A Boreal Forest Divided Cannot Stand: A Cumulative Effects Story

By Mai-Linh Huynh

Cumulative effects of resource development to Alberta's expansive Boreal region deserves its own euphemism as it's a well publicized matter that decision makers continue to ignore or struggle to grasp. Why, you wonder? Because effective management of cumulative effects requires institutional change, both in policy and law, that has been persistently rejected due to Alberta's economic priorities.

In the Lower Athabasca region, University of Saskatchewan researchers Joshua Cronmiller and Bram Noble theorized in 2018 that institutional arrangements are the main cause of "stifled" cumulative effects management. They made their claim after reviewing past and current studies and programs geared to monitor long-term environmental effects for the region. Institutional arrangements are critical for providing decision makers with the foundation to create and implement policies. They also are vital for delegating or sharing decision-making power with Indigenous groups, non-government organizations, and private sector groups to support and implement these policies.

> "The Lower Athabasca is probably one of the most monitored ecosystems in North America. There is room for science improvement, but institutional challenges tend to pose the most enduring and significant constraints to long-term monitoring programs…"
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> *- Cronmiller & Noble 2018, Environmental Reviews 26(2).*

Cronmiller and Noble stated that discontinuous support for environmental monitoring in the region resulted from shifting priorities, short term commitments, lack of meaningful and balanced stakeholder engagement, and unclear governance. Such discontinuity has unquestionably led us down the rabbit hole, having us anxiously wonder "what's really happening to our Boreal forest"?

With the state of uncertainty and lack of credible scientific long-term environmental monitoring data, how can one begin to tell the story of cumulative effects on the Boreal?

Landscape Impacts to Alberta's Boreal

Early last year, the Alberta Biodiversity Monitoring Institute (ABMI) updated its online reporting about the status and trend of human footprint. Human footprint, measured as land area directly altered by human activities, provides a good indication of direct habitat loss. Information is reported by ecological and Land-use Framework planning regional boundaries.

As of 2016, human footprint occupied 18.34 percent or 69,884 km^2 of the Boreal region, a region that occupies 58 percent or 381,047 km^2 of the province. Major footprint types in the Boreal were agriculture (11.27 percent or 7,876km^2) followed by forestry (3.50 percent or 2,446km^2) and energy (1.97 percent, or 1,377km^2).

ABMI's trend data from 1999 to 2015 showed that human footprint increased by 3.30 percent in the Boreal (Figure 1). This increase came through the expansion in forestry (1.91 percent increase) and in agriculture and energy (both a 0.5 percent increase).

Footprint information is useful in a number of ways. For example, ABMI can determine the effect of a footprint on a species per unit area by assessing the strength of the footprint's effect (positive, negative, neutral), degree to which the footprint occurs in the species' suitable habitat, and the total area of the footprint. Footprint data also serve as a baseline for evaluating future land-use changes in Alberta. ABMI notes that thresholds related to human footprint and for protecting undisturbed native habitat are expected to be established and that availability of baseline human footprint information is essential for this to occur.

As shown in the maps in Figure 2, Webster et al. in 2015 visually portrayed the spatial extent of total linear disturbance, active oil wells, roads, and seismic lines - *pipelines and transmission lines were not included in their analysis*. Clearly, linear disturbances are much more pervasive in Alberta than other parts of Canada. Although these linear footprints do not occupy large total areas compared to mining, agriculture or forestry, they can result in significant indirect habitat loss for species requiring intact forests and wetlands. The habitat loss is caused by fragmentation and habitat changes from being in close proximity to the disturbance. These 'edge effects' include changes in noise levels, natural and artificial light, air quality, groundwater, and surface water. More research is needed to inform resource management and restoration of these disturbances for minimizing their long-term effects on the Boreal and

