patches of large live trees in harvest areas makes the harvested areas more similar to burned areas. In addition, residual live trees may create some old forest attributes in young regenerating harvest areas. Retaining some large snags within harvest areas creates habitat for some biota associated with naturally disturbed habitat.

* Coniferous quota holders (QHs) operating in the FMA area are required to retain 1 per cent of merchantable trees (based on the 2006 FMP) in their harvest blocks. The Government of Alberta has mandated that starting in 2018 QHs are now to leave 3 per cent structure retention in all their harvest blocks; this is detailed in the new 2015 Forest Management Plan for the FMA area.

Additional large snags may be created by retaining large live trees, as some of these trees will die as the stand ages. Stand structure patches are generally located such that natural features, riparian areas, sensitive sites (e.g. stick nests), and proximity to standing forests are taken into account to maximize their utility or usefulness by the biotic community.

Structure is generally created by machine operators leaving patches and single trees throughout a harvest area. Al-Pac provides the operators with training in retention protocols and checks on the post-harvest results. The operator-initiated stand structure can be augmented by larger, planned patches laid out by Al-Pac team members. Larger retention patches have become more common since 1998 when Al-Pac began using aggregated harvest systems, also known as “single pass” or “single entry” systems. Aggregated harvests replaced the previous “two-pass” system in which about half of merchantable timber in a stand was harvested in the first pass, with the remainder left for harvest 15 or 20 years later when regrowth was established in the first area. Among other things, aggregated harvests reduced the number of roads and the need to keep these roads open for long periods.

Al-Pac undertook remedial steps, including more operator training and more planned patch designations, after average retention fell below target levels between 2006 and 2009.





Stand structure pattern and size differs from harvest area to harvest area, throughout the FMA area. Upper left photo shows understory protection.



Monitoring Stand Structure

Monitoring stand structure retention involves a sequence of steps:

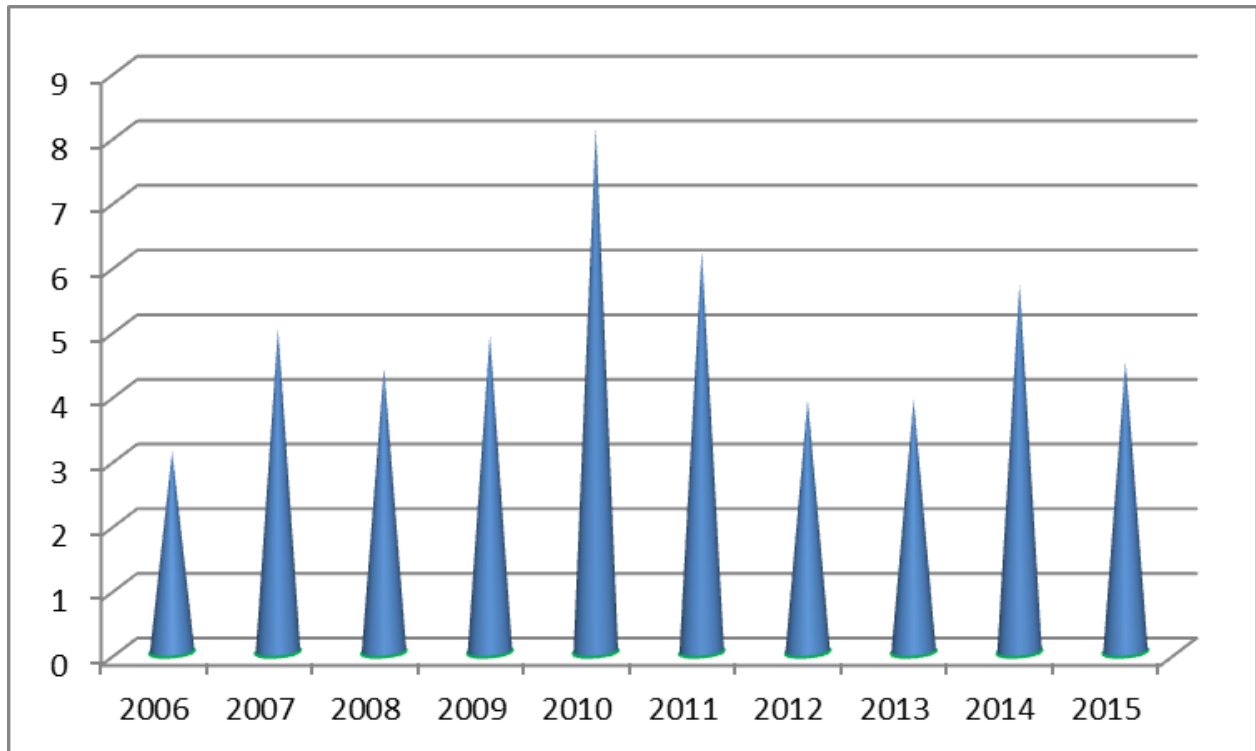
- Aerial update photography (leaf-on imagery) of all harvested areas occurs 1-2 years after harvest. This program is also augmented by the annual forest inventory imagery program that covers upwards of 75 adjacent townships / year.
- Air photo interpretation of a subset (50 percent by area) of blocks from these photographs occurs in the year following photography. The monitored areas include:
 - All harvest areas with pre-planned patches
 - Approximately 50% of the Harvest areas with limited conifer understorey
 - Normal harvest blocks (which make up the remainder of the sampling after the above two categories)
- Stand structure metrics are reported in Al-Pac's next year's Annual Operating Plan (AOP).

