ABMI

The Status of

BIODIVERSITY

IN THE ALBERTA-PACIFIC FOREST INDUSTRIES INC. FOREST MANAGEMENT AGREEMENT AREA

Five-Year Update // *2015*

[THIS REPORT DESCRIBES THE STATUS OF SPECIES, HABITAT, AND HUMAN FOOTPRINT IN THE ALBERTA-PACIFIC FOREST INDUSTRIES INC. FOREST MANAGEMENT AGREEMENT AREA LOCATED IN NORTHEASTERN ALBERTA FIVE YEARS AFTER THE FIRST BIODIVERSITY STATUS REPORT]

In partnership with:

Alberta Innovates

Royal Alberta Museum

University of Alberta

University of Calgary

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OLD DECIDUOUS AND MIXEDWOOD FOREST STANDS SUPPORT A WIDE RANGE OF BIODIVERSITY; THIS REPORT HIGHLIGHTS RESULTS FOR SPECIES ASSOCIATED WITH THESE FOREST TYPES.

About the ABMI

The Alberta Biodiversity Monitoring Institute (ABMI) is an arm's-length, not-for-profit scientific organization. The business of the ABMI is to monitor and report on the status (current condition) and trends of Alberta's species, habitat, and human footprint.* The goal of the ABMI is to provide relevant scientific information on the state of Alberta's biodiversity to support natural resource and land-use decision making in the province.

The ABMI is jointly delivered by Alberta Innovates - Technology Futures, the Royal Alberta Museum, the University of Alberta, and the University of Calgary. The ABMI Board of Directors includes representatives from the Government of Alberta; environmental non-governmental organizations; the forest, energy, and agriculture sectors; and the research community.

The ABMI reports on a range of biodiversity indicators that act as a guide for establishing biodiversity-related management goals and tracking performance against those goals. Notwithstanding, the ABMI is not a management agency and does not make management recommendations. The ABMI generates value-neutral, independent, publicly accessible data, and presents knowledge derived from the data in a value-neutral format.

The ABMI is guided by a core set of principles—we are independent, objective, credible, accessible, transparent, and relevant.

*The ABMI defines "human footprint" as the visible conversion of native ecosystems to temporary or permanent residential, recreational, agricultural, or industrial landscapes.

About Alberta-Pacific Forest Industries Inc.

Alberta-Pacific Forest Industries Inc. (Al-Pac) manages the largest Forest Management Agreement (FMA) area in Alberta (Figure 01). Located in northeastern Alberta, the Al-Pac FMA area covers approximately 10% of Alberta's land area and includes a mosaic of deciduous, mixedwood, and coniferous forests along with an abundance of aquatic ecosystems, including lakes, rivers, and a variety of types of wetlands (e.g., bogs and fens). This range of habitats supports a rich array of biodiversity requiring responsible forest management to sustain it along with the social and economic benefits provided by the FMA area.

Al-Pac takes an ecosystem-based management (EBM) approach to manage their activities in the forests of their FMA area. By following a natural disturbance model as part of EBM, Al-Pac has adopted a risk management approach to maintain biodiversity. The underlying assumption of this approach is that the biodiversity living in boreal forests is adapted to frequent natural disturbances, particularly wildfire, as the main agent of change.[1] Therefore, if the patterns, structure, and vegetation communities resulting after forest harvesting are similar to those produced after wildfire disturbance, biodiversity is more likely to be maintained.

While there are some well-documented differences in post-disturbance ecology immediately after wildfire and timber harvesting,[2] it is assumed that differences in biodiversity will diminish with time. By implementing harvest planning and practices that are inspired by natural disturbance, it's expected that less time will be required for biodiversity to recover post-forest harvesting and approach post-wildfire conditions.

Al-Pac is committed to long-term monitoring of biodiversity in northeastern Alberta to allow the company, the regulators, and the public to understand how biodiversity responds to a variety of natural and human-caused disturbances. Al-Pac has been a long-time supporter of the ABMI and believes strongly in the mandate of the ABMI to conduct credible third-party monitoring with results that are available to all. This report represents a five-year update on biodiversity monitoring on the Al-Pac FMA area using the ABMI's core monitoring program. In addition, Al-Pac collaborated with the ABMI to conduct a supplementary effectiveness monitoring study that compared the biodiversity response of timber harvest areas versus those exposed to wildfire, 15 years following disturbance. The results of this study are also included in this report.

FIGURE 01
LOCATION OF THE AL-PAC FMA AREA IN ALBERTA.

Report Summary

The Alberta Biodiversity Monitoring Institute (ABMI) measures and reports on the state of biodiversity and human footprint across the province. This report is the five-year status update for biodiversity in the Alberta-Pacific Forest Industries Inc. (Al-Pac) Forest Management Agreement (FMA) area located in northeastern Alberta. Building on the first biodiversity status report released in 2009, in this report the ABMI presents the status of most of the same indicators of environmental health for the Al-Pac FMA area (e.g., human footprint, old-forest birds, vascular plants), but also presents the status of other indicators for the first time (e.g., armoured mites, mosses). This is the first administrative unit in the province for which a five-year biodiversity status update is available.[†]

The Al-Pac FMA area makes up 10% of Alberta's land area. This predominantly forested region is naturally disturbed by wildfire and insect outbreaks, which results in a patchy mixture of young, mature, and old forest across the landscape.

The ABMI has 157 permanent monitoring sites in the Al-Pac FMA area. Between 2003 and 2013, we conducted field surveys at 120 of these sites. At each location, ABMI technicians recorded the species present, and measured a variety of habitat characteristics. The ABMI also measured human footprint using fine-resolution aerial photography and satellite imagery at two spatial scales. Detailed assessment of human footprint was completed using a 3 × 7 km area around each of the 157 permanent monitoring sites between 1999 and 2013. A broad assessment of human footprint was also conducted using a wall-to-wall human footprint map for the entire province circa 2012.

As of 2013, the total human footprint across the Al-Pac FMA area was 7.5%. Covering 4.8% of the FMA area, forest harvest was the largest human footprint and approximately two times larger than the energy footprint, which covered 2.1% of the Al-Pac FMA area.

The total amount of human footprint in the Al-Pac FMA area increased by 3.1% between 1999 and 2013, from 4.1% to 7.5% (Figure 05). This increase was largely driven by forestry footprint, which grew by 2.3%. Energy footprint increased by almost 1% during this period, from 1.3% to 2.1%.

As of 2012, 92.5% of the Al-Pac FMA area has no direct human footprint. But the vast majority of natural habitat in the Al-Pac FMA area is within 500 m of human footprint; only 5.7% of natural habitat in the FMA area is more than 500 m from human footprint. At present, the measure of human footprint does not account for the recovery of biodiversity in forests that are regenerating following temporary disturbances such as logging or energy exploration (e.g., seismic lines). The ABMI is currently advancing the science necessary to account for this regeneration so that recovering areas can make a reduced contribution to the estimate of total human footprint.

The ABMI assessed the status (current condition) of 477 species in the Al-Pac FMA area and found the Biodiversity Intactness Index[§] to be, on average, 94% in 2012. Biodiversity intactness for each species group was:

- 92% for native birds
- 97% for winter-active mammals
- 96% for armoured mites
- 91% for native vascular plants
- 95% for mosses

[†] Results of the report published in 2009 and this assessment are not directly comparable because of improvements in statistical analyses and changes to some methods (e.g., delineation of human footprint). Instead, we apply the current analyses using maps of the current landbase, and maps from earlier years back to 1999, including 2009. This shows how the abundance and intactness of species is predicted to have changed from 1999 to present based on changes in the landbase.

[§] The ABMI's Biodiversity Intactness Index is used to report on the status of biodiversity, including birds, winter-active mammals, armoured mites, vascular plants, and mosses and liverworts, within Alberta. The index ranges from 100% intact to 0% intact. An area with little evidence of human impact is nearly 100% intact, whereas a parking lot surrounded by big-box stores is nearly 0% intact. The Biodiversity Intactness Index is a measure of how much more or less common a species is relative to its predicted abundance if there were no human footprint present.

Of the full suite of species assessed by the ABMI in the Al-Pac FMA area, we profile species of birds, armoured mites, vascular plants, and mosses associated with old deciduous and mixedwood forests because Al-Pac forestry activities disproportionately affect deciduous and mixedwood forests. In general, intactness of species associated with old deciduous and mixedwood forests was high for all assessed taxa, ranging from 94% intact for birds up to 97% intact for winter-active mammals and vascular plants.

Additional results of note include the following:

- A total of 23 non-native vascular plant species were detected in the Al-Pac FMA area, including 3 noxious weeds: Creeping Thistle (detected at 3% of the sites surveyed), Perennial Sow-thistle (0.6%), and Scentless Chamomile (0.6%). Non-native species were detected at 41% of the sites surveyed. At sites where they were found, there were an average of 1.9 non-native species present.

- The ABMI detected 88 species designated as sensitive species or species at risk[**] in the Al-Pac FMA area. The majority of these species (73%) were vascular plants and mosses that are provincially listed as sensitive.

- Woodland Caribou has the highest public profile of all the species at risk. There are six caribou populations whose ranges overlap with the Al-Pac FMA area, at least five of which declined between 1994 and 2012. In 2012, the total human footprint ranged from a low of < 1% in the Richardson range to a high of over 7% in the Nipisi population range. When human footprint is buffered by the federal guideline of 500 m, these values are much higher, ranging from 22% for the Richardson population to 77% of the East Side Athabasca River range.

- The basal area (m^2/ha) of living trees and snags (standing dead trees) in the Al-Pac FMA area was similar, or was predicted to have increased slightly between 1999 and 2012 because of aging and maturing forests in the landbase.

- The volume (m^3/ha) of all downed woody material and large downed woody material was predicted to have increased slightly between 1999 and 2012.

- After 15 years, aspen stands harvested with structural retention have recovered substantially towards older forest conditions, supporting the recovery of many components of biodiversity after forest harvesting.

This report describes the status of biodiversity in the Al-Pac FMA area, five years after the ABMI's first status report. These findings can be used as a foundation for evaluating outcomes of responsible forest management in the Al-Pac FMA area. Over the next few years, the ABMI will broaden the assessment of biodiversity in the Al-Pac FMA area to include status reporting for lichens and wetlands, and trends for all groups.

[**] *Threat categories for sensitive species and species at risk as identified by the Government of Canada and/or the Government of Alberta. This assessment includes species identified by Canada's Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered, Threatened, or Special Concern; Canada's Species at Risk Act (SARA) as Endangered, Threatened, or Special Concern; Alberta's Ministry of Environment and Parks (AEP) as May Be at Risk, At Risk, or Sensitive; and Alberta's Endangered Species Conservation Committee (AB ESCC) as Endangered, Threatened, or Special Concern.*

Report Overview

Monitoring biodiversity is an important part of Al-Pac's responsible forest management strategy to evaluate the effectiveness of management actions and continually improve results. The ABMI[††] is part of Alberta's environmental monitoring system. We measure the health of biodiversity and changes in human land use (i.e., human footprint) in Alberta, including the Al-Pac FMA area. Our biodiversity data and human footprint data are designed to assess whether forest management practices are meeting their goal of maintaining species in the presence of other human activities, such as energy development in the boreal forest.

This report is the five-year update on the status of biodiversity in the Al-Pac FMA area, since status was first assessed in 2009.[3] In this report, we describe the status of species, habitat, and human footprint in the Al-Pac FMA area using field data collected between 2003 and 2013, and human footprint trend data available from 1999 to 2013. We examine the status of hundreds of species and highlight results for those species that are associated with old deciduous and mixedwood forests. We also assess the status of non-native species, and species designated as sensitive or at risk. We summarize the status of habitat elements, core natural habitat, and area of human footprint, including information on the trend of human footprint over the past 13 years. Information from this report can be used as a foundation for evaluating the sustainability of forest management practices that are designed to maintain biodiversity in the Al-Pac FMA area.

†† The ABMI is hereafter referred to in this report in the first person plural using "we" and "our" (for example, "We collected biodiversity data" or "Our biodiversity data").

REPORTING AREA

About the Al-Pac FMA Area

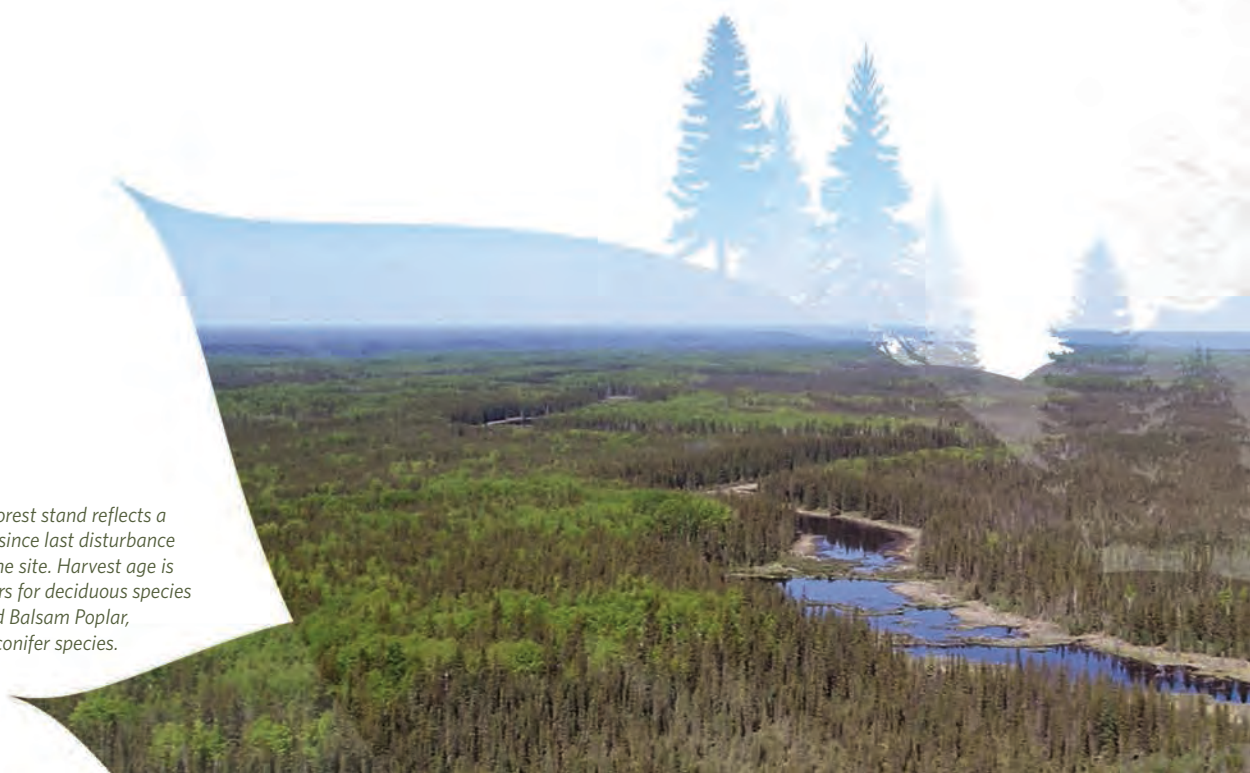
The Al-Pac FMA area (Figure 02) is situated in the Boreal Forest Natural Region of Alberta, which is characterized by a mosaic of upland forests composed mainly of Trembling Aspen, Balsam Poplar, White Spruce, White Birch, and Jack Pine, and lowland forests composed of Black Spruce and Larch. Wildfire is the principal natural disturbance in these forests; more than 500,000 hectares of the FMA area has burned since 2000.[5] The frequency of wildfires, along with other natural disturbances like insect outbreaks and disease, results in a mosaic of stands of different ages from young forests to forests more than 140 years old.

The Al-Pac FMA area boundary has changed since the 2009 ABMI biodiversity report as a result of several land-use processes. Portions of the FMA area were removed as a result of the treaty land entitlement process settled between the governments of Canada, Alberta, and Bigstone Cree Nation. Deletions and additions to the FMA boundary also occurred as a result of the Government of Alberta's Lower Athabasca Regional Plan in 2012.[6] The Al-Pac FMA area currently includes:

- 10% of Alberta, or 63,700 km^2 in northeastern Alberta (Figure 02)
- 2 million hectares of potentially harvestable‡‡ forest, mainly upland Trembling Aspen and White Spruce forest
- Large areas leased for oil and gas development and its associated infrastructures, such as roads and utilities
- Socially and economically valued activities including hunting, fishing, trapping, and other recreational pursuits

Al-Pac primarily harvests deciduous trees, Trembling Aspen and Balsam Poplar, and smaller amounts of White Birch, White Spruce, and other species. Other forest companies that operate in the FMA area harvest conifer species such as White Spruce, Black Spruce, and Jack Pine. From 1993 to 2011, Al-Pac and other forest companies harvested about 250,000 hectares, which represents 2% of the total FMA area and about 6% of the commercially productive forest.[5]

The status of biodiversity, habitat, and human footprint in the Al-Pac FMA area is the focus of this report.



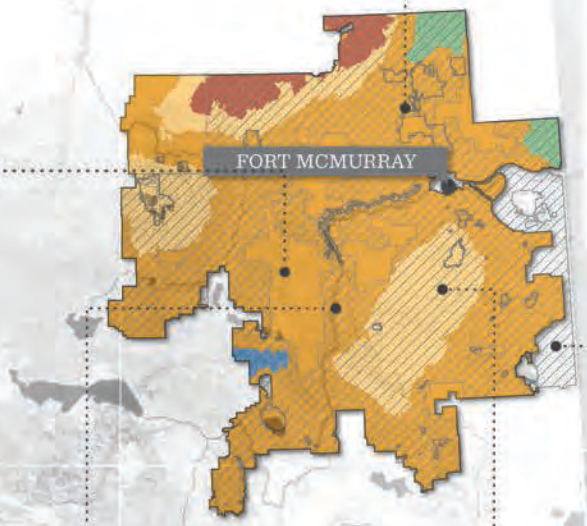
‡‡ *The size of trees in a forest stand reflects a combination of the time since last disturbance and the productivity of the site. Harvest age is reached by 60 to 80 years for deciduous species like Trembling Aspen and Balsam Poplar, and 80 to 100 years for conifer species.*

FIGURE 02

AL-PAC'S FMA AREA, OCCUPYING 63,700 KM^2 OR 10% OF ALBERTA'S LAND AREA, IS THE FOCUS OF THIS REPORT.

ENERGY EXPLORATION ACTIVITIES, SUCH AS THE CREATION OF SEISMIC LINES, ARE COMMON FEATURES ON THE LANDBASE.

WETLANDS, INCLUDING FENS AND BOGS (LOCALLY KNOWN AS MUSKEG), AND NON-COMMERCIAL BLACK SPRUCE FORESTS COVER LARGE AREAS OF THE AL-PAC FMA AREA.



3,486 KM^2 WAS EXCLUDED FROM THE AL-PAC FMA AREA AND ANNOUNCED AS PROTECTED AREAS IN 2012 AS PART OF THE LOWER ATHABASCA REGIONAL PLAN.

LEGEND

- *AL-PAC FMA AREA (2014)*
- *AL-PAC FMA AREA (2009)*
- *CENTRAL MIXEDWOOD*
- *UPPER BOREAL HIGHLANDS*
- *LOWER BOREAL HIGHLANDS*
- *LOWER FOOTHILLS*
- *ATHABASCA PLAIN*

AL-PAC PRIMARILY HARVESTS TREMBLING ASPEN AND BALSAM POPULAR IN THE CENTRAL MIXEDWOOD NATURAL SUB-REGION.

