Alberta Biodiversity Monitoring Institute

The STATUS OF BIODIVERSITY in the Lower Peace Region

Supplementary Report 2014

1.0 Table of Contents

2.0 Introduction

The report *The Status of Biodiversity in the Lower Peace Region* provides a high-level overview of biodiversity and human footprint in this planning region, one of seven land-use planning regions in the province of Alberta (Figure 1). This supplemental report provides the detailed methods and results that the Alberta Biodiversity Monitoring Institute (ABMI) used to generate the high-level findings presented in the status report (available at: www.abmi.ca).

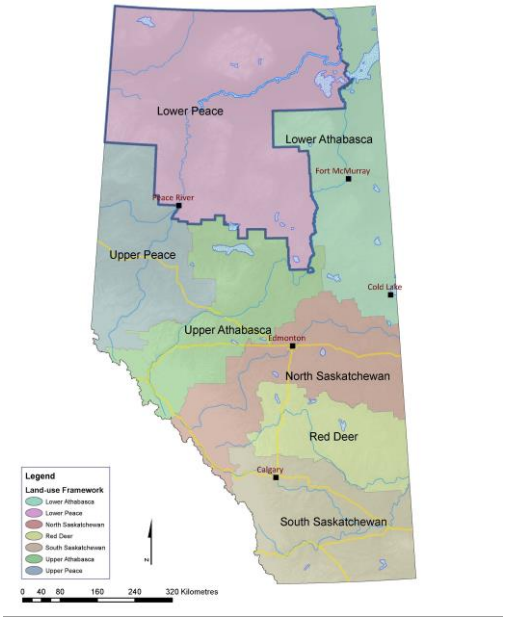


Figure 1. There are seven land-use planning regions in Alberta; this report focuses on the Lower Peace Region.

3.0 About the ABMI

The ABMI is a province-wide, long-term monitoring program designed to support natural resource decision-making. The ABMI provides relevant, timely and credible scientific knowledge on the state of provincial biodiversity and wildlife. Monitoring survey design and methods are regularly and extensively peer-reviewed by the greater scientific community to ensure scientific credibility.

Services offered by the Institute include: public access to raw data and value-added information products. These two services are designed to encourage:

1. ***Application*** **–** Return on investment in biodiversity monitoring is realized only if the resulting knowledge is applied. Public and timely access to ABMI products encourages the use of information in decision-making processes including resource management and public policy.
2. ***Transparency*** – Scientific credibility is at the foundation of the ABMI. Scientific inference produced by the Institute, or any other third-party, must be subject to independent audit and verification by the greater research and management community.
3. ***Efficiency*** **–** Collection and management of comprehensive, science-based biodiversity data is a significant investment. Use of this information by many stakeholders will reduce redundancy and costs in provincial environmental monitoring.

4. ***Innovation*** – Long-term, scientifically rigorous environmental data sets are highly valuable to the research and management communities. By making the ABMI's data publicly available, significant innovation is anticipated to occur in the discipline of sustainable resource management.
5. ***Awareness*** –The ABMI produces publicly available information on the status of biodiversity in different regions of interest in the province. Public access to this information raises awareness about changes in provincial biodiversity over time.

Under sustainable resource management systems, monitoring information is needed to assess the effectiveness of policies and programs: the ABMI is a key component in achieving the vision of sustainable resource management. Monitoring allows for confirmation when actions are successful or provides insight into what changes might be needed when desired outcomes are not being attained. As applied to biodiversity, monitoring should assess the effectiveness of resource management and support its improvement. The ABMI's information can be used to support the preparation of management plans and responses, as well as to identify any gaps in our understanding of the implications associated with changes in biodiversity.

This description of the ABMI's strengths is not meant to be restrictive. The ABMI recognizes, and encourages, the innovative use of the Institute's information. However, we strongly urge practitioners to make use of ABMI information in a responsible manner.

3.1 "Preliminary" Characterization of the Status Report

We characterize the status report as a preliminary assessment of biodiversity in the Lower Peace Region for two reasons. First, we have not implemented ABMI protocols at all sites in this region. As a result, the statistical confidence associated with results presented in the status report will be enhanced as additional data is collected and analyzed for the region. As we collect this additional data, we will remove the "preliminary" characterization of the report.

Second, we have not presented results for all the indicator types that are monitored by the ABMI. Over the next few years, the ABMI will broaden the assessment of biodiversity in the Lower Peace Region to include status and trends reporting for lichens and wetlands, as well as trends for all taxonomic groups as monitoring information continue to build.

4.0 Sampling Design

ABMI terrestrial sites are spaced throughout Alberta using the 20 km National Forest Inventory (NFI) grid. This results in ABMI having 1656 terrestrial sites (Figure 2). To ensure the site locations remain confidential, the ABMI sites are offset a random direction and distance from the NFI sites. Exact ABMI site locations are not shared. ABMI has created approximate locations (randomly located within 5 km of the actual site), and these are available from the ABMI website.

The Lower Peace Region is the focus of this report. Of the ABMI's 1656 sites, 481 of these sites are located in this region (Figure 2). We implemented ABMI spring and summer data collection protocols at 142 of the Lower Peace Region's 481 sites between 2003 and 2012.

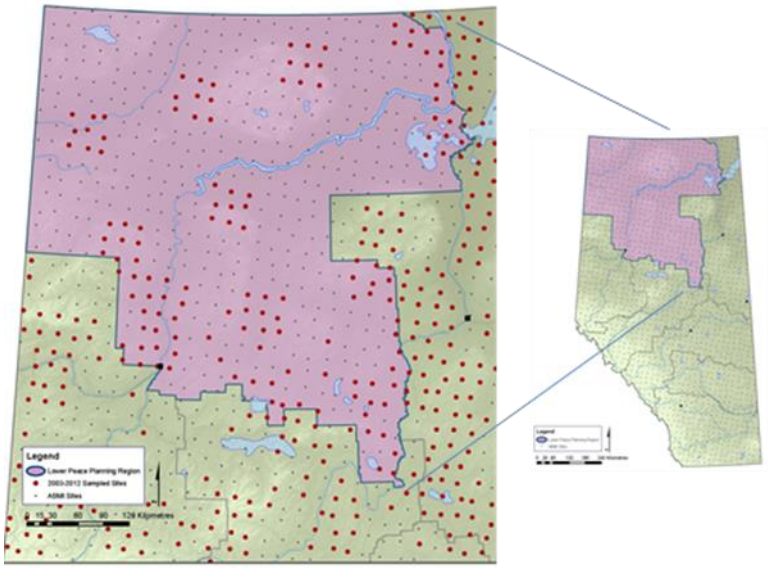


Figure 2. The Lower Peace Region represents 29% (192,176 km^2) of Alberta's total land area. The ABMI has 481 of our 1,656 survey sites in the Lower Peace; 142 of these sites have been sampled between 2003 to 2012.

Starting in May, through to the end of June, we sample breeding birds, armoured mites, and physical characteristics at each site. In July, we implement vascular plant and moss protocols. During the winter months (November to March depending on snow conditions) we sample winter-active mammals using snow tracking protocols. We implement protocols in the same way at all sites in each sampling year, except where protocol updates are noted in our methodology (see Further Reading at the end of this document).

Detailed data analysis protocols are available from the ABMI website (www.abmi.ca) under Reports (see Further Reading at the end of this document). We report on the status of biodiversity in the Lower Peace Region using only statistical results relevant to this area, or regions specified therein. Here we present methods and results for the following:

- Human Footprint
- Native Habitat
- Protected Areas
- Biodiversity Intactness including:
  - Predicted Biodiversity Intactness
  - Breeding Birds

  - Winter-active Mammals
  - Armoured Mites
  - Vascular Plants
  - Mosses
  - Species at risk
- Non-native species including:
  - Percentage occurrence in the Lower Peace Region
  - Predicted abundance of non-native species in the Lower Peace Region

5.0 Amount of Footprint – Remote Sensing Surveys

The ABMI defines human footprint (also known as human land use) as the visible conversion of native ecosystems to temporary or permanent residential, recreational, or industrial landscapes. This includes land conversion activities that support the forest, agriculture and energy industries, commercial and residential settlement, recreational infrastructure, and transportation infrastructure. The ABMI monitors the state of Alberta's human footprint using fine-resolution aerial photography and satellite imagery. The ABMI Remote Sensing Group conducts analyses of human footprint at two spatial scales:

1. Using a sampling design, the ABMI monitors human footprint annually in a 3 × 7 km area around each ABMI site location. These detailed annual samples of human footprint are available from 1999 to 2012, except for 2000 and 2006 because data from these years is unreliable.
2. At the provincial scale, existing satellite imagery is used to create a wall-to-wall inventory of human footprint of the entire province. This 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 and 2010.

These mapped products are updated at regular intervals to track changes in human footprint and habitat through time. To assess the status of human footprint, the ABMI uses the GIS Inventory of Provincial Human Footprint. To assess trend in human footprint, the ABMI uses the 3 × 7 km detailed inventory. To report on the status and trend of human footprint, the ABMI presents 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 Lower Peace Region is based on the 3 × 7 km samples of human footprint data. Human footprint data for Caribou population ranges is calculated using the GIS Inventory of Provincial Human Footprint circa 2007 and 2010.

5.1 Human Footprint Methods

The ABMI's GIS Inventory of Provincial Human Footprint Map Layer (circa 2007 and 2010) is the product of multiple sub-layers, many of which were obtained through data-sharing agreements with Alberta Sustainable Resource Development and the forest industry (Table 1). To the degree practical, we corrected or created human footprint features when source data was inaccurate or missing. We created new inventories for cities, human settlement, oil sands facilities and mines, and farmsteads to ensure data would conform to the ABMI's human footprint categories, and were scientifically credible. Other data used include: roads, well sites, facilities, pipelines, power lines, railways, and cutlines (seismic lines and narrow trails). We validated source data and created new provincial inventories using SPOTS imagery (circa 2007 and 2010). See Table 2 for a description of ABMI human footprint categories.

Table 1. Sources for base features used to represent human footprint.

Features	Source	Year Represented
Forest harvesting	Alberta Vegetation Inventory (AVI), AVI Updates, the Crown, AESRD, and individual companies in conjunction with ABMI-created inventory (based on SPOT 2007 and 2010 mosaic of the province)	2007 and 2010
Agriculture	ABMI-created provincial inventory (based on SPOT 2007 and 2010 mosaic of the province); in conjunction with Alberta Ground Cover Characterization (AGCC), Agricultural Land Cover Classification (ALCC), and Grassland Vegetation Inventory (GVI) as reference	2007 and 2010
Cities and Settlements	ABMI created inventory (based on SPOT 2007 and 2010 mosaic of the province)	2007 and 2010
Roads	Provincial "roads" GIS data layer (line; GoA source) and in conjunction with ABMI-created area estimates for linear features.	2008 and 2010
Wellsites	Provincial "wellsites" GIS data layer (point; GoA source) and in conjunction with ABMI validation procedures	2007 and 2010
Pipelines	Provincial "pipelines" GIS data layer (line; GoA source)	2008 and 2010
Power Lines	Provincial "powerlines" GIS data layer (line; GoA source)	2008 and 2010
Rail Lines	Provincial "raillines" GIS data layer (line; GoA source)	2006 and 2010
Cutlines	Provincial "cutlines" GIS data layer (line; GoA source)	2008 and 2010
Facilities	Provincial "facilities" GIS data layer (line; GoA source) and in conjunction with ABMI validation procedures	2007 and 2010

Table 2. ABMI human footprint types used in the ABMI's GIS Inventory of Provincial Human Footprint Map Layer.

Human Footprint Category	Human Footprint Type	Human Footprint Description
Agriculture	Canals	• created to transport water
	Cultivation (Crop/Pasture/Bare Ground)	• any area where evidence of cultivation is visible during the photo interpretation
Commercial and Industrial	Industrial Site Rural	• rural area developed for industrial use
	High Density Livestock Operation	• confined feeding operation and other high density livestock area
	Reservoirs	• man-made lake
	Landfill	• landfill
Energy and Mining	Peat Mine	• area where vegetation is disturbed
	Well Site	• well pads created by the energy industry
	Mine Site	• area where vegetation is disturbed
	Wind Generation Facility	• area around the windmill
	Pipeline	• area where vegetation is disturbed
	Transmission Line	• area where vegetation is disturbed
	Seismic Line	• area where vegetation is disturbed
	Borrow-pits, Dug-outs, Sumps	• created to extract fill, or for livestock watering
Forestry	Cut Blocks	• area with trees harvested for industrial purposes
Residential and Recreation	Urban	• cities and towns
	Rural (Residential/Industrial)	• small rural development (mostly residential but some industrial)
	Other Disturbed Vegetation	• recreation areas and other vegetated areas created for human use, including golf courses, grave yards vegetated edges of airports, and any other disturbed areas that have recovered vegetation
	Municipal (Water and Sewage)	• created for municipal purposes
Transportation	Road - Hard Surface	• paved or gravel
	Rail - Hard Surface	• usually gravel
	Road/Trail (vegetated)	• road/trail without gravel or pavement
	Road - Vegetated Verge	• vegetated strips along paved/gravel roads
	Rail - Vegetated Verge	• vegetated strips along railways

The 2007 and 2010 versions of the ABMI's GIS Provincial Inventory of Human Footprint do not account for succession (or reclamation) of human footprint, but treats all types of human footprint on the landscape equally. The current maps do not present age of disturbance or the current

habitat/vegetation cover within features such as cut blocks or seismic lines. The ABMI is currently developing the science necessary to account for this regeneration so that recovering areas can make a reduced contribution to the estimate of total human footprint.

5.2 Human Footprint Results

As of 2012, the total human footprint across the Lower Peace Region was 7.3% (Figure 3, 4a). Forestry footprint was the largest human footprint category covering 2.8% of the planning region in 2012 (Figure 4B), followed by agriculture footprint at 2.5% (Figure 4C), and energy footprint at 1.6% (Figure 4D).

The total area of human footprint increased by 2% from 5.3% to 7.3% of the area between 1999 and 2012 (Figure 3). This increase was largely driven by forestry footprint increasing from 1.5% coverage to 2.8% coverage in 2012, and surpassing agriculture as the predominant footprint. Energy footprint and agriculture footprint increased slightly during this period.

