Alberta Biodiversity Monitoring Institute

The STATUS OF BIODIVERSITY in the Grassland and Parkland Regions of Alberta

Supplementary Report 2015

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2.0 Introduction

The report *The Status of Biodiversity in the Grassland and Parkland Regions of Alberta* presents results on the status of human footprint, habitat and biodiversity for the Grassland and Parkland Natural Regions (hereafter the Prairie Region) located in southern Alberta (Figure 1). Produced in partnership with the Prairie Conservation Forum (PCF), this report presents data on several indicators of environmental health for the Prairie Region. Also included is a summary of results for the High Value Landscape (HVL), a region identified by the PCF by combining mapping information on native vegetation, species at risk, ecosystem services, and environmentally significant areas. This supplementary report provides the detailed methods 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. The Prairie Region which includes the Grassland and Parkland Natural Regions, is located in southern Alberta. The High Value Landscape in the Prairie Region is an area identified by the PCF for its high biodiversity values.

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 Prairie 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. 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 Prairie Region to include

status and trends reporting for lichens and wetlands, as well as trends for all taxonomic groups as monitoring information continue to grow.

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 1,656 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 Prairie Region is the focus of this report. Of the ABMI's 1,656 sites, 383 of these sites are located in this region—240 in the Grassland Natural Region and 143 in the Parkland Natural Region (Figure 2). We implemented ABMI spring and summer data collection protocols at 204 of the Prairie Region's 383 sites between 2003 and 2012.

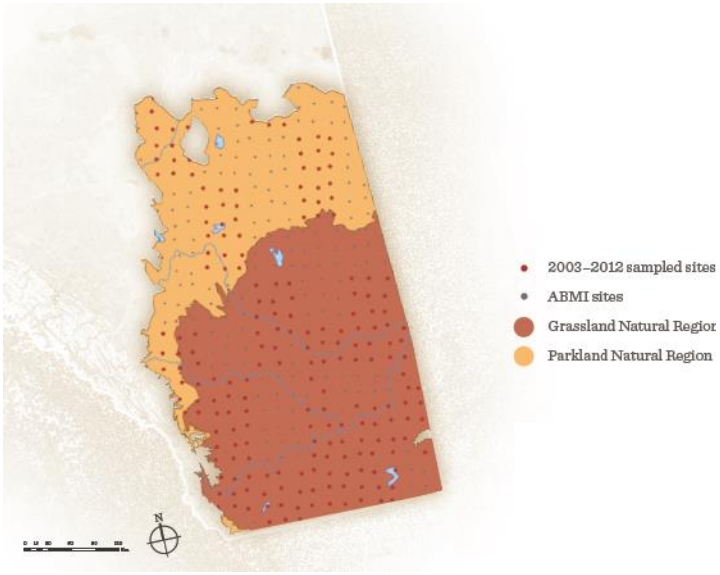

Figure 2. The ABMI has 383 of our 1,656 survey sites in the Prairie Region; 204 of these sites have been sampled as of 2012, including 146 sites in the Grassland Natural Region and 58 sites in the Parkland Natural Region.

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. 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, "Manual for Species Modeling and Intactness"are available from the ABMI website (www.abmi.ca) under Publications (see Further Reading at the end of this document). We report on the status of biodiversity in the Prairie Region using only statistical results relevant to this region, or regions specified therein. Here we present methods and results for the following:

- Human Footprint
- Biodiversity Intactness including:
  - Predicted Biodiversity Intactness
  - Breeding Birds
  - Armoured Mites
  - Vascular Plants
  - Mosses
  - Species at risk
- Non-native species including:
  - Percentage occurrence in the Prairie Region

    - Estimated abundance of non-native species in the Prairie Region
- Native Habitat, including:
    - Area of native vegetation at three different buffer distances from human footprint—0 m, > 50 m, and > 200 m
    - Effective mesh size
    - Protected areas

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 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 1656 locations, a 3 × 7 km rectangle is examined at a 1:5000 scale to delineate all human footprint types present. These detailed annual samples of human footprint are available from 1999 to 2013, except for 2000.
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, 2012.[1]

These mapped products are updated at regular intervals to track changes in human footprint and habitat through time. To assess the status and 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 Prairie Region is based on the 3 × 7 km samples of human footprint data.