WILDFIRE IS THE DOMINANT NATURAL DISTURBANCE TYPE AFFECTING BOREAL FORESTS.

ABMI Measures Biodiversity

From the boreal forest in the north to the grasslands in the south, the ABMI monitors the state of Alberta's biodiversity. To do this, the ABMI employs a systematic grid of 1,656 site locations, spaced 20 km apart, to collect biodiversity information at terrestrial and wetland sites (Figure 03).

At each location, ABMI technicians record the species that are present, and measure a variety of habitat characteristics. For species that cannot be identified in the field (e.g., mites and lichen), ABMI taxonomists located at the Royal Alberta Museum sort, identify, and archive samples to complete the Institute's species-level dataset. Through our field and laboratory efforts, the ABMI tracks over 2,000 species.

The ABMI monitors the state of Alberta's human footprint using satellite imagery and fine-resolution aerial photography. Human footprint refers to the geographic extent of areas under human use that either have lost their natural cover (e.g., cities, roads, agricultural land, industrial areas) or whose natural cover is periodically or temporarily replaced by resource extraction activities (e.g., forestry, seismic lines, surface mining).

The ABMI's Geospatial Centre monitors the state of Alberta's human footprint at two spatial scales:

1. Using a sampling design that covers approximately 5% of the province, the ABMI monitors human footprint annually in a 3 × 7 km rectangular area centred on each ABMI site location. At each of the 1,656 locations, a 3 × 7 km rectangle is examined at a 1:5,000 scale to delineate all human footprint types present. These detailed annual samples of human footprint are available from 1999 to 2013, except for 2006.

2. At the provincial scale, existing satellite imagery is used to create a wall-to-wall inventory of human footprint of the entire province at a 1:15,000 scale; this product is updated every two years. The wall-to-wall Inventory of Provincial Human Footprint is a compilation of externally sourced information about provincial human footprint, supplemented with ABMI remote sensing data that has undergone quality-control procedures. The Inventory of Provincial Human Footprint is available for 2007, 2010, and 2012.[§§]

These human footprint products are used to track short- and long-term trends and changes in human footprint in Alberta.

FIGURE 03

THE ABMI HAS 157 OF OUR 1,656 SURVEY SITES DIRECTLY IN THE AL-PAC FMA AREA; 120 OF THESE SITES HAVE BEEN SAMPLED AS OF 2013.

[§§] *Due to changes in methodology, the 2007 and 2010 Inventory of Provincial Human Footprint are not comparable with the 2012 inventory.*

Biodiversity Indicators in This Report

Habitat loss and the invasion of non-native species are major drivers of biodiversity decline on the planet.[4] In the Al-Pac FMA area, habitat is being modified by humans primarily as a result of activities associated with the forest industry and energy industry. Responsible development of this region depends on understanding the complex interactions between human footprint, species, and habitat. The ABMI assesses indicators of human footprint, species, and habitat in the following ways.

Species

To assess the status of species, the ABMI collects and analyzes data on breeding birds, winter-active mammals, armoured mites, vascular plants, and mosses. To report on the status of species, the ABMI has developed the Biodiversity Intactness Index (also referred to using the terms "species intactness," "intactness," and "intact"). The index ranges from 0% to 100% and is interpreted as follows (see Figure 04 for a visual guide):

- If a species is 100% intact in a given area, the current abundance of the species is equal to the reference abundance one would expect in an area without any human footprint (although natural disturbances still occur).

- As the intactness index declines, it reflects one of two possible scenarios. In the first, the species abundance is lower relative to an undisturbed area. In other words, the species has become more rare. In the second scenario, the species is more abundant than expected. In both instances, the abundance of the species or element has deviated from an "intact reference condition."

There are three steps in calculating biodiversity intactness. The first is fitting the data to statistical models that describe the relationship between each species and human footprint at the site scale. This step uses the field data from ABMI sites across broad regions (e.g., the Boreal and Foothills Natural Regions). The next step is to use these models to predict the current and reference abundance of each species at every quarter section in the reporting region. These predictions are based on GIS summaries of human footprint and other variables in each quarter section in the reporting region. The third step is summing the predicted current abundances and reference abundances of each species across the region and using these to calculate intactness of each species, broader groups (e.g., birds associated with old deciduous and mixedwood forests), and overall biodiversity.

While the ABMI collects data on over 2,000 species throughout the province, intactness can only be calculated for species with at least 20 records in our dataset. In this report we are able to report on intactness for 477 species. This number will increase as the ABMI surveys more sites.

We followed a similar procedure to estimate how intactness has changed in the Al-Pac FMA area from 1999 to 2012. Instead of applying the species models to each quarter section, we applied them to the vegetation and human footprint from the 3 × 7 km areas that subsample the FMA area. We used the years 1999, 2005, 2009, and 2012 to cover the time span, including the year of the previous report, 2009. These results show how changes in the landbase over that time are predicted to have affected species' abundances. They do not show the actual trend in the abundance of any species, which can differ from the predictions based on landbase changes. Many factors besides changes in habitat quality affect species, and the ABMI cannot yet assess those changes.

To estimate the individual effects of forestry footprint, we applied the species' models to a landbase with all non-forestry footprint removed ("back-filled" to the vegetation type that was there prior to the non-forestry footprint). We report the difference in predicted abundance of each species in this landbase with forestry as the only footprint compared to the reference condition with no footprint. Similarly, we used the models on a landbase with forestry footprint removed to estimate the effects of non-forestry footprint on each species.

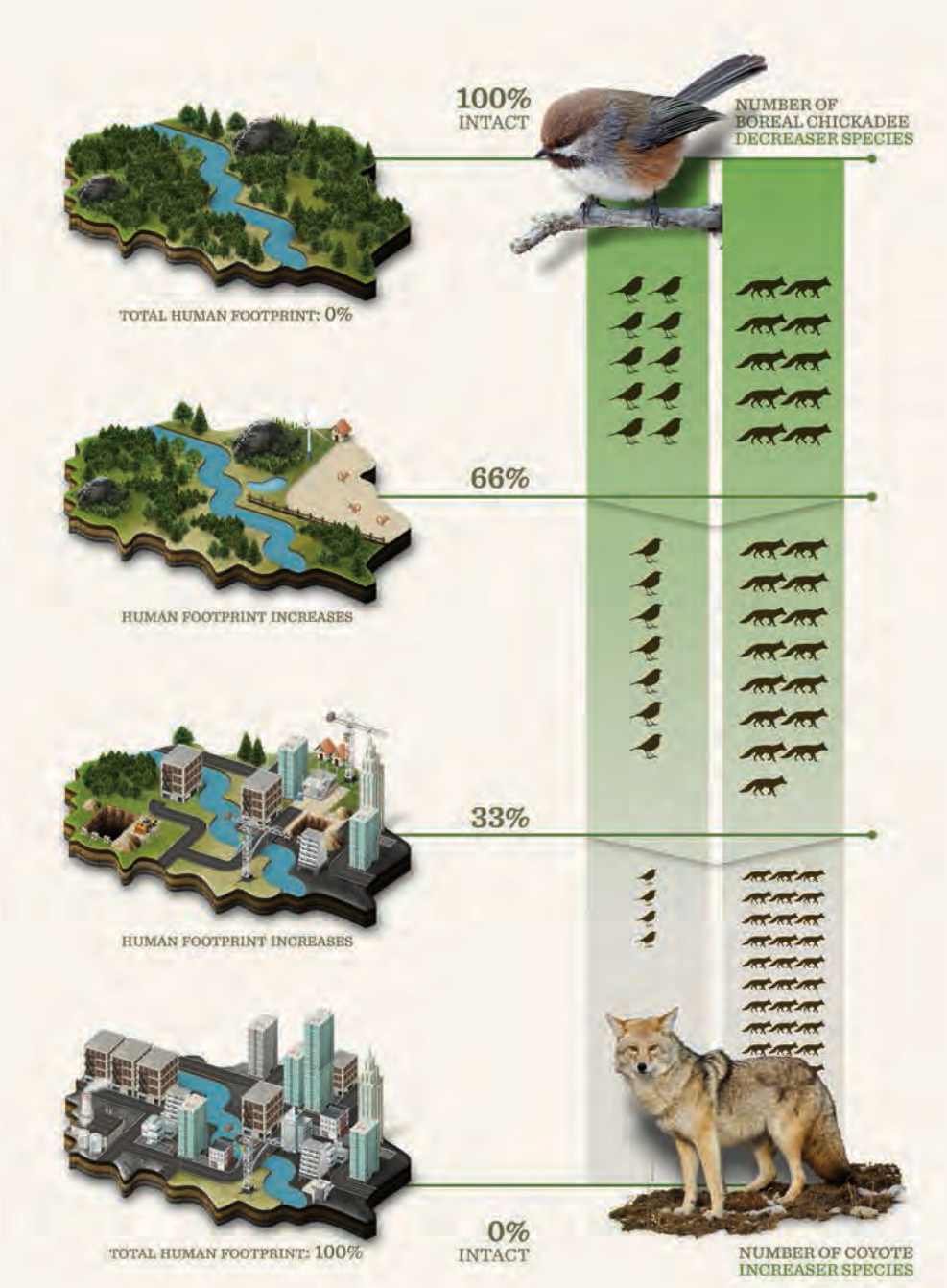
FIGURE 04 THE ABMI BIODIVERSITY INTACTNESS INDEX

The ABMI uses a metric called the Biodiversity Intactness Index to report on the health of a species in a region. In this figure, we illustrate how the index changes for:

- A “decreaser” species, the Boreal Chickadee
- An “increaser” species, the Coyote.

The intactness index ranges from 0% to 100%. At 100% intact, the current abundance of both species is equal to the reference abundance expected in an undisturbed area—one with 0% human footprint. As the intactness index declines toward 0%, it reflects a change in the current abundance of a species in response to human footprint:

- For the Chickadee, a decrease in number is observed
- For the Coyote, an increase in number is observed.



Natural Habitat

To assess the status of natural habitat, the ABMI uses the GIS Inventory of Provincial Human Footprint circa 2012. To report on the status of natural habitat, we present the per cent area of land cover that has no human footprint, and the area of natural habitat at three different buffer distances away from human footprint—greater than 50 m, greater than 500 m, and greater than 2 km. In addition, the ABMI also presents the per cent area that is designated as legislatively protected in the region surrounding the Al-Pac FMA area.

Human Footprint

To assess the status of human footprint, the ABMI uses GIS to calculate the percentage of land directly altered by human activities, which is interpreted as follows:

- 0% means there is no visible human footprint.
- 100% means the landscape has been completely modified by human footprint.[***]

In general, cities and cultivated fields have high human footprint, while protected and undeveloped areas have low human footprint. Information related to the entire Al-Pac FMA area is based on the 2012 Provincial Inventory of Human Footprint. Trend information is based on the detailed 3 × 7 km human footprint data. Human footprint in Woodland Caribou ranges that overlap the Al-Pac FMA area are based on the Inventory of Provincial Human Footprint circa 2012. Trend in human footprint is estimated using 3 × 7 km human footprint data for the three largest caribou ranges: East Side Athabasca River, West Side Athabasca River, and Red Earth.

See the Al-Pac FMA Area Data Supplement (available at www.abmi.ca) for further details.

[***] *At present, the measure of human footprint does not account for the recovery of forests that are regenerating following temporary disturbances such as logging or energy exploration (i.e., seismic lines), and includes both recent and older logging activity. The ABMI is currently conducting research to determine how to account for the recovery of biodiversity in forests that are regenerating following logging.*

Human Footprint

HUMAN FOOTPRINT DATA, INCLUDING FOOTPRINT TYPE, AMOUNT, AND TREND, PROVIDE THE CONTEXT FOR INTERPRETING THE CHANGE IN BIODIVERSITY OVER TIME.

The ABMI defines "human footprint" as the visible alteration or conversion of native ecosystems to temporary or permanent residential, recreational, agricultural, or industrial landscapes. This includes activities that support the energy, forest, and agriculture industries, residential settlement, and transportation infrastructure. At present, however, the measure of human footprint does not account for the recovery of biodiversity in forests that are regenerating following temporary disturbances such as logging or energy exploration (e.g., seismic lines). In other words, an older regenerated timber harvest area or seismic line is treated the same as a more recent disturbance of the same type. The ABMI is currently advancing the science necessary to account for this regeneration so that recovering areas can make a reduced contribution to the estimate of total human footprint.

AS OF 2013, THE TOTAL HUMAN FOOTPRINT ACROSS THE AL-PAC FMA AREA WAS 7.5% (FIGURE 05, 06A).

Covering 4.8% of the Al-Pac FMA area, forestry footprint (Figure 06B) was the largest human footprint, more than double that of energy footprint (Figure 06C), which covered 2.1% of the Al-Pac FMA area. The remaining categories of human footprint (e.g., transportation footprint) covered 0.5% of the FMA area.

The total amount of human footprint in the Al-Pac FMA area increased by 3.4% between 1999 and 2013, from 4.1% to 7.5% (Figure 05). This increase was largely driven by forestry footprint, which grew by 2.3%, increasing from 2.5% to 4.8%. Energy footprint increased by almost 1% during this period, from 1.3% to 2.1%.

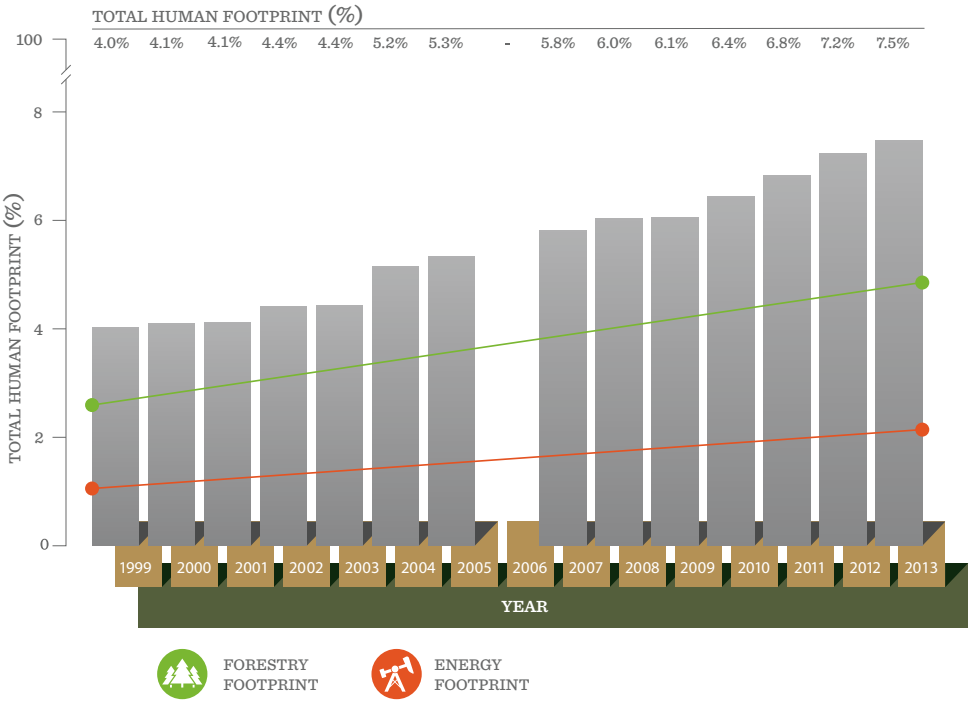
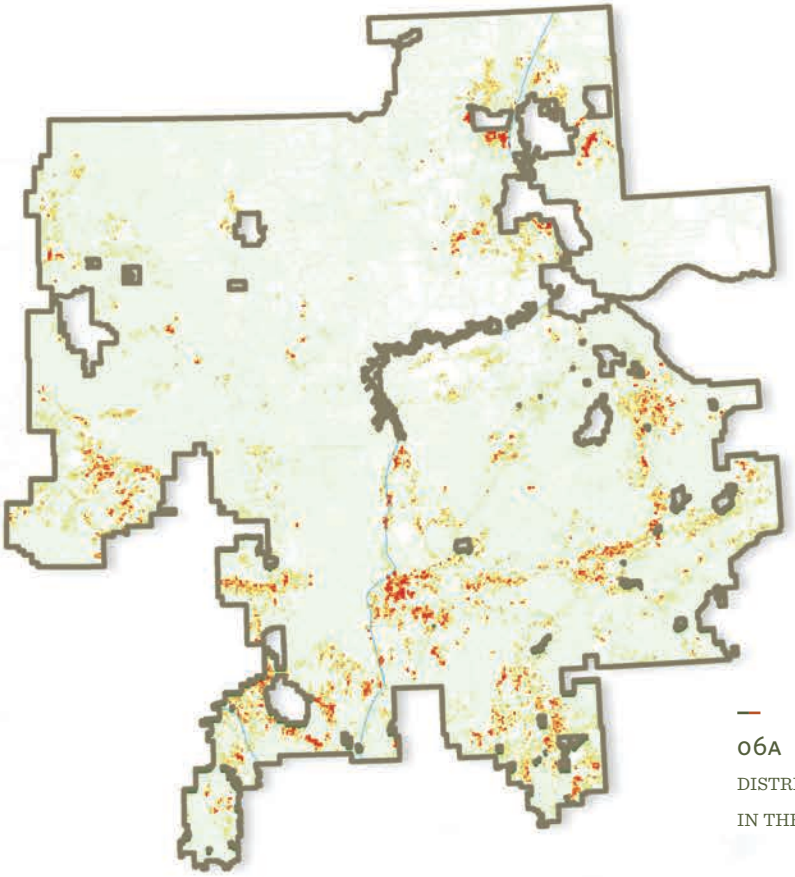


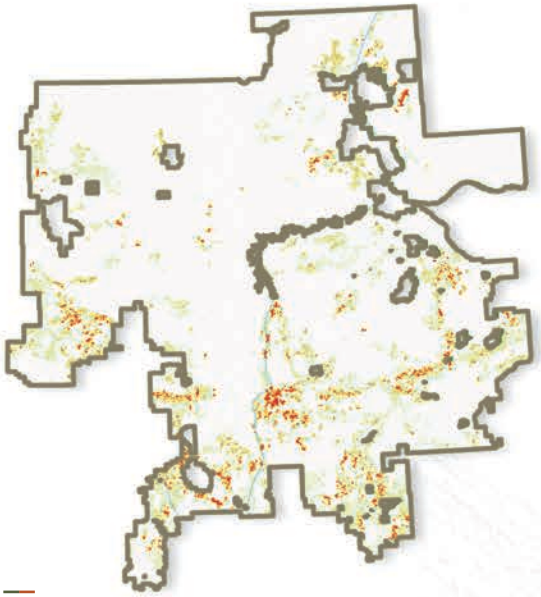
FIGURE 05

TREND IN THE PERCENTAGE OF TOTAL HUMAN FOOTPRINT AND ITS PRIMARY COMPONENTS—FORESTRY FOOTPRINT AND ENERGY FOOTPRINT—IN THE AL-PAC FMA AREA.