To date, understorey protection blocks have not been monitored for stand structure. Understorey protection (UP) is a harvest treatment designed to retain portions of an existing immature conifer understorey, while harvesting the majority of the deciduous over-storey. This is also sometime referred to as a shelter-wood or partial cut (PC) harvest. Post-harvest, these harvest areas have an abundance of retained stand structure (see upper left photo on previous page).

For Al-Pac's monitoring purposes, there is a correlation between area retained and volume retained. If the retained stand structure is representative of the original forest stand, then the assumption is that on average, the structure is comparable to average volumes from pre-harvest forest stands. For these purposes, area rather than volume is the monitored variable. The Al-Pac average structural retention percentage within harvest area boundaries for the FMA area is 4.97 percent for the 10 years from 2006 to 2015. The following figure provides actual post-harvest stand structure retention percentage metrics (clumps and single trees) for Al-Pac harvest operations.



Al-Pac FMA Area Retained Stand Structure – Average Percent per Year



Landscape Structure

There are many definitions of “landscape.”* Some could apply for the entire boreal plain in northeastern Alberta. For planning purposes, Al-Pac considers landscapes in units between about 10,000 hectares and 30,000 hectares. These units are smaller than major wildfire burn areas, which can be hundreds of thousands of hectares, but they are large enough to include the mosaic of species, wetlands, and forest stands of various ages that are typical of the region. A key element of diverse forest ecosystems relates to the patterns or interspersions of forest and aquatic types, ages, and structural attributes.

Al-Pac’s strategies to maintain forest cover patterns that more closely resemble natural disturbance patterns at the landscape level include:

- Maintain existing forest cover patterns at the landscape scale by implementing landscape-level aggregated harvest plans (single-pass systems), as outlined in the approved FMP and the OGRs.
- Landscape-level harvest strategies are planned and harvested by following natural stand boundaries and stand types.
- Stand structure retention is part of landscape structure
- An increase in the variation of patch or harvest area size and shape that should more closely approach the naturally existing stand type and size variation on the landscape.
- Variation in planning unit size and distribution within a forest management unit (FMU).†
- Aggregated disturbance planning units no larger than 30,000 hectares in size.
- Reclamation of roads and access after completion of harvest and silvicultural activities.