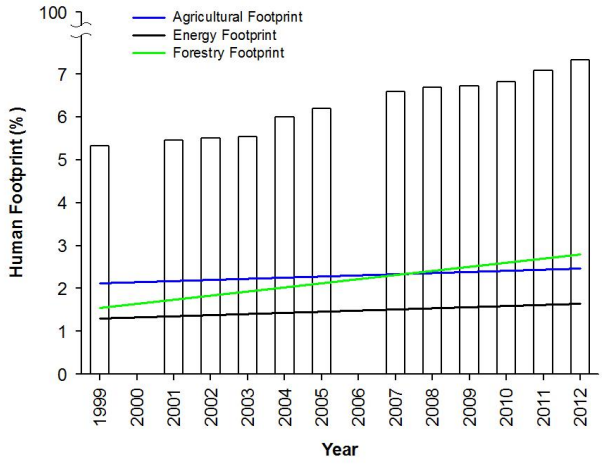


Figure 3. The percentage of total human footprint (vertical bars), agriculture footprint, energy footprint, and forestry footprint in the Lower Peace Region from 1999 to 2012. Detailed human footprint trend data is available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

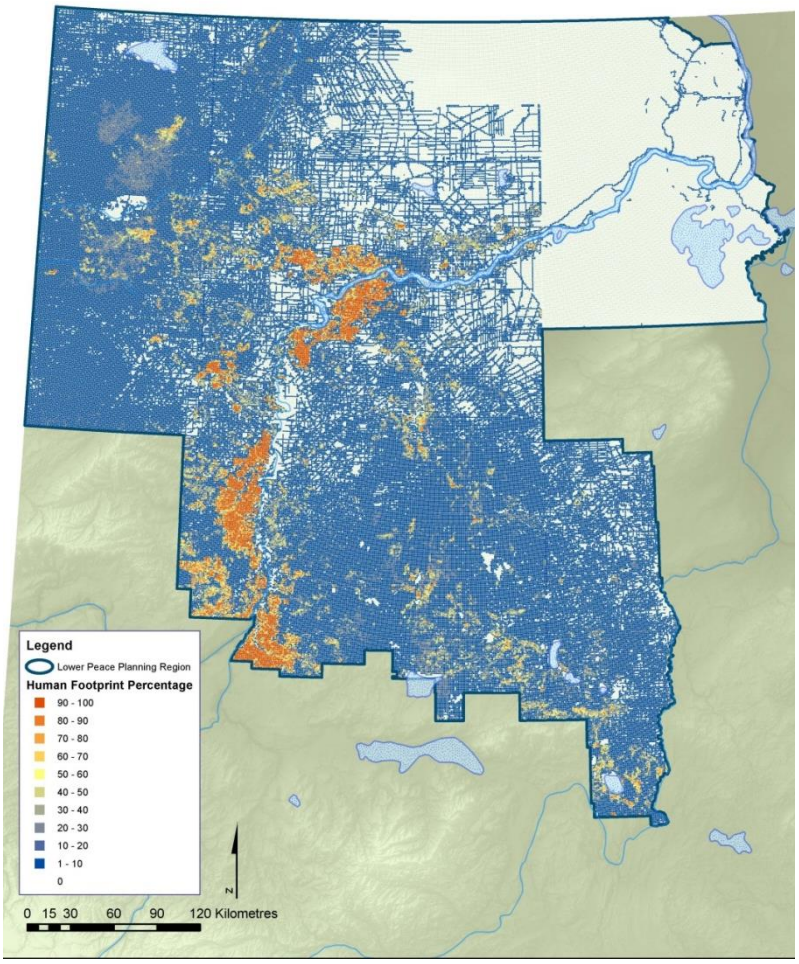
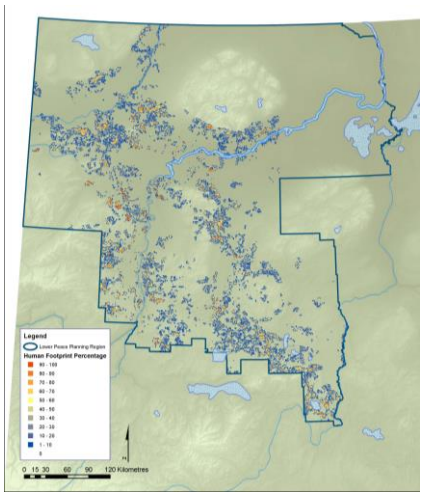
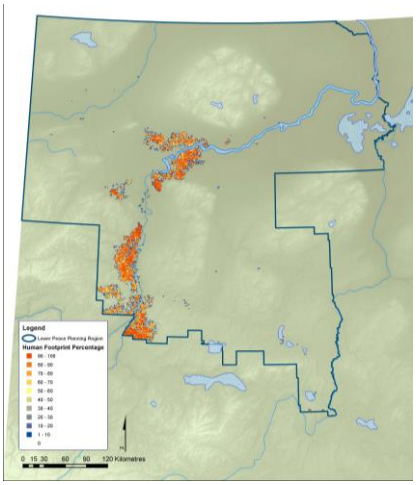


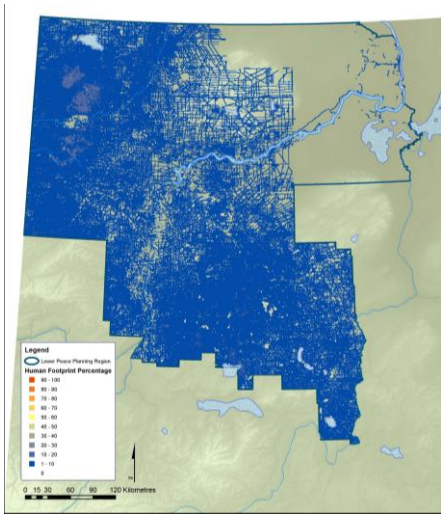
Figure 4a. Distribution of human footprint across the Lower Peace Region circa 2010.



4b. Distribution of forestry footprint in the Lower Peace Region, circa 2010.



4c. Distribution of agriculture footprint in the Lower Peace Region, circa 2010.



4d. Distribution of energy footprint in the Lower Peace Region, circa 2010.

6.0 Native Habitat Methods and Results

Proximity of human footprint can affect how species use native habitat. 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 native habitat using four different buffer distances: 0 m, > 50 m, > 200 m, and > 2 km away from footprint. These distances delimit the amount of native habitat available with a given "buffer" from human footprint. For example, at 0 m from human footprint, all native habitat in the region is included. These numbers are valuable because species respond differently to human activity with some requiring more distance from footprint.

Overall, 93% of the Lower Peace Region is composed of native habitat with a 0 m buffer from human footprint whereas, in the case of native habitat that is at least 2 km away from development, 19% remains (Table 3).

As a note of caution, our summary of native habitat does not yet account for some forms of human land use (e.g., livestock grazing or hunting) that may not be consistent with the management objectives of a particular stakeholder. Successional recovery in cut blocks and seismic lines to native habitat is also not yet accounted for.

Table 3. Total area and percent area of native habitat in the Lower Peace Region expressed using four buffers.

	Native Habitat	
Buffer size	**Total Area (km^2)**	**Percent Area (%)**
No Buffer	178,662	93
50 m	146,530	76
200 m	96,460	50
2 km	35,646	19

7.0 Protected Area Methods and Results

The ABMI used geographic information system (GIS) analyses to summarize the percentage of the Lower Peace Region that are managed as protected areas. The ABMI's definition of protected areas in the Lower Peace Region includes Alberta's parks and protected areas network, national parks, and National Wildlife Areas.

Overall, 22% (42,914 km^2) of the Lower Peace Region is managed as protected areas (Figure 5), including: a portion of one national park, all or portions of three provincial parks, seven provincial recreation areas, two wilderness areas, one wildland park, three natural areas and five wildland provincial parks. Over 36,000 km^2 (84%) of the protected area in the Lower Peace Region is a part of Wood Buffalo National Park.

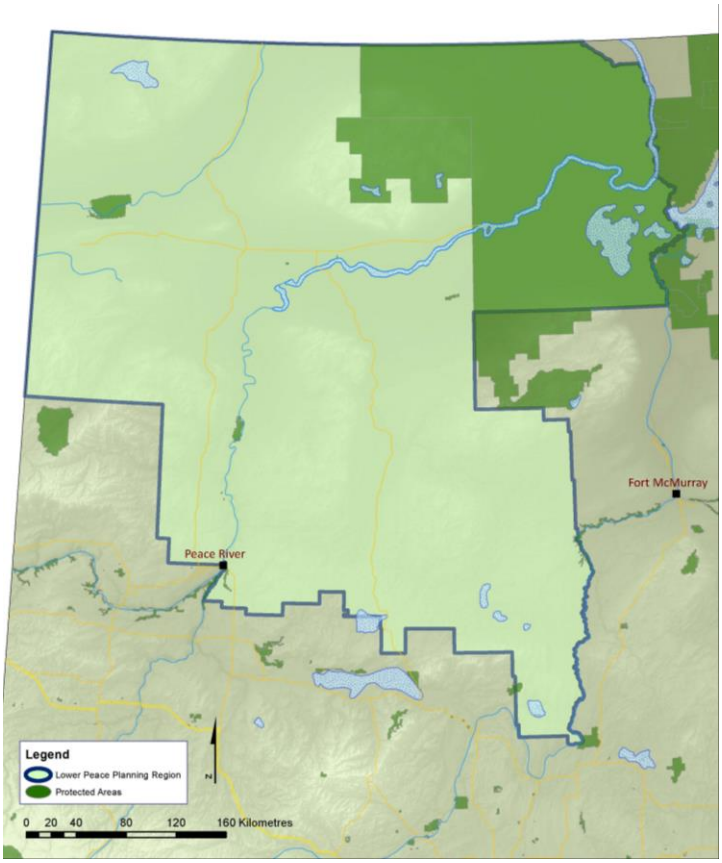


Figure 5. Distribution of protected areas in the Lower Peace Region. Overall, 22% (42,914 km^2) of the region is managed as protected areas.

8.0 Biodiversity Intactness Analysis

There are three steps in calculating biodiversity intactness: 1) Fitting statistical models that describe the relationship between each species and human footprint. This step uses the field data from ABMI sites across broad regions (e.g., the boreal natural region). 2) Using these models to predict the current and reference abundance of each species at every quarter section in the reporting region. This is based on GIS summaries of human footprint and other variables in each quarter section in the reporting region. 3) 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) and overall biodiversity.

1) Fitting models of footprint relationships. ABMI collects data on relative abundances of many species at each monitoring site. We also summarize GIS layers of human footprint and vegetation types for each area we sample (1 ha squares at each site for plants, mosses, mites; nine 150 m-radius circles for birds). We use a set of statistical models to estimate how the abundance of each species responds to the different levels of human footprint types at sites. We use several models of human footprint, each summarizing the different types of footprint in different ways. For example, one model combines all footprint types as “total human footprint”, while another distinguishes footprint types that permanently remove vegetation (e.g. industrial sites) from those that allow vegetation to regrow (e.g. forestry), while a third model distinguishes linear features like roads from non-linear footprint types. All of these models

are used to make predictions for each species, with the data being used to determine how much weight each model has.

Fitting footprint models is complicated by the fact that footprint levels differ in different vegetation types and in different parts of the province. To separate out the effects of footprint from these other factors, we include additional variables in our models for vegetation types and for geographic location. Vegetation types in forested regions are described by major stand types – deciduous, upland conifers with pine as a separate type, mixedwood, lowland conifers – and broad age classes, along with some non-treed types like wetlands, open water, grass and shrubs. Geographic location is described by a smooth surface based on latitude and longitude. A set of models is used for each species to find out how best to summarize the vegetation variables. The best vegetation variables and the geographic surface are then used in the main set of models for footprint relationships.

2) Predicting current and reference abundances at each quarter-section. Once we have fit the footprint models, we use them to predict the current and reference abundances of each species at each quarter section in the reporting region. Current abundance is the abundance predicted with the current amount of each footprint type. Reference abundance is the abundance if there was no footprint. The predictions use GIS summaries of the footprint types, and the additional vegetation variables and geographic location, at each quarter section.

ABMI monitors birds with plots totaling about a quarter section in area. The footprint models for birds can therefore be applied directly at the quarter section scale. Other taxa are measured in a 1-ha plot. The models for those taxa are therefore applied to a random 1-ha area in each quarter section.

3) Regional totals of current and reference abundance and intactness. After predictions are made for each taxa, we sum the total relative abundances under current conditions, and under reference conditions, for the reporting region. Intactness is then calculated as current abundance / reference abundance x 100% if current abundance is less than reference (i.e., a species that declines with footprint). If current abundance is greater than reference, then intactness is reference abundance / current abundance x 100%. In both cases, intactness declines from 100% as the current abundance differs more from reference. Intactness for groups of species is calculated as a simple average of the values for each species.

Confidence intervals are estimated for each species by bootstrapping, which resamples the original data and reruns the entire analysis on that resampled data. This is repeated 100 times to show how variable the intactness estimates are.

Further details about the analysis can be found in:

Alberta Biodiversity Monitoring Institute. 2012. Manual for Estimating Species and Habitat Intactness at the Regional Scal, Version 2012-12-04. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

The Biodiversity Intactness Index is calculated for species in the following taxonomic groups: native birds, winter-active mammals, armoured mites, vascular plants, and mosses and liverworts. We present methods and results for the predicted biodiversity intactness across the Lower Peace Region along with methods and results for the five taxonomic groups.

9.0 Predicted Biodiversity Intactness Methods and Results

Based on collected data, 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 individual species in the region. The models can also be used to estimate intactness for each species for every quarter section of land in the Lower Peace Region—in other words, for locations where the ABMI is not directly monitoring. Using the ABMI's Inventory of Human Footprint (circa 2010) and data on vegetation types, the average intactness for 420 species in the Lower Peace Region has been estimated and mapped to generate an overall picture of biodiversity in the region (Figure 6).

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 Lower Peace Region is calculated at 94%. Clearly, the map shows that large areas of the region have little to no human footprint, and correspondingly higher biodiversity intactness (shown as dark green in Figure 6). On the other hand, other areas, particularly some areas bordering the Peace River, have more intense human footprint which results in lower biodiversity intactness (e.g., < 30%, shown as orange in Figure 6). Regional biodiversity intactness is high because large areas in the Lower Peace Region that 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.

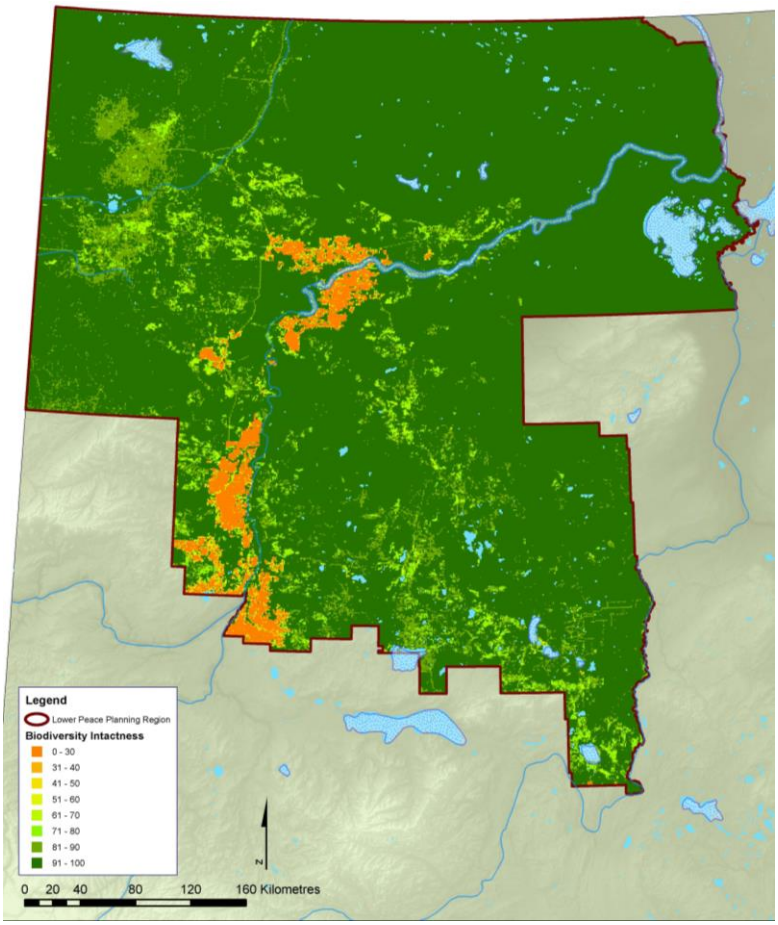


Figure 6. Average predicted intactness for over 400 species in the Lower Peace Region. Orange identifies the quarter sections that are predicted to have the lowest average biodiversity intactness values, and dark green identifies quarter sections with the highest intactness. To view the same image in an alternative colour palette please see Figure A-1 in Appendix 1.

10.0 Breeding Bird Methods and Results

10.1 Breeding Bird Survey Methods

At each site, we measured breeding birds at nine point-count stations arranged in a grid pattern with point-count station #1 located at site-centre and the remaining stations located at 300 m intervals in a square around site centre (Figure 7). We conducted breeding bird surveys from one half hour before sunrise to 10:00 am.

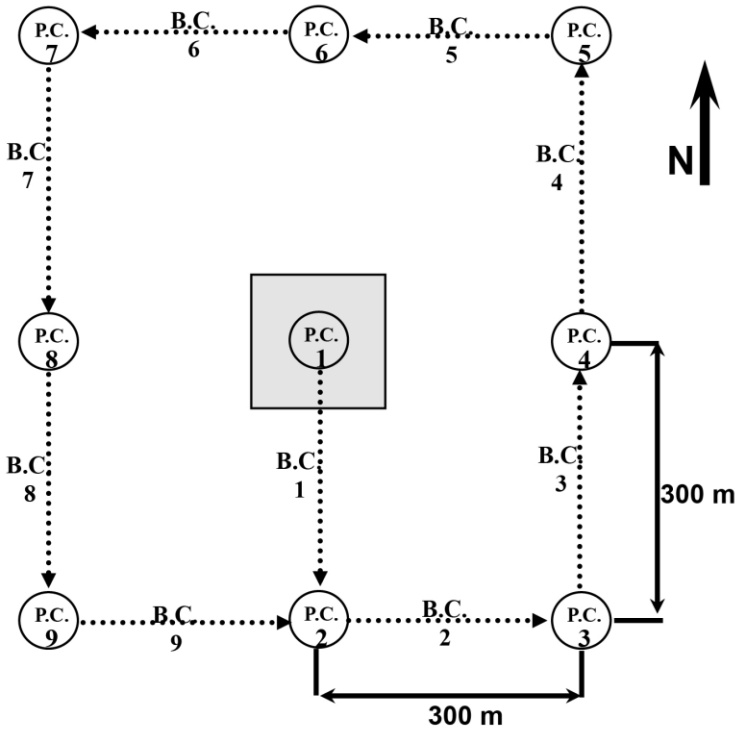


Figure 7. Diagram showing the layout of the nine bird-point count stations at the ABMI's terrestrial survey sites. Technicians proceed consecutively from station 1 to station 9.