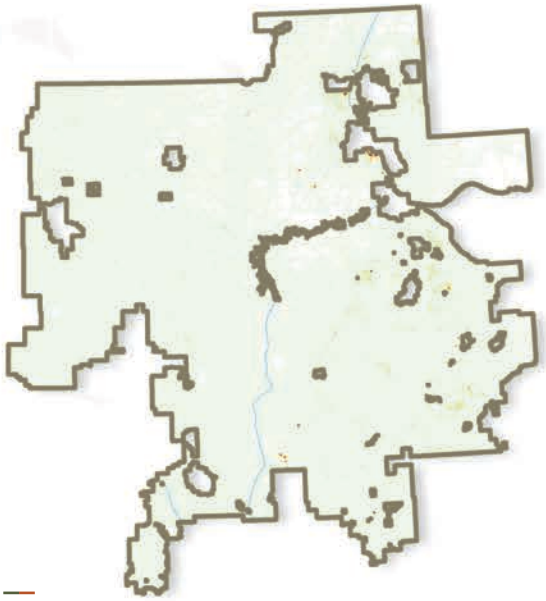
06A

DISTRIBUTION OF TOTAL HUMAN FOOTPRINT IN THE AL-PAC FMA AREA CIRCA 2012.



06B

DISTRIBUTION OF FORESTRY FOOTPRINT IN THE AL-PAC FMA AREA CIRCA 2012. NOTE: 0% HUMAN FOOTPRINT AS INDICATED IN WHITE ARE AREAS WITH NO FORESTRY FOOTPRINT BUT OTHER FOOTPRINT TYPES MAY STILL BE PRESENT.



06C

DISTRIBUTION OF ENERGY FOOTPRINT IN THE AL-PAC FMA AREA CIRCA 2012. NOTE: 0% HUMAN FOOTPRINT AS INDICATED IN WHITE ARE AREAS WITH NO ENERGY FOOTPRINT BUT OTHER FOOTPRINT TYPES MAY STILL BE PRESENT.

FIGURE 06

DISTRIBUTION OF HUMAN FOOTPRINT IN THE AL-PAC FMA AREA FOR A. TOTAL HUMAN FOOTPRINT, B. FORESTRY FOOTPRINT, AND C. ENERGY FOOTPRINT. MAPS SHOW THE PERCENTAGE AREA OF HUMAN FOOTPRINT IN EACH QUARTER SECTION IN THE AL-PAC FMA AREA. LIGHT GREEN INDICATES QUARTER SECTIONS WITH < 10% HUMAN FOOTPRINT WHILE DARK RED INDICATES QUARTER SECTIONS WITH > 90% HUMAN FOOTPRINT.

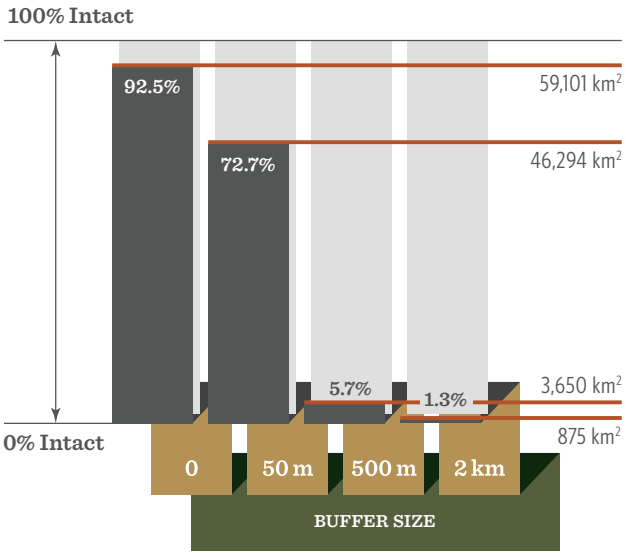
Natural Habitat and Protected Areas

Natural Habitat

The ABMI uses the phrase and concept of "natural habitat" to identify areas in Alberta, including in the Al-Pac FMA area, that have not been visibly disturbed by humans, although natural disturbances such as wildfire and insect outbreaks and indirect effects of humans, like pollution, still occur. While natural habitat can be defined in different ways, the ABMI defines it as "undeveloped habitat that is distant enough from human footprint that it meets a particular management objective."

Natural habitat can be affected by nearby human footprint. For example, some species can effectively use habitat that is adjacent to human footprint while others require habitat that is more distant. Therefore, we measure natural habitat using four different buffer distances: 0 m, > 50 m, > 500 m, and > 2 km away from footprint. These distances delimit the amount of natural habitat available with a given "buffer" from human footprint. For example, at 0 m from human footprint, all natural habitat in the region is included. However, at > 50 m, only natural habitat that is at least 50 m away from human footprint is included. These numbers are valuable because species respond differently to human activity, with some requiring more distance from footprint.

Overall, in 2012, 92.5% of the Al-Pac FMA area is composed of natural habitat with a 0 m buffer from human footprint while 5.7% of natural habitat is at least 500 m away from development, and only 1.3% is at least 2 km away from development (Figure 07). As a note of caution, our summary of natural habitat does not yet account for some forms of human activity (e.g., livestock grazing or hunting). Successional recovery following human disturbance (e.g., timber harvest, well sites, or seismic lines) is also not yet accounted for in these summaries.



Protected Areas

Protected areas are an important landscape-level management tool to conserve biodiversity. Resource managers and conservationists are often interested in protecting native ecosystems with little or no human footprint to maintain the biodiversity within these naturally functioning systems.[7]

As an approach to ecosystem-based management, the Conservation Matrix Model espouses a landscape-level zonation approach to conservation that includes a suite of zones that vary from legislatively protected areas to areas managed for varying types and intensities of human land use. The Al-Pac FMA area is managed for natural resources like forestry and energy. Other land-use zones within or adjacent to the Al-Pac FMA area

FIGURE 07

TOTAL AREA AND PERCENTAGE OF NATURAL HABITAT IN THE AL-PAC FMA AREA EXPRESSED USING FOUR BUFFERS. NOTE THAT THE PERCENTAGE AREA OF NATURAL HABITAT THAT IS AT LEAST 500 M AWAY FROM HUMAN FOOTPRINT AS CALCULATED BY ABMI IS LOWER THAN THE PERCENTAGE AREA CALCULATED BY ENVIRONMENT CANADA (2011) PRESENTED IN TABLE 08 ON PAGE 40 OF THIS REPORT. THESE VALUES ARE LIKELY DIFFERENT BECAUSE THE VALUES ARE FOR TWO DIFFERENT STUDY AREAS (FMA AREA VS. CARIBOU RANGE), AND BECAUSE METHODS TO DELINEATE HUMAN FOOTPRINT ARE DIFFERENT.

include urban development zones (e.g., city of Fort McMurray), First Nations reserves and treaty land entitlement areas, oil sands surface mineable areas, and legislatively protected areas.

In 2011–12, areas were removed from Al-Pac's former FMA area boundary to create new protected areas, such as the Gipsy-Gordon and Dillon River Wildland Parks, as part of the Lower Athabasca Regional Plan 2012–22.[6] While no protected areas overlap the Al-Pac FMA area, protected areas††† in the surrounding landscape serve an important role supporting conservation and land-use planning decisions in the FMA and adjacent area.

Of the natural subregions that overlap the Al-Pac FMA area, 12% (or 34,176 km^2) of their total area is managed as protected areas (Table 01; Figure 08). This percentage is not evenly distributed across natural subregions. Approximately one-quarter is located in the Athabasca Plain Subregion, 18% in the Upper Boreal Highlands, and 14% in the Central Mixedwood.

The Al-Pac FMA, while occupying 10% of Alberta's land area, contains disproportionately higher areas of Central Mixedwood (28% of its provincial area), Lower Boreal Highlands (22%), and Upper Boreal Highlands (22%), and therefore Al-Pac has higher proportional responsibility for these natural subregions (Table 01). Conversely, Al-Pac has lower proportional responsibility for the Athabasca Plain and Lower Foothills Subregions.

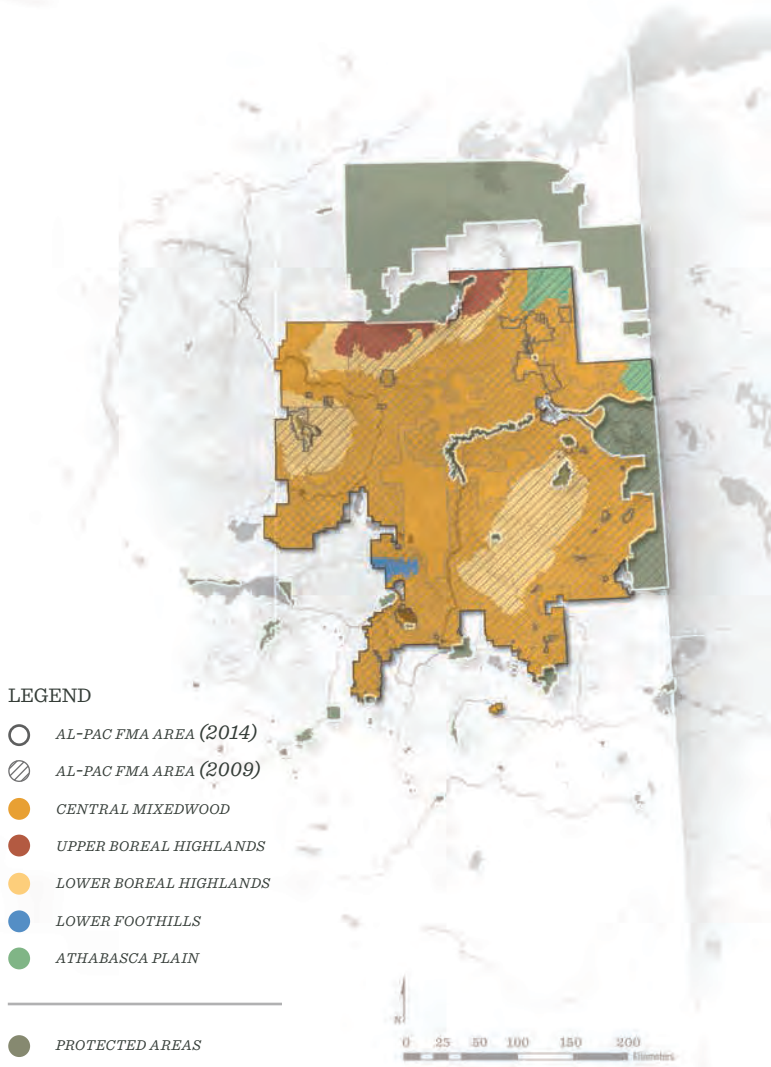


FIGURE 08

DISTRIBUTION OF PROTECTED AREAS SURROUNDING THE AL-PAC FMA AREA. NOTE: NOT ALL PROTECTED AREAS FOR NATURAL SUBREGIONS THAT OVERLAP THE AL-PAC FMA AREA ARE SHOWN.

Natural Subregion	Total Area of Natural Subregion in Alberta (km^2)	% Managed as a Protected Area	% of Subregion Located in Al-Pac's FMA Area
Athabasca Plain	13,525	28	12
Central Mixedwood	167,856	14	28
Lower Boreal Highlands	55,615	8	22
Lower Foothills	44,899	1	1
Upper Boreal Highlands	11,858	18	22
Total	293,754	12	-

TABLE 01

AMOUNT AND DISTRIBUTION OF PROTECTED AREAS FOR NATURAL SUBREGIONS THAT OVERLAP AL-PAC'S FMA AREA.

††† *The ABMI's definition of protected areas near the Al-Pac FMA area includes Alberta's parks and protected areas network, national parks, and National Wildlife Areas. This analysis also includes the Birch River Conservation Area (a quarter of the protected area total) located north of the Al-Pac FMA area, which is classified as a Public Land-use Conservation Area within the Lower Athabasca Regional Plan 2012–22. Unlike other protected areas, resource management plans for the Birch River Conservation Area may allow for forest harvesting (but timber in this area is not part of Al-Pac's wood supply).*

Estimated Biodiversity Intactness by Quarter Section in the Al-Pac FMA Area

Based on data collected throughout the boreal forest, the ABMI has developed statistical models that describe the relationship between the relative abundance of individual species, habitat, and human footprint. These statistical models are used to calculate the Biodiversity Intactness Index for each species in the Al-Pac FMA area that has sufficient data. The models can also be used to estimate the Biodiversity Intactness Index for each species for every quarter section of land (approximately 65 hectares) in the Al-Pac FMA area—in other words, for locations where the ABMI is not directly monitoring. Using the ABMI's Inventory of Provincial Human Footprint (circa 2012) and vegetation types, the average intactness of over 450 species in the Al-Pac FMA area has been estimated and mapped to generate an overall picture of biodiversity in the region (Figure 09).

Since the estimated intactness map provides a visual representation of biodiversity intactness across the region, it illustrates how the average biodiversity intactness value for the entire Al-Pac FMA area is calculated at 94%. Much of the Al-Pac FMA area has little to no human footprint, and correspondingly higher biodiversity intactness (shown as dark green in Figure 09). However, other areas have lower biodiversity intactness (shown as lighter green and yellow in Figure 09). There are a few localized areas where biodiversity intactness is very low (i.e., <30%, shown as orange and red in Figure 09). Overall, regional biodiversity intactness is high because large areas in the Al-Pac FMA area have little to no human footprint.

Any interpretations of estimated biodiversity intactness maps must take the following into account:

- The information in the estimated intactness map is preliminary and will change as analyses are refined and as more data are gathered.
- There may be considerable uncertainty in the intactness value for any particular quarter section. (i.e., variance in the quarter section predictions is not yet reported by the ABMI).
- ABMI estimated biodiversity intactness maps are intended to show broad patterns of intactness, not exact values for each quarter section.

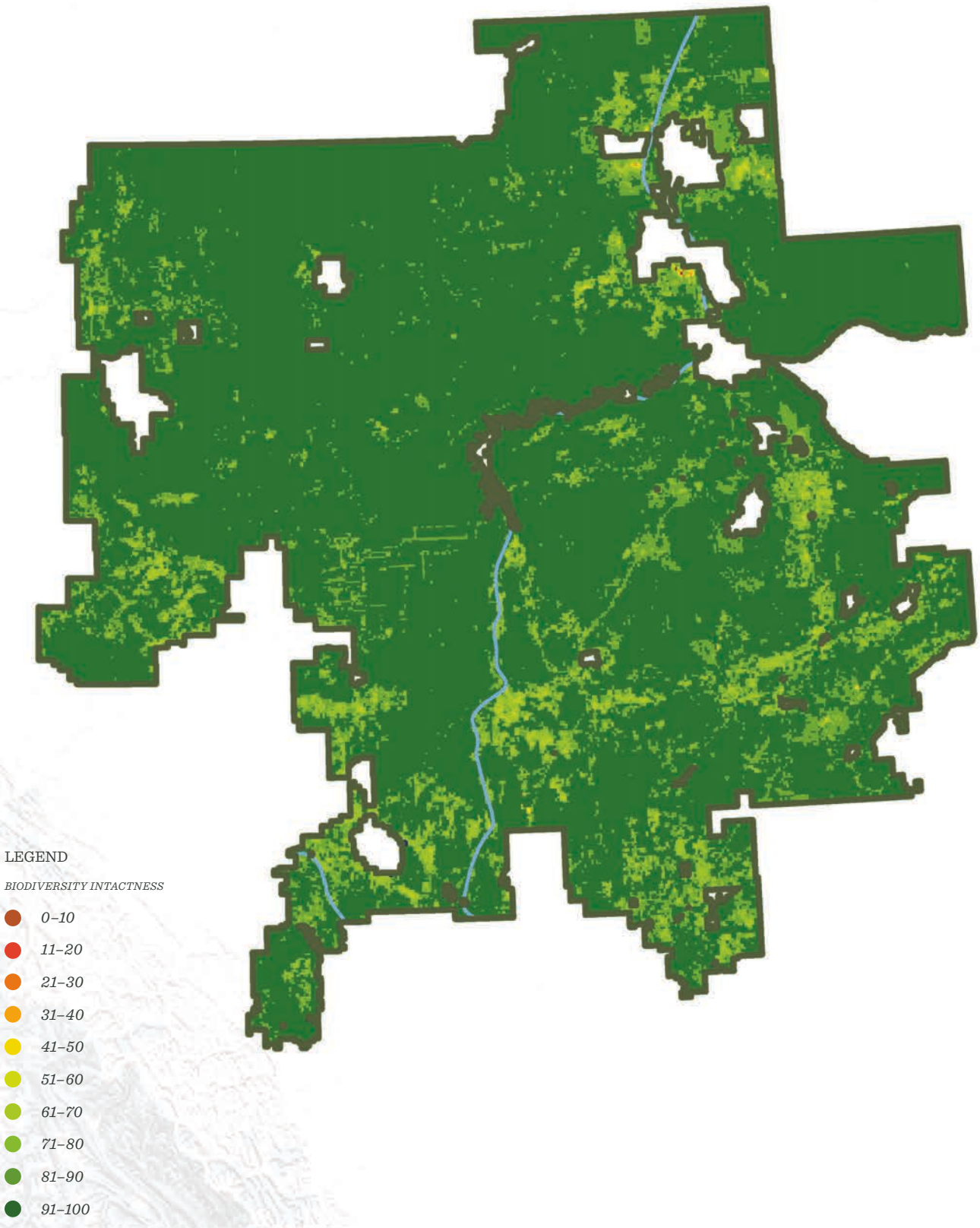


FIGURE 09

THE AVERAGE ESTIMATED INTACTNESS FOR 477 SPECIES (FROM 5 TAXA) IN THE AL-PAC FMA AREA IS 94%. DARK RED IDENTIFIES THOSE QUARTER SECTIONS THAT ARE PREDICTED TO HAVE THE LOWEST AVERAGE BIODIVERSITY INTACTNESS, AND DARK GREEN IDENTIFIES QUARTER SECTIONS WITH THE HIGHEST INTACTNESS.

Biodiversity Intactness

Thousands of animal and plant species live in the Al-Pac FMA area. Native birds, mammals, armoured mites, vascular plants, and mosses ‡‡‡ represent a diverse subset of all species in the region.

THE ABMI ASSESSED THE STATUS OF 477 COMMON NATIVE SPECIES IN THE AL-PAC FMA AREA USING THE BIODIVERSITY INTACTNESS INDEX AND FOUND THEM TO BE 94% INTACT IN 2012 (TABLE 02).

At 91% intact, native vascular plants showed the greatest deviation from reference conditions while mammals, at 97% intact, showed the least.

It is important to note that the intactness results in this report are averages for the entire Al-Pac FMA area. As with most landscapes in Alberta, specific locations within this region are nearly 0% intact (e.g., active industrial sites), and other sites are 100% intact (e.g., undeveloped forest and wetland habitat). See Figure 10 for an explanation of how the Biodiversity Intactness Index changes depending on the area of focus.

Of the full suite of species assessed by the ABMI in the Al-Pac FMA area, we profile species of birds, armoured mites, vascular plants, and mosses associated with old (> 80 years) deciduous and mixedwood forests. Because the habitat associations of many species are poorly known, the association with old deciduous and mixedwood forests is based on our monitoring results—these are species that we found to be more abundant in those forest types than in other habitat types. Those associations may change for some species as more data are collected. We also profile several habitat elements, such as large trees and snags, non-native plants, and species at risk, within the Al-Pac FMA area. Because Woodland Caribou have a high public profile in the Al-Pac FMA area, we provide a spotlight on the status of this species. Comprehensive detail on all species is available in supplemental material associated with this report (available at www.abmi.ca).