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

5.1 Human Footprint Methods

The ABMI's GIS Inventory of Provincial Human Footprint information (circa 2007, 2010, 2012) is the product of multiple geospatial sub-layers, many of which were obtained through data-sharing agreements with Alberta Environment and Parks (formerly Sustainable Resource Development) and the forest industry (Table 1). To the degree practical, we updated or created Human Footprint (HF) features when source data was inaccurate or missing, and to ensure that each of the HF sub-layers had provincial scale coverage. We created new sub-layers for cities, human settlement, industrial sites, oil sands facilities and mines, and farmsteads to ensure data would conform to the ABMI's (HF) categories, and were scientifically credible. Other data used in the ABMI's HF Inventory include: roads, well sites, facilities, pipelines, power lines, railways, and cutlines (seismic lines and narrow trails). We used SPOT imagery (circa 2007, 2010, and 2012) to validate source data sub-layers and create new HF sub-layers. . See Table 2 for a description of ABMI human footprint categories.

Table 1. Sources for sub-layers and base features used to represent Human Footprint.

Features	Source
Forest harvesting	Alberta Vegetation Inventory (AVI), AVI Updates, the Crown, AEP (former AESRD), and individual companies in conjunction with ABMI-created inventory (based on SPOT 2007, 2010 and 2012 mosaics of the province)
Agriculture	ABMI-created provincial inventory (based on SPOT 2007 and 2010 mosaics of the province); in conjunction with Alberta Ground Cover Characterization (AGCC), Agricultural Land Cover Classification (ALCC), and Grassland Vegetation Inventory (GVI) as reference
Cities and Settlements	ABMI created inventory (based on SPOT 2007, 2010 and 2012 mosaics of the province)
Roads	Provincial "roads" GIS data layer (line; GoA source) and in conjunction with ABMI-created area estimates for linear features.
Wellsites	Provincial "wellsites" GIS data layer (point; GoA source) and in conjunction with ABMI validation procedures
Pipelines	Provincial "pipelines" GIS data layer (line; GoA source) and in conjunction with ABMI validation procedures
Power Lines	Provincial "powerlines" GIS data layer (line; GoA source) and in conjunction with ABMI validation procedures
Rail Lines	Provincial "raillines" GIS data layer (line; GoA source) and in conjunction with ABMI validation procedures
Cutlines	Provincial "cutlines" GIS data layer (line; GoA source) and in conjunction with ABMI validation procedures
Facilities	Provincial "facilities" GIS data layer (line; GoA source) and in conjunction with ABMI validation procedures

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	Cultivation (Crop/Pasture/Bare Ground)	Any area where evidence of cultivation is visible during the photo interpretation
	High Density Livestock Operation	Confined feeding operation and other high density livestock area
Forest Harvest	Harvested Areas (former Cut Blocks)	Area with trees harvested for industrial purposes
Human-created Water Bodies	Borrow-Pits, Dug-outs, Sumps	Created to extract fill, or for livestock watering
	Canals	Created to transport water
	Municipal (Water and Sewage)	Created for municipal purposes
	Reservoirs	Man-made lake
Mines, Wells & Other Energy Features	Cutline	Area where vegetation is disturbed
	Mine Site	Area where vegetation is disturbed
	Peat Mine	Area where vegetation is disturbed
	Pipeline	Area where vegetation is disturbed
	Seismic Line	Area where vegetation is disturbed
	Transmission Line	Area where vegetation is disturbed
	Well Site	Well pads created by the energy industry
	Wind Generation Facility	Area around the windmill
Transportation	Rail – Hard Surface	Usually gravel
	Rail – Vegetated Verge	Vegetated strips along railways
	Road – Hard Surface	Paved or gravel
	Road – Vegetated Verge	Vegetated strips along paved/gravel roads
	Road/Trail (Vegetated)	Road/Trail without gravel or pavement
Urban, Rural & Industrial	Industrial Site Rural	Rural area developed for industrial use
	Other Disturbed Vegetation	Recreation areas and other vegetated areas created for human use, including golf courses, grave yards, vegetated edges of airports, sometimes along roads and any other disturbed areas that have recovered vegetation
	Rural (Residential/Industrial)	Small rural development (confounded with rural industrial development)
	Urban	Cities and towns

The 2007, 2010, and 2012 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 harvested areas 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 2013, the total human footprint across the Prairie Region was 63.1% (Figure 3, 4, Table 3). Agriculture footprint was the largest human footprint category covering 55.2% of the area (Figure 3, 5a). Transportation footprint, energy footprint, and urban, rural, and industrial footprint, at 2.8%, 2.5%, and 2.3%, covered a low percentage area of the region but were broadly dispersed across the landscape (Figure 3, 5).

Human footprint was approximately two to three times higher outside the HVL than inside for all human footprint categories except energy footprint, where the reverse was true. See Table 3 for a summary of human footprint in the Prairie Region, outside the HVL, and inside the HVL.