We recorded vocalizations of birds for 10 minutes at each point-count station using an omni-directional microphone (CZM microphone; River Forks Research Corp.) mounted at ear level on a professional tripod and connected to a mini recorder. We recorded birds on an iRiver HP-120 Recorder or a Marantz PMD670 Solid State recorder at 320 kbps in .mp3 format. We calibrated the recorder volume to be in the mid ranges.

While conducting the 10-minute bird recordings, we scanned the areas surrounding the point-count station for all birds (even those vocalizing), noting for all bird observations: species, number of individuals (including flock sizes of birds flying overhead), and distance from the point-count station. We also noted factors that potentially bias bird recordings, such as wind speed, precipitation, and human-caused noise. We recorded detailed information on the physical and ecological characteristics within 150 metres around the point-count station. Ecological information included: ecosite type, any human and/or natural disturbance (e.g. cutblocks, fires, roads), dominant tree species, average distance between trees, tree heights, and shrub and herbaceous cover. Physical conditions include the slope, aspect, and proportion of bare ground and/or water present.

When bird point-count stations were located within a waterbody, we established a new station if we were able to get within 100 m of the original point (i.e., > 200 m from the last point), recording the new GPS location and distance and direction from the original station. If it was not possible to get within 100 m of the point (i.e., < 200 m from the last point), we conducted a 10-minute visual point-count of the waterbody, noting observations with the recorder. We may not have sampled certain points because they were inaccessible (e.g., location of a stream made access hazardous or impossible).

We analyzed bird recordings in a laboratory setting. We identified the species, time of first detection (within 10 second intervals), behaviour (e.g., singing, calling, or alarm-calling), and the time interval that individual birds were detected. We recognized three time intervals: Interval 1 (0–200 seconds), Interval 2 (201–400 seconds), and Interval 3 (401–600 seconds). Individual birds were detected in 1, 2, or 3 of the time intervals.

10.2 Breeding Bird Data Analysis

For each species detected at each site, we calculated the relative abundance as the occurrence at each point-count station (0 through 9). We determined intactness values for each species that was detected at a minimum of 20 sites in the Boreal, Lower Foothills, and Parkland Natural Regions north of 53.5 N, the area we used for fitting the models. We summarize intactness for birds in the Lower Peace Region as a whole, and for the Peace River Oil Sands Area in the Lower Peace Region.

Results are summarized for all birds (Table 4, Figure 8).

10.3 Bird Results

10.3.1 Intactness of all birds in the Lower Peace Region

Table 4. Complete list of breeding bird species analyzed in the Lower Peace Region including: species common name, species scientific name, percent (%) occurrence, relative abundant, reference abundance, intactness, and whether it was more abundant (Above) or less abundant (Below) than expected compared to reference conditions. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

Common Name	Scientific Name	Occurrence in the Lower Peace (%)	Relative Abundance (mean detections per ABMI site; maximum 9)	Reference Abundance per Site (expected modeled abundance under zero human development)	Intactness Index (0-100 scale)	Above or Below Reference Conditions
Alder Flycatcher	*Empidonax alnorum*	44	1.75	1.43	82	Above
American Crow	*Corvus brachyrhynchos*	20	0.35	0.23	65	Above
American Goldfinch	*Carduelis tristis*	8	0.10	0.08	95	Above
American Redstart	*Setophaga ruticilla*	48	1.54	1.52	100	
American Robin	*Turdus migratorius*	45	1.42	1.21	87	Above
Bank Swallow	*Riparia riparia*	4	0.04	0.04	97	Above
Bay-breasted Warbler	*Dendroica castanea*	14	0.15	0.15	100	
Black and White Warbler	*Mniotilta varia*	44	1.50	1.49	99	Below
Black-billed Magpie	*Pica hudsonia*	3	0.22	0.14	62	Above
Black-capped Chickadee	*Poecile atricapillus*	28	0.33	0.31	96	Above
Blackpoll Warbler	*Dendroica striata*	12	0.26	0.24	97	Above
Black-throated Green Warbler	*Dendroica virens*	12	0.21	0.25	86	Below
Blue-headed (solitary) Vireo	*Vireo solitarius*	35	0.64	0.67	95	Below
Blue Jay	*Cyanocitta cristata*	8	0.05	0.05	95	Above
Boreal Chickadee	*Poecile hudsonica*	24	0.34	0.35	94	Below
Brewer's Blackbird	*Euphagus cyanocephalus*	4	0.05	0.04	92	Above
Brown Creeper	*Certhia americana*	7	0.07	0.09	79	Below
Brown-headed Cowbird	*Molothrus ater*	13	0.15	0.16	100	
Canada Warbler	*Wilsonia canadensis*	17	0.31	0.33	96	Below
Cape May Warbler	*Dendroica tigrina*	33	0.54	0.55	96	Below
Cedar Waxwing	*Bombycilla cedrorum*	24	0.48	0.48	98	Above
Chipping Sparrow	*Spizella passerina*	89	4.26	4.14	98	Above
Clay-colored Sparrow	*Spizella pallida*	28	0.79	0.60	77	Above
Common Raven	*Corvus corax*	54	1.10	1.05	96	Above
Common Yellowthroat	*Geothlypis trichas*	39	1.03	0.99	97	Above
Connecticut Warbler	*Oporornis agilis*	21	0.31	0.30	98	Above

Dark-eyed Junco	*Junco hyemalis*	60	1.85	1.93	96	Below
Evening Grosbeak	*Coccothraustes vespertinus*	7	0.07	0.06	94	Above
Fox Sparrow	*Passerella iliaca*	16	0.74	0.72	100	
Golden-crowned Kinglet	*Regulus satrapa*	11	0.15	0.16	94	Below
Gray Jay	*Perisoreus canadensis*	83	3.34	3.43	97	Below
Greater Yellowlegs	*Tringa melanoleuca*	19	0.35	0.34	99	Above
Hairy Woodpecker	*Picoides villosus*	5	0.06	0.05	94	Above
Hermit Thrush	*Catharus guttatus*	71	3.32	3.52	95	Below
Killdeer	*Charadrius vociferus*	4	0.09	0.04	59	Above
Least Flycatcher	*Empidonax minimus*	60	1.62	1.77	93	Below
Le Conte's Sparrow	*Ammodramus leconteii*	22	0.39	0.38	96	Above
Lesser Yellowlegs	*Tringa flavipes*	10	0.41	0.40	96	Above
Lincoln's Sparrow	*Melospiza lincolnii*	71	2.23	2.01	92	Above
Magnolia Warbler	*Dendroica magnolia*	56	1.58	1.52	95	Above
Mourning Warbler	*Oporornis philadelphia*	24	0.25	0.22	94	Above
Northern Flicker	*Colaptes auratus*	18	0.38	0.33	87	Above
Northern Waterthrush	*Parkesia noveboracensis*	32	1.56	1.62	98	Below
Olive-sided Flycatcher	*Contopus cooperi*	13	0.38	0.39	99	Below
Orange-crowned Warbler	*Oreothlypis celata*	29	0.60	0.56	92	Above
Ovenbird	*Seiurus aurocapilla*	72	2.68	3.00	89	Below
Palm Warbler	*Dendroica palmarum*	48	2.23	2.46	91	Below
Pileated Woodpecker	*Dryocopus pileatus*	18	0.18	0.17	90	Above
Pine Siskin	*Carduelis pinus*	46	1.32	1.32	99	Above
Red-breasted Nuthatch	*Sitta canadensis*	33	0.49	0.46	93	Above
Red-eyed Vireo	*Vireo olivaceus*	66	2.88	2.75	95	Above
Red-winged Blackbird	*Agelaius phoeniceus*	29	1.09	0.98	90	Above
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	49	0.87	0.89	96	Below
Ruby-crowned Kinglet	*Regulus calendula*	75	3.72	3.89	96	Below
Ruffed Grouse	*Bonasa umbellus*	25	0.30	0.28	93	Above
Rusty Blackbird	*Euphagus carolinus*	9	0.12	0.11	94	Above
Savannah Sparrow	*Passerculus sandwichensis*	10	0.28	0.10	36	Above
Solitary Sandpiper	*Tringa solitaria*	20	0.42	0.46	96	Below
Song Sparrow	*Melospiza melodia*	8	0.22	0.08	37	Above
Sora	*Porzana carolina*	18	0.37	0.35	94	Above
Spotted Sandpiper	*Actitis macularius*	12	0.26	0.23	88	Above
Swainson's Thrush	*Catharus ustulatus*	84	4.78	4.82	99	Below

Swamp Sparrow	*Melospiza georgiana*	17	0.46	0.46	98	Below
Tennessee Warbler	*Oreothlypis peregrina*	86	5.82	5.81	100	
Tree Swallow	*Tachycineta bicolor*	23	0.37	0.35	95	Above
Vesper Sparrow	*Pooecetes gramineus*	3	0.05	0.00	5	Above
Warbling Vireo	*Vireo gilvus*	29	0.40	0.36	90	Above
Western Tanager	*Piranga ludoviciana*	51	0.91	0.97	95	Below
Western Wood Pewee	*Contopus sordidulus*	12	0.21	0.18	89	Above
White-throated Sparrow	*Zonotrichia albicollis*	89	5.09	4.88	97	Above
White-winged Crossbill	*Loxia leucoptera*	53	2.20	2.22	100	
Wilson's Snipe	*Gallinago delicata*	53	1.90	1.85	98	Above
Wilson's Warbler	*Wilsonia pusilla*	13	0.46	0.43	96	Above
Winter Wren	*Troglodytes troglodytes*	33	0.66	0.57	87	Above
Yellow-bellied Flycatcher	*Empidonax flaviventris*	15	0.45	0.50	94	Below
Yellow-bellied Sapsucker	*Sphyrapicus varius*	46	1.06	1.01	96	Above
Yellow-rumped Warbler	*Dendroica coronata*	91	5.01	5.30	94	Below
Yellow Warbler	*Dendroica petechia*	31	1.14	1.07	93	Above

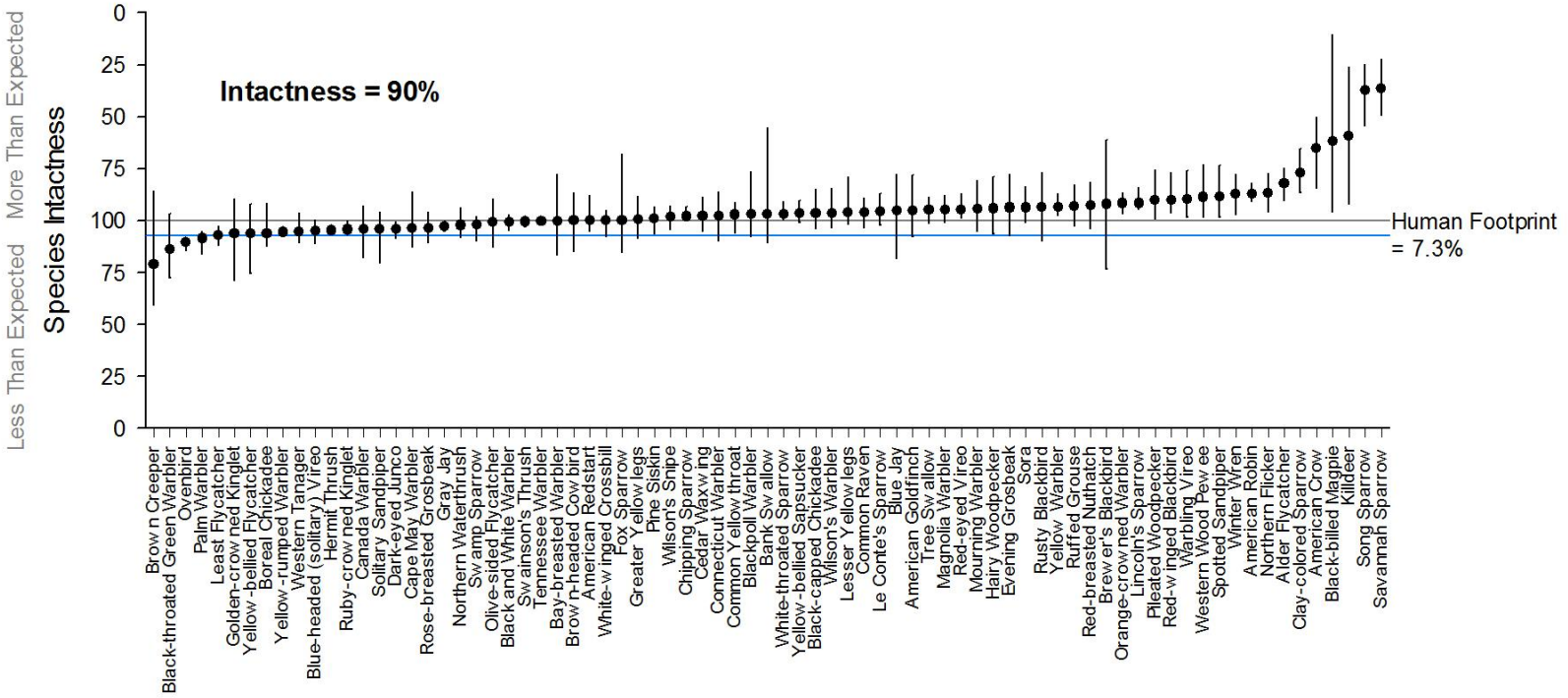


Figure 8. Intactness (with 90% confidence intervals) of 78 native bird species measured at 142 ABMI sites in the Lower Peace Region between 2003 and 2012. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada.

11.0 Winter-active Mammals - Snow Tracking Methods and Results

11.1 Winter Mammal Tracking Survey Methods

At each site, we measured mid to large-sized mammals using winter snow-tracking protocols. We did not implement winter protocols at the same location as spring and summer protocols but instead surveyed transects along existing linear feature (to the extent possible) in the area of the ABMI site. The ABMI endeavored to snow track the same sites that were surveyed the previous summer but this was not always feasible if snow conditions were not suitable for tracking. We completed surveys between December and March, the timing of which depended largely on appropriate snow conditions.

At each site we surveyed one 10 km transect using snow mobiles, if possible. The transects generally followed linear features, such as unimproved roads, cutlines, or seismic lines, to improve ease of access for crews. Transects were as straight as possible, with the midpoint located as close as possible to the NFI site[1] (Figure 9). For remote sites without linear features, NW to SE transects were surveyed on skiis or snowshoes with the transect passing as close to the NFI site centre as possible. We identified suitable transects ahead of time using high-resolution GIS images. We also selected a backup transect in case the preferred route was found to be impassable when crews arrived on site.

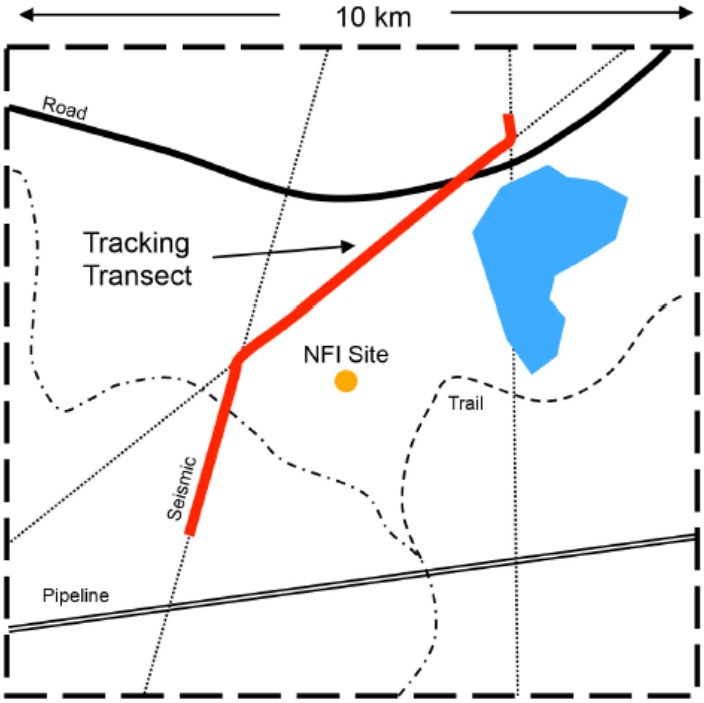


Figure 9. Diagram showing an example layout of an ABMI winter mammal tracking transect. The transect passes as close to the NFI site as possible, and is as straight as possible while following existing linear features.