TABLE 02

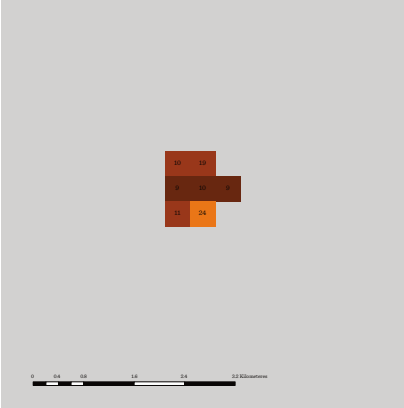
INTACTNESS* FOR DIFFERENT COMPONENTS OF BIODIVERSITY IN THE AL-PAC FMA AREA IN ALBERTA.

Biodiversity Component	Number of Species	Intactness
Native birds	77	92 %
Winter-active mammals	10	97 %
Armoured mites	74	96 %
Native plants	218	91 %
Mosses	98	95 %
Overall intactness	477	94 %

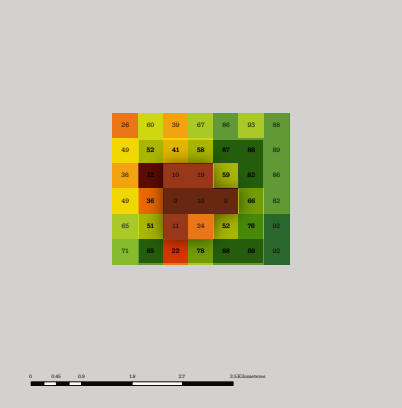
Overall intactness is calculated as the average of the five biodiversity components as opposed to the average of individual species intactness values.

‡‡‡ *We use the noun "moss" to collectively refer to mosses, hornworts, and liverworts, which are non-vascular plants known more technically as bryophytes.*

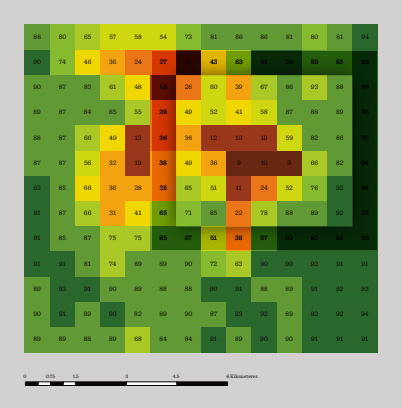
For Biodiversity Intactness, Context Matters



10A. 7 QUARTER SECTIONS WITH INTENSE HUMAN DEVELOPMENT
AVERAGE INTACTNESS: 13%



10B. 42 QUARTER SECTIONS WITH LOW TO INTENSE HUMAN DEVELOPMENT
AVERAGE INTACTNESS: 56%



10C. 182 QUARTER SECTIONS WITH LOW TO INTENSE HUMAN DEVELOPMENT
AVERAGE INTACTNESS: 72%

FIGURE 10

ESTIMATED BIODIVERSITY INTACTNESS MAPS[§§§] WITH BIODIVERSITY INTACTNESS INDEX VALUES FOR EACH QUARTER SECTION OF LAND WITHIN A GIVEN AREA. SHADING REPRESENTS BIODIVERSITY INTACTNESS FROM LOW (RED SQUARE: 0%–10%) TO HIGH (DARK GREEN SQUARE: 91%–100%). 10A. INTACTNESS VALUES (9%–24%) FOR 7 QUARTER SECTIONS. 10B. INTACTNESS VALUES (9%–93%) FOR 42 QUARTER SECTIONS, INCLUDING THE 7 QUARTER SECTIONS PRESENTED IN 10A. 10C. INTACTNESS VALUES (9%–99%) FOR 182 QUARTER SECTIONS, INCLUDING THE 42 QUARTER SECTIONS PRESENTED IN 10B.

Using statistical models, the ABMI estimates Biodiversity Intactness Index values for each quarter section in Alberta. Based on these, the average intactness for a given area can be calculated.

The example above, however, illustrates that average intactness depends on the area of focus. If we focus exclusively on an area of intense human development, such as the area in Figure 10A, average intactness will be very low. By contrast, if we consider areas with a range of human development from minimal to intense, such as those shown in Figures 10B and 10C, average intactness will increase accordingly.

The context dependence of the Biodiversity Intactness Index must be considered when interpreting data contained in this report.

[§§§] Please refer to page 20 of the report for an explanation of how estimated biodiversity intactness maps are interpreted.

Birds Associated with Old Deciduous and Mixedwood Forests

Old deciduous and mixedwood forests provide important habitat to a range of bird species.[8,9] These forests supply an abundance of nesting sites for cavity-nesting birds like the Pileated Woodpecker and Red-breasted Nuthatch. The leaves of deciduous trees host numerous herbivorous insect species gleaned by canopy-foraging birds like the Blue-headed Vireo. In addition, the complexity in the habitat structure of deciduous and mixedwood forests, including an abundance o f shrubs, and a mixture of deciduous trees of various sizes and states of decay, allows more species to coexist. Finally, old mixedwood stands with even a few conifer trees support species that are often found in coniferous forests, such as the Red-breasted Nuthatch. Overall, deciduous and mixedwood forests support a greater diversity of birds than younger stands or coniferous forests in the boreal.[8]

THE ABMI ASSESSED THE STATUS OF 14 BIRD SPECIES ASSOCIATED WITH OLD DECIDUOUS AND MIXEDWOOD FORESTS IN THE AL-PAC FMA AREA, AND ESTIMATED THEM TO BE, ON AVERAGE, 94% INTACT IN 2012 (FIGURE 11).

Overall, the abundance of more than half of the deciduous and mixedwood-associated birds assessed by the ABMI was within 5% of intact reference conditions in the Al-Pac FMA area (Figure 11). However, the habitat suitability for many of these species was predicted to have declined between 1999 and 2012 as indicated by the decrease in predicted intactness over this time frame.

Two species were at least 5% less abundant than expected in all assessed years: Golden-crowned Kinglet and Brown Creeper. These species are disproportionately affected by forestry footprint compared to other non-forestry footprint types (Table 03). For example, of all the old-forest birds assessed, habitat suitability for the Brown Creeper declined the most as indicated by a decrease in predicted species intactness; intactness dropped from 92% in 1999 to 85% in 2012. The predicted change in relative abundance based on changes in habitat suitability due to forestry footprint alone for the Brown Creeper is estimated to be -12.9% compared to -1.8% for non-forestry footprint (Table 03).

TABLE 03

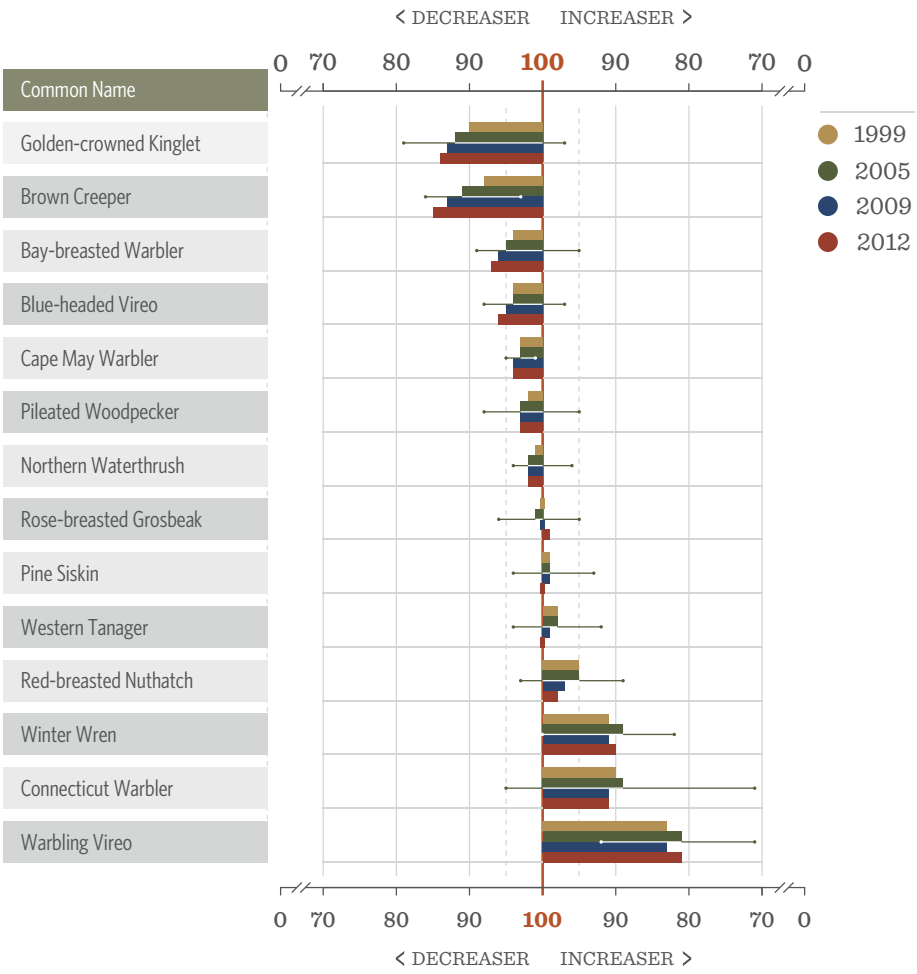
THE PREDICTED CHANGE IN BIRD RELATIVE ABUNDANCE ESTIMATED FOR THE YEAR 2012 BASED ON CHANGES TO HABITAT AS A RESULT OF FORESTRY FOOTPRINT AND NON-FORESTRY FOOTPRINT FOR FOUR DECREASER SPECIES AND THREE INCREASER SPECIES.

	Species	Forestry Footprint Effects (%)	Non-forestry Footprint Effects (%)
Decreaser	Golden-crowned Kinglet	-16.9	-1.6
	Brown Creeper	-12.9	-1.8
	Bay-breasted Warbler	-7.6	-1.5
	Blue-headed Vireo	-5.5	-2.3
Increaser	Winter Wren	0.7	5.4
	Connecticut Warbler	-4.8	3.8
	Warbling Vireo	-4.6	25

Three species were consistently at least 5% more abundant than expected in all assessed years: Winter Wren, Connecticut Warbler, and Warbling Vireo. Two of these species, Warbling Vireo and Winter Wren, were more strongly affected by non-forestry-related-footprint than forestry footprint (Table 03). For the Warbling Vireo, for example, the predicted change in relative abundance based on changes in habitat suitability as result of non-forestry footprint alone was +25.0% compared to -4.6% for forestry footprint.

FIGURE 11

PER CENT INTACTNESS FOR BIRD SPECIES ASSOCIATED WITH OLD DECIDUOUS AND MIXEDWOOD FORESTS IN THE AL-PAC FMA AREA ESTIMATED FOR 1999, 2005, 2009, AND 2012; 90% CONFIDENCE INTERVALS ARE SHOWN FOR 2005 RESULTS BUT ARE SIMILAR FOR ALL FOUR YEARS THAT WERE ESTIMATED. CHANGE IN INTACTNESS OVER TIME FOR EACH SPECIES INDICATES PREDICTED CHANGE IN HABITAT SUITABILITY AS A RESULT OF HUMAN FOOTPRINT RATHER THAN ACTUAL MEASURED CHANGE IN SPECIES ABUNDANCE.



WARBLING VIREO NESTS AND FORAGES FOR CATERPILLARS IN THE TREETOPS OF DECIDUOUS FORESTS. AT 81% INTACT, WARBLING VIREO WAS MORE ABUNDANT THAN EXPECTED IN THE AL-PAC FMA AREA.

Winter-Active Mammals

The Al-Pac FMA area is home to nearly 50 mammal species. Some of these mammals play an important role in northern Alberta ecosystems by filling the role as top predators (e.g., Gray Wolf), while others are socially and economically important, providing hunting and trapping opportunities for Aboriginal and local people.

Mammal populations in the Al-Pac FMA area have long been affected by hunting and trapping pressure. More recent human activities, like forestry and energy development, are also having an impact on their populations. Some species, like the Coyote and White-tailed Deer, benefit from many forms of human development, while other species become less common as human land use intensifies. Human activities that divide contiguous tracts of boreal forest into smaller patches impact species that require large undisturbed areas, such as Woodland Caribou.

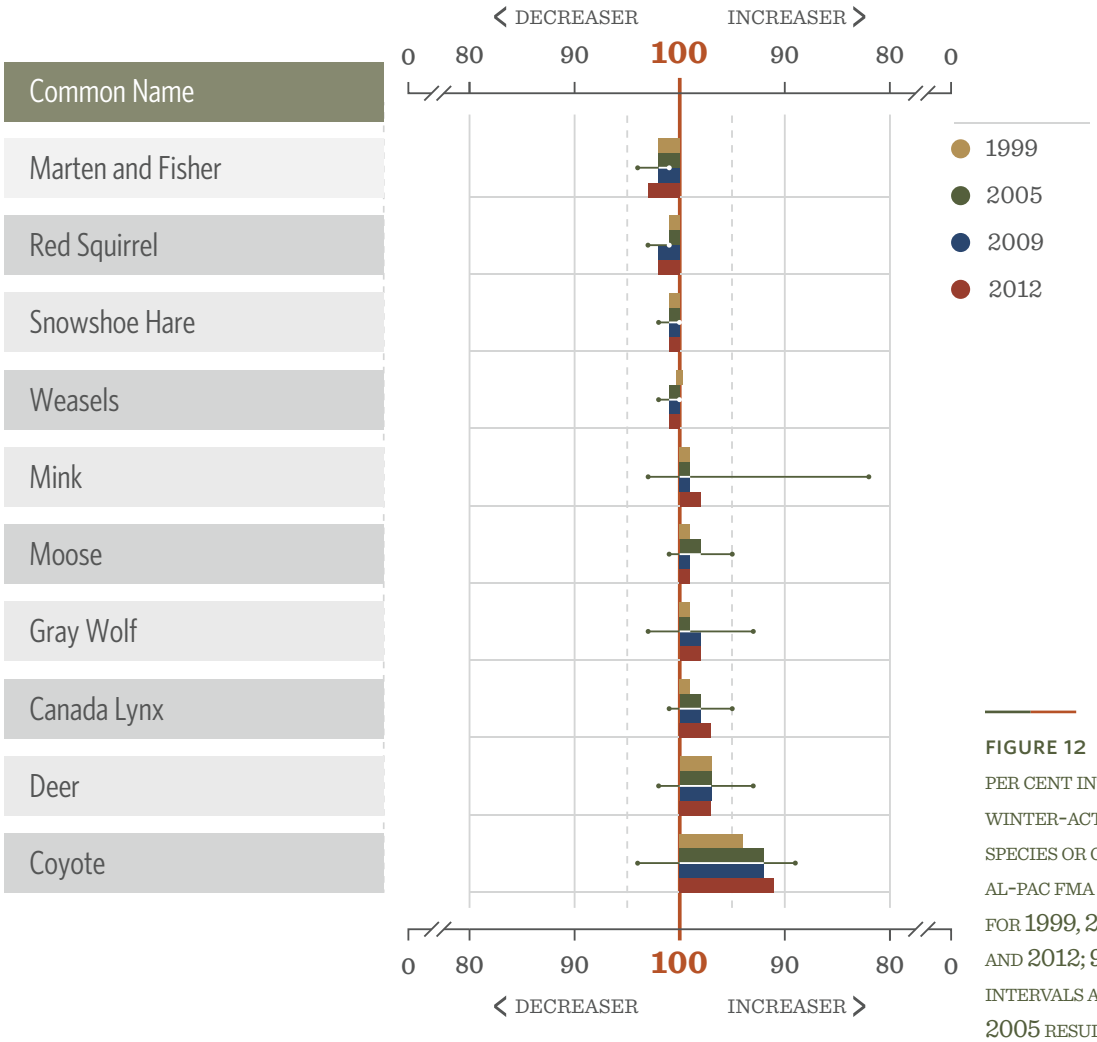
THE ABMI ASSESSED THE STATUS OF 10 WINTER-ACTIVE MAMMAL SPECIES OR GROUPS OF SPECIES IN THE AL-PAC FMA AREA AND FOUND THEM TO BE, ON AVERAGE, 97% INTACT IN 2012 (FIGURE 12).

Overall, the abundance of all but one of the mammal species assessed by the ABMI was within 3% of expected compared to intact reference conditions in the Al-Pac FMA area. Predicted intactness for these species was also virtually unchanged from 1999 to 2012, indicating little change in habitat suitability for mammals over this time frame.

The Coyote differed the most from what we expected under intact reference conditions; at 91% intact, it was more abundant than expected in the Al-Pac FMA area. Coyotes are habitat generalists and readily adapt to human-dominated landscapes.

The ABMI does not yet have enough data to determine intactness for uncommon species such as Wolverine.

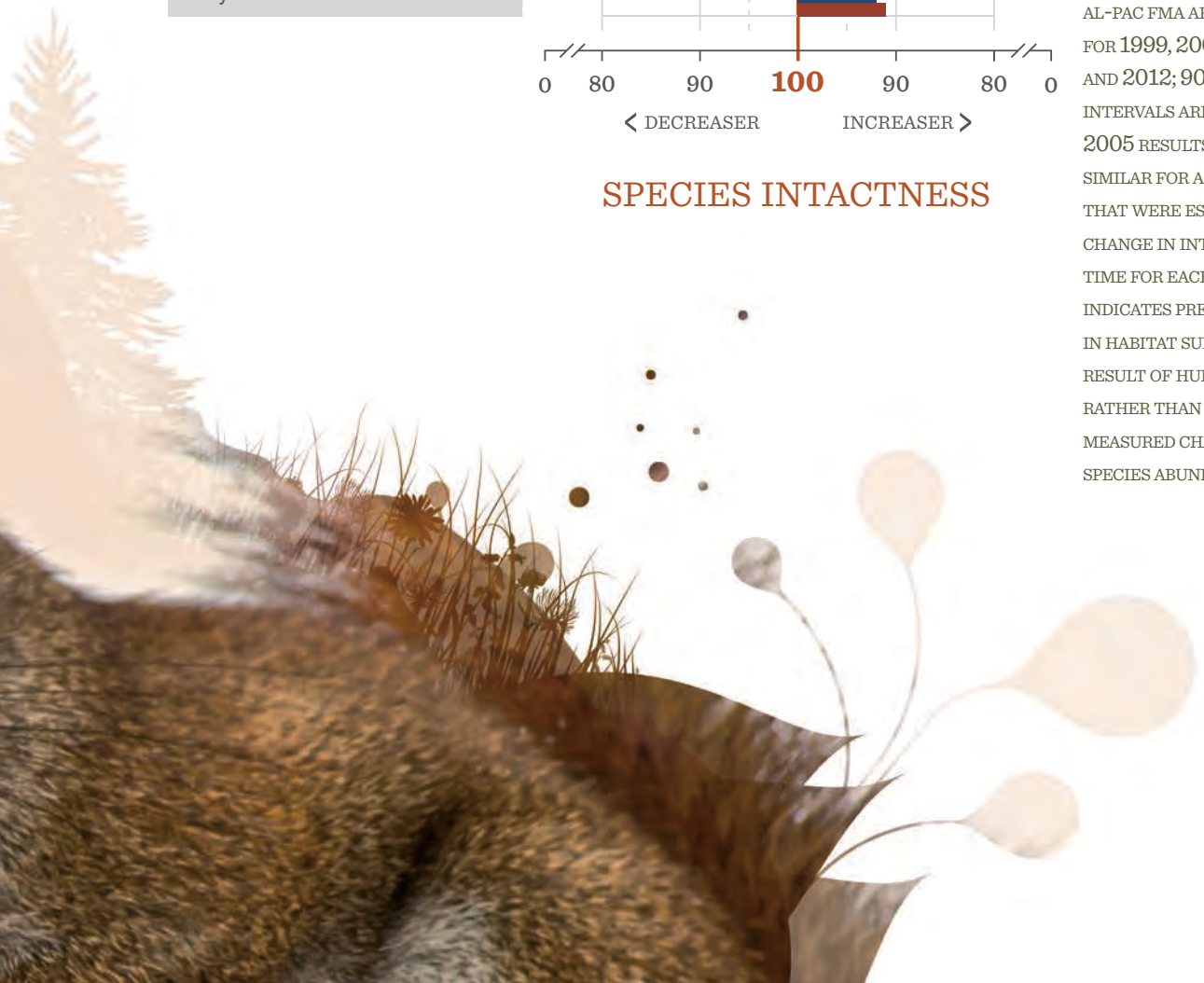
Red Squirrel



SPECIES INTACTNESS

FIGURE 12

PER CENT INTACTNESS FOR WINTER-ACTIVE MAMMAL SPECIES OR GROUPS IN THE AL-PAC FMA AREA ESTIMATED FOR 1999, 2005, 2009, AND 2012; 90% CONFIDENCE INTERVALS ARE SHOWN FOR 2005 RESULTS BUT ARE SIMILAR FOR ALL FOUR YEARS THAT WERE ESTIMATED. CHANGE IN INTACTNESS OVER TIME FOR EACH SPECIES INDICATES PREDICTED CHANGE IN HABITAT SUITABILITY AS A RESULT OF HUMAN FOOTPRINT RATHER THAN ACTUAL MEASURED CHANGE IN SPECIES ABUNDANCE.