The per cent area of human footprint increased from 61.3% to 63.1% in the Prairie Region between 1999 and 2013 (Figure 3). There was a larger increase in the per cent area of human footprint in the HVL which increased by 2.4% from 28.4% to 30.8% between 1999 and 2013 compared to a 1.6% increase outside the HVL which increased from 80.7% to 82.3% (Table 3). The increase in the HVL was largely driven by agriculture footprint, which increased by 1.3% during this time frame.

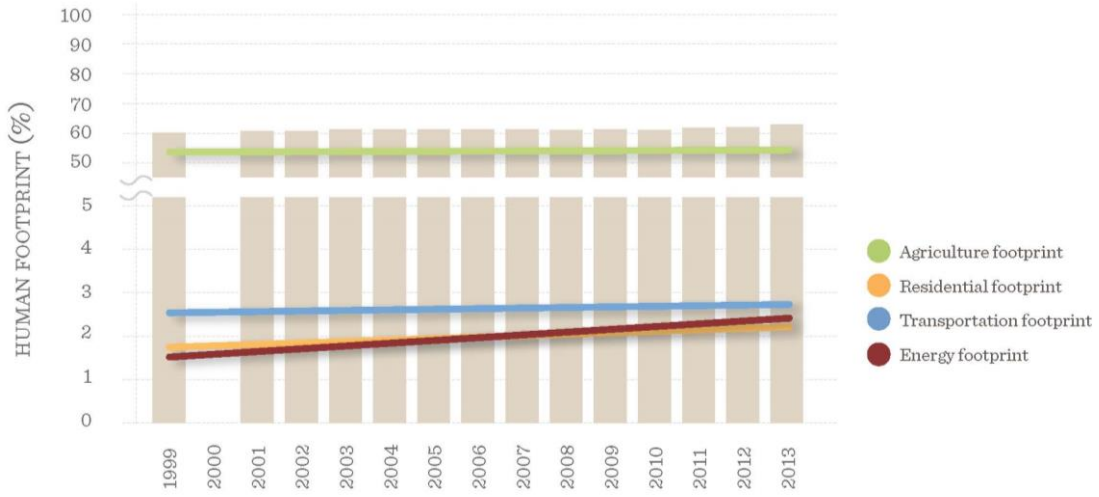

Figure 3. The percentage of total human footprint, agriculture footprint, residential, transportation, and energy footprint in the Prairie Region from 1999 to 2013.

Table 3. Summary of percentage area of human footprint by category for the Prairie Region, inside the HVL, and outside the HVL, from 1999 to 2013, except for 2000.

Human Footprint Category	1999	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Prairie Region														
Agriculture	54.4	54.7	54.7	54.6	54.6	54.7	54.6	54.7	54.7	54.6	54.7	54.9	55.2	55.2
Forest Harvesting	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Human-created Water Bodies	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Mines, Wells & Other Energy Features	1.6	1.6	1.6	1.6	1.8	1.9	2.3	1.9	2.0	2.0	2.0	2.2	2.3	2.5
Transportation	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.8
Urban, Rural & Industrial	1.8	1.8	1.8	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.2	2.3
Total Human Footprint	61.3	61.5	61.5	61.6	61.8	61.9	61.9	62.0	62.1	62.0	62.1	62.5	63.0	63.1
Inside the HVL														
Agriculture	22.6	23.0	23.0	23.0	23.1	23.2	23.3	23.4	23.4	23.4	23.4	23.6	23.8	23.9
Forest Harvesting	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Human-created Water Bodies	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Mines, Wells & Other Energy Features	2.2	2.2	2.2	2.3	2.6	2.6	2.6	2.7	2.8	2.8	2.9	3.1	3.2	3.4
Transportation	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.9
Urban, Rural & Industrial	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8
Total Human Footprint	28.4	28.9	28.9	28.9	29.2	29.4	29.5	29.6	29.7	29.7	29.7	30.1	30.5	30.8
Outside the HVL														
Agriculture	73.4	73.5	73.5	73.4	73.4	73.4	73.1	73.3	73.2	73.2	73.3	73.4	73.7	73.7
Forest Harvesting	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Human-created Water Bodies	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Mines, Wells & Other Energy Features	1.2	1.2	1.2	1.2	1.3	1.4	2.2	1.5	1.5	1.5	1.5	1.6	1.7	1.9
Transportation	3.2	3.2	3.2	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Urban, Rural & Industrial	2.5	2.5	2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.8	2.9	3.0	3.1	3.1
Total Human Footprint	80.7	80.9	80.9	80.9	81.1	81.2	81.2	81.2	81.3	81.2	81.3	81.7	82.2	82.3