[1] ABMI's 1,656 terrestrial sites are based on the 20 km National Forest Inventory (NFI) grid. To ensure ABMI site locations remain confidential, the ABMI sites are offset a random direction and distance from the NFI sites; however, winter mammal transects are selected to ensure they pass as close as possible to the NFI site centre, which is the geographical centre of each of the 20 × 20 km area, rather than the confidential ABMI site location.

All surveys took place within 3 to 6 days after a track obliterating snowfall (defined as > 1 cm of snow and/or winds exceeding 30 km/hr). At each site we recorded the days since snow, temperature, weather, snow depth, and snow conditions. We divided the 10 km transect into forty 250 m segments, and kept a GPS log of the location of these segments during data collection. For each segment, we recorded all tracks that crossed the transect (within 1 m), or travelled along the transect. We also recorded the primary and secondary habitat types (see protocols for habitat classification), and any human disturbances in each segment.

If a track could not be identified in the field, we took photographs, measurements, and notes that were used to identify the track in the laboratory. Photographs were taken whenever an unusual species was recorded (e.g., wolverine, swift fox, or animals outside their normal range or not normally observed in winter).

A comprehensive description of the protocols used to collect data for this report is described in:

- Alberta Biodiversity Monitoring Institute. 2012. Terrestrial field data collection protocols (abridged version) 2012-06-27. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: www.abmi.ca.

11.2 Winter-active Mammal Tracking Data Analysis

For the data analysis, we divided the 10 km snow tracking transects into 10 1-km subtransects. We calculated the relative abundance of each mammal species or taxonomic group as the occurrence on each 1-km subtransect. We determined intactness values for each species or taxonomic group that occurred on > 50 1-km subtransects in the Lower Peace Region (Table 5, Figure 10). A comprehensive description of the scientific methods used in analyses of data for this report is described in:

- Alberta Biodiversity Monitoring Institute. 2011. Manual for Estimating Species and Habitat Structure Intactness (20029), Version 2011-07-07. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at http://abmi.ca/abmi/reports/reports.jsp.

11.3 Winter-active Mammal Tracking Results

11.3.1 Intactness of winter-active mammals in the Lower Peace Region

Table 5. Complete list of winter-active mammals species analyzed in the Lower Peace Region including: species common name, species scientific name, percent (%) occurrence, relative abundant, reference abundance, intactness, and whether it was more abundant (Above) or less abundant (Below) than expected compared to reference conditions. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

Common Name	Scientific Name	Occurrence in the Lower Peace Planning Region (%)	Relative Abundance (mean detections per ABMI site)	Reference Abundance per Site (expected modeled abundance under zero human development)	Intactness Index (0-100 scale)	Above or Below Reference Conditions
Canada Lynx	*Lynx canadensis*	75	0.45	0.47	97	Below
Coyote	*Canis latrans*	60	0.18	0.15	82	Above
Deer	*Odocoileus*	57	0.24	0.22	92	Above
Marten & Fisher	*Martes*	82	0.16	0.18	90	Below
Mice & Voles		84	0.46	0.47	99	Below
Moose	*Alces alces*	78	0.31	0.30	97	Above
Red Squirrel	*Tamiasciurus hudsonicus*	97	0.18	0.18	95	Below
Snowshoe Hare	*Lepus americanus*	95	0.98	0.98	100	Below
Weasels	*Mustela*	85	0.63	0.63	100	Above
Wolf	*Canis lupus*	37	0.01	0.01	99	Below

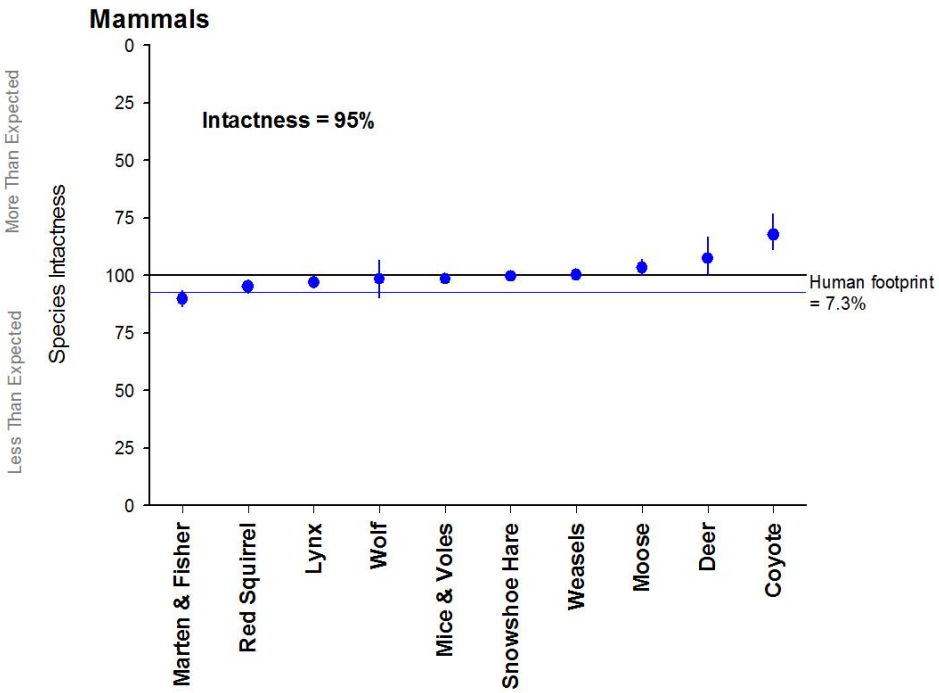


Figure 10. Intactness (with 90% confidence intervals) of 10 winter-active mammal species or groups measured at 142 ABMI sites in the Lower Peace Region between 2003 and 2012. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

12.0 Armoured Mites - Methods and Results

12.1 Armoured Mite Survey Methods

We took samples of the organic component of the soil profile (litter, fermentation, and humus horizons or LFH) for armoured mites (Order Oribatida). To minimize disturbance to the ABMI site, we took soil samples located 80 m from site centre (just outside the 1 ha plot) in each of the four sub-ordinal (NE, SE, SW, NW) directions (Figure 11). We used a 2 inch diameter soilcorer to collect 500 ml of organic soil in each of the sample locations (quadrants) totaling 2 L of organic material per site. We took a minimum of 4 cores from each sample location but took additional cores if more were required to accumulate 500 ml of organic material. Additional cores were sampled in a clockwise direction until we obtained 500 ml or until we collected 24 cores. We took a maximum of 24 cores per sample location even if less than 500 ml of organic material was obtained, and we recorded the number of cores taken. When the LFH was indistinct (i.e. grasslands), we collected the plant rooting zone. When there was no distinct LFH layer (i.e. cultivated agriculture fields), we collected only the litter. When the core location was situated in standing water, we did not collect a sample unless a vegetative mat was present above the water table. When the organic layer was deeper than our corer could penetrate (i.e. black spruce/tamarack bogs), we collected the entire 40 cm of organic material which the corer extracted.

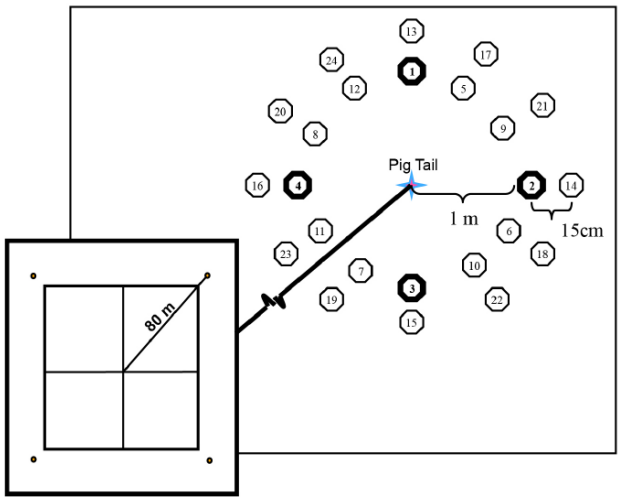


Figure 11. Soil core protocol – note the location outside of 1 ha plot and the circular arrangement of soil cores.

We described each core location, including: slope, aspect, primary ecotype/structural stage and percentage of dominant ecotype, and the type and percentage of human or natural disturbance in the 2 m radius area where cores are collected.

We placed the samples in cloth bags labeled by site, quadrant, and soil type before shipping them to the Royal Alberta Museum within three days of collection. In the lab, armoured mites were extracted from organic soil samples within six days of collection using Berlese funnel extractors. We preserved the extracted mites in ethanol. All adult mites were identified by an expert to the lowest taxonomic level possible within 60 days of extraction.

A comprehensive description of the protocols used to collect mite data for this report is described in:

- Alberta Biodiversity Monitoring Institute. 2012. Terrestrial field data collection protocols (abridged version) 2012-06-27. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: www.abmi.ca.

Detailed field sampling protocols and laboratory sampling manuals are available at www.abmi.ca.

12.2 Armoured Mite Data Analysis

For each species detected at each site, we calculated the relative abundance as the occurrence in each quadrant (0 to 4). We determined intactness values for each species that was detected at a minimum of 20 sites in the Boreal, Lower Foothills, and Parkland Natural Regions north of 53.5 N, the area we used for fitting the models. We summarized intactness for armoured mites in the Lower Peace Region (Table 6, Figure 12). A comprehensive description of the scientific methods used in analyses of data for this report is described in:

- Alberta Biodiversity Monitoring Institute. 2011. *Manual for Estimating Species and Habitat Structure Intactness* (20029), Version 2011-07-07. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: http://abmi.ca/abmi/reports/reports.jsp .

12.3 Armoured Mite Results

12.3.1 Intactness of armoured mites in the Lower Peace Region

Table 6. Complete list of armoured mite species analyzed in the Lower Peace Region including: species scientific name, species common name (when available), percent (%) occurrence, relative abundant, reference abundance, intactness, and whether it was more abundant (Above) or less abundant (Below) than expected compared to reference conditions. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

Species (Scientific Name)	Species (Common Name)	Occurrence in the Lower Peace Region (%)	Relative Abundance (mean detections per ABMI site)	Reference Abundance per Site (expected modeled abundance under zero human development)	Intactness Index (0-100 scale)	Above or Below Reference Conditions
Achipteria coleoptrata		10	0.26	0.26	99	Below
Achipteria sp. 1 DEW		31	0.50	0.51	98	Below
Allosuctobelba sp. 2 DEW		12	0.12	0.13	98	Below
Anachipteria howardi	Howard's Knifeless Mite	6	0.20	0.23	89	Below
Anachipteria sp. 1 DEW	Dave's Knifeless Mite	10	0.37	0.35	94	Above
Atropacarus striculus	Pink Box Mite	9	0.18	0.19	95	Below
Camisia biurus	Twice-stung Nightgown Mite	5	0.14	0.10	75	Above
Carabodes granulatus		10	0.10	0.10	96	Above
Carabodes labyrinthicus		32	0.80	0.80	100	Above
Cepheus sp. 1 DEW		41	0.71	0.71	99	Above
Ceratoppia quadridentata arctica		55	0.99	1.03	96	Below
Ceratozetes cuspidatus	Cusped Ceramic Mite	6	0.05	0.05	86	Below
Ceratozetes gracilis	Gracefull Ceramic	46	0.72	0.75	95	Below

	Mite					
Ceratozetes thienemanni		6	0.08	0.07	100	Above
Chamobates cuspidatus		19	0.26	0.27	97	Below
Dentizetes ledensis		8	0.18	0.18	98	Below
Diapterobates humeralis		32	0.36	0.36	100	Above
Eniochthonius crosbyi		20	0.36	0.37	96	Below
Epidamaeus arcticola		26	0.66	0.69	98	Below
Epidamaeus coxalis	Paddle-legged Mitre Mite	25	0.28	0.30	93	Below
Epidamaeus floccosus		12	0.14	0.14	98	Below
Epidamaeus sp. 2 DEW	Yeti Mite	11	0.06	0.06	94	Above
Eremaeus translamellatus	Furrowed Hermit Mite	15	0.24	0.24	97	Above
Eueremaeus marshalli		9	0.11	0.11	95	Above
Eueremaeus quadrilamellatus	Lost Hermit Mite	11	0.19	0.21	94	Below
Euphthiracarus flavus		22	0.32	0.32	98	Below
Gymnodamaeus ornatus	Ornate Hatless Mite	9	0.13	0.15	90	Below
Heminothrus longisetosus		21	0.37	0.35	98	Above
Hermanniella robusta		15	0.13	0.13	98	Below
Hydrozetes sp. E.RAN		4	0.09	0.09	97	Below
Hypochthonius rufulus		14	0.25	0.25	99	Above
Mycobates incurvatus		21	0.49	0.52	97	Below
Nanhermannia sp. 1 DEW		30	0.69	0.69	100	Below
Neogymnobates luteus	Yellow Streaker	3	0.05	0.06	92	Below
Neonothrus humicola		15	0.30	0.27	94	Above
Neoribates aurantiacus		9	0.08	0.07	94	Above
Nothrus borussicus		5	0.06	0.06	97	Below
Nothrus pratensis	Meadow Nothrus	15	0.46	0.43	96	Above
Nothrus sp. B DEW		1	0.07	0.08	95	Below
Oribatodes mirabilis	Wonderful King Mite	28	0.25	0.27	96	Below
Oribatula sp. 1 DEW	Field Roamer	8	0.11	0.09	89	Above
Peloribates canadensis	Canadian Dark-eye	12	0.25	0.20	84	Above
Peloribates pilosus	Hairy Dusky Roamer	14	0.23	0.22	97	Above
Pergalumna sp. 1 DEW		32	0.68	0.66	98	Above
Phthiracarus borealis		15	0.11	0.11	99	Below

Phthiracarus boresetosus		21	0.21	0.22	96	Below
Pilogalumna sp. 1 DEW		27	0.21	0.21	100	Above
Platynothrus peltifer		29	0.43	0.42	100	Above
Platynothrus yamasakii	Yamasaki Flat Nothrus	14	0.11	0.12	94	Below
Propelops alaskensis	Alaskan Dark-eye	66	1.33	1.41	94	Below
Protoribates haughlandae		4	0.09	0.09	99	Above
Quatrobelba montana		9	0.06	0.06	97	Below
Rhysotritia ardua		15	0.42	0.42	98	Above
Roynortonella sp. 1 DEW		7	0.14	0.12	92	Above
Scheloribates pallidulus		21	0.38	0.39	96	Below
Scutozetes lanceolatus	Lanceolate Wingshield	10	0.25	0.19	81	Above
Sphaerozetes arcticus	Arctic Winged-sphere Mite	18	0.34	0.32	94	Above
Tectocepheus sarekensis	Six-dimpled Northern Mite	9	0.13	0.10	78	Above
Tectocepheus velatus		9	0.22	0.22	98	Above
Tegoribates americanus		9	0.32	0.32	99	Above
Trhypochthonius tectorum		21	0.38	0.40	96	Below
Unduloribates dianae	Diana's Undulate-Roamer	8	0.26	0.23	94	Above