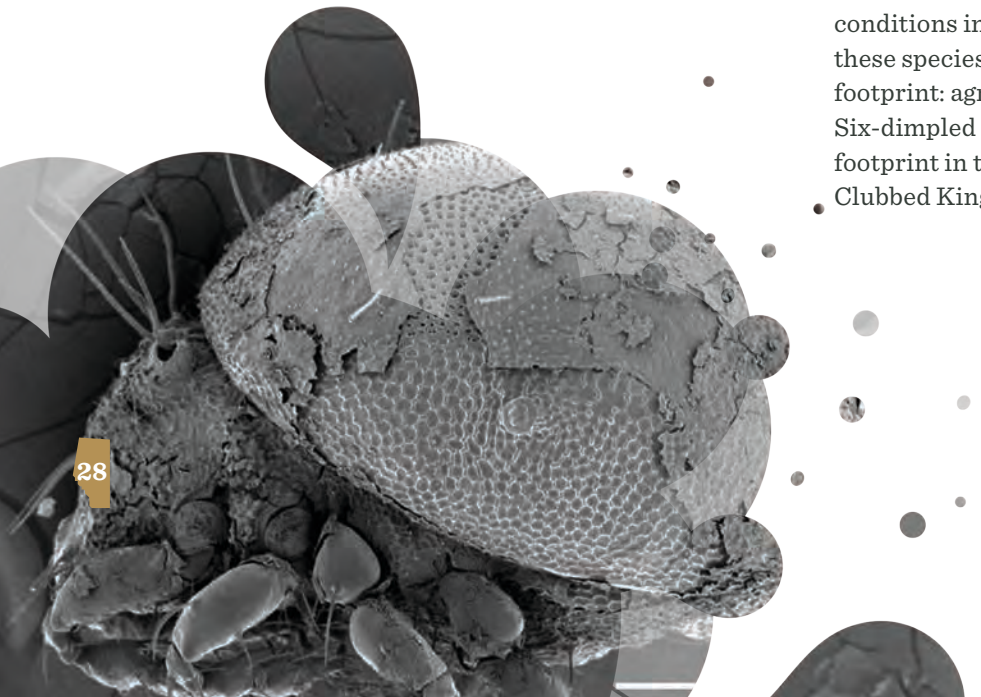


Armoured Mites Associated with Old Deciduous and Mixedwood Forests

Armoured mites (also known as oribatid mites) are a critical component of Alberta's soil biodiversity. With each mite no larger than the tip of a ballpoint pen, several hundred thousand armoured mites can be found in a cubic metre of healthy topsoil. Of the 10,000 armoured mite species known to exist on the planet, at least 344 occur in our province, and more are being discovered each year.

Like mammals and birds, some species of armoured mites are carnivores and some are herbivores. However, the majority of mites live off the remains of plants, animals, and fungi, playing a critical role in the formation and maintenance of soil structure. Armoured mites also serve as food for many small arthropods such as beetles, ants, and spiders, and for some small frogs and birds. As a result, these tiny unseen species are vital to the maintenance of healthy ecosystems in our province.

THE ABMI ASSESSED THE STATUS OF 18 SPECIES OF ARMOURED MITES ASSOCIATED WITH MATURE DECIDUOUS AND MIXEDWOOD FOREST TYPES IN THE AL-PAC FMA AREA AND FOUND THEM TO BE, ON AVERAGE, 96% INTACT IN 2012 (FIGURE 13).



Not a lot is known about armoured mites in the Al-Pac FMA area or how human footprint influences them. However, ABMI data is providing new information about these species, including what types of habitat different species like to live in, and how human footprint might influence them. The species highlighted in Figure 13 are all associated with mixedwood and deciduous forests in the boreal.

Overall, the abundance of more than half of the deciduous-associated mites assessed by the ABMI was within 5% of expected compared to intact reference conditions in the Al-Pac FMA area. Predicted intactness for these species was also virtually unchanged from 1999 to 2012, indicating that habitat suitability for these species changed little over this time frame.

Habitat suitability declined the most for the Ornate Hatless Mite as this species was at least 5% less abundant than expected if there were no human footprint in all assessed years; habitat suitability was predicted to have decreased between 1999 and 2012 as indicated by intactness, which dropped from 94% intact in 1999 to 90% intact in 2012. This species is negatively associated with human footprint.

There were four species that were at least 5% more abundant than expected compared to intact reference conditions in all assessed years (Figure 13). All of these species are positively associated with human footprint: agriculture footprint in the case of the Six-dimpled Northern Mite, and urban and industrial footprint in the case of Thienemann's Ceramic Mite, Clubbed King Mite, and Jacot's Box Mite.

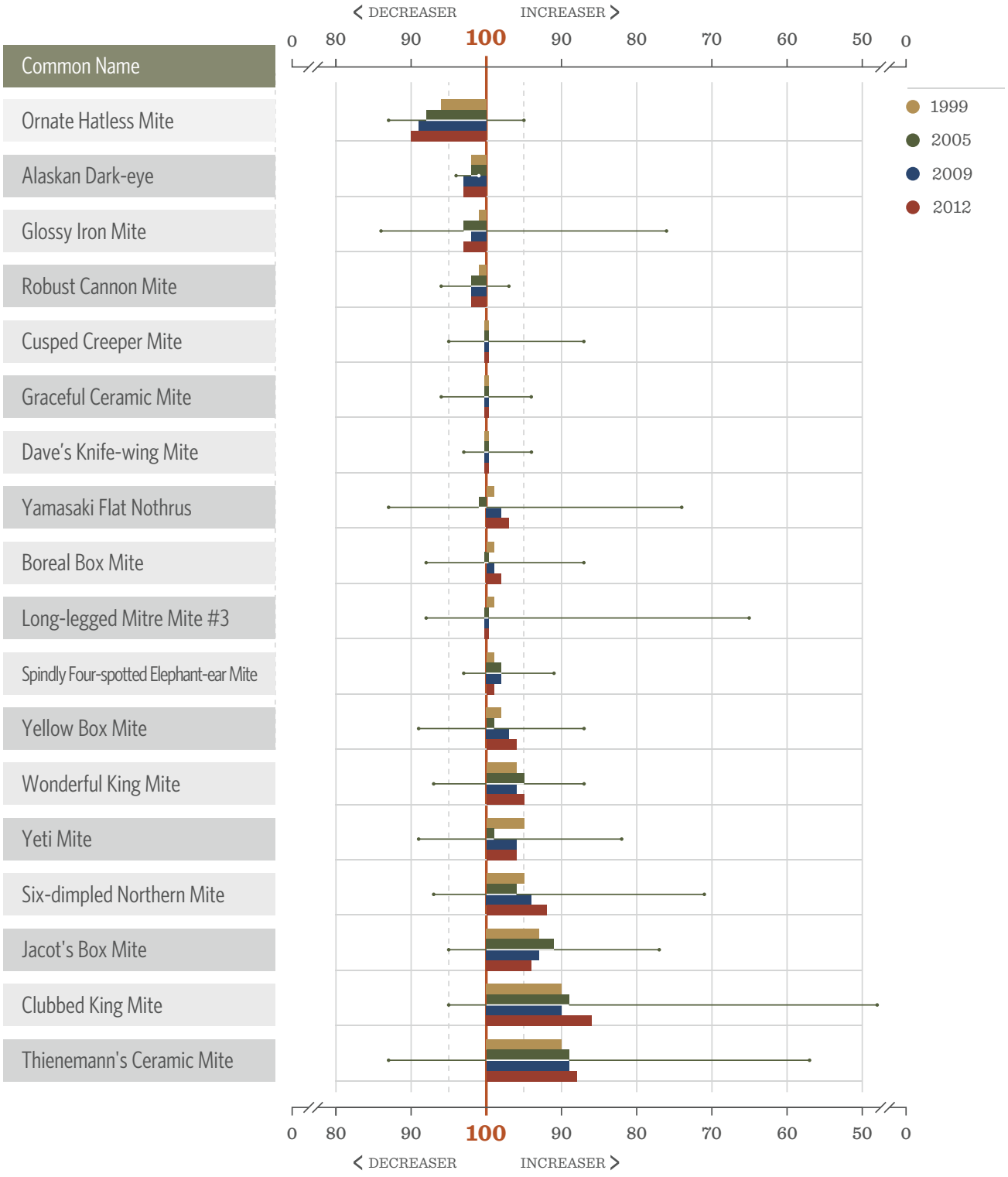


FIGURE 13

PER CENT INTACTNESS FOR DECIDUOUS AND MIXEDWOOD ASSOCIATED MITE SPECIES IN THE AL-PAC FMA AREA ESTIMATED FOR 1999, 2005, 2009, AND 2012; 90% CONFIDENCE INTERVALS ARE SHOWN FOR 2005 RESULTS BUT ARE SIMILAR FOR ALL FOUR YEARS THAT WERE ESTIMATED. CHANGE IN INTACTNESS OVER TIME FOR EACH SPECIES INDICATES PREDICTED CHANGE IN HABITAT SUITABILITY AS A RESULT OF HUMAN FOOTPRINT RATHER THAN ACTUAL MEASURED CHANGE IN SPECIES ABUNDANCE.

Vascular Plants Associated with Old Deciduous and Mixedwood Forests

Understory plant communities represent an important part of biodiversity in northern boreal forests. These communities influence the trees that grow in the overstory, the fertility of the soil via nutrient cycling, and the availability of food and habitat for a variety of wildlife.[10]

Given that stand-replacing wildfire is the principal natural disturbance of boreal forests, vascular plants are adapted to frequent disturbance events; few species are restricted to one particular forest type but instead can be found in a broad range of habitats.[11] Despite these broad tolerances, there are differences in vascular plant communities between forest types. Deciduous and mixedwood forests, characterized by higher light levels, warmer soils, and higher nitrogen availability, support a greater diversity of vascular plants than do coniferous forests,[12] and there are some vascular plant species that are more strongly associated with older mixedwood forests than other stand types of different ages.

While variability is inherent in the structure and composition of boreal forest ecosystems, understanding elements commonly associated with older deciduous and mixedwood forests, including vascular plants, informs the management of these forest types.

THE ABMI ASSESSED THE STATUS OF 14 VASCULAR PLANTS ASSOCIATED WITH OLD DECIDUOUS AND MIXEDWOOD FORESTS IN THE AL-PAC FMA AREA AND FOUND THEM TO BE, ON AVERAGE, 97% INTACT (FIGURE 14).

Overall, the abundance of most vascular plants associated with old deciduous and mixedwood forests was within 5% of expected compared to intact reference conditions in the Al-Pac FMA area. Predicted intactness for these species changed little (e.g., Sweet-scented Bedstraw), or declined slightly (e.g., Bishop's Cap) from 1999 to 2012 (Figure 14), indicating very little change in habitat suitability for most species.

The three species that differed the most from intact reference conditions were Ground Cedar at 93% intact, Bristly Black Currant at 94% intact, and Greenish-flowered Wintergreen at 94% intact, down 2% to 3% from 1999 intactness, indicating that habitat suitability declined slightly over this time frame. All of these species are disproportionately affected by forestry footprint compared to other non-forestry footprint types (Table 04). For example, for Greenish-flowered Wintergreen, the predicted change in relative abundance based on changes in habitat suitability due to forestry footprint alone is -7.1% compared to a slight positive influence (+0.3%) of non-forestry footprint.

Only two species were more abundant than expected in all assessed years, and but only slightly—Woodland Horsetail and Wild Sarsaparilla (Figure 14).

Overall, native vascular plants associated with old deciduous and mixedwood forests tend to be disproportionately affected by forestry footprint.**** Non-forestry human footprint in the FMA area had a greater effect than forestry footprint for only four of the 14 species assessed by the ABMI: Saskatoon, Twining Honeysuckle, Twining Sarsaparilla, and Woodland Horsetail (Table 04).

GREENISH-FLOWERED WINTERGREEN IS ASSOCIATED WITH OLD DECIDUOUS FORESTS IN THE AL-PAC FMA AREA. AT 94% INTACT, THIS SPECIES WAS LESS ABUNDANT THAN EXPECTED.

*****See page 44 for an evaluation of the response of various biota to time since disturbance (wildfire vs. timber harvest) and the convergence that is occurring.*

FIGURE 14

PER CENT INTACTNESS OF 14 VASCULAR PLANTS IN THE AL-PAC FMA AREA THAT ARE ASSOCIATED WITH OLD DECIDUOUS AND MIXEDWOOD FOREST ESTIMATED FOR 1999, 2005, 2009, AND 2012; 90% CONFIDENCE INTERVALS ARE SHOWN FOR 2005 RESULTS BUT ARE SIMILAR FOR ALL FOUR YEARS THAT WERE ESTIMATED. CHANGE IN INTACTNESS OVER TIME FOR EACH SPECIES INDICATES PREDICTED CHANGE IN HABITAT SUITABILITY AS A RESULT OF HUMAN FOOTPRINT RATHER THAN ACTUAL MEASURED CHANGE IN SPECIES ABUNDANCE.

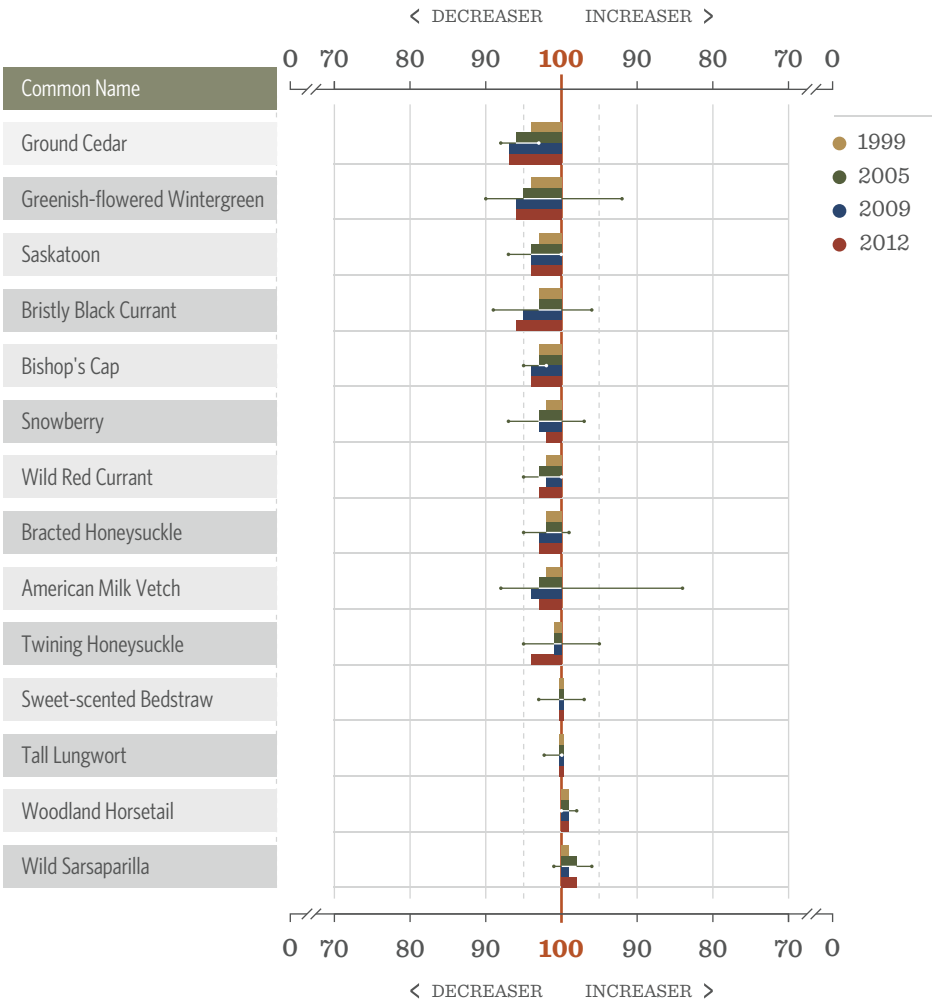


TABLE 04

THE PREDICTED CHANGE IN RELATIVE ABUNDANCE OF VASCULAR PLANTS ESTIMATED FOR THE YEAR 2012 BASED ON CHANGES TO HABITAT AS A RESULT OF FORESTRY FOOTPRINT AND NON-FORESTRY FOOTPRINT FOR FOUR DECREASER SPECIES AND TWO INCREASER SPECIES.

	Common Name	Forestry Footprint Effects (%)	Non-forestry Footprint Effects (%)
Decreaser	Greenish-flowered Wintergreen	-7.1	0.3
	Bristly Black Currant	-6.8	0.6
	American Milk Vetch	-6.3	-0.2
	Ground Cedar	-5.9	-2.7
Increaser	Wild Sarsaparilla	-0.6	2.3
	Woodland Horsetail	-0.6	0.9

Non-native Plants

Non-native plants are those species that have been introduced, intentionally or otherwise, into new areas beyond their natural range. While non-native plants do not currently present a large risk to native biodiversity in boreal forests, given the right conditions, they could become a bigger environmental management challenge.[13] For example, some non-native plant species, like the Creeping Thistle and Narrow-leaved Hawksbeard, can interfere with tree regeneration after wildfire or forest harvesting.[13] As human activities such as forestry and oil and gas development increase in northern Alberta, creating favourable environmental conditions for weeds to establish themselves and spread, non-native species like these could become a much bigger concern.