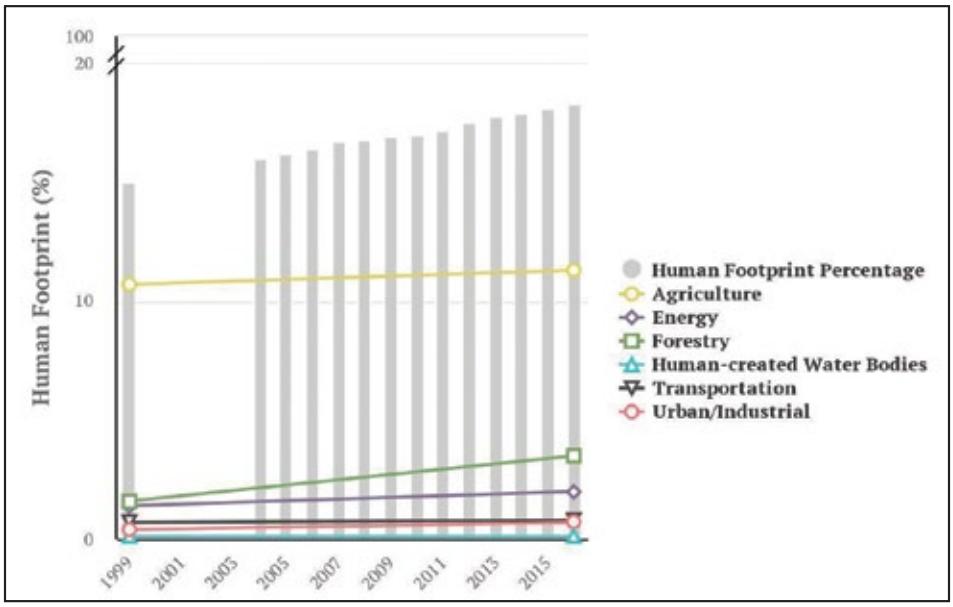

Figure 1: Trend in the percentage area of total human footprint, and by human footprint category in the Boreal Forest Natural Region between 1999 and 2016. SOURCE: ABMI, 2018.

for restoring landscape connectivity and ecological resilience.

Examining structural indicators such as footprint area or density alone cannot tell the full story on the Boreal's state of ecosystem integrity and health. They also cannot measure all of the potential anthropogenic impacts that might affect the Boreal ecosystem which can run the risk of an environmental issue going undetected (e.g. effects of invasive species, wildlife toxicology).

Assessing cumulative effects on the Boreal requires careful consideration of various factors such as spatial scale, ecological focus (whether it be physiological responses, population impacts, ecosystem impacts)