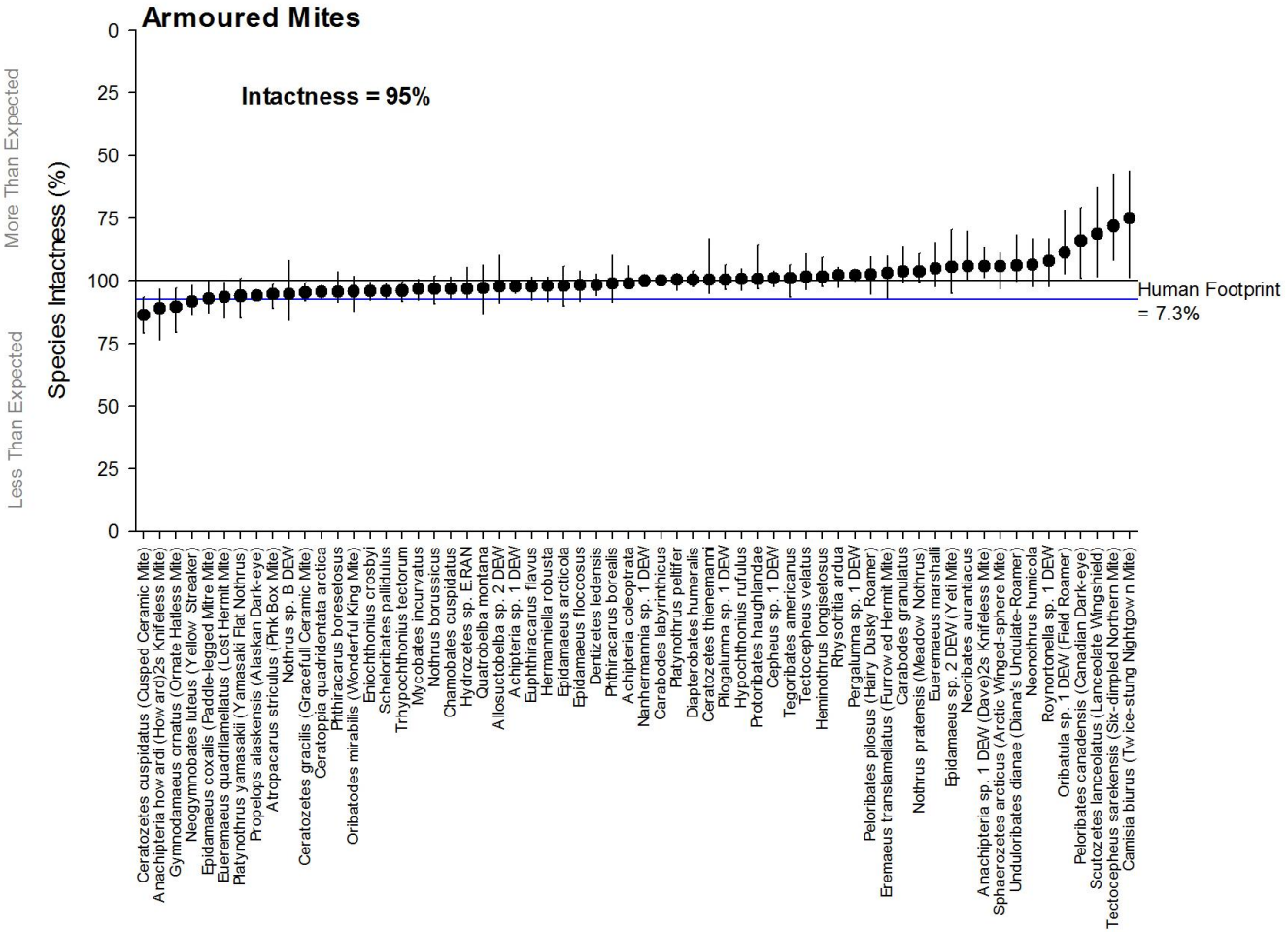


Figure 12. Intactness (with 90% confidence intervals) of 62 armoured mite species measured at 142 ABMI sites in the Lower Peace Region between 2003 and 2012. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

13.0 Vascular Plants – Methods and Results

13.1 Vascular Plant Survey Methods

We conducted 90-minute vascular plant searches to determine the presence of as many species as possible within the central hectare at each ABMI site. Vascular plants include all angiosperms, gymnosperms, ferns, and club mosses. We spent the first 10 minutes at site centre recording all vascular plant species observed. We then spent 20 minutes in each of 4 quadrants (NE, SE, SW, NW) of the central hectare for a total of 80 minutes recording the presence of as many vascular plants as possible (Figure 13). To maintain consistency among observers we started the 20 minute searches at the centre of each quadrant, moved to within 5 to 10 m of the site centre, then moved in a clockwise direction around the quadrant staying approximately 5 to 10 m from the quadrant edge. We started surveys in the NE quadrant and proceeded in a clockwise direction to the next quadrant (NE, SE, SW, NW).

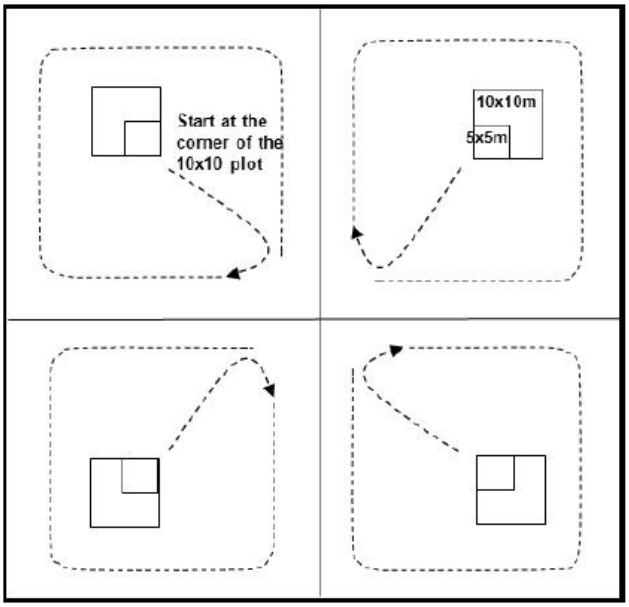


Figure 13. Vascular plant survey protocol.

When unknown or uncertain species were encountered, we collected voucher specimens for identification after the 90-minute searches were complete. This ensured that the 20 minutes spent in each quadrant was used looking for species rather than identifying plants. If we could not identify the specimen in the field, voucher specimens were brought to the Royal Alberta Museum where they were identified by experts.

13.2 Vascular Plant Data Analysis

We calculated the relative abundance of plant species at each site by scoring each species according to the number of quadrants in which they were present. If present at a site, relative abundance values for each species ranged from 1 (present in a single quadrant) to 4 (present in all 4 quadrants). We determined intactness values for each native vascular plant species that was detected at a minimum of 20 sites in the Boreal, Lower Foothills, and Parkland Natural Regions north of 53.5 N, the area we used for fitting the models. We summarize intactness for native vascular plants in the Lower Peace Region (Table 7, Figure 14). A complete list of non-native species that were detected in the Lower Peace Region

is also presented, along with per cent occurrence of each species (Table 8), and a visual presentation of the predicted number of non-native species per 1 ha plot in each quarter section of the Lower Peace Region (Figure 15). A comprehensive description of the scientific methods used in analyses of data for this report is described in:

- Alberta Biodiversity Monitoring Institute. 2011. *Manual for Estimating Species and Habitat Structure Intactness* (20029), Version 2011-07-07. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at http://abmi.ca/abmi/reports/reports.jsp .

13.1 Vascular Plant Results

13.1.1 Intactness of native vascular plants in the Lower Peace Region

Table 7. Complete list of native vascular plant species analyzed in the Lower Peace Region including: species scientific name, species common name (when available), percent (%) occurrence, relative abundant, reference abundance, intactness, and whether it was more abundant (Above) or less abundant (Below) than expected compared to reference conditions. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

Common Name	Scientific Name	Occurrence in the Lower Peace Region (%)	Relative Abundance (mean detections per ABMI site)	Reference Abundance per Site (expected modeled abundance under zero human development)	Intactness Index (0-100 scale)	Above or Below Reference Conditions
Balsam Fir	*Abies balsamea*	10	0.18	0.18	95	Below
Many-Flowered Yarrow	*Achillea alpina*	15	0.17	0.13	80	Above
Common Yarrow	*Achillea millefolium*	60	1.52	1.48	98	Above
Red and White Baneberry	*Actaea rubra*	47	0.72	0.77	94	Below
Moschatel	*Adoxa moschatellina*	11	0.15	0.18	84	Below
Rough Hair Grass	*Agrostis scabra*	7	0.15	0.12	82	Above
Mountain Alder	*Alnus incana*	34	0.83	0.87	96	Below
Green Alder	*Alnus viridis*	32	0.86	0.86	100	
Short-Awned Foxtail	*Alopecurus aequalis*	3	0.18	0.16	83	Above
Saskatoon	*Amelanchier alnifolia*	35	0.54	0.58	93	Below
Bog Rosemary	*Andromeda polifolia*	5	0.15	0.14	97	Above
Spreading Dogbane	*Apocynum androsaemifolium*	2	0.08	0.07	99	Above
Wild Sarsaparilla	*Aralia nudicaulis*	40	0.64	0.68	94	Below
Common Bearberry	*Arctostaphylos uva-ursi*	18	0.54	0.54	98	Below
Heart-leaved Arnica	*Arnica cordifolia*	6	0.06	0.07	89	Below
American Milk Vetch	*Astragalus americanus*	9	0.22	0.20	91	Above
Slough Grass	*Beckmannia syzigachne*	7	0.21	0.20	94	Above

Bog Birch	*Betula glandulosa*	17	0.57	0.58	98	Below
Alaska Birch	*Betula neoalaskana*	7	0.10	0.10	100	
Paper Birch	*Betula papyrifera*	56	1.42	1.43	100	
Dwarf Birch	*Betula pumila*	28	1.19	1.20	99	Below
Fringed Brome	*Bromus ciliatus*	4	0.06	0.04	74	Above
Bluejoint	*Calamagrostis canadensis*	78	2.30	2.32	99	Below
Narrow Reed Grass	*Calamagrostis stricta*	8	0.25	0.24	94	Above
Marsh Marigold	*Caltha palustris*	16	0.50	0.52	96	Below
Harebell	*Campanula rotundifolia*	5	0.09	0.09	99	Below
Water Sedge	*Carex aquatilis*	35	1.13	1.13	100	
Golden Sedge	*Carex aurea*	8	0.06	0.05	86	Above
Bebb's Sedge	*Carex bebbii*	5	0.02	0.01	71	Above
Brownish Sedge	*Carex brunnescens*	14	0.31	0.31	97	Above
Short Sedge	*Carex canescens*	15	0.42	0.40	95	Above
Two-stamened Sedge	*Carex diandra*	7	0.11	0.11	99	Above
Two-seeded Sedge	*Carex disperma*	21	0.66	0.67	97	Below
Hay Sedge	*Carex foenea*	7	0.07	0.06	82	Above
Northern Bog Sedge	*Carex gynocrates*	7	0.21	0.22	97	Below
Boreal Bog Sedge	*Carex magellanica*	10	0.43	0.45	97	Below
Hay Sedge	*Carex siccata*	4	0.05	0.05	88	Above
Small Bottle Sedge	*Carex utriculata*	15	0.43	0.42	97	Above
Sheathed Sedge	*Carex vaginata*	8	0.39	0.39	98	Above
Leatherleaf	*Chamaedaphne calyculata*	10	0.70	0.70	99	Above
Fireweed	*Chamerion angustifolium*	79	2.81	2.83	99	Below
Water Hemlock	*Cicuta maculata*	5	0.07	0.07	97	Below
Small Enchanter's Nightshade	*Circaea alpina*	14	0.26	0.26	93	Above
Marsh Cinquefoil	*Comarum palustre*	20	0.58	0.60	96	Below
Pale Coralroot	*Corallorrhiza trifida*	8	0.10	0.08	83	Above
Bunchberry	*Cornus canadensis*	76	2.50	2.58	96	Below
Silky Dogwood	*Cornus sericea*	30	0.80	0.82	97	Below
Beaked Hazelnut	*Corylus cornuta*	7	0.05	0.06	91	Below
Tall Larkspur	*Delphinium glaucum*	18	0.31	0.34	90	Below
Tufted Hair Grass	*Deschampsia cespitosa*	1	0.06	0.04	79	Above
Round-leaved Sundew	*Drosera rotundifolia*	6	0.34	0.35	98	Below
Spreading Woodfern	*Dryopteris expansa*	7	0.09	0.11	84	Below
Slender Wheat Grass	*Elymus trachycaulus*	15	0.20	0.17	86	Above
Crowberry	*Empetrum nigrum*	9	0.34	0.36	93	Below

Northern Willowherb	*Epilobium ciliatum*	4	0.07	0.06	80	Above
Marsh Willowherb	*Epilobium palustre*	7	0.19	0.18	91	Above
Common Horsetail	*Equisetum arvense*	62	1.75	1.72	99	Above
Swamp Horsetail	*Equisetum fluviatile*	13	0.35	0.34	98	Above
Common Scouring Rush	*Equisetum hyemale*	4	0.08	0.07	98	Above
Meadow Horsetail	*Equisetum pratense*	26	0.66	0.66	100	
Dwarf Scouring Rush	*Equisetum scirpoides*	26	0.81	0.83	96	Below
Woodland Horsetail	*Equisetum sylvaticum*	54	1.63	1.60	98	Above
Sheathed Cotton Grass	*Eriophorum vaginatum*	14	0.57	0.54	96	Above
Showy Aster	*Eurybia conspicua*	35	0.36	0.38	95	Below
Red Fescue	*Festuca rubra*	2	0.03	0.01	34	Above
Woodland Strawberry	*Fragaria vesca*	13	0.13	0.13	99	Below
Wild Strawberry	*Fragaria virginiana*	67	1.99	2.01	98	Below
Northern Bedstraw	*Galium boreale*	62	1.51	1.60	94	Below
Small Bedstraw	*Galium trifidum*	23	0.45	0.47	95	Below
Sweet-scented Bedstraw	*Galium triflorum*	53	1.05	1.10	95	Below
Northern Bastard Toadflax	*Geocaulon lividum*	22	0.77	0.82	95	Below
Bicknell's Geranium	*Geranium bicknellii*	4	0.07	0.07	100	
Yellow Avens	*Geum aleppicum*	15	0.34	0.31	92	Above
Large-leaved Yellow Avens	*Geum macrophyllum*	7	0.14	0.14	98	Above
Purple Avens	*Geum rivale*	5	0.14	0.13	98	Above
Lesser Rattlesnake Plantain	*Goodyera repens*	8	0.16	0.17	92	Below
Oak Fern	*Gymnocarpium dryopteris*	16	0.22	0.23	92	Below
Spurred Gentian	*Halenia deflexa*	2	0.03	0.02	76	Above
Cow Parsnip	*Heracleum maximum*	10	0.26	0.26	100	
Narrow-leaved Hawkweed	*Hieracium umbellatum*	13	0.32	0.25	78	Above
Foxtail Barley	*Hordeum jubatum*	10	0.13	0.10	74	Above
Arctic Rush	*Juncus arcticus*	6	0.23	0.22	97	Above
Northern Laurel	*Kalmia polifolia*	3	0.04	0.04	96	Below
Tamarack	*Larix laricina*	29	1.04	1.04	99	Below
Cream-colored Vetchling	*Lathyrus ochroleucus*	49	0.94	1.00	94	Below
Purple Peavine	*Lathyrus venosus*	13	0.12	0.11	98	Above
Hairy Wild Rye	*Leymus innovatus*	28	0.72	0.69	98	Above
Western Wood Lily	*Lilium philadelphicum*	0	0.07	0.06	99	Above
Twinflower	*Linnaea borealis*	65	2.16	2.30	94	Below