* Forman and Godron (1986) defined landscape as a heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout. Turner et al (2002) define landscape as an area that is spatially heterogeneous in at least one factor of interest. The landscape concept differs from the traditional ecosystem concept in focusing on groups of ecosystems and the interactions among them – the focus is on spatial heterogeneity and its impact on process. There are many variants of the definition depending on the research or management context.

http://www.umass.edu/landeco/teaching/landscape_ecology/schedule/chapter3_landscape.pdf

† The 6.3 million-hectare Al-Pac FMA area consists of 12 forest management units delineated by the Government of Alberta. Each FMU has unique forest tenure percentages for conifer allocations.

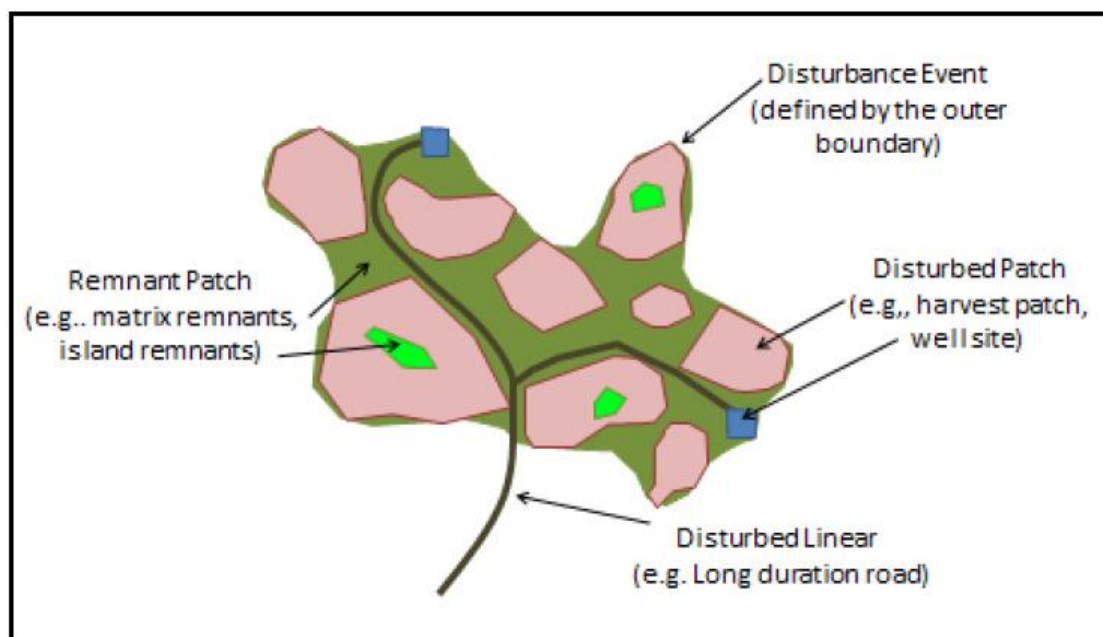
Landscape Structure within a Planning Unit

Landscape structure is the area retained outside an individual harvest area, but within the planning unit. Retained stand structure also contributes to overall landscape structure. This post-harvest structure is comprised of merchantable and non-merchantable trees (e.g., black spruce muskegs, patches of juvenile forest, grassy non-forested areas) representative of the boreal mixedwood forest in the harvesting area. Al-Pac then quantifies all of this residual landscape structure in planning units along with the retained stand structure.

To monitor landscape structure, Al-Pac defines the areas within a planning unit as either disturbed features or remnant areas left undisturbed. A disturbed feature can be a harvest area or patch, linear disturbance (such as roads, seismic lines, transmission lines and/or pipelines), or other industrial (anthropogenic) disturbance.