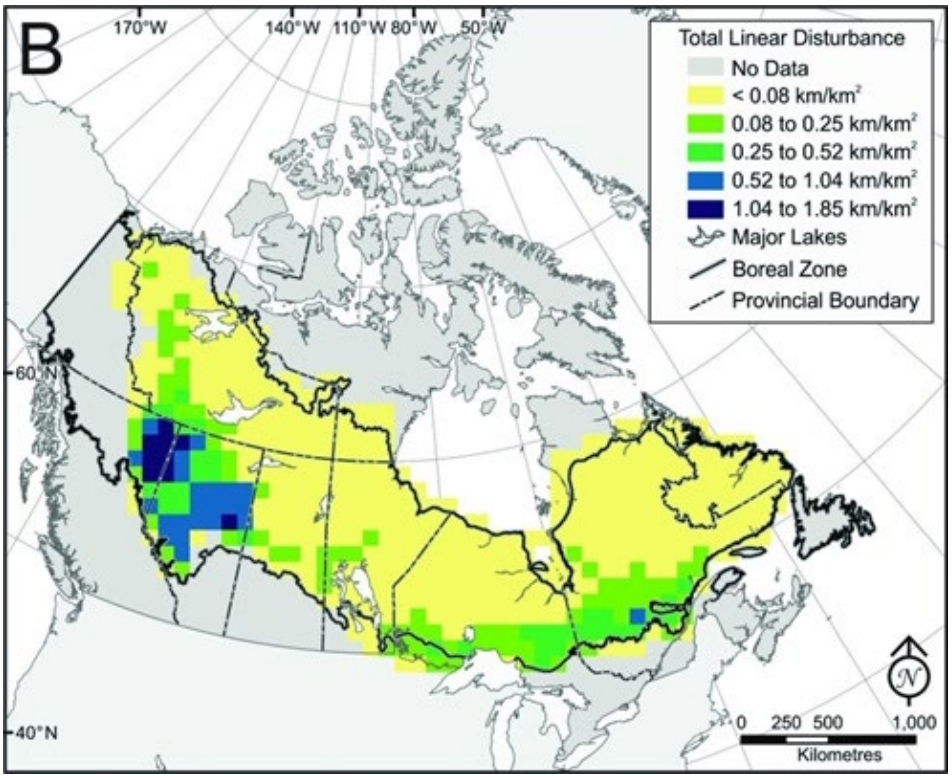

Figure 2: Total linear disturbances SOURCE: ENVIRONMENT CANADA, ANTHROPOGENIC DISTURBANCES ACROSS THE CANADIAN BOREAL ECOSYSTEM COLLECTED FROM 2008 TO 2010, LANDSAT IMAGERY GRIDDED TO 1 KM RESOLUTION. CITED BY WEBSTER ET AL. 2015, 54.

and ecological complexities (such as synergistic and antagonistic effects, impacts across space and time). Current academic research is looking to uncover innovative methods to address these challenges of cumulative effects assessment. Scientists Emma Hodgson and Benjamin Halpern suggested in 2018 that a combination of methods is a more useful approach for addressing ecological complexity. For example, multi-model comparisons could address uncertainty, a common issue with modelling, and provide a more holistic understanding of ecosystem impacts. Another 2018 study, this one by Jason Fisher and A. Cole Burton, described the 'common mammal community' of their northeast Alberta study region using data from a network of camera 'traps' along with species distribution models. They found this approach useful for assessing mammal community change and altered landscape function in the oil sands region, which was both an outcome and a cause of biodiversity loss.

Although cumulative effects research on the Boreal is currently limited, Paul Pickell (2015) believes examining the historical range-of-variability (HRV), (i.e. variability caused by historical fire disturbances) could provide insights into knowledge gaps and areas more at risk in the Boreal. They suggest that anthropogenic disturbance patterns have been outside the HRV for several decades and that, despite recent efforts by forest managers to implement HRV-based forestry practices, the energy sector activity may be overwhelming any concomitant change towards HRV from forest management.

Cumulative Effects on Boreal Wildlife

The ultimate story of the Boreal would tell us about its adaptive capacity or resilience to both cumulative natural and anthropogenic disturbances. Although scientifically defensible long-term monitoring information is currently limited, the latest research on Boreal biological indicators provides useful insights about ecosystem processes as well as potential solutions for minimiz-

ing and mitigating cumulative effects.

Boreal wildlife responds to human disturbance in various ways. This variety provides crucial information on how the Boreal ecosystem is functioning. Such information could be used to help decision makers set ecological thresholds for cumulative effects management. However, there are challenges in assessing species' response to disturbance. These challenges include: determining abundance estimates together with natural variability, developing the ability to distinguish human-caused effects from natural variation, and establishing agreement on a reference or baseline condition that suits all interested parties (e.g. pre-industrial, pre-European settlement, or another specified period).

Woodland caribou is the most well-known example of a Boreal species' response to disturbance. Caribou are found to avoid areas with linear disturbances like roads and seismic lines due to the increased prevalence of predators (for example, wolves) and the associated increased mortality risk. Schneider et al wrote in 2010 that, if habitat loss trends continue, woodland caribou extirpation in Alberta is predicted over the next 70 years and the East Side of the Athabasca River caribou extirpation is estimated within the next three decades.

Deer and coyote response to disturbance in the Boreal provides a good example of how ecological changes can have positive effects to a species. University of Alberta researchers Erin Bayne, Stan Boutin, and Richard Moses found in 2004 that human disturbance is driving these animals to expand their range in the Boreal forest. This expansion could potentially result in altered predator-prey dynamics, new competitive interactions, and changes in the feeding patterns of herbivores. The above-mentioned research by Fisher and Burton reinforced this observation. Their camera trapping data showed white-tailed deer and coyotes exhibiting a positive response to disturbance associated with linear features and areas converted from mature forest to early post-disturbance vegetation in the oil sands region.