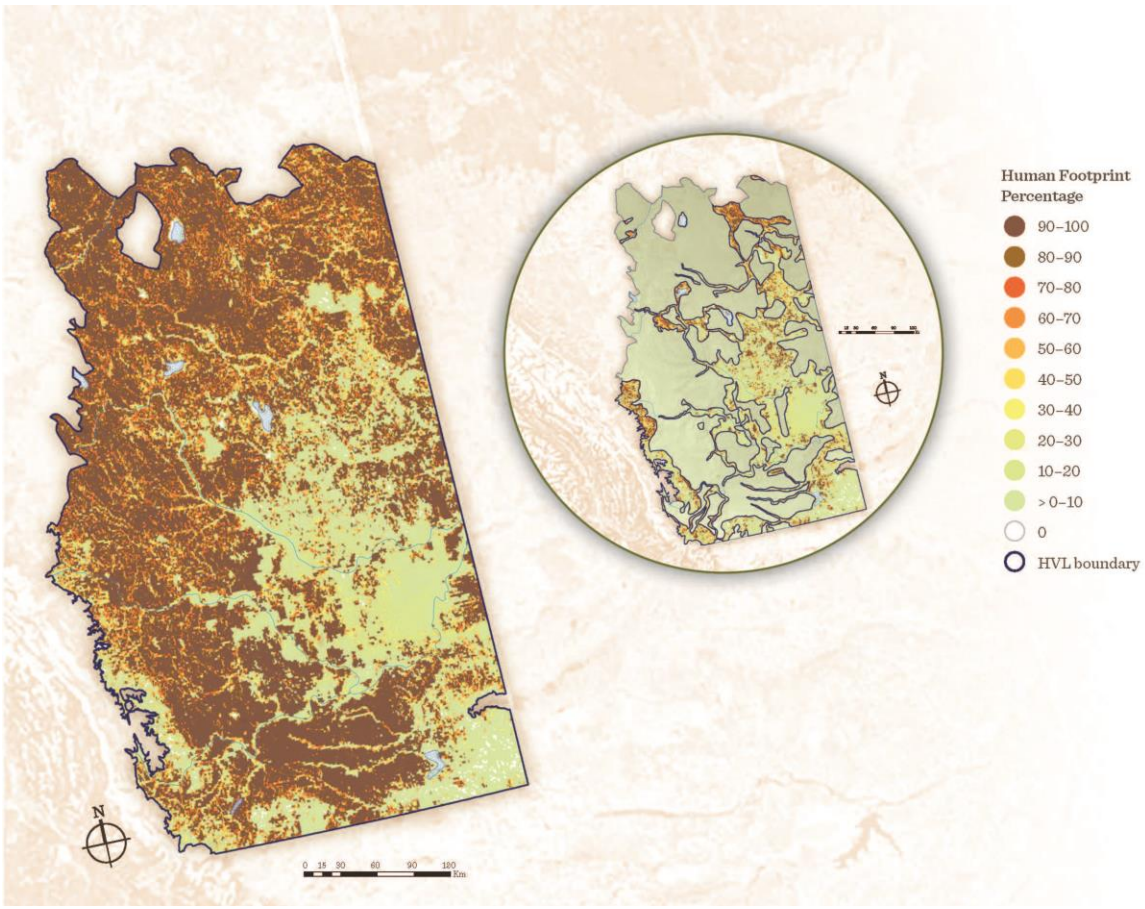

Figure 4. Distribution of human footprint across the Prairie Region, circa 2012.

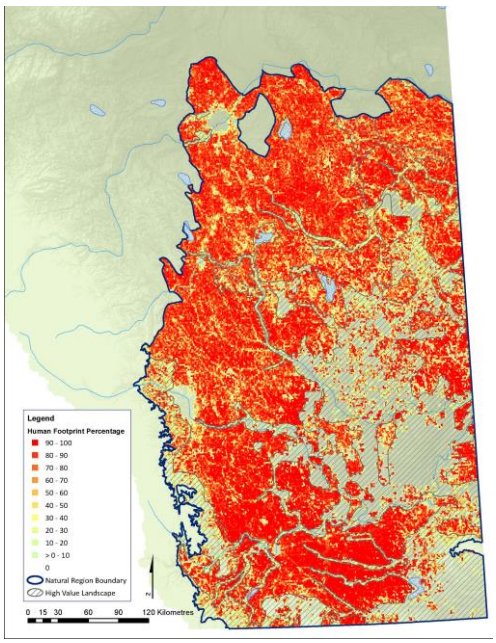

Figure 5A. Agriculture footprint.