Collectively these disturbances form a disturbance event, essentially a cluster of disturbed patches and linear features sufficiently close in space and time. The spatial dimension is defined as having a maximum distance between disturbed patches of 400 meters within individual events. In terms of the temporal dimension, 10 years is used to define a harvesting disturbance event (collection of harvest areas). In other words, forest management has up to 10 years to harvest an area for it to be considered within the same event.

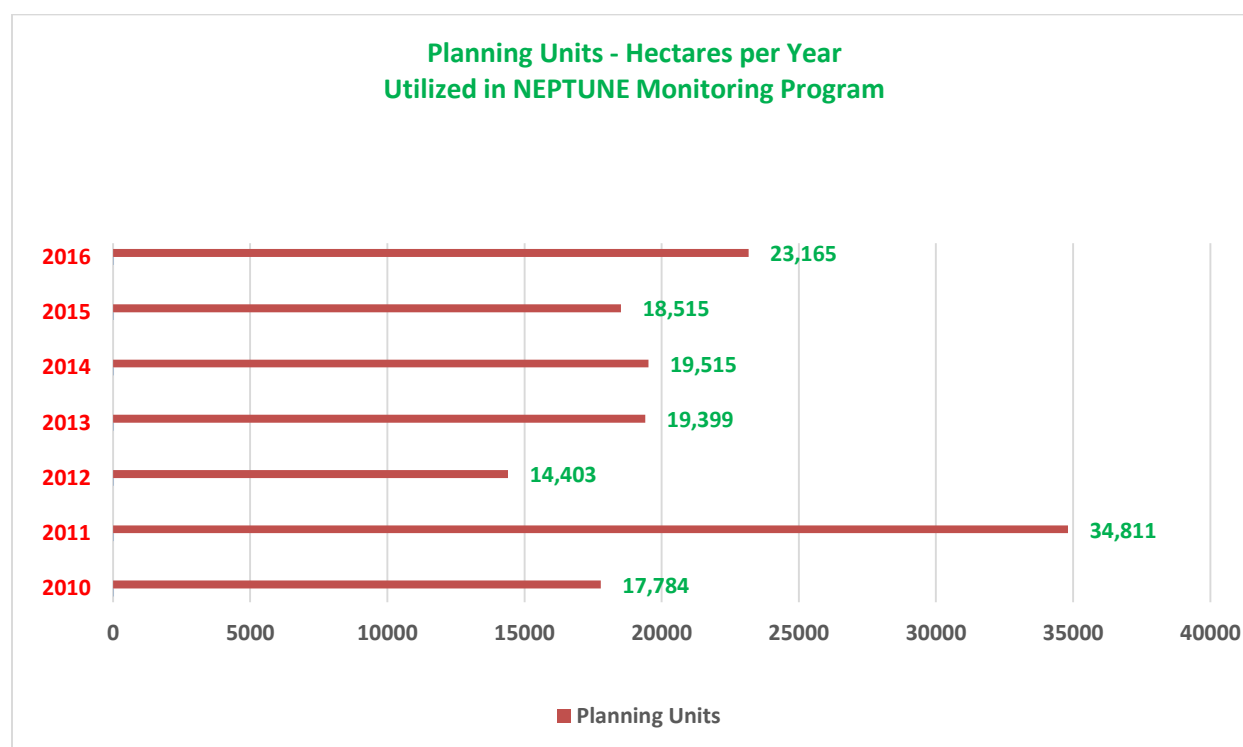
Undisturbed patches can take the form of either “Island remnants” (unharvested area within a disturbed patch) or “matrix remnants” (undisturbed areas between disturbed patches – treed and un-treed).



The page 9 illustration shows a planning unit—the “disturbance event” - that contains aggregated harvest areas and harvest blocks (pink), well-sites (blue), roads, and various forms of undisturbed area (light and dark green). These green areas are usually areas of muskegs or un-merchantable trees. The AI-Pac analysis of landscape residual structure is based on the amount of undisturbed area (green) as a percentage of the planning unit.