One of the challenges of managing non-native species is understanding when a species shifts from a low-impact introduction to an influential invader.[14] Monitoring data are a means to assess the current level of invasion and detect trends in invasion level through time, serving as a warning signal of potential risk to native biodiversity and boreal forest ecosystems. ABMI data can be used by managers to set regional targets for non-native species management, and to measure progress toward achieving those targets.

The ABMI found 23 non-native plants in the Al-Pac FMA area as of 2012; all but 2 species had been detected prior to 2009 (Table 05 summarizes the most common non-native species; see supplementary material available at www.abmi.ca for a complete list). Combined, non-native plants were detected across 41% of sites in the Al-Pac FMA area. Most non-native species occurred infrequently; 20 of the 23 species occurred at 5% or fewer of ABMI sites. For each quarter section in the Al-Pac FMA area, the predicted number of non-native species per 1 ha plot ranged from an average of 0 up to 10 species (Figure 15).

Common Dandelion was the most abundant non-native plant, occurring at 22% of ABMI sites in the Al-Pac FMA area, followed by Kentucky Bluegrass (12%) and Alsike Clover (10%).

Three of the non-native species detected are listed under the Alberta Weed Control Act, including Creeping Thistle (3%), Perennial Sow-thistle (0.6%), and Scentless Chamomile (0.6%).

NARROW-LEAVED HAWKSBEARD, A SPECIES THAT CAN INTERFERE WITH TREE REGENERATION, WAS DETECTED AT 3% OF ABMI SITES IN THE AL-PAC FMA AREA.

TABLE 05

PERCENTAGE OCCURRENCE OF THE FIVE MOST COMMONLY DETECTED NON-NATIVE VASCULAR PLANTS AT ABMI SITES IN THE AL-PAC FMA AREA, AND ALL NOXIOUS WEEDS REGARDLESS OF HOW COMMON THEY ARE.

Scientific Name	Common Name	Percentage Occurrence	Alberta Weed Control Act
Taraxacum officinale	Common Dandelion	22	
Poa pratensis	Kentucky Bluegrass	12	
Trifolium hybridum	Alsike Clover	10	
Phleum pratense	Timothy	5	
Cirsium arvense	Creeping Thistle	3	Noxious
Sonchus arvensis	Perennial Sow-thistle	1	Noxious
Tripleurospermum inodorum (formerly *Matricaria perforata*)	Scentless Chamomile	1	Noxious

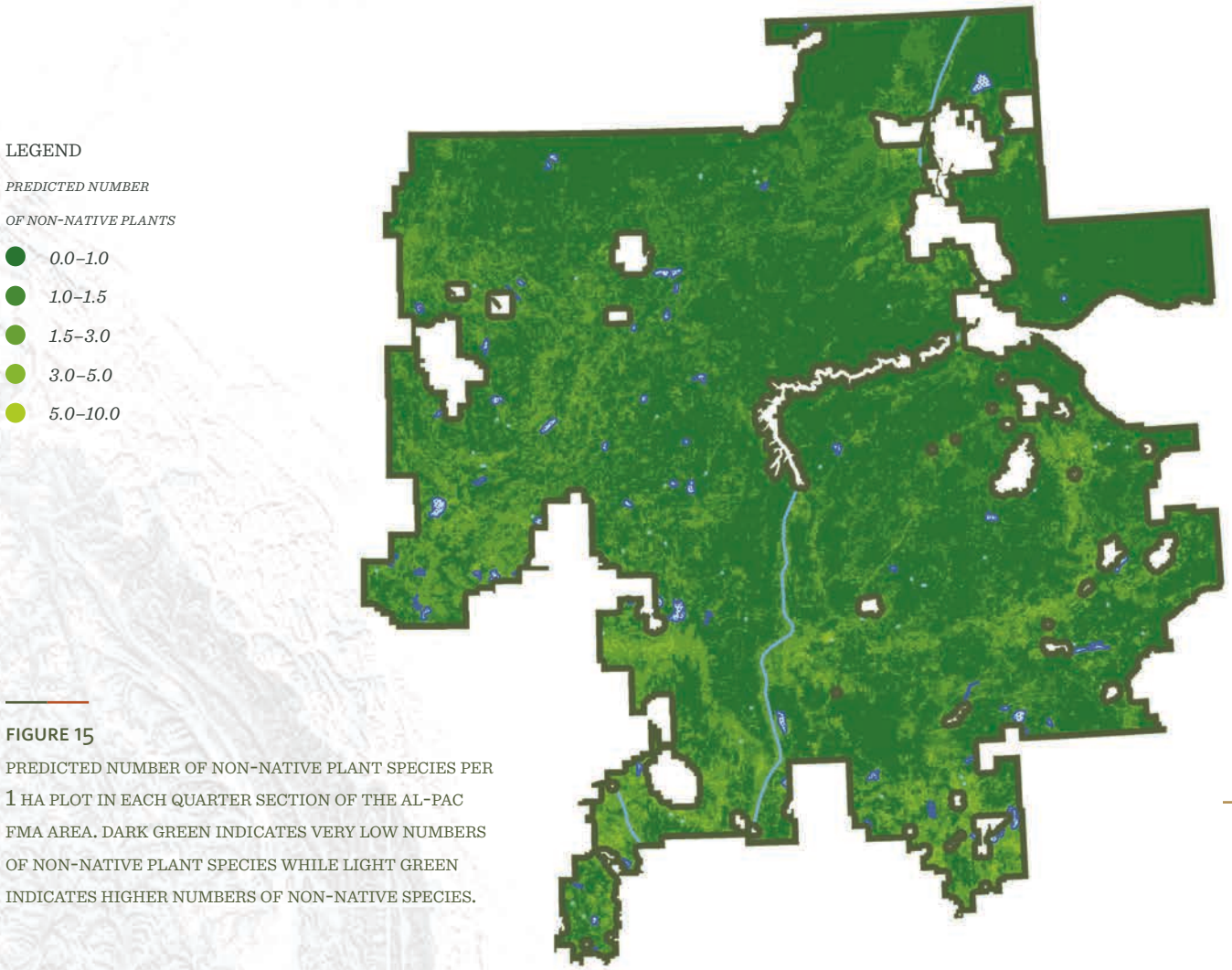


FIGURE 15

PREDICTED NUMBER OF NON-NATIVE PLANT SPECIES PER 1 HA PLOT IN EACH QUARTER SECTION OF THE AL-PAC FMA AREA. DARK GREEN INDICATES VERY LOW NUMBERS OF NON-NATIVE PLANT SPECIES WHILE LIGHT GREEN INDICATES HIGHER NUMBERS OF NON-NATIVE SPECIES.

Mosses Associated with Old Deciduous and Mixedwood Forests

Mosses†††† provide a number of important functions in northern boreal forests.[15] For example, a blanket of moss on the forest floor regulates soil moisture and temperature, and intercepts incoming nutrients, such as nitrogen, making these nutrients available to other plants. Moss beds can also limit the establishment of understory plants as well as tree seedlings, thereby directly affecting the boreal plant community.[13] And mosses are home to a diverse community of micro-organisms, such as fungi, bacteria, and mites, that play critical roles in decomposing plant material and maintaining healthy soil.

While mosses are common throughout the boreal forest, many species have specialized habitat requirements.[16] For example, there are a large number of species that prefer to colonize specific substrates, such as on the surfaces of decaying logs, or in the rough creviced bark of large old trees. In deciduous and mixedwood forests, mosses may be restricted to these habitats because they do not grow well on leaf litter.[10] These habitat requirements, and their dependence on the availability of moisture from their immediate surroundings for growth and survival, make many moss species susceptible to disturbances like forest harvesting. In fact, a number of mosses have been identified as indicators of closed-canopy forest because these species decline in harvested sites.[17]

THE ABMI ASSESSED THE STATUS OF 11 MOSSES ASSOCIATED WITH OLD DECIDUOUS AND MIXEDWOOD FORESTS IN THE AL-PAC FMA AREA AND FOUND THEM TO BE, ON AVERAGE, 96% INTACT IN 2012 (FIGURE 16).

Overall, the predicted intactness of most mosses associated with old deciduous and mixedwood forests was within 5% of expected compared to intact reference conditions in the Al-Pac FMA area, indicating very little change in habitat suitability for most species (Figure 16).

The two species that differed the most from intact reference conditions were less abundant than expected—Heller's Notchwort (91% intact) and Glaucous-headed Earwort (93% intact). These two decreaser species were both disproportionately affected by forestry footprint compared to non-forestry footprint types (Table 06), particularly for Heller's Notchwort. Both the Heller's Notchwort and Glaucous-headed Earwort are associated with closed-canopy forest in Alberta's boreal forest and grow almost exclusively on decaying logs.[17]

Overall, the seven mosses that were less abundant than expected compared to intact reference conditions were all more negatively affected by forestry footprint than non-forestry footprint. With the exception of Plume Moss, these decreaser species grow on either decaying logs or the bark of living trees. In contrast, three of the four increaser species were more positively influenced by non-forestry footprint compared to effects of forestry footprint (Table 06).

HELLER'S NOTCHWORT (91% INTACT IN 2012) PREFERENTIALLY GROWS ON DECAYING LOGS AND IS ASSOCIATED WITH CLOSED-CANOPY FOREST.[17]

†††† *We use the noun "moss" to collectively refer to mosses, hornworts, and liverworts, which are non-vascular plants known more technically as bryophytes.*

FIGURE 16

PER CENT INTACTNESS OF 11 MOSSES IN THE AL-PAC FMA AREA THAT ARE ASSOCIATED WITH OLD DECIDUOUS AND MIXEDWOOD FOREST ESTIMATED FOR 1999, 2005, 2009, AND 2012; 90% CONFIDENCE INTERVALS ARE SHOWN FOR 2005 RESULTS BUT ARE SIMILAR FOR ALL FOUR YEARS THAT WERE ESTIMATED. CHANGE IN INTACTNESS OVER TIME FOR EACH SPECIES INDICATES PREDICTED CHANGE IN HABITAT SUITABILITY AS A RESULT OF HUMAN FOOTPRINT RATHER THAN ACTUAL MEASURED CHANGE IN SPECIES ABUNDANCE.

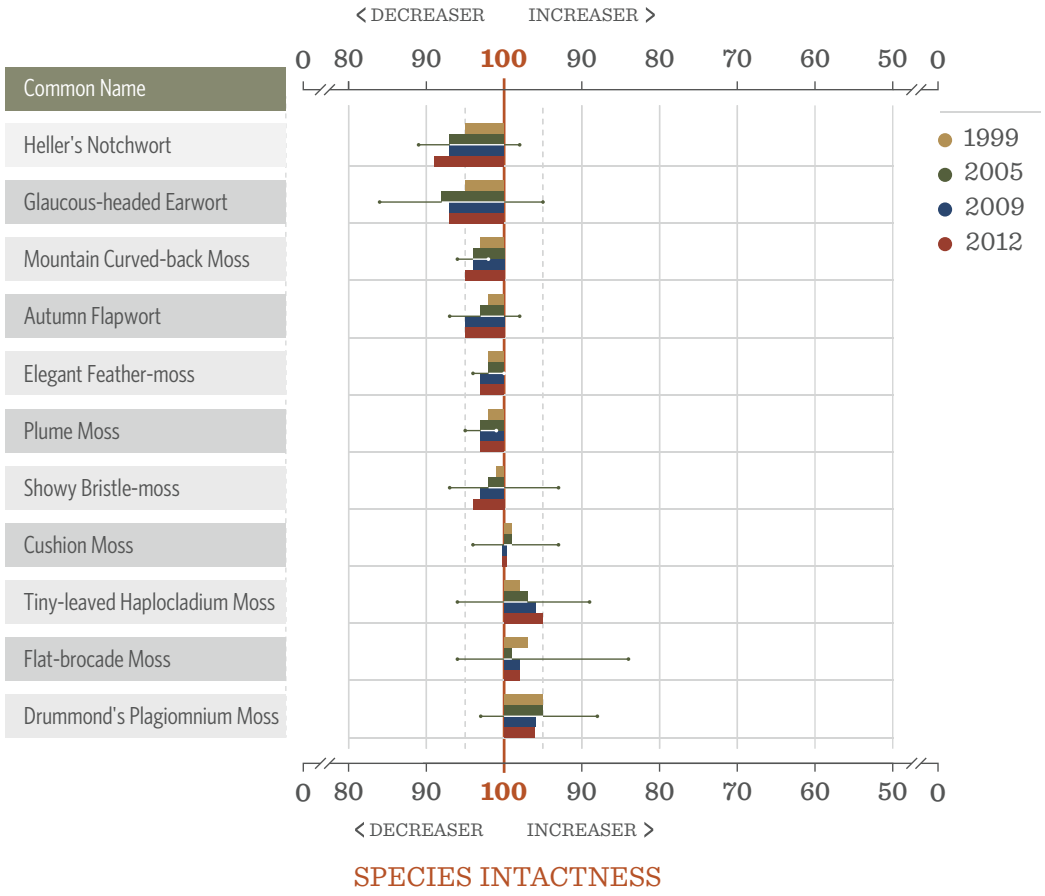


TABLE 06

THE PREDICTED CHANGE IN MOSS RELATIVE ABUNDANCE ESTIMATED FOR THE YEAR 2012 BASED ON CHANGES TO HABITAT AS A RESULT OF FORESTRY FOOTPRINT AND NON-FORESTRY FOOTPRINT FOR SEVEN DECREASER SPECIES AND FOUR INCREASER SPECIES.

	Common Name	Forestry Footprint Effects (%)	Non-forestry Footprint Effects (%)
Decreaser	Heller's Notchwort	-9.6	-0.4
	Glaucous-headed Earwort	-9.6	1.9
	Mountain Curved-back Moss	-4.1	-2.2
	Autumn Flapwort	-5.4	1.4
	Showy Bristle-moss	-8.2	2.2
	Elegant Feather-moss	-4.2	0.3
	Plume Moss	-3.5	-0.6
	Cushion Moss	-4.4	3.4
Increaser	Flat-brocade Moss	-3.8	4.8
	Drummond's Plagiogmnium Moss	-3.2	7.8
	Tiny-leaved Haplocladium Moss	3.7	-1.5

Species Designated as Sensitive or at Risk

The health of biodiversity in a region includes an assessment of species that are considered sensitive to human activities or that have demonstrated a significant decline in abundance. These species are of management concern because future declines in abundance may result in the loss of the species from an area.

ABMI detected 88 species that are either considered sensitive or officially designated as species at risk in the Al-Pac FMA area (see the supplemental report available at www.abmi.ca for a complete list); the majority of these species (73%) are vascular plants and mosses that are provincially listed as sensitive.

Eighteen of the species considered sensitive or at risk occurred with enough frequency to enable the calculation of the ABMI's Intactness Index, including six species that are listed as threatened or of special concern by the Government of Canada and/or by the Government of Alberta (Table 07). Intactness ranged from 66% intact to 98% intact for increaser species. Intactness ranged from 85% intact to 99% intact for decreaser species.

Of the decreaser species, the species that differed the most from intact reference conditions was the Brown Creeper at 85%. The Brown Creeper prefers old forests to meet its habitat requirements; it nests within cracks or under loose bark in larger-diameter dead or dying trees, and prefers to forage on the largest diameter trees. The Brown Creeper is more negatively affected by forestry footprint compared to non-forestry footprint in northern Alberta (see pages 24–25).

In 2015, the ABMI and the University of Alberta launched the Bioacoustic Unit. Using Automated Recording Units (ARUs), all vocalizing species will be recorded at pre-defined intervals for several months at each ABMI site. ARUs have proven successful at providing data on many vocalizing species, including species at risk that are not currently monitored by the ABMI, such as Barred Owl, Common Nighthawk, Yellow Rail, and Canada Toad.

THE RUSTY BLACKBIRD IS LISTED AS SPECIAL CONCERN BY CANADA'S COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA AND SPECIES AT RISK ACT. AT 99% INTACT, THE ABMI FOUND THE RUSTY BLACKBIRD TO BE AS ABUNDANT AS EXPECTED COMPARED TO INTACT REFERENCE CONDITIONS IN THE AL-PAC FMA AREA.

TABLE 07

SUMMARY OF SPECIES CONSIDERED SENSITIVE OR DESIGNATED AS SPECIES AT RISK‡‡‡‡ IN THE AL-PAC FMA AREA FOR WHICH ABMI COULD CALCULATE AN INTACTNESS INDEX.