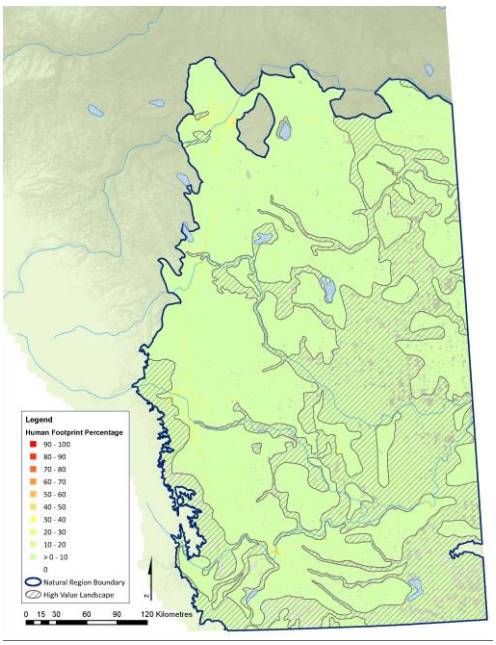

Figure 5B. Transportation footprint.

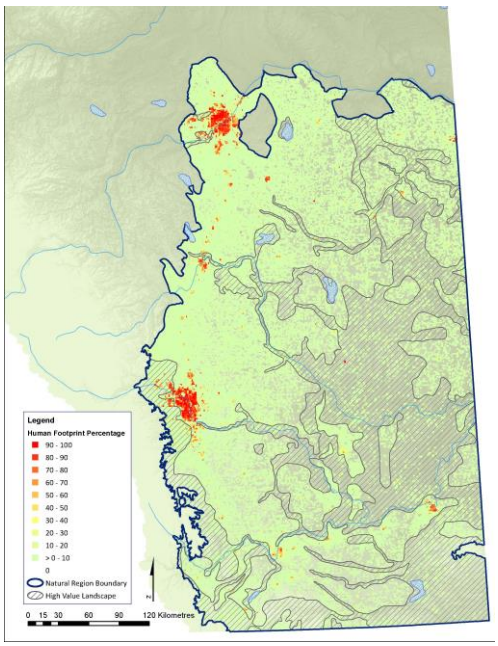

Figure 5C. Urban, rural, and residential footprint.

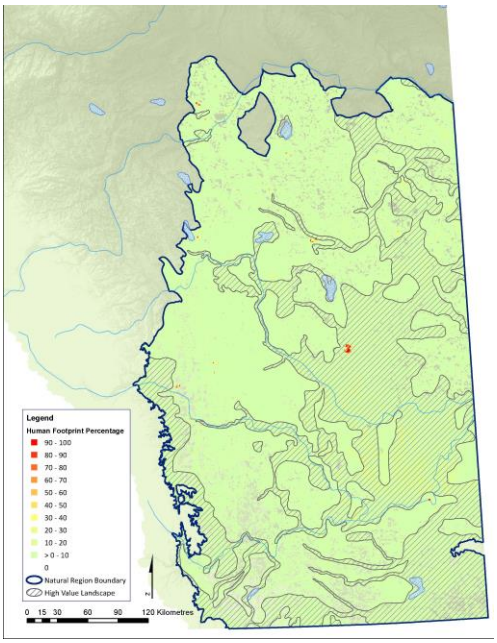

Figure 5D. Energy footprint.

Figure 5. Distribution of A. agriculture footprint, B. transportation footprint, C. urban, rural, and residential footprint, and D. energy footprint in the Prairie Region, circa 2012.

6.0 Natural Habitat: Methods and Results

Proximity of human footprint can affect how species use natural 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 natural habitat using four different buffer distances: 0 m, > 50 m, and > 200 m, 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. These numbers are valuable because species respond differently to human activity with some requiring more distance from footprint.

Overall, 69% of the Prairie Region is composed of natural habitat with a 0 m buffer from human footprint whereas, in the case of natural habitat that is at least 2 km away from development, 6% remains (Table 4).

As a note of caution, our summary of natural 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 natural habitat is also not yet accounted for.

Table 4. Total area and percent area of natural habitat in the Prairie Region expressed using three buffers.