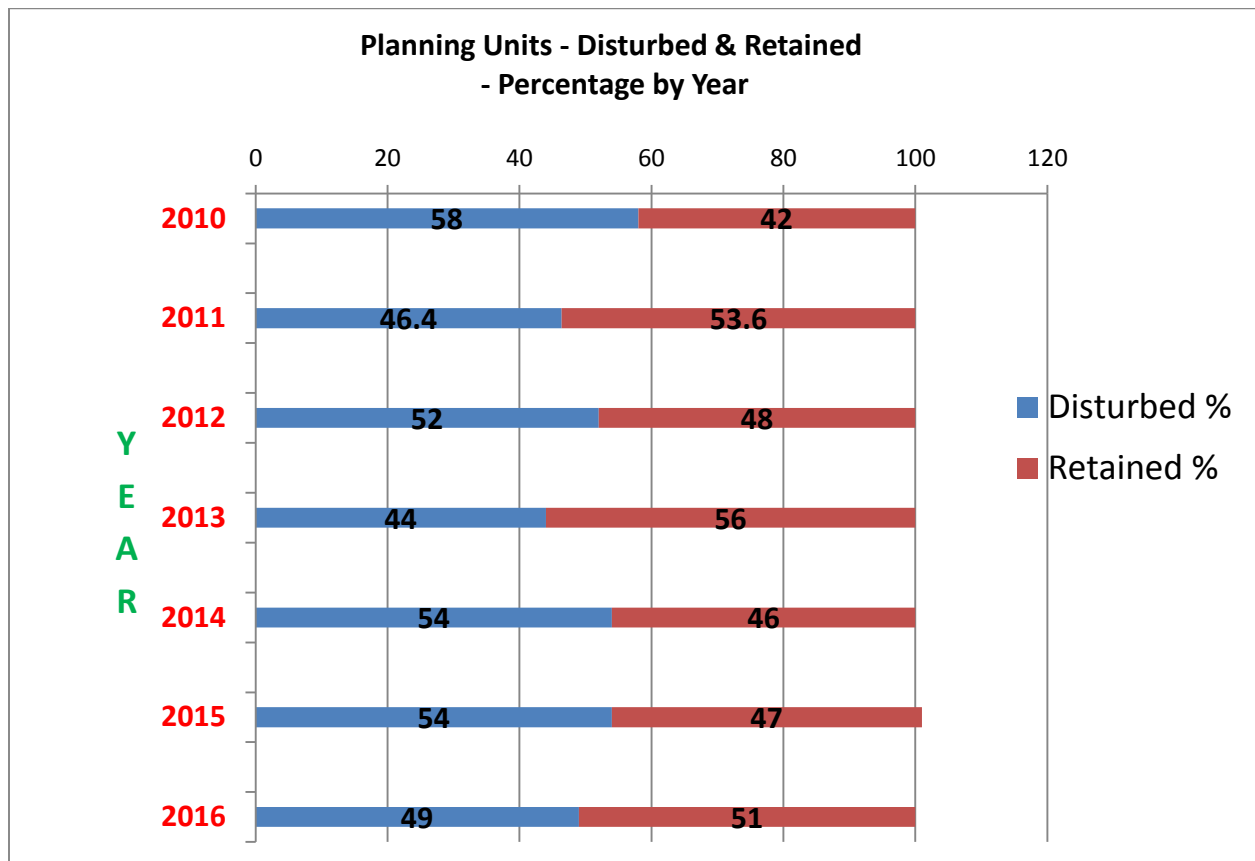
Monitoring Landscape Structure

Quantifying landscape structure in the FMA area, requires AI-Pac to have an imagery update program (leaf-on imagery) of all harvested blocks 1-2 years after harvest; this is the same imagery required for all stand structure retention monitoring. Accounting for this structure is achieved by using a program called NEPTUNE* that maps and tabulates all the disturbed and undisturbed area within a planning unit. AI-Pac has been using NEPTUNE and tabulating the output since 2010. Over the past 7 years, almost 150,000 hectares of anthropogenic disturbance events have been analyzed, comprising 44 AI-Pac planning units.