ABMI also has publicly available research data relating to human footprint type on the predicted relative abundance of a species. Their impressive online reports and infographics are useful in understanding a species status and relative abundance in the Boreal. Species reported by ABMI include: Canada lynx, elk, gray wolf, marten/fisher (weasels), and mink.

ABMI finds that Canada Lynx, for example, benefit from young to mid-succession forests that have originated from either fire or logging. These stands provide sufficient cover and prey. Canada Lynx were observed less at their southern range as a result of poor habitat quality from human development (e.g. conversion of boreal forest to agriculture and increased road densities), increased competition with coyotes, and the lower availability of its main prey, the snowshoe hare. Fisher and Burton also found similar results in their camera trapping research in the oil sands region where Canada Lynx positively responded to the conversion from mature to early succession forest.

I also will refer to ABMI's conclusions about the relative abundance of Canada lynx, marten, and fisher between reference and current conditions. Canada Lynx has shifted further into the interior of the Boreal, away from the expansion of agriculture and urban areas in the Peace region and southern Boreal. In contrast, ABMI's comparative abundance maps for marten and fisher portray a predicted decline in relative abundance compared to reference conditions. Marten and fisher are most commonly found in mature/old coniferous and mixedwood stands that provide habitat structure for meeting their foraging and cover requirements. Those requirements include large trees and snags, coarse-woody debris, and understory vegetation. ABMI reported negative unit effects on marten and fisher from all human footprint types. The energy footprint had the strongest negative unit effect.

Fisher and Burton's study also discusses Boreal species experiencing negative consequences to the changes in habitat caused by human disturbances in the oil sands region. They note that moose, black bear, red fox, and fisher populations are decreasing while other species are benefiting from human disturbances (i.e. white-tailed deer, wolf, coyote, and lynx) and are increasing in population. Their research depicts an emerging community-level shift in relative abundance and distribution of common mammals in an oil sands landscape, and a large-scale restructuring of spatial ecological processes caused by human disturbances.

Where do we go from here?

The optimist in me wishes there will be a happy ending to this story. However, the story's ending remains open to all possibilities until we better understand cumulative effects in the Boreal and about the natural processes and the drivers of change. That knowledge may produce better and more well-informed decision making.

A few big victories fuel my optimism. In May 2018, the Government of Alberta formally announced the creation or expansion of five Wildland Provincial Parks, most of which were committed to in the 2012 Lower Athabasca Regional Plan (LARP), adding more than 1.36 million hectares of new protected land in the Boreal. With the addition of these parks that are contiguous with Wood Buffalo National Park, Alberta is now home to the largest Boreal protected forest in the world. In an adjacent area, the 162,000 hectare Kitaskino Nuwenëné Wildland Provincial Park was created in March 2019.

According to Scott Duguid, Executive Director of the Land Use Secretariat of Alberta Environment and Parks, work continues on completing a Lower Athabasca Region Biodiversity Management Framework. This ongoing work includes developing and refining indicator methods and engagement with Indigenous communities. This Framework is intended to support the achievement of the regional biodiversity outcome where landscapes are managed to maintain ecosystem function and biodiversity. It also intends to add to Alberta's natural resource management system by providing open, transparent information on a suite of bio-

diversity indicators that informs land-use decision-making in the region.

As land-use planning initiatives progress and new programs to study the Boreal emerge, there is unquestionable doubt about whether institutional arrangements can move forward from the "stifling" management issues of the past. Sustaining Canada's boreal ecosystems and the ecological services they provide for future generations requires institutional change. Empowering local governments, stakeholders, and Indigenous peoples are part of this change along with our own individual responsibilities, as consumers and citizens, in ensuring sustainable development remains top priority.

Mai-Linh is a recent volunteer researcher at AWA and has significant former regulatory experience in federal environmental assessment. She enjoys traveling near and afar to discover and experience Earth's natural wonders.