	Buffer size	Total Area (km^2)	Per cent Area (%)
Prairie Region	**No Buffer**	56,757	37
	50 m	38,431	25
	200 m	14,980	10
Inside HVL	**No Buffer**	39,647	69
	50 m	29,039	51
	200 m	12,857	23
Outside HVL	**No Buffer**	17,139	18
	50 m	8,868	9
	200 m	2,160	2

7.0 Protected Areas: Methods and Results

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

Overall, 1.4% (or 2,218 km^2) of the Prairie Region is managed as protected areas (Table 5; Figure 6). All natural subregions within the Praire Region have <2% representation in protected areas (Table 5).

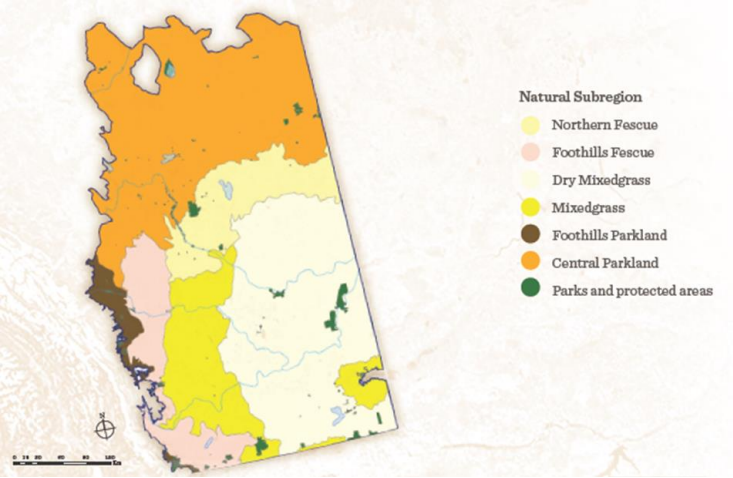

Figure 6. Distribution of protected areas in the Prairie Region.

There are opportunities for protection of native vegetation in each of the Natural Subregions. The Dry Mixedgrass and Foothills Parkland Natural Subregions have the most native vegetation remaining with more than 50%, and most of this area is located in the HVL (Table 04). In contrast, about one-quarter of the Central Parkland remains as native vegetation, with one-third of this located in the HVL (Table 4).

Table 5. Amount and distribution of protected areas for Natural Subregions contained in the Prairie Region.

Natural Region	Natural Subregions	Total Area (km^2) and Percentage Area (%) of Natural Subregion in Prairie Region	Total Area (km^2) and Percentage Area (%) of Natural Subregion Remaining as Native Vegetation	Total Area (km^2) and Percentage Area (%) of Natural Subregion Managed as Protected Areas	Total Area (km^2) and Percentage Area (%) Inside HVL Remaining as Native Vegetation	Total Area (km^2) and Percentage Area (%) of Natural Subregion Outside HVL Remaining as Native Vegetation
Grassland	Northern Fescue	14,933 (10%)	6,062 (40.6%)	196 (1.3%)	3,528 (23.6%)	2,531 (16.9%)
	Foothills Fescue	13,623 (9.1%)	4,791 (35.2%)	52 (0.4%)	2,826 (20.7%)	1,966 (14.4%)
	Dry Mixedgrass	46,937 (31.4%)	25,832 (55.0%)	759 (1.6%)	22,029 (46.9%)	3,803 (8.1%)
	Mixedgrass	20,072 (13.4%)	7,049 (35.1%)	185 (0.9%)	5,359 (26.7%)	1,688 (8.4%)
Parkland	Foothills Parkland	3,922 (2.6%)	2,050 (52.3%)	41 (1.1%)	1,860 (47.4%)	192 (4.9%)
	Central Parkland	53,706 (36.0%)	13,105 (24.4%)	467 (0.9%)	4,477 (8.3%)	7,513 (14.0%)

8.0 Biodiversity Intactness Analysis

8.1 Estimating Biodiversity Intactness

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. 2015. Manual for Species Modeling and Intactness (20029), Version 2015-11-27. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: www.abmi.ca.

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 Prairie Region—in other words, for locations where the ABMI is not directly monitoring. Using the ABMI's Inventory of Human Footprint (circa 2012) and data on vegetation types, the average intactness for 197 species in the Prairie Region was estimated and mapped to generate an overall picture of biodiversity in the region (Figure 7).

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 Prairie Region is calculated at 53%. Clearly, the map shows that while some areas have low human footprint and higher biodiversity intactness (shown as green in Figure 6), while much of the region has some human footprint, and correspondingly lower biodiversity intactness (shown as orange and red in Figure 6). Overall, regional biodiversity intactness is approaching 50% because much of the Prairie Region has 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.