Heart-leaved Twayblade	*Listera cordata*	6	0.13	0.13	95	Below
Fly Honeysuckle	*Lonicera caerulea*	7	0.09	0.08	100	
Twining Honeysuckle	*Lonicera dioica*	28	0.54	0.55	97	Below
Bracted Honeysuckle	*Lonicera involucrata*	34	0.45	0.49	92	Below
Small-flowered Wood Rush	*Luzula parviflora*	4	0.03	0.02	78	Above
Stiff Club Moss	*Lycopodium annotinum*	25	0.52	0.57	92	Below
Ground Cedar	*Lycopodium complanatum*	10	0.27	0.27	96	Below
Treelike Clubmoss	*Lycopodium dendroideum*	6	0.13	0.13	96	Below
Wild Lily Of The Valley	*Maianthemum canadense*	46	0.99	1.08	93	Below
Star-flowered Solomon's Seal	*Maianthemum stellatum*	7	0.10	0.10	98	Above
Three-leaved Solomon's Seal	*Maianthemum trifolium*	38	1.39	1.40	98	Below
Tall Lungwort	*Mertensia paniculata*	62	1.49	1.58	94	Below
Bishop's Cap	*Mitella nuda*	70	2.13	2.28	93	Below
Blunt-leaved Sandwort	*Moehringia lateriflora*	21	0.60	0.60	98	Below
One-flowered Wintergreen	*Moneses uniflora*	8	0.24	0.25	93	Below
One-sided Wintergreen	*Orthilia secunda*	41	0.96	1.01	94	Below
Spreading Sweet Cicely	*Osmorhiza depauperata*	5	0.05	0.05	91	Below
Balsam Groundsel	*Packera paupercula*	7	0.28	0.29	98	Below
Northern Grass Of Parnassus	*Parnassia palustris*	11	0.28	0.28	100	
Labrador Lousewort	*Pedicularis labradorica*	13	0.40	0.40	99	Below
Arctic Sweet Coltsfoot	*Petasites frigidus*	79	2.51	2.59	97	Below
White Spruce	*Picea glauca*	65	1.82	1.87	99	Below
Black Spruce	*Picea mariana*	40	1.88	1.94	97	Below
Jack Pine	*Pinus banksiana*	14	0.65	0.67	97	Below
Lodgepole Pine	*Pinus contorta*	7	0.41	0.39	100	
Northern Rice Grass	*Piptatherum pungens*	1	0.12	0.12	100	
Northern Green Bog Orchid	*Platanthera hyperborea*	19	0.47	0.47	100	
Blunt-leaved Bog Orchid	*Platanthera obtusata*	11	0.30	0.34	89	Below
Round-leaved Bog Orchid	*Platanthera orbiculata*	7	0.16	0.17	91	Below
Fowl Bluegrass	*Poa palustris*	17	0.16	0.12	79	Above
Tall Jacob's Ladder	*Polemonium*	11	0.25	0.23	91	Above

	acutiflorum					
Balsam Poplar	*Populus balsamifera*	58	1.06	1.06	99	Below
Trembling Aspen	*Populus tremuloides*	67	1.92	1.94	99	Below
Rough Cinquefoil	*Potentilla norvegica*	16	0.17	0.13	79	Above
Rough-fruited Mandarin	*Prosartes trachycarpa*	11	0.07	0.08	90	Below
Pin Cherry	*Prunus pensylvanica*	1	0.08	0.08	97	Below
Choke Cherry	*Prunus virginiana*	4	0.05	0.05	98	Below
Common Pink Wintergreen	*Pyrola asarifolia*	59	1.62	1.75	92	Below
Greenish-flowered Wintergreen	*Pyrola chlorantha*	11	0.27	0.29	95	Below
Lapland Buttercup	*Ranunculus lapponicus*	6	0.24	0.25	92	Below
Macoun's Buttercup	*Ranunculus macounii*	6	0.08	0.06	85	Above
Yellow Rattle	*Rhinanthus minor*	8	0.05	0.03	59	Above
Common Labrador Tea	*Rhododendron groenlandicum*	65	2.36	2.42	98	Below
Skunk Currant	*Ribes glandulosum*	23	0.55	0.57	97	Below
Northern Black Currant	*Ribes hudsonianum*	24	0.75	0.75	100	
Bristly Black Currant	*Ribes lacustre*	28	0.43	0.46	93	Below
Northern Gooseberry	*Ribes oxyacanthoides*	53	1.39	1.47	95	Below
Wild Red Currant	*Ribes triste*	55	1.25	1.30	96	Below
Prickly Rose	*Rosa acicularis*	71	2.21	2.29	97	Below
Common Wild Rose	*Rosa woodsii*	16	0.59	0.61	97	Below
Dwarf Raspberry	*Rubus arcticus*	32	1.21	1.23	98	Below
Cloudberry	*Rubus chamaemorus*	25	1.01	1.03	98	Below
Wild Red Raspberry	*Rubus idaeus*	52	1.12	1.09	97	Above
Dewberry	*Rubus pubescens*	67	1.90	1.96	97	Below
Western Dock	*Rumex occidentalis*	7	0.11	0.11	95	Above
Shrubby Willow	*Salix arbusculoides*	10	0.27	0.25	93	Above
Beaked Willow	*Salix bebbiana*	47	1.04	1.00	96	Above
Pussy Willow	*Salix discolor*	10	0.40	0.39	99	Above
Smooth Willow	*Salix glauca*	12	0.49	0.45	92	Above
Velvet-fruited Willow	*Salix maccalliana*	5	0.31	0.30	99	Above
Myrtle-leaved Willow	*Salix myrtillifolia*	16	0.52	0.52	98	Below
Bog Willow	*Salix pedicellaris*	8	0.16	0.17	95	Below
Basket Willow	*Salix petiolaris*	5	0.10	0.09	94	Above
Flat-leaved Willow	*Salix planifolia*	32	1.35	1.34	98	Above
Firmleaf Willow	*Salix pseudomyrsinites*	9	0.28	0.28	98	Above
Balsam Willow	*Salix pyrifolia*	15	0.33	0.32	97	Above
Scouler's Willow	*Salix scouleriana*	17	0.32	0.32	98	Above
Purple Oat Grass	*Schizachne*	5	0.10	0.11	97	Below

	purpurascens					
Small-fruited Bulrush	*Scirpus microcarpus*	4	0.09	0.08	94	Above
Marsh Skullcap	*Scutellaria galericulata*	12	0.52	0.52	99	Above
Canada Buffaloberry	*Shepherdia canadensis*	42	1.24	1.30	96	Below
Three-toothed Cinquefoil	*Sibbaldiopsis tridentata*	1	0.05	0.05	98	Below
Canada Goldenrod	*Solidago canadensis*	4	0.06	0.05	83	Above
Alpine Goldenrod	*Solidago multiradiata*	4	0.06	0.06	97	Below
Hooded Ladies' Tresses	*Spiranthes romanzoffiana*	7	0.16	0.16	97	Above
Long-leaved Chickweed	*Stellaria longifolia*	32	0.68	0.67	97	Above
Long-stalked Chickweed	*Stellaria longipes*	8	0.11	0.10	93	Above
Snowberry	*Symphoricarpos albus*	32	0.40	0.44	90	Below
Buckbrush	*Symphoricarpos occidentalis*	8	0.14	0.15	97	Below
Lindley's Aster	*Symphyotrichum ciliolatum*	38	0.68	0.69	98	Below
Swamp Aster	*Symphyotrichum puniceum*	16	0.24	0.22	93	Above
Veiny Meadow Rue	*Thalictrum venulosum*	4	0.06	0.04	78	Above
Northern Starflower	*Trientalis borealis*	28	0.56	0.57	97	Below
Common Cattail	*Typha latifolia*	11	0.38	0.33	86	Above
Common Nettle	*Urtica dioica*	21	0.26	0.27	98	Below
Dwarf Bilberry	*Vaccinium caespitosum*	13	0.41	0.39	94	Above
Common Blueberry	*Vaccinium myrtilloides*	30	1.08	1.07	100	
Small Bog Cranberry	*Vaccinium oxycoccos*	27	1.14	1.18	96	Below
Bog Cranberry	*Vaccinium vitis-idaea*	57	2.44	2.51	97	Below
Low Bush Cranberry	*Viburnum edule*	63	1.73	1.83	94	Below
Wild Vetch	*Vicia americana*	54	1.07	1.09	99	Below
Western Canada Violet	*Viola canadensis*	27	0.28	0.32	89	Below
Kidney-leaved Violet	*Viola renifolia*	40	1.13	1.22	92	Below

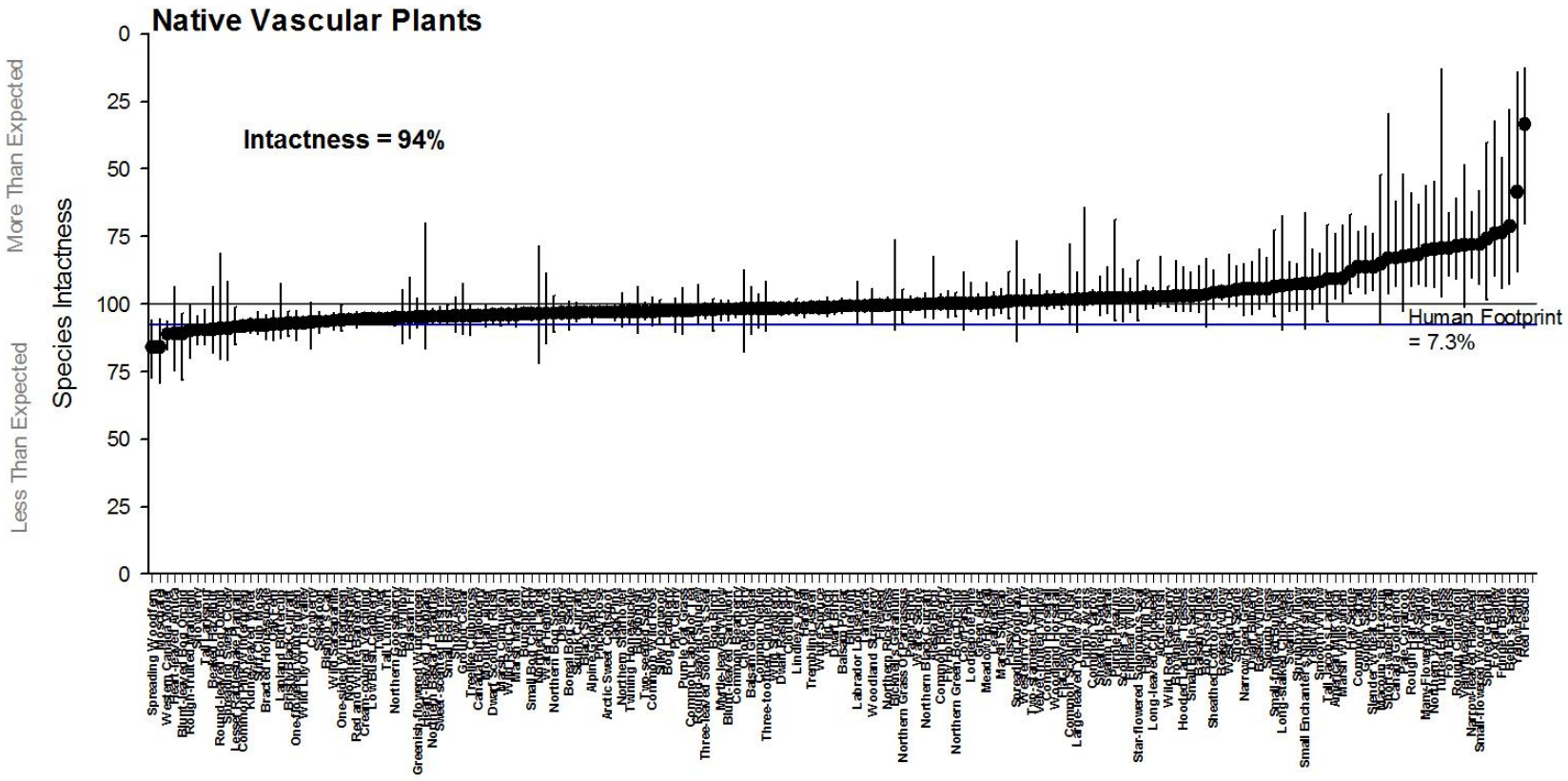


Figure 14. Intactness (with 90% confidence intervals) of 182 native vascular plant species measured at 142 ABMI sites in the Lower Peace Region between 2003 and 2012. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

13.1.2 Non-native vascular plants occurrence in the Lower Peace Region

The ABMI found 37 species of non-native plants in the Lower Peace Region (Table 8). Combined, non-native plants were detected at 50% of ABMI sites that were sampled in the Lower Peace Region. Most non-native species occurred very infrequently as 31 of the 37 species occurred at less than 5% of ABMI sites. At sites where they were found, an average of 2.8 non-native species were detected. For each quarter section in the Lower Peace Region, the predicted number of non-native species per 1 ha plot ranged from an average of 0 up to 18 species (Figure 15). High predicted numbers of non-native species are associated with increased agriculture footprint.

Common Dandelion was the most abundant non-native plant and was found at 36% of ABMI sites in the Lower Peace Region. Several species, such as Argentine Canola, Cultivated Barley, and Common Wheat, are agronomic species and occur in areas with increased agriculture footprint. Three of the species detected are listed under the Alberta Weed Control Act, including Creeping Thistle (7%), Perennial Sow-thistle (4%), and Tall Buttercup (2%) (Table 8).

Table 8. Non-native vascular plants detected in the Lower Peace Region.

Common Name	Scientific Name	Percent Occurrence (%)	Alberta Weed Control Act
Crested Wheatgrass	*Agropyron cristatum*	1	
Wild Oat	*Avena fatua*	1	
Argentine Canola	*Brassica napus*	2	
Awnless Brome	*Bromus inermis*	5	
Shepard's purse	*Capsella bursa pastoris*	2	
Lamb's Quarters	*Chenopodium album*	3	
Creeping Thistle	*Cirsium arvense*	7	Noxious Weed
Narrow-leaved Hawksbeard	*Crepis tectorum*	3	
Flixweed	*Descurainia sophia*	2	
Quackgrass	*Elymus repens*	1	
Wormseed Mustard	*Erysimum cheiranthoides*	2	
Wild Buckwheat	*Fallopia convolvulus*	3	
Common Hemp-nettle	*Galeopsis tetrahit*	1	
Cleavers	*Galium aparine*	1	
Cultivated Barley	*Hordeum vulgare*	1	
Pineapple Weed	*Matricaria discoidea*	2	
Alfalfa	*Medicago sativa*	2	
Yellow Sweet-clover	*Melilotus alba*	2	
White Sweet-clover	*Melilotus officinalis*	3	
Reed Canary Grass	*Phalaris arundinacea*	1	
Common Timothy	*Phleum pratense*	7	
Garden Pea	*Pisum sativum*	1	
Common Plantain	*Plantago major*	6	
Canada Bluegrass	*Poa compressa*	1	
Kentucky Bluegrass	*Poa pratensis*	16	
Tall Buttercup	*Ranunculus acris*	2	Noxious Weed

Curly-leaved Dock	*Rumex crispus*	2	
Perennial Sow-thistle	*Sonchus arvensis*	4	Noxious Weed
Common Chickweed	*Stellaria media*	2	
Common Dandelion	*Taraxacum officinale*	36	
Stinkweed	*Thlaspi arvense*	2	
Alsike Clover	*Trifolium hybridum*	14	
Red Clover	*Trifolium pratense*	2	
White Clover	*Trifolium repens*	3	
Scentless False Mayweed	*Tripleurospermum inodorum*	1	
Common Wheat	*Triticum aestivum*	1	
Cow Soapwort | Cowherb | Cowcockle |Cow Basil	*Vaccaria hispanica*	1	

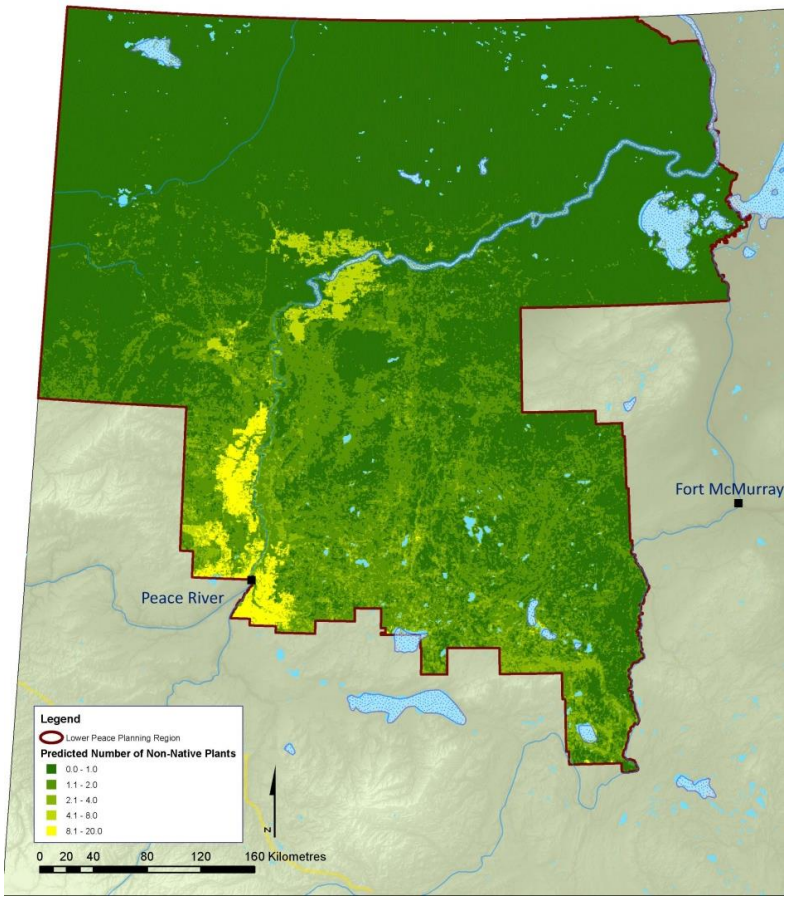


Figure 15. Predicted number of non-native plant species per 1 ha plot in each quarter section of the Lower Peace Region. Dark green indicates very low numbers of non-native plant species while yellow indicates high numbers of non-native species.