	Common Name	Scientific Name	Occurrence (%) at ABMI Sites	Intactness Index (0-100 scale)	Above or Below Reference Conditions	Threat*
BIRDS	Bay-breasted Warbler	*Setophaga castanea*	23%	93%	BELOW	AEP - Sensitive | AB ESCC - Species of Special Concern
BIRDS	Black-throated Green Warbler	*Setophaga virens*	4%	100%	-	AEP - Sensitive | AB ESCC - Species of Special Concern
BIRDS	Brown Creeper	*Certhia americana*	10%	85%	BELOW	AEP - Sensitive
BIRDS	Canada Warbler	*Cardelina canadensis*	9%	100%	-	AEP - Sensitive | COSEWIC - Threatened | SARA - Threatened
BIRDS	Cape May Warbler	*Setophaga tigrina*	36%	96%	BELOW	AEP - Sensitive | AB ESCC - Species of Special Concern
BIRDS	Common Yellowthroat	*Geothlypis trichas*	46%	86%	ABOVE	AEP - Sensitive
BIRDS	Least Flycatcher	*Empidonax minimus*	47%	96%	BELOW	AEP - Sensitive
BIRDS	Olive-sided Flycatcher	*Contopus cooperi*	14%	95%	ABOVE	AEP - May Be at Risk | COSEWIC - Threatened | SARA - Threatened
BIRDS	Pileated Woodpecker	*Dryocopus pileatus*	25%	97%	BELOW	AEP - Sensitive
BIRDS	Rusty Blackbird	*Euphagus carolinus*	7%	99%	BELOW	AEP - Sensitive | COSEWIC - Special Concern | SARA - Special Concern
BIRDS	Sora	*Porzana carolina*	13%	98%	BELOW	AEP - Sensitive
BIRDS	Western Tanager	*Piranga ludoviciana*	39%	100%	-	AEP - Sensitive
BIRDS	Western Wood-Pewee	*Calcarius mccownii*	12%	98%	ABOVE	AEP - Sensitive
MAMMALS	Marten and Fisher	*Martes*	41%	97%	BELOW	AEP - Sensitive (Fisher only)
VASCULAR PLANTS	Athabasca Willow	*Salix athabascensis*	6%	97%	BELOW	AEP - Sensitive
VASCULAR PLANTS	Northern Wood Fern	*Dryopteris expansa*	3%	92%	BELOW	AEP - Sensitive
VASCULAR PLANTS	Veiny Vetchling	*Lathyrus venosus*	8%	66%	ABOVE	AEP - Sensitive
MOSSES	Flat-brocade Moss	*Platygyrium repens*	19%	98%	ABOVE	AEP - Sensitive

‡‡‡‡ *Threat categories for sensitive species and species at risk as identified by the Government of Canada and/or the Government of Alberta. This assessment includes species and sub-species identified by Canada's Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered, Threatened, or Special Concern; Canada's Species at Risk Act (SARA) as Endangered, Threatened, or Special Concern; Alberta's Ministry of Environment and Parks (AEP) as May Be at Risk, At Risk, or Sensitive; or identified by Alberta's Endangered Species Conservation Committee (AB ESCC) as Endangered, Threatened, or Special Concern.*

Species Spotlight: Woodland Caribou

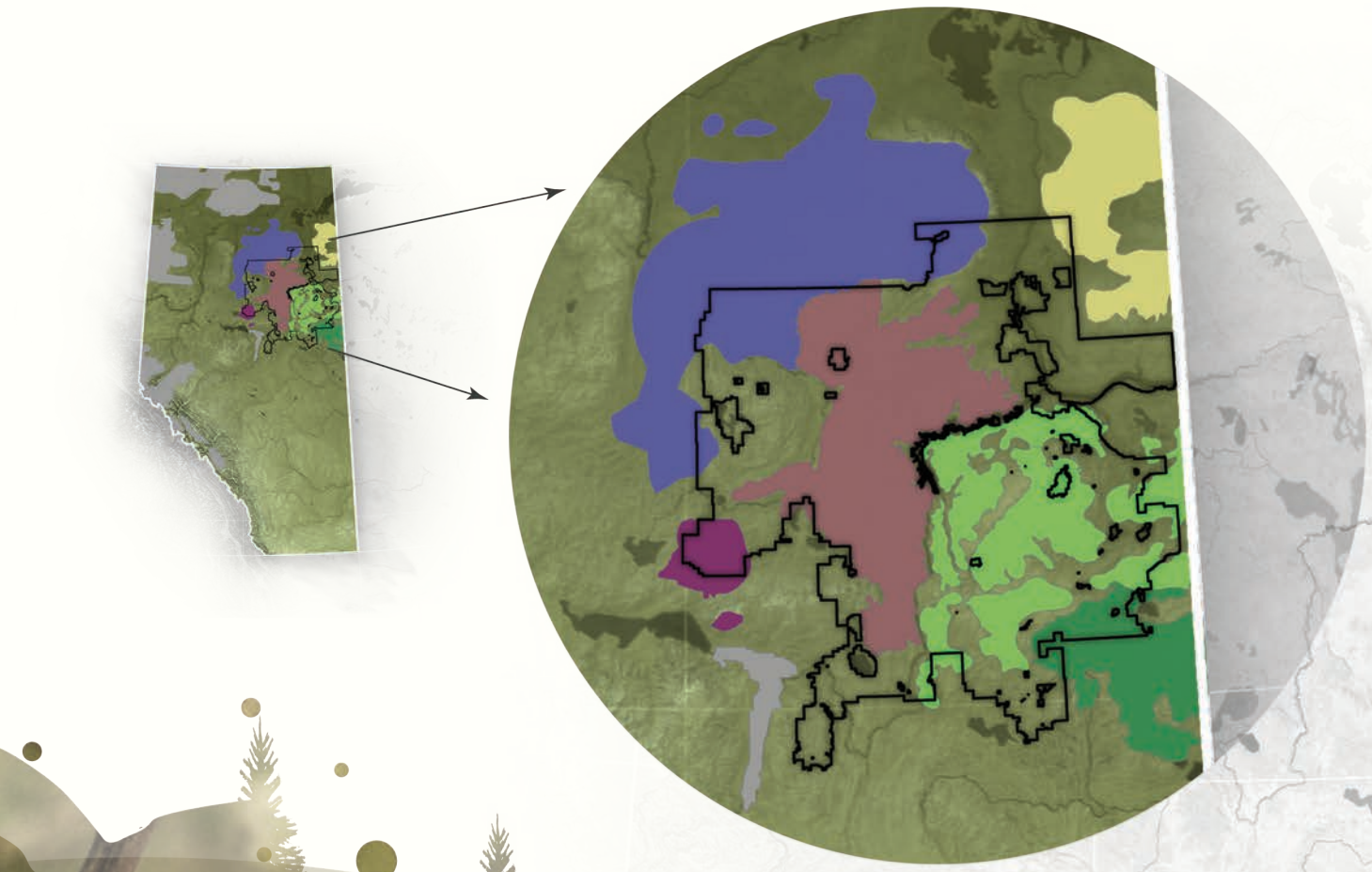
Woodland Caribou have the highest public profile of any species at risk that occurs in the Al-Pac FMA area. While the ABMI does not detect this species often enough to assess its status, comprehensive monitoring by the Government of Alberta (GoA) has been in place for many populations since 1993.

Six of Alberta's 16 populations of Woodland Caribou occur in and around the Al-Pac FMA area (Figure 17), the Cold Lake (Alberta), East Side Athabasca River, Nipisi, Red Earth, Richardson, and West Side Athabasca River ranges. These six populations are part of the Boreal conservation unit (or "Designatable Unit")[18] and are listed as "Threatened" by the GoA and under the Federal Species at Risk Act.

Actual population numbers are not known; however, tracking the survival of collared caribou, in conjunction with conducting calf surveys, allows reliable determination of population trend. Between 1994 and 2012, at least five of the six populations that overlap the Al-Pac FMA area were declining (Table 08).[19] The estimated annual rates of decline range from -1.6% per year for the Richardson population to -16.0% per year for the Cold Lake (Alberta) population (Table 08). Where data exists (four of six populations in the Al-Pac FMA area), the rate of decline has increased in the last 10 years.[19]

In Alberta, caribou decline is best explained by natural disturbance (fire), climate change (via milder winters), and human-caused habitat alteration. Habitat alteration and milder winters favour an increase in the abundance and distribution of ungulate prey (such as moose and deer) and their carnivore predators (such as wolves).[20,21] The probable expansion of white-tailed deer and coyotes into boreal caribou range in the recent past may have significantly altered the predator-prey system in and near caribou ranges. The increase in predator density results in an unsustainable increase in caribou mortality.

It is unlikely that declining populations on the east side of the Peace River will gain new members from caribou populations in other parts of the province as indicated by genetic evidence. Caribou populations on the east side of the Peace River, including those that overlap the Al-Pac FMA area, are genetically distinct from the caribou populations north and west of the Peace River and from those located in west-central Alberta.[22] Therefore, improved adult and calf survival, as well as habitat conservation and restoration are required to halt and reverse the decline of caribou.[18,19] In response to these threats, the Federal Government has stipulated that a maximum of 35% of a caribou range can be "disturbed".[23] Disturbance is defined as any human footprint buffered by 500 m, plus any area that has been subjected to wildfire in the past 40 years (burned areas are not buffered by 500 m).



LEGEND

- *AL-PAC FMA AREA*

CARIBOU RANGE

- *COLD LAKE*
- *EAST SIDE ATHABASCA*
- *NIPISI*
- *RED EARTH*
- *RICHARDSON*
- *WEST SIDE ATHABASCA*
- *OTHER*

FIGURE 17

SIX BOREAL CARIBOU POPULATIONS OVERLAP WITH THE AL-PAC FMA AREA; ALL ARE PART OF THE BOREAL DESIGNATABLE UNIT.

Human Footprint in Woodland Caribou Population Ranges

Tracking the rate of human land-use development and natural disturbance in caribou range is an important component of caribou conservation. The ABMI provides scientific information on status and trend of human footprint for the province of Alberta, including the six population ranges that overlap with the Al-Pac FMA area.

In 2012, the total amount of actual or direct human footprint in each caribou population range in the Al-Pac FMA area varied from a low of 0.95% in the Richardson range to a high of over 7.60% in the Nipisi range (Table 08). When human footprint is buffered by the federal guideline of 500 m, these values are much higher, ranging from 22% for the Richardson population to 77% of the East Side Athabasca River range (Table 08). All six ranges in the Al-Pac FMA are above the target of 35% disturbed habitat (human footprint and fire combined), with three of them containing more than 80% disturbed habitat (Table 08).

The ABMI calculated trend in human footprint for the three largest caribou ranges (Figure 18): East Side Athabasca River, West Side Athabasca River, and Red Earth. The total amount of human footprint increased in all three ranges between 1999 and 2013. The largest increase occurred in the East Side Athabasca River range, which grew by 4.0% between 1999 and 2013, from 2.6% to 6.6% (Figure 18). Next was the West Side Athabasca River range, which increased by 1.9%, from 1.9% to 3.8% (Figure 18), followed by the Red Earth Range, which increased by 1.1%, from 2.5% to 3.6% (Figure 18).

TABLE 08

HUMAN FOOTPRINT (CIRCA 2012) WITH NO BUFFER (AS CALCULATED BY THE ABMI), HUMAN FOOTPRINT WITH A 500 M BUFFER (AS CALCULATED BY ENVIRONMENT CANADA, 2011), FIRE PERCENTAGE AREA DISTURBED SINCE 1971, AND ANNUAL RATE OF POPULATION CHANGE (1994-2012) FOR CARIBOU RANGES AND POPULATIONS THAT OVERLAP WITH THE AL-PAC FMA AREA. AVERAGE [1] ANNUAL RATE OF POPULATION CHANGE (%), AND THE CUMULATIVE REALIZED POPULATION CHANGE ARE FOR THE NUMBER OF YEARS MONITORED (FROM HERVIEUX ET AL. 2013).

Range/Population	Total Area of Range (km²)	2012 Total Human Footprint	Disturbance (human footprint is buffered by 500 m)[2]			Average Annual Rate of Population Change	Years Monitored	Cumulative Change (over the years monitored)[3]
			Human	Fire	Total			
Cold Lake (Alberta)	6,726	3.79%	72%	32%	85%	-15.67%	12	-86.9%
East Side Athabasca River	13,154	6.06%	77%	26%	81%	-8.77%	17	-77.6%
Nipisi	2,104	7.60%	66%	6%	68%	NA	NA	NA
Red Earth	24,702	3.02%	44%	30%	62%	-12.33%	15	-84.3%
Richardson	7,074	0.95%	22%	67%	82%	-1.61%	3	-4.9%
West Side Athabasca River	15,707	2.76%	68%	4%	69%	-6.94%	18	-71.3%

[1] *Calculated as the geometric mean.*

[2] *Human disturbance buffered by 500 m and fire disturbance overlap; therefore, total disturbance will not equal the sum of these two disturbances.*

[3] *These values are based on extrapolations from the average annual rate of population change based on the number of years monitored. These values have not been directly observed in the field. Actual population densities will be available from the Government of Alberta for the Cold Lake, West Side Athabasca River, and East Side Athabasca River ranges once genetic mark-recapture analyses are complete.*

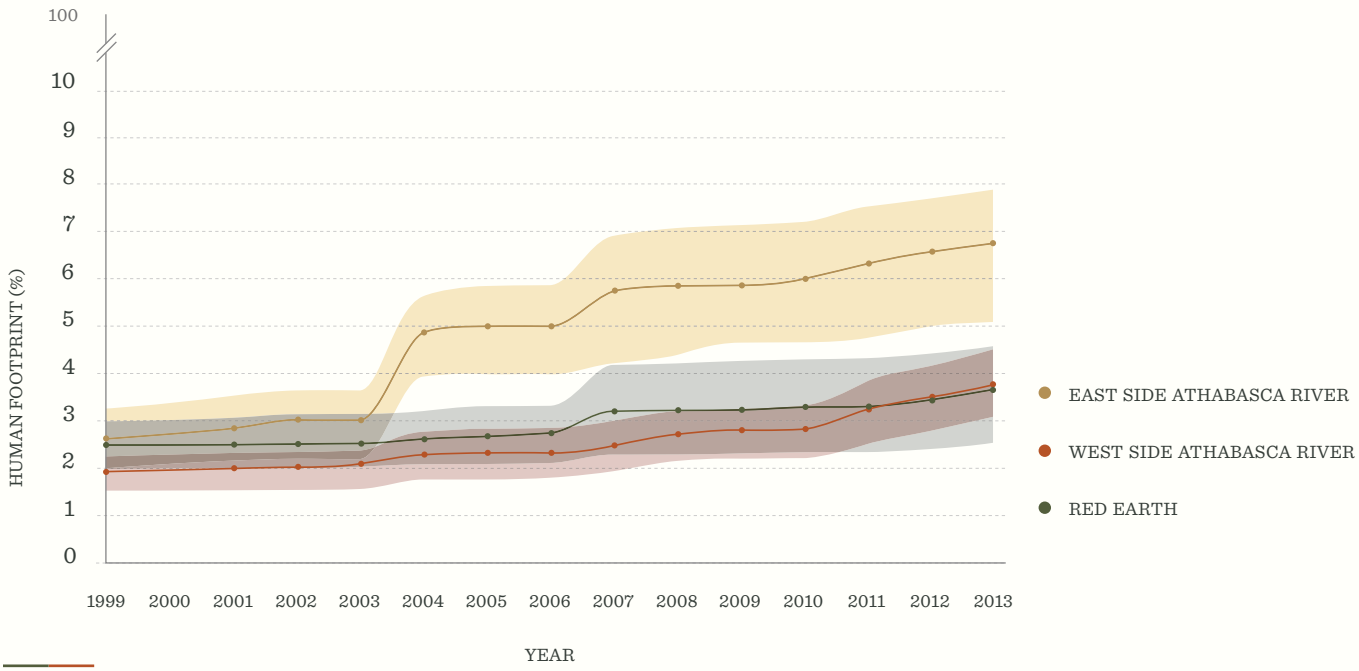


FIGURE 18

CHANGE IN PER CENT (%) AREA OF HUMAN FOOTPRINT (± 1SE) IN THE EAST SIDE ATHABASCA RIVER RANGE, WEST SIDE ATHABASCA RIVER RANGE, AND RED EARTH RANGE FROM 1999 TO 2013. CHANGE IN PER CENT AREA OF HUMAN FOOTPRINT IS ESTIMATED FOR EACH YEAR (EXCEPT 2000) FROM A 3 × 7 KM SAMPLE AREA SURROUNDING ALL ABMI SITES WITHIN EACH CARIBOU RANGE.

Currently there is very little information about when or how human footprint (linear features in particular) no longer impacts caribou. This uncertainty has important implications for caribou recovery plans and targets, because such plans are based on removing human footprint from the landscape. Removing human footprint can be accomplished using intensive silviculture techniques such as mounding soil and planting seedlings, or by using physical barriers that deter predator movement. Few of these methods have been evaluated.

The ABMI is supporting caribou management by working with the Government of Alberta, the forest industry, and the energy industry to coordinate research and monitoring activities. The ABMI Caribou Monitoring Unit is engaged in management trials aimed at determining when human footprint no longer impacts caribou. These trials include reducing the use of linear features by wolves, a primary predator of woodland caribou. Monitoring these trials will help inform managers about successful ways to accelerate habitat restoration for woodland caribou. In addition, our Caribou Monitoring Unit is engaged in a collaborative process designed to update caribou population estimates in the Athabasca Oil Sands Area (which includes the Al-Pac FMA area), and to produce a seamless province-wide habitat quality map.

HABITAT RESTORATION OF HUMAN FOOTPRINT, SUCH AS LINEAR FEATURES, IS ONE PROPOSED MANAGEMENT STRATEGY TO SUPPORT THE RECOVERY OF WOODLAND CARIBOU.

Habitat Elements

Resource managers do not often manage for individual species but instead manage habitat. There are several key habitat elements that are important to many species that live in the boreal forest, including large trees, snags (or standing dead trees), and downed woody material (or fallen dead trees). For example, many birds, such as chickadees and woodpeckers, are associated with large trees and snags for nesting and foraging; these birds are known to be sensitive to a reduction in these forest habitat elements. Mammal species, like Fisher and Marten, use large snags and fallen trees as den sites; fallen trees are also important for these species during the winter, providing them with access routes under the snow as they hunt for prey.

Fallen trees have a number of other important functions in the boreal forest, such as improving soil fertility and health by storing organic matter, moisture, carbon, and nutrients; serving as seed or spore germination sites, particularly for some mosses; and supporting diverse communities of invertebrates, such as oribatid mites, that are unlike communities found on the forest floor.

Overall, many components of biodiversity are linked to large trees, snags, and fallen trees. Because these habitat elements are generally more abundant in older forests, they can be challenging to maintain in landscapes managed for the production of timber, energy, or agricultural commodities.

THROUGH THE USE OF GROUND-BASED SAMPLING, THE ABMI MEASURED THE BASAL AREA OF LIVING TREES AND SNAGS IN THE AL-PAC FMA AREA; PREDICTED BASAL AREAS FOR ALL CATEGORIES OF TREES AND SNAGS WERE SIMILAR, OR INCREASED SLIGHTLY BETWEEN 1999 AND 2012 (FIGURE 19).

CAVITY-NESTING SPECIES, LIKE THE RED-BREASTED NUTHATCH AND NORTHERN FLICKER, RELY ON DEAD AND DYING TREES FOR FORAGING AND NESTING.

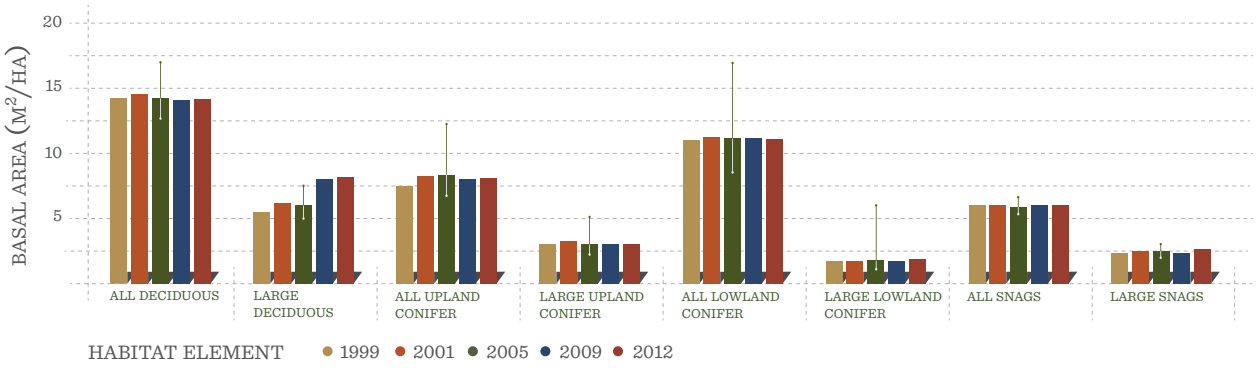


FIGURE 19

THE BASAL AREA (M^2/HA) OF LIVING TREES AND SNAGS IN THE AL-PAC FMA AREA ESTIMATED FOR 1999, 2001, 2005, 2009, AND 2012; 90% CONFIDENCE INTERVALS ARE SHOWN FOR 2005 RESULTS BUT ARE SIMILAR FOR ALL FIVE YEARS THAT WERE ESTIMATED. BASAL AREA DESCRIBES THE TOTAL CROSS-SECTIONAL AREA NEAR THE BASE OF ALL TREE STEMS AND/OR SNAGS, PER HECTARE OF LAND.