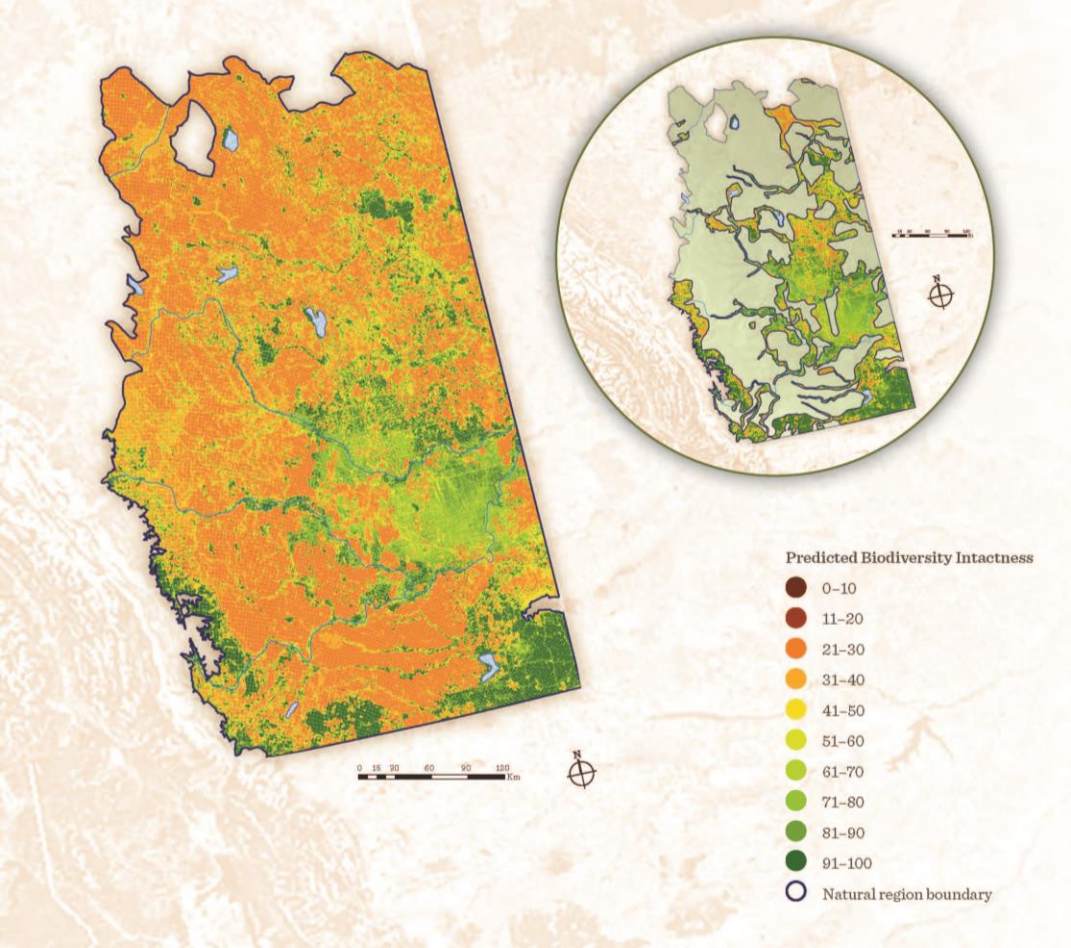

Figure 7. The average estimated intactness for 194 species (from 4 taxa) in the Prairie Region is 53%. Red identifies the quarter sections that are predicted to have the lowest average biodiversity intactness values, and dark green identifies quarter sections with the highest intactness. To view the 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 8). We conducted breeding bird surveys from one half hour before sunrise to 10:00 am.