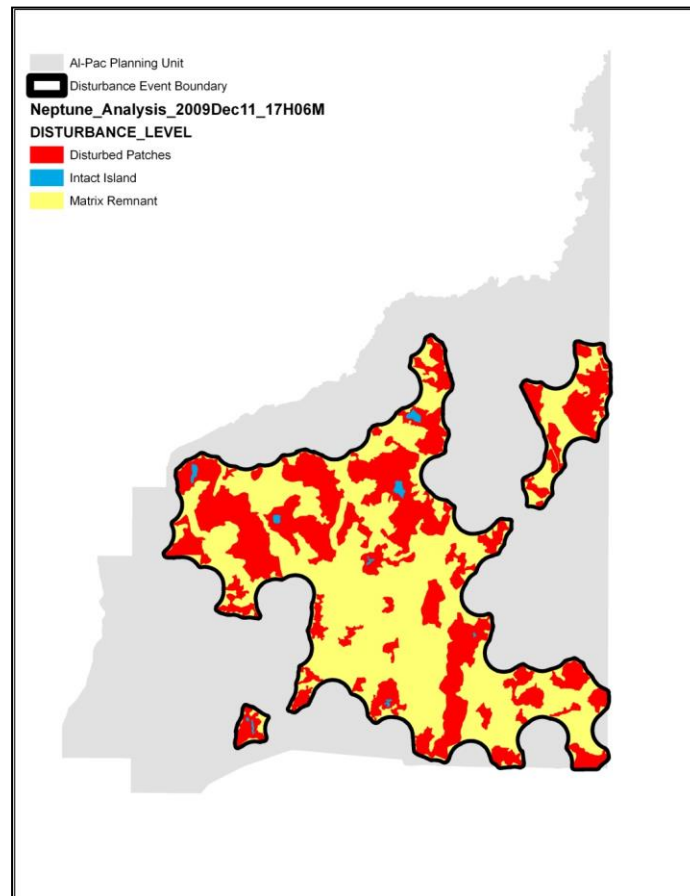
* NEPTUNE (**N**atural **E**mulation **P**attern **T**ool for **U**nderstanding **N**atural **E**vents) is a GIS-based decision-support tool that allows existing and future disturbance patterns to be compared to the range of patterns created by natural wildfires. It was developed by Dr. David Anderson in 2004. With continuing enhancements, the application is now managed under a non-profit shareholder agreement by five industry partners, including AI-Pac, and the governments of Alberta and Saskatchewan. <https://firesearch.ca/resource/neptune>

To date, the analysis has illustrated that on average, 51 percent of the event is disturbed and 49 percent of the area is undisturbed or retained. The results for the past 7 years are presented below:



To acquire the landscape metrics requires Al-Pac to prepare a map, typical of the one above, where the perimeter of the “disturbed” portion of the planning unit is delineated (black lines) and actual harvest block areas (dark red), and retained or undisturbed areas (yellow) are mapped. The small blue patches are large retained stand structure patches within harvest blocks. The entire disturbance event is the combination of the blue, yellow and red areas; harvest blocks and structure plus the areas from the 400-metre buffer adjacency rule. The surrounding grey area is also undisturbed land--primarily black spruce muskegs, aquatic features and their associated OGR buffer areas, non-forested areas and juvenile forest. The total planning unit is the sum of the area from the grey, red, blue and yellow hectares. The “disturbed” and “retained” percentages of the planning unit can then be tabulated, as illustrated on the page 11 chart.

Landscape Structure Mapping



Al-Pac PU - illustrates numerous harvest block areas, retained stand structure and undisturbed areas; black spruce muskegs, bogs and fens, patches of juvenile forest, and grassy non-forested areas.