THROUGH THE USE OF GROUND-BASED SAMPLING, THE ABMI MEASURED THE VOLUME OF DOWNED WOODY MATERIAL IN THE AL-PAC FMA AREA; THE PREDICTED VOLUME OF ALL DOWNED WOODY MATERIAL AND LARGE DOWNED WOODY MATERIAL INCREASED SLIGHTLY BETWEEN 1999 AND 2012 (FIGURE 20).

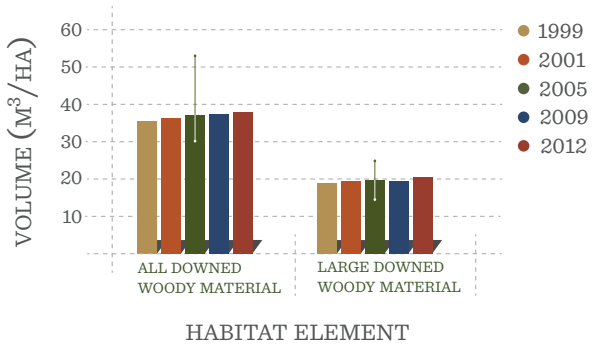


FIGURE 20

THE VOLUME (M^3/HA) OF DOWNED WOODY MATERIAL IN THE AL-PAC FMA AREA ESTIMATED FOR 1999, 2001, 2005, 2009, AND 2012; 90% CONFIDENCE INTERVALS ARE SHOWN FOR 2005 RESULTS BUT ARE SIMILAR FOR ALL FIVE YEARS THAT WERE ESTIMATED.

Spotlight: Biodiversity Recovery of Harvested Areas††††

Like areas burned in forest fires, harvested forests grow into old stands over time. In order to compare these areas, we asked two questions: How quickly do species in harvested stands return to the levels found in older, naturally-disturbed stands? And how similar are burned and harvested stands at different ages? The faster that species in harvest areas return to older-forest levels, the less total effect harvesting is expected to have on native species.

ABMI measured birds, plants, mites, and mosses in 15-year old harvest areas in aspen in Al-Pac's FMA area, and in burned aspen stands of different ages. We also measured habitat structures like live trees, snags, downed wood, and cover of vegetation layers. We surveyed 31 harvest areas, two stands that burned 0 to 10 years ago, eight 10- to 20-year-old burns, six 20- to 40-year-old burns, and 28 stands that burned more than 40 years ago. The harvest areas included "structural retention"; some merchantable trees and many non-merchantable trees were left standing. (Non-merchantable trees are too small, too damaged or the wrong species to use for wood products).

PLANT COMMUNITIES IN 15-YEAR-OLD PARTIALLY HARVESTED STANDS ARE RECOVERING TOWARD CONDITIONS IN OLDER FORESTS.

The composition of plant, moss, and mite species in the 15-year-old harvest areas was most similar to the communities in the > 40-year-old burned stands (Figure 21 shows results for plant species). Bird species in the harvest areas were intermediate between the bird communities in 15-year-old and 20- to 40-year-old burns (Figure 21). Most habitat structures were at levels similar to comparable age or older burns, except that snags, moss and lichen cover were at lower levels in harvest areas than in burned stands (Figure 22).

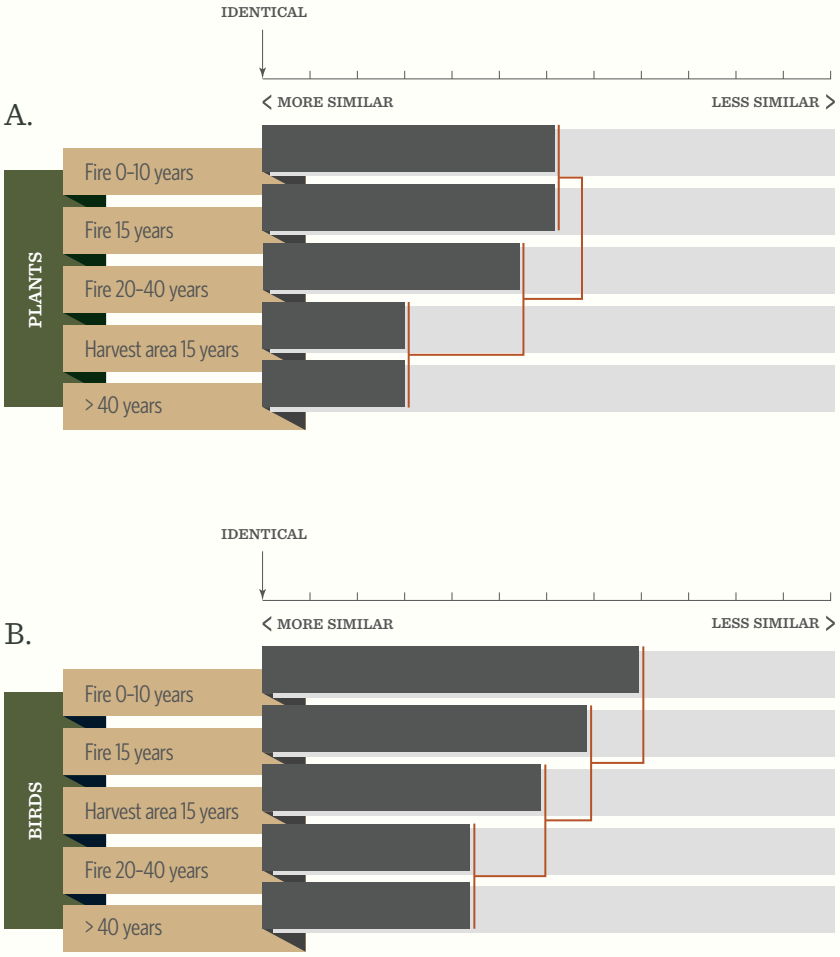


FIGURE 21

CLUSTER DIAGRAMS OF 15-YEAR HARVEST TREATMENTS AND AGE CLASSES OF FIRE, BASED ON RELATIVE ABUNDANCES OF A. 111 PLANT SPECIES, AND B. 67 BIRD SPECIES. TREATMENTS THAT CLUSTER TOGETHER MORE CLOSELY HAVE MORE SIMILAR COMPOSITIONS OF SPECIES.

†††† Full results of this spotlight can be found in Huggard, D.J., B.E. Grover, E. Dzus, M. Smith, J. Schieck. 2014. Effectiveness Monitoring for Biodiversity: Comparing 15 Year Old Structural Retention Harvest Areas to Fires in Boreal Aspen. Canadian Journal of Forest Research 44: 1-9. Web access: dx.doi.org/ 10.1139/cjfr-2014-0091.

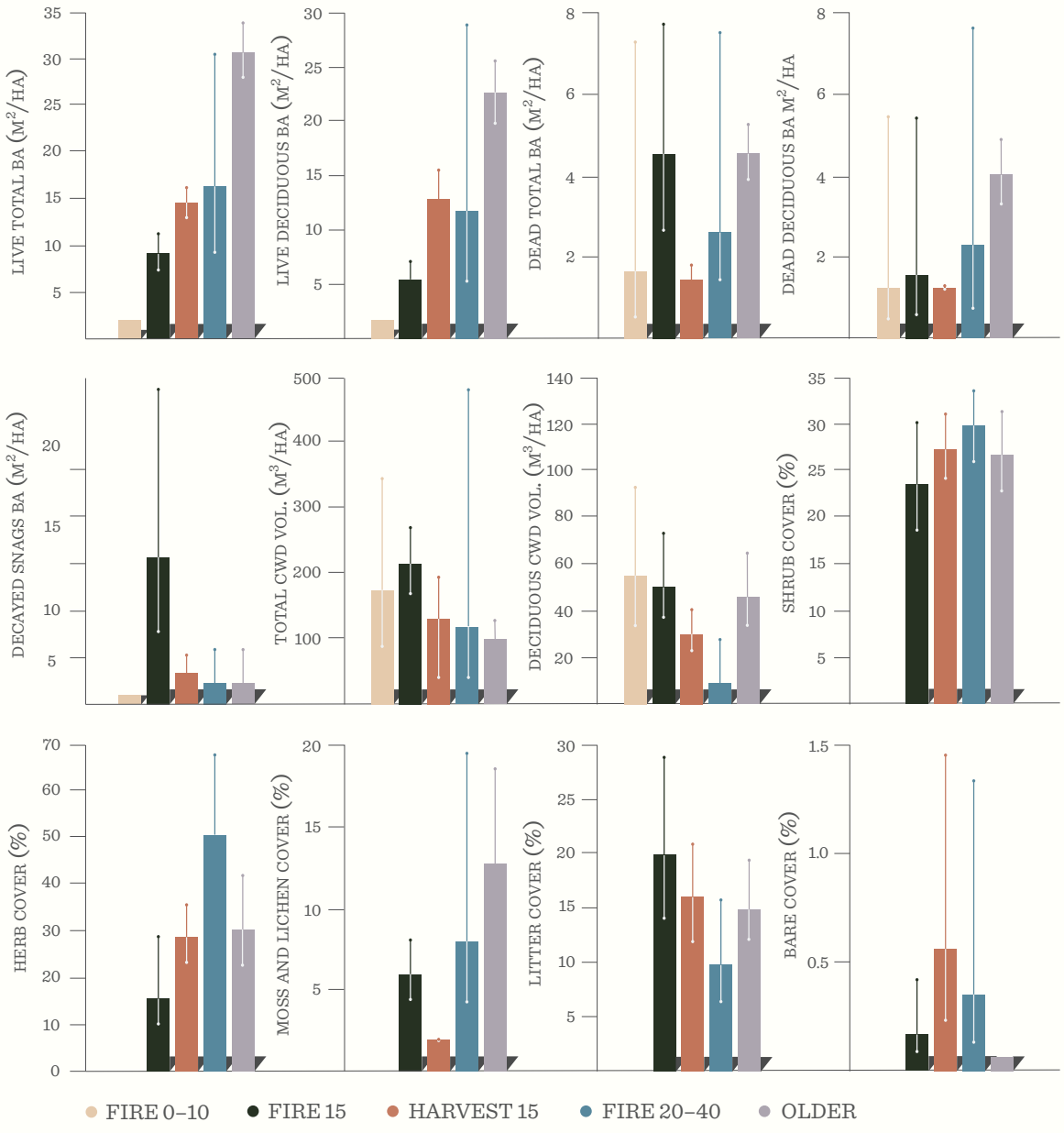


FIGURE 22

HABITAT STRUCTURES IN FOUR AGE CLASSES OF BURNED ASPEN STANDS AND IN A 15-YEAR OLD HARVEST. ERROR BARS ARE 90% CONFIDENCE INTERVALS. BA = BASAL AREA, CWD = COARSE WOODY DEBRIS.

In another analysis, we found that the 15-year-old harvest areas had bird and plant communities that were most similar (on average) to communities we would expect in an older forest. Given that most of the treed vegetation in a new cut block has been removed (i.e., human footprint is > 90%), we interpret results to mean that biodiversity in 15 year-old harvest areas is approximately 60% recovered. There was variation among the individual harvest areas, with some at lower and some at higher levels of recovery.

After 15 years, aspen stands harvested with structural retention have recovered substantially toward older forest conditions. Aspen stands probably recover quickly because aspen sprouts rapidly from stumps. This avoids the long initial periods with distinct herb or shrub cover that are seen in harvested conifer stands. Many bird species use larger trees, snags, and complex canopies, which may explain why they recover more slowly than plants, mosses, and mites.[24]

Harvested aspen stands recovered faster than burned stands, for most habitat elements and species. Exceptions are snags, moss and lichen cover, and a few old-forest birds and plants that remain rare in the harvest areas—for example, Black-throated Green Warbler, Brown Creeper, and Golden-crowned Kinglet; Rattlesnake Plantain, Buffaloberry, and Ground Cedar. These species will be important to monitor as the harvest areas continue to age.

MANY SPECIES IN 15-YEAR-OLD ASPEN HARVEST AREAS HAVE RECOVERED TO LEVELS FOUND IN OLDER BURNED STANDS, BUT A FEW REMAIN RARE, SUCH AS THIS GOLDEN-CROWNED KINGLET.

Conclusion

Responsible forest management requires a clear understanding of how forestry operations impact biodiversity, and monitoring helps identify opportunities for improvement. The biodiversity indicators in this report establish the current conditions that can be used to evaluate forest management objectives.

In this report, we describe the current status of human footprint and biodiversity in the Al-Pac FMA area. We found:

- As of 2013, the total human footprint across the Al-Pac FMA area was 7.5%. Covering 4.8% of the FMA area, forestry was the largest human footprint, followed by energy footprint, which covered 2.1% of the Al-Pac FMA area.
- Overall, 92.5% of the Al-Pac FMA area is composed of natural habitat with a 0 m buffer from human footprint, while 5.7% of native habitat is at least 500 m away from any development.
- Biodiversity intactness for the Al-Pac FMA area is 94%.
- Predicted intactness of species associated with old deciduous and mixedwood forest in the Al-Pac FMA area was high for all assessed taxa, ranging from 94% intact for birds up to 97% intact for winter-active mammals and vascular plants. However, individual species in each taxonomic group showed declines in estimated intactness from 1999 to 2012 as a result of changing habitat suitability; these species were disproportionately affected by forestry footprint compared to non-forestry footprint.
- After 15 years, aspen stands harvested with structural retention have recovered substantially to older forest conditions, with many habitat elements recovering more quickly as compared to burned stands.

Results from this report set the stage for openly addressing key questions such as:

1. What components of biodiversity are the most sensitive to forestry footprint, and what might be done to minimize undesired and lasting effects?
2. What are the cumulative effects of resource development on biodiversity, and how effective are efforts to manage regional cumulative effects?
3. What is the effect of forestry development on biodiversity as compared to other land uses, such as energy activities?
4. What is the duration of biotic effects of forest harvesting as harvested stands return to forest?
5. Given that economic benefits from resource development may have a biodiversity trade-off both spatially and temporally, what trade-offs are Albertans prepared to make?

With the Al-Pac FMA area at 94% intact today, there is significant opportunity for forest managers to make informed and deliberate choices about its future. As development continues to unfold in the Al-Pac FMA area, the ABMI will continue to measure and report on the changing state of biodiversity.

Next Steps

The ABMI will continue to work with federal and provincial agencies to implement scientifically credible monitoring systems for the Al-Pac FMA area and for the province as a whole. The analyses in this report are preliminary as not all ABMI sites in the Al-Pac FMA area have been sampled. As monitoring information for the region accumulates and our analysis methods continually improve, the ABMI will report on more species and habitats. Future reports will also report on biodiversity trends—the primary purpose of the ABMI. We look forward to the next five-year update on the status of biodiversity in the Al-Pac FMA area.

General Terms

Limitations

The ABMI is designed primarily as a proactive tool used to identify the status, trends, and correlative relationships among common species, habitats, and human footprint. While the status and trends of some rare species and species at risk can be evaluated using the ABMI monitoring program, the monitoring program cannot directly evaluate all rare and endangered species.

The ABMI indices are based on the establishment of current, intact reference conditions that are statistical predictions designed to account for human footprint. These reference conditions and subsequent ABMI analyses and reporting do not account for historical changes in the overall abundance of a species (i.e., the ABMI cannot account for any change in a species that occurred before 2003). ABMI reference conditions have statistical uncertainty for individual species. This uncertainty will decrease as the ABMI surveys more sites in the Al-Pac FMA area.

Looking Forward

The ABMI has made considerable strides in supporting biodiversity management in Alberta; however, we are just beginning. The ABMI continues to build momentum and is committed to:

- Ensuring the effective delivery of relevant, timely, and scientific biodiversity information
- Improving biodiversity management by contributing knowledge to decision-making systems
- Supporting governments and industries in meeting their domestic and international reporting obligations
- Eliminating duplication and redundancy in provincial biodiversity monitoring
- Facilitating the transfer of information to government, industry, the research community, and the public

Scientific Integrity

The ABMI is committed to the responsible analysis and evaluation of data. The ABMI holds itself to the highest ethical standards, including operational transparency, honesty, conscientiousness, and integrity. The ABMI strongly encourages the responsible and ethical evaluation and interpretation of the knowledge contained in this report. For a complete discussion of the ethical behaviour endorsed by the ABMI, please see Honor in Science, published by Sigma Xi (1997), available at www.sigmaxi.org/programs/ethics/Honor-in-Science.pdf. A broader discussion about the use of ABMI data and information can be found in Scope and Application of the ABMI's Data and Information (00048), Version 2008-01-04, Alberta Biodiversity Monitoring Institute, Alberta, Canada. This report is also available at www.abmi.ca under "Publications."

Disclosure

Data used in the preparation of this report is available on the ABMI's website and include species, habitat, and remotely sensed data collected between 2003 and 2013. The scientific methods used in analyses of data for this report are described in the following documents:

1. Alberta Biodiversity Monitoring Institute. 2012. Manual for Estimating Species and Habitat Structure Intactness (20029), Version 2012-12-04. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at www.abmi.ca under "Publications."

2. Alberta Biodiversity Monitoring Institute. 2012. Manual for Reporting Human Footprint (20030), Version 2013-03-26. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at www.abmi.ca under "Publications."

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Terms, Conditions, and References of Report

Preparation

In 2014, Alberta-Pacific Forest Industries Inc. requested the ABMI produce a five year update on the status of biodiversity in Al-Pac's FMA area. Al-Pac funded the creation of this report. The following terms were applied as a condition of the ABMI preparing this report:

1. The ABMI reports on a standardized list of biodiversity indicators that are relevant to regional planning, policy, and management. Developed by the ABMI, these indicators were consistently applied.

2. The ABMI maintains full control over all language and messaging in this report.

3. This biodiversity status report encompasses the Al-Pac FMA area and cannot be localized to smaller landscapes within the Al-Pac FMA area unless already specified in this report.

4. This biodiversity status report uses data collected between 2003 and 2013.

5. The report was released publicly in a timely manner.

Image Credits

Cover page, credit: Al-Pac / p.3: mixedwood forest, credit: Stephan Pietzko / p.4: ABMI data collection, credit: Daina Anderson / p.4: ABMI data collection, credit: Dinyar Minocher / p.8: mixedwood stand, credit: unknown / p.9: boreal forestry, credit: unknown / p.9: Aspen, credit: Christine Pachowski / p.10: boreal forest, credit: unknown / p.11: boreal fen, credit: unknown / p.11: seismic lines, credit: Pembina Institute / p.11: fall aspen, credit: colacat / p.11: boreal forest burn, credit: Richard Caners / p.15: forestry birch, credit: unknown / p.15: pipeline, credit: unknown / p.15: powerline, credit: unknown / p.24: Warbling Vireo, credit: Royal Alberta Museum / p.26: Red Squirrel, credit: Paul Reeves / p.28: Hermanniella robusta, credit: David Walters / p.30: Pyrola cholorantha, credit: Ed Ogle (Flickr) / p.32: Narrow-leaved Hawksbeard, credit: Dustin Delfs / p.34: Heller's Notchwort, credit: Oskar Gran (Flickr) / p.36: Rusty Blackbird, credit: Paul Reeves / p.39: Caribou, credit: John Nickles / p.41: linear features, credit: Kirsten Tereschyn / p.42: Common Flicker, credit: ABMI / p.42: Red-breasted Nuthatch, credit: Wayne Lynch / p.43: wetland, credit: Richard Caners / p.44: harvesting, credit: Al-Pac / p.47: Golden-crowned Kinglet, credit: Paul Reeves

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