13.2 Moss (Bryophyte) Survey Methods

Bryophytes (known as mosses hereafter), collectively include mosses, liverworts, and hornworts. We conducted timed moss searches to determine the presence of as many species as possible at each ABMI site; we also recorded the type and amount of human disturbance for each plot.

Surveys were divided into two search periods. During the first search period, we spent a minimum of 5 minutes up to a maximum of 25 minutes searching for specimens in each of four 25 x 15 m plots (Figure 16). In each plot, primary strata that support diverse communities of moss, defined as logs/stumps, wetlands/peatlands, and rocks and cliffs, were searched by zigzagging throughout the plot. During the second period, we surveyed secondary strata that have less diverse moss communities (defined as trees/other structures and upland soil) for exactly 10 minutes in two 25 m belt transects that follow the long side of each plot (Figure 16). Moss samples were collected from less diverse strata that occurred within 1 m to either side of the two 25 m belt transects. For all stratum (both primary and secondary), we collected samples of all mosses that appeared distinct. Samples were dried for 3 days and then sent to the lab for sorting and identification. In the lab, we identified common species where possible, and sent unidentified species to a taxonomist expert for identification.

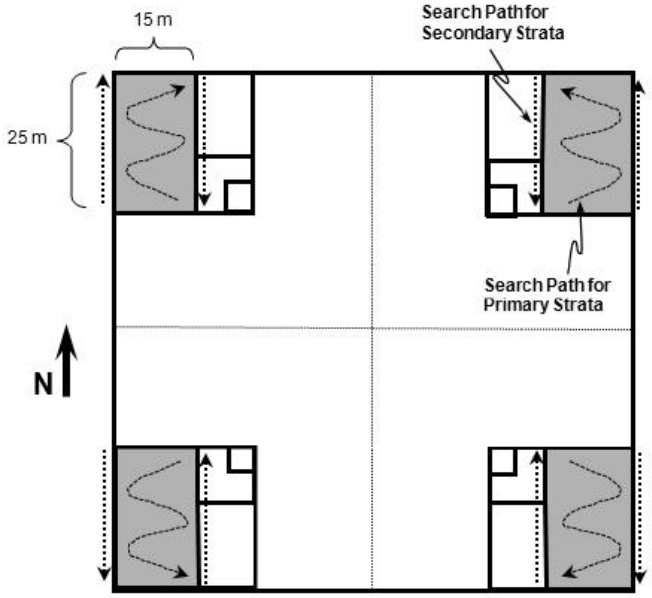


Figure 16. Moss survey protocol.

13.3 Moss (Bryophyte) Data Analysis

Starting in 2009, for each moss species detected at each site, we calculated the relative abundance as the occurrence in each quadrant (0 to 4). Prior to 2009, only presence or absence of mosses was recorded at the site. In the analysis, we compensate for the change in protocol by using an additional Protocol factor. We determined intactness values for each species that was detected at a minimum of 20 sites in the Boreal, Lower Foothills, and Parkland Natural Regions north of 53.5 N, the area we used for fitting the models. We summarized intactness for mosses in the Lower Peace Region (Table 9, Figure 17). A comprehensive description of the scientific methods used in analyses of data for this report is described in:

- Alberta Biodiversity Monitoring Institute. 2011. *Manual for Estimating Species and Habitat Structure Intactness* (20029), Version 2011-07-07. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at http://abmi.ca/abmi/reports/reports.jsp .

13.4 Moss Results

13.4.1 Intactness of mosses in the Lower Peace Region

Table 9. Complete list of moss species or taxonomic groups analyzed in the Lower Peace Region, including: species scientific name, species common name (when available), percent (%) occurrence, relative abundant, reference abundance, intactness, and whether it was more abundant (Above) or less abundant (Below) than expected compared to reference conditions. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

Species (Common Name)	Species (Scientific Name)	Occurrence in the Lower Peace Region	Relative Abundance (mean detections per ABMI site)	Reference Abundance per Site (expected modeled abundance under zero human development)	Intactness Index (0-100 scale)	Above or Below Reference Conditions
Creeping Feather Moss	*Amblystegium serpens*	86	2.11	2.18	97	Below
Heller's Notchwort	*Anastrophyllum hellerianum*	16	0.25	0.27	93	Below
Glow Moss	*Aulacomnium palustre*	80	2.64	2.73	97	Below
Hairy Threadwort	*Blepharostoma trichophyllum*	30	0.76	0.81	94	Below
Heart-leaved Spear Moss	*Calliergon cordifolium*	5	0.26	0.30	91	Below
Giant Spear Moss	*Calliergon giganteum*	6	0.06	0.06	96	Below
Bog Pouchwort	*Calypogeia sphagnicola*	18	0.40	0.42	97	Below
Golden Feather Moss	*Campyliadelphus chrysophyllus*	12	0.43	0.39	94	Above
Yellow Starry Feather Moss	*Campylium stellatum*	29	0.52	0.53	98	Below
Campylophyllum hispidulum	*Campylophyllum hispidulum*	53	1.21	1.20	100	Below
Forcipated Pouchwort	*Cephalozia connivens*	10	0.37	0.39	95	Below
Hispid Campylium Moss	*Cephalozia lunulifolia*	16	0.74	0.76	98	Below
Blunt Pincerwort	*Cephalozia pleniceps*	12	0.19	0.19	99	Below
Fire Moss	*Ceratodon purpureus*	70	1.36	1.26	92	Above
Purple Horn-toothed Moss	*Chiloscyphus pallescens*	14	0.24	0.24	99	Below
St. Winifrid's Moss	*Chiloscyphus polyanthos*	8	0.50	0.58	85	Below
Northern Tree Moss	*Climacium dendroides*	16	0.13	0.15	94	Below
Cushion Moss	*Dicranum acutifolium*	8	0.18	0.18	98	Above
Long Forked Moss	*Dicranum elongatum*	5	0.17	0.20	86	Below

Whip Fork Moss	*Dicranum flagellare*	37	0.35	0.37	96	Below
Cushion Moss	*Dicranum fragilifolium*	27	0.57	0.59	96	Below
Fuscous Moss	*Dicranum fuscescens*	33	0.54	0.56	95	Below
Wavy Dicranum	*Dicranum polysetum*	39	0.63	0.63	99	Above
Broom Moss	*Dicranum scoparium*	16	0.24	0.26	95	Below
Wavy Dicranum	*Dicranum undulatum*	54	1.70	1.77	97	Below
Knieff's Hook Moss	*Drepanocladus aduncus*	37	0.71	0.71	99	Below
Eurhynchiastrum pulchellum	*Eurhynchiastrum pulchellum*	58	1.34	1.43	94	Below
	Genus Brachythecium		2.94	3.04	97	Below
	Genus Bryum		1.65	1.60	97	Above
	Genus Cephaloziella		1.65	1.68	98	Below
Bristle Mosses	*Genus Orthotrichum*		0.91	0.99	92	Below
	Genus Plagiochila		0.29	0.29	98	Below
Turpswort	*Geocalyx graveolens*	17	0.25	0.24	98	Above
Slender Green Feather Moss	*Hamatocaulis vernicosus*	4	0.08	0.08	92	Below
Tiny-leaved Haplocladium Moss	*Haplocladium microphyllum*	26	0.11	0.12	98	Below
Wetland-plume Moss	*Helodium blandowii*	13	0.28	0.30	96	Below
Flat Stump Moss	*Herzogiella turfacea*	11	0.05	0.05	97	Below
Stair-step Moss	*Hylocomium splendens*	81	2.65	2.75	97	Below
Lindberg's Plait Moss	*Hypnum lindbergii*	5	0.19	0.19	100	Above
Meadow Plait Moss	*Hypnum pratense*	39	0.87	0.87	98	Below
Autumn Flapwort	*Jamesoniella autumnalis*	49	0.88	0.91	96	Below
Little Hands Liverwort	*Lepidozia reptans*	28	0.71	0.74	96	Below
Golden Thread Moss	*Leptobryum pyriforme*	41	0.52	0.48	93	Above
Variable-leaved Crestwort	*Lophocolea heterophylla*	36	1.31	1.33	97	Below
	Lophocolea minor	24	0.57	0.59	96	Below
Capitate Notchwort	*Lophozia excisa*	9	0.20	0.20	100	Above
Tumid Notchwort	*Lophozia ventricosa*	25	1.03	1.05	97	Below
Common Liverwort	*Marchantia polymorpha*	17	0.35	0.31	93	Above
Largetooth Calcareous Moss	*Mnium spinulosum*	18	0.19	0.19	95	Below
Anomalous Flapwort	*Mylia anomala*	20	0.83	0.89	96	Below
Mountain Curved-back Moss	*Oncophorus wahlenbergii*	59	1.29	1.36	94	Below
Woodsy Leafy Moss	*Plagiomnium cuspidatum*	67	1.42	1.53	94	Below
Drummond's Plagiomnium Moss	*Plagiomnium drummondii*	36	0.39	0.39	99	Above
Marsh Leafy Moss	*Plagiomnium ellipticum*	51	0.99	1.02	98	Below
Common Leafy Moss	*Plagiomnium medium*	21	0.37	0.39	96	Below
Dented Silk Moss	*Plagiothecium*	14	0.17	0.17	99	Above

	denticulatum					
Bright Silk Moss	*Plagiothecium laetum*	6	0.12	0.14	88	Below
False Willow Moss	*Platydictya jungermannioides*	5	0.19	0.20	93	Below
Flat-brocade Moss	*Platygyrium repens*	22	0.22	0.22	98	Below
Big Redstem	*Pleurozium schreberi*	85	2.68	2.75	97	Below
Copper Wire Moss	*Pohlia nutans*	83	2.84	2.88	98	Below
Common Hair-cap	*Polytrichum commune*	18	0.38	0.38	99	Above
Juniper Polytrichum Moss	*Polytrichum juniperinum*	37	0.56	0.53	95	Above
Bristly Haircap Moss	*Polytrichum piliferum*	4	0.03	0.03	87	Above
Bog Haircap Moss	*Polytrichum strictum*	36	1.10	1.09	100	Above
Ciliated Fringewort	*Ptilidium ciliare*	27	0.77	0.81	96	Below
Naugehyde Liverwort	*Ptilidium pulcherrimum*	80	2.53	2.62	97	Below
Plume Moss	*Ptilium crista castrensis*	61	1.52	1.54	98	Below
Aspen Stocking Moss	*Pylaisia polyantha*	77	1.84	1.94	96	Below
Slender Leafy Moss	*Rhizomnium gracile*	10	0.31	0.32	98	Below
Bog Germanderwort	*Riccardia latifrons*	19	0.55	0.53	96	Above
Sickle-leaved Hook Moss	*Sanionia uncinata*	88	2.62	2.70	98	Below
Ringless Hook Moss	*Sarmentypnum exannulatum*	7	0.14	0.15	92	Below
Glaucous-headed Earwort	*Scapania glaucocephala*	13	0.14	0.13	97	Above
Fine Bog Moss	*Sphagnum angustifolium*	19	0.46	0.45	100	Below
Acute-leaved Peat Moss	*Sphagnum capillifolium*	19	0.93	0.94	98	Below
Rusty Peat Moss	*Sphagnum fuscum*	22	0.94	0.95	99	Below
Girgensohn's Moss	*Sphagnum girgensohnii*	5	0.11	0.13	84	Below
Midway Peat Moss	*Sphagnum magellanicum*	5	0.20	0.20	100	Below
Wide-tongued Peat Moss	*Sphagnum russowii*	9	0.25	0.26	96	Below
Sqarrose Peat Moss	*Sphagnum squarrosum*	11	0.16	0.15	96	Above
Warnstorf's Peat Moss	*Sphagnum warnstorfii*	16	0.17	0.17	97	Above
Straw Spear Moss	*Straminergon stramineum*	9	0.17	0.17	99	Below
Common Four-tooth Moss	*Tetraphis pellucida*	15	0.27	0.29	94	Below
Narrow-leaved Splachnum	*Tetraplodon angustatus*	3	0.02	0.03	97	Below
Hook-Leaved Fern Moss	*Thuidium recognitum*	33	0.65	0.67	96	Below
Golden Moss	*Tomentypnum nitens*	40	1.40	1.44	97	Below
Forest Brownwort	*Tritomaria exsectiformis*	10	0.20	0.20	99	Below

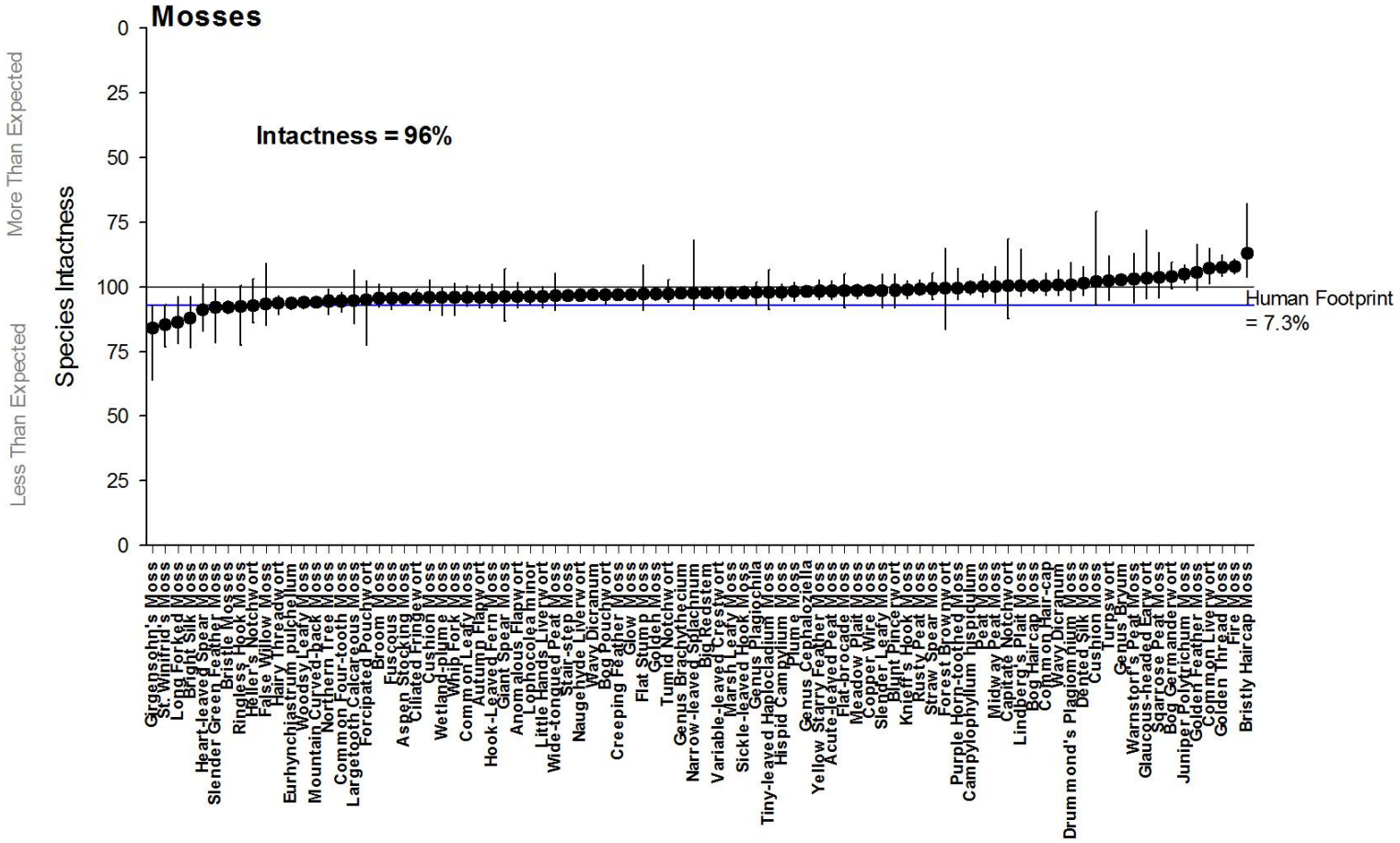


Figure 17. Intactness (with 90% confidence intervals) of 83 moss species and 5 moss genera measured at 142 ABMI sites in the Lower Peace Region between 2003 and 2012. Detailed statistics available in The Status of Biodiversity in the Lower Peace Region: Supplementary Data File. 2014. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

14.0 Species at risk

We derived intactness values for species at risk that we detected with enough frequency to enable this calculation. Species at risk were designated by the following sources (Table 10):

1. General Status of Alberta Wild Species 2010, including those designated as May be At Risk, At Risk, Sensitive, or Undetermined;
2. Canada's Species at Risk Act (SARA), including those designated as Endangered, Threatened, or Special Concern;
3. Alberta's Wildlife Act, including those designated as Endangered or Threatened;
4. Canada's Committee on the Status of Endangered Wildlife in Canada (COSEWIC), including those designated as Endangered, Threatened, Special Concern, or Data Deficient.
5. Alberta's Endangered Species Conservation Committee (ESCC), including those designated as Endangered, Threatened, Special Concern, Data Deficient, or In Process.

There are at least 107 species at risk in the Lower Peace Region; the ABMI detected 95 of these species (Table 10). Twenty-six of these species occurred with enough frequency to enable the calculation of the ABMI's intactness index, including four species that are listed as threatened or of special concern by the Government of Canada and/or by the Government of Alberta (Table 10). Of the species at risk assessed by the ABMI, approximately half were more abundant than expected (increasers), while half were less abundant than expected (decreasers). For increasers, intactness ranged from 83% to 99% intact. For decreasers, intactness ranged from 84% intact to 99% intact. Included in list of species at risk are several species of vascular plants and mosses with an "undetermined" status as identified by Alberta's Ministry of Environment and Sustainable Resource Development (ESRD).

Table 10. Summary of species at risk in the Lower Peace Region. No species analyzed by the ABMI is considered Threatened or Endangered under the Wildlife Act in Alberta.

Common Name	Scientific Name	Occurrence in the Lower Peace Planning Region	Intactness Index (0-100 scale)	Above or Below Reference Conditions	Threat
BIRDS					
Brown Creeper	*Certhia americana*	7	79	Below	ESRD - Sensitive
Black-throated Green Warbler	*Dendroica virens*	12	86	Below	ESRD - Sensitive | AB ESCC 2010 - Species of Special Concern
Western Wood Pewee	*Contopus sordidulus*	12	89	Above	ESRD - Sensitive
Pileated Woodpecker	*Dryocopus pileatus*	18	90	Above	ESRD - Sensitive
Least Flycatcher	*Empidonax minimus*	60	93	Below	ESRD - Sensitive
Rusty Blackbird	*Euphagus carolinus*	9	94	Above	ESRD - Sensitive | COSEWIC - Special Concern | SARA - Special Concern
Yellow-bellied Flycatcher	*Empidonax flaviventris*	15	94	Below	ESRD - Undetermined
Sora	*Porzana carolina*	18	94	Above	ESRD - Sensitive
Western Tanager	*Piranga ludoviciana*	51	95	Below	ESRD - Sensitive

Canada Warbler	*Wilsonia canadensis*	17	96	Below	ESRD - Sensitive | COSEWIC - Threatened | SARA - Threatened
Cape May Warbler	*Dendroica tigrina*	33	96	Below	ESRD - Sensitive | AB ESCC 2010 - In Process
Common Yellowthroat	*Geothlypis trichas*	39	97	Above	ESRD - Sensitive
Olive-sided Flycatcher	*Contopus cooperi*	13	99	Below	ESRD - May Be at Risk | COSEWIC - Threatened | SARA - Threatened
Bay-breasted Warbler	*Dendroica castanea*	14	100		ESRD - Sensitive | AB ESCC 2010 - In Process
Western Grebe	*Aechmophorus occidentalis*	n/a			AB ESCC - Special Concern | ESRD - Sensitive
Common Nighthawk	*Chordeiles minor*	n/a			ESRD - Sensitive | COSEWIC - Threatened | SARA - Threatened
Yellow Rail	*Coturnicops noveboracensis*	1			ESRD - Undetermined
Trumpeter Swan	*Cygnus buccinator*	n/a			AB ESCC - Threatened | Wildlife Act - Threatened | ESRD - At Risk | Not at Risk - COSEWIC
Peregrine Falcon	*Falco peregrinus*	n/a			AB ESCC - Threatened | ESRD - Threatened | Wildlife Act - Threatened | COSEWIC - Special Concern | SARA - Threatened
Sandhill Crane	*Grus canadensis*	23			ESRD - Sensitive
Barn Swallow	*Hirundo rustica*	3			ESRD - Sensitive
Baltimore Oriole	*Icterus galbula*	1			ESRD - Sensitive
White-winged Scoter	*Melanitta deglandi*	n/a			AB ESCC - Special Concern | ESRD - Sensitive
Black-backed Woodpecker	*Picoides arcticus*	1			ESRD - Sensitive
Horned Grebe	*Podiceps auritus*	n/a			ESRD - Sensitive | COSEWIC - Special Concern
Brewer's Sparrow	*Spizella breweri*	1			ESRD - Sensitive
Barred Owl	*Strix varia*	n/a			AB ESCC - Special Concern | ESRD - Sensitive
Sharp-tailed Grouse	*Tympanuchus phasianellus*	1			ESRD - Sensitive
MAMMALS					
Marten & Fisher	*Martes*	82	90	Below	AB ESCC - Sensitive (Fisher)
Lynx	*Lynx canadensis*	75	99	Below	AB ESCC - Sensitive | COSEWIC - Not at Risk
American Bison	*Bison bison*	5			ESRD - At Risk

Wolverine	*Gulo gulo*	6			ESRD - May Be At Risk
Cougar	*Puma concolor*	3			ESRD - Sensitive
Caribou	*Rangifer tarandus*	6			ESRD - At Risk
Grizzly Bear	*Ursus arctos*	n/a			ESRD - At Risk
VASCULAR PLANTS					
Canada Goldenrod	*Solidago canadensis*	4	83	Above	ESRD - Undetermined
Northern Wood Fern	*Dryopteris expansa*	7	84	Below	ESRD - Sensitive
Dry Spike Sedge	*Carex siccata*	4	88	Above	ESRD - Undetermined
Silvery Sedge	*Carex canescens*	15	95	Above	ESRD - Undetermined
Tree Clubmoss	*Lycopodium dendroideum*	6	96	Below	ESRD - Undetermined
Veiny Vetchling	*Lathyrus venosus*	13	98	Above	ESRD - Sensitive
Wood Anemone	*Anemone quinquefolia*	1			ESRD - May Be At Risk
Thimbleweed	*Anemone virginiana*	1			ESRD - Undetermined
Field Pussytoes	*Antennaria neglecta*	1			ESRD - Undetermined
Bodin's Milk-vetch	*Astragalus bodinii*	1			ESRD - May Be At Risk
Pumpelly Brome	*Bromus pumpellianus*	1			ESRD - Undetermined
Capitate Sedge	*Carex capitata*	1			ESRD - Sensitive
Swollen Beaked Sedge	*Carex rostrata*	1			ESRD - Sensitive
Quill Sedge	*Carex tenera*	2			ESRD - Sensitive
Iowa Golden Saxifrage	*Chrysosplenium iowense*	1			ESRD - Sensitive
Glaucous Willowherb	*Epilobium glaberrimum*	4			ESRD - Sensitive
Fleabane	*Erigeron acris*	1			ESRD - Undetermined
Narrow-leaved Cotton-grass	*Eriophorum angustifolium*	2			ESRD - Undetermined
Sheathed Cotton-grass	*Eriophorum callitrix*	1			ESRD - Sensitive
Rough Fescue	*Festuca altaica*	1			ESRD - Sensitive
Twin-leafved Bedstraw	*Galium bifolium*	1			ESRD - May Be At Risk
Colorado Rush	*Juncus confusus*	2			ESRD - Sensitive
One-cone Clubmoss	*Lycopodium lagopus*	2			ESRD - Undetermined
White Adder's-mouth	*Malaxis monophyllos*	1			ESRD - Sensitive
Bog Adder's-mouth	*Malaxis paludosa*	1			ESRD - May Be At Risk
Ostrich Fern	*Matteuccia struthiopteris*	1			ESRD - Sensitive
Alkali Muhly	*Muhlenbergia asperifolia*	1			ESRD - Sensitive
Slender Naiad	*Najas flexilis*	1			ESRD - May Be At Risk
White Bog Orchid	*Platanthera dilatata*	3			ESRD - Sensitive
Erect Knotweed	*Polygonum erectum*	1			ESRD - Undetermined
Rock Polypody	*Polypodium virginianum*	1			ESRD - May Be At Risk
Spreading Alkali Grass	*Puccinellia distans*	3			ESRD - May Be At Risk
Alder-leaved Buckthorn	*Rhamnus alnifolia*	1			ESRD - Sensitive

Athabasca Willow	*Salix athabascensis*	5			ESRD - Sensitive
Pacific Willow	*Salix lasiandra*	1			ESRD - Undetermined
Western Goldenrod	*Solidago lepida*	1			ESRD - Undetermined
Narrow-leaved Bur-reed	*Sparganium angustifolium*	1			ESRD - Undetermined
Purple Meadow-rue	*Thalictrum dasycarpum*	2			ESRD - Sensitive
Few-flowered Meadow-rue	*Thalictrum sparsiflorum*	4			ESRD - Sensitive
Arctic Starflower	*Trientalis europaea*	1			ESRD - Sensitive
Alpine Bilberry	*Vaccinium uliginosum*	3			ESRD - Sensitive
MOSSES					
Flat Stump Moss	*Herzogiella turfacea*	11	97	Below	ESRD - Undetermined
Cushion Moss	*Dicranum acutifolium*	8	98	Above	ESRD - Undetermined
Flat-brocade Moss	*Platygyrium repens*	22	98	Below	ESRD - Sensitive
Drummond's Plagiomnium Moss	*Plagiomnium drummondii*	36	99	Above	ESRD - Undetermined
Little Groove Moss	*Aulacomnium androgynum*	1			ESRD - Sensitive
Lesser Bird's-claw Beard Moss	*Barbula convoluta*	3			ESRD - Sensitive
Bird's-claw Beard Moss	*Barbula unguiculata*	2			ESRD - Sensitive
River Ragged Moss	*Brachythecium rivulare*	1			ESRD - Sensitive
Richardson's Spear Moss	*Calliergon richardsonii*	3			ESRD - Undetermined
Schreber's Forklet Moss	*Dicranella schreberiana*	2			ESRD - Undetermined
False Beard Moss	*Didymodon fallax*	1			ESRD - Sensitive
	Ditrichum gracile	1			ESRD - Sensitive
Cypress-leaved Plait Moss	*Hypnum cupressiforme*	2			ESRD - Sensitive
Kneiff's Feather Moss	*Leptodictyum riparium*	2			ESRD - Undetermined
Many-fruited Leske's Moss	*Leskea polycarpa*	2			ESRD - Sensitive
Bordered Leafy Moss	*Mnium marginatum*	2			ESRD - Undetermined
	Orthothecium chryseum	1			ESRD - Sensitive
Toothed Leafy Moss	*Plagiomnium ciliare*	4			ESRD - Undetermined
Cottony Nodding Moss	*Pohlia proligera*	1			ESRD - Undetermined
Central Peat Moss	*Sphagnum centrale*	1			ESRD - Undetermined
Flat-top Peat Moss	*Sphagnum fallax*	2			ESRD - Undetermined
Fringed Peat Moss	*Sphagnum fimbriatum*	1			ESRD - Undetermined
Olive Peat Moss	*Sphagnum majus*	1			ESRD - Undetermined
Obtuse Peat Moss	*Sphagnum obtusum*	2			ESRD - Undetermined
Yellow Dung Moss	*Splachnum luteum*	3			ESRD - Sensitive
Red Dung Moss	*Splachnum rubrum*	2			ESRD - Sensitive
Round-fruited Dung Moss	*Splachnum sphaericum*	1			ESRD - Undetermined

Cylindric Hairy-teeth Moss	*Trichodon cylindricus*	1	ESRD - Sensitive
AMPHIBIANS			
Western Toad (Boreal Toad)	*Bufo boreas boreas*	n/a	ESRD - Sensitive | COSEWIC - Special Concern | SARA - Special Concern
Canadian Toad	*Bufo hemiophrys*	n/a	AB ESCC - Data Deficient | ESRD - May be at Risk
FISH			
Arctic Grayling	*Thymallus arcticus*	n/a	AB ESCC - Special Concern | ESRD - Sensitive

15.0 Further Reading

Additional detail on the ABMI field protocols and analytical methodology can be found on our website under the Reports section (www.abmi.ca) including:

- Terrestrial Data Collection Protocols (Abridged)
- Manual for Species Modeling and Intactness
- Human Footprint Map Layer 3 × 7 Areas Version 1.0 – Metadata
- 2010 Human Footprint Map Layer Version 1.0 - Metadata

Appendix 1

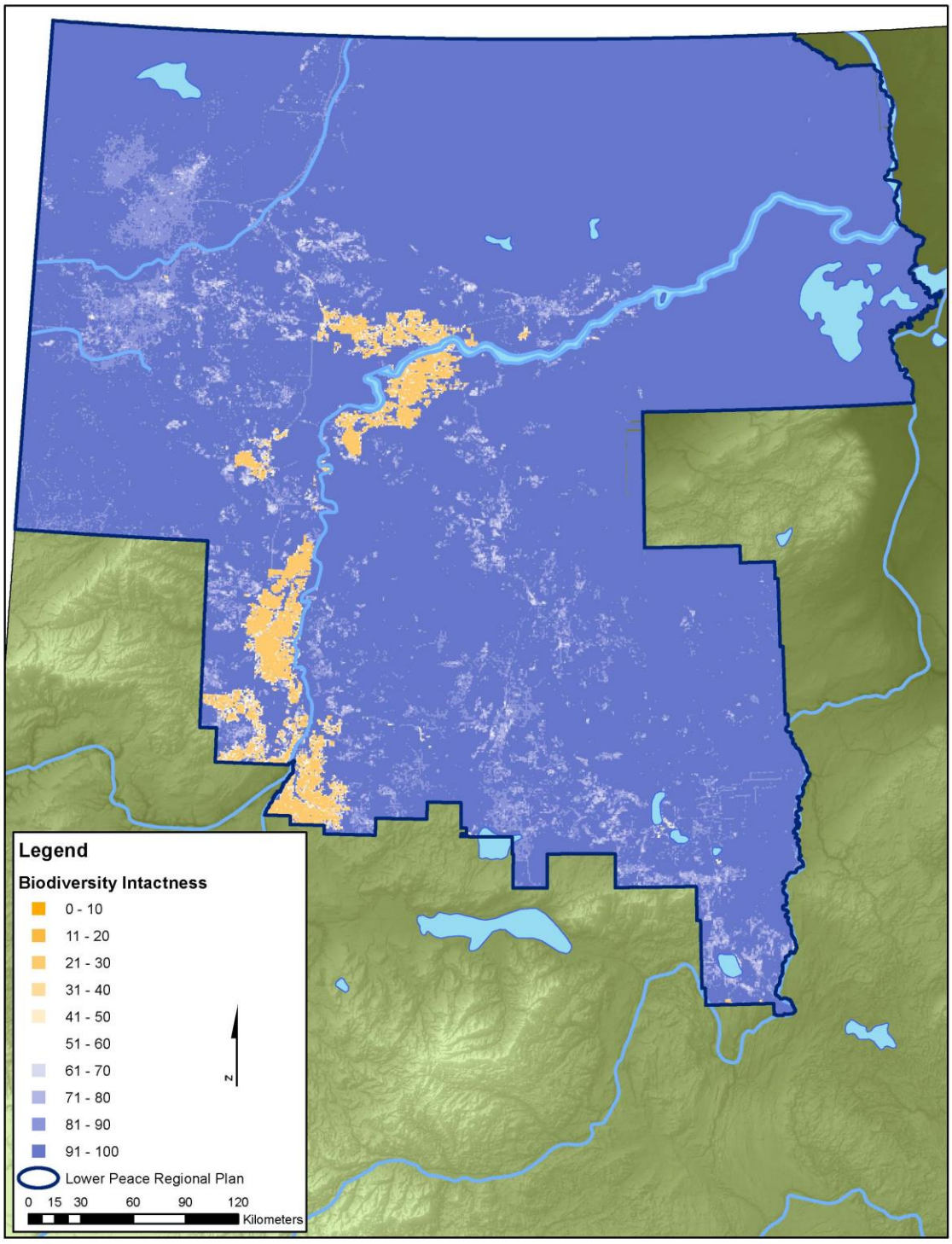


Figure A-1. Average predicted intactness for 425 species in the Lower Peace Region. Orange identifies the quarter sections that are predicted to have the lowest average biodiversity intactness values, and dark purple identifies quarter sections with the highest intactness.