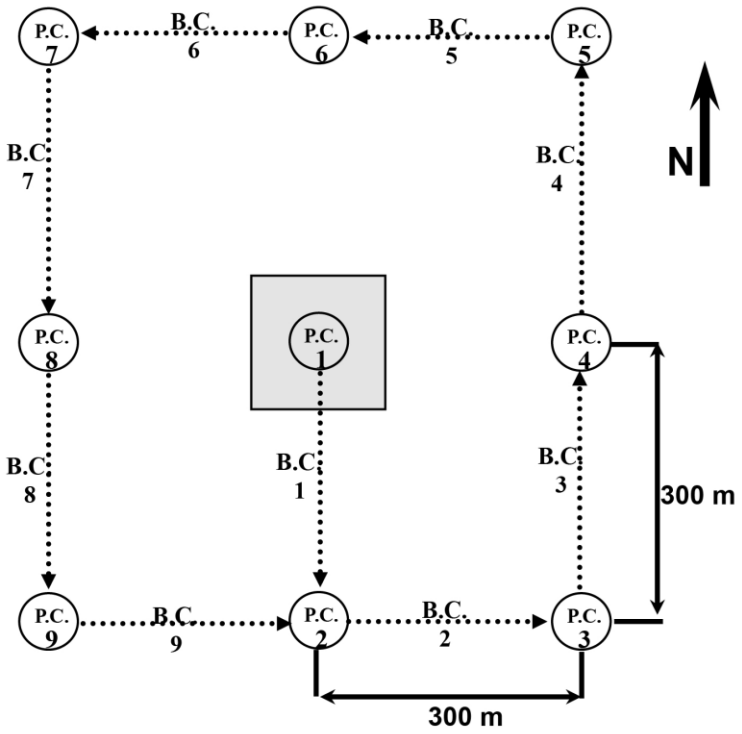

Figure 8. Diagram showing the layout of the nine bird-point count stations at the ABMI's terrestrial survey sites. Technicians proceed consecutively from station 1 to station 9.

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 Prairie and Parkland Natural Regions south of 53.5 N, the area we used for fitting the models. We summarize intactness for birds in the Prairie Region.

Results are summarized for all birds (Table 6, Figure 8).

10.3 Bird Results

10.3.1 Intactness of all birds in the Prairie Region

Table 6. The ABMI detected 55 bird species with enough frequency to calculate intactness. The complete list of breeding bird species analyzed in the Prairie Region, outside the HVL (non-HVL), and inside the HVL includes: species common name, species scientific name, percent (%) occurrence (in the Prairie Region only), relative abundance, reference abundance, intactness, whether it was more abundant (Above) or less abundant (Below) than expected compared to reference conditions. Detailed statistics are available in The Status of Biodiversity in the Prairie Region: Supplementary Data File. 2016. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

Common Name	Scientific Name	Occurrence in the Prairie Region (%)	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
Prairie Region						
American Crow	*Corvus brachyrhynchos*	72	4.12	2.56	62	Above
American Goldfinch	*Spinus tristis*	58	1.51	1.88	81	Below
American Robin	*Turdus migratorius*	50	2.00	1.11	56	Above
Baird's Sparrow	*Ammodramus bairdii*	32	0.93	2.73	34	Below
Baltimore Oriole	*Icterus galbula*	18	0.69	0.74	87	Below
Bank Swallow	*Riparia riparia*	10	0.20	0.35	53	Below
Barn Swallow	*Hirundo rustica*	25	0.40	0.15	37	Above
Black-billed Magpie	*Pica hudsonia*	66	2.92	1.53	53	Above
Black-capped Chickadee	*Poecile atricapillus*	16	0.37	0.35	99	Above
Brewer's Blackbird	*Euphagus cyanocephalus*	36	0.64	0.35	56	Above
Brown-headed Cowbird	*Molothrus ater*	84	4.04	3.45	86	Above
Cedar Waxwing	*Bombycilla cedrorum*	15	0.39	0.25	67	Above
Chestnut-collared Longspur	*Calcarius ornatus*	34	1.02	1.94	52	Below
Chipping Sparrow	*Spizella passerina*	7	0.20	0.03	15	Above
Clay-colored Sparrow	*Spizella pallida*	80	4.49	5.53	82	Below
Cliff Swallow	*Petrochelidon pyrrhonota*	14	0.17	0.25	66	Below
Common Raven	*Corvus corax*	36	0.95	1.68	57	Below
Eastern Kingbird	*Tyrannus tyrannus*	20	0.33	0.28	84	Above
Grasshopper Sparrow	*Ammodramus savannarum*	11	0.18	0.31	63	Below
Gray Catbird	*Dumetella carolinensis*	13	0.34	0.42	87	Below
Horned Lark	*Eremophila alpestris*	74	4.36	3.02	70	Above
House Wren	*Troglodytes aedon*	38	2.65	2.63	98	Above
Killdeer	*Charadrius vociferus*	59	1.48	0.68	48	Above
Lark Sparrow	*Chondestes grammacus*	9	0.13	0.17	80	Below

Least Flycatcher	*Empidonax minimus*	21	0.54	1.99	27	Below
Le Conte's Sparrow	*Ammodramus leconteii*	18	0.30	0.26	85	Above
Lincoln's Sparrow	*Melospiza lincolnii*	7	0.14	0.15	90	Below
Long-billed Curlew	*Numenius americanus*	36	1.04	0.61	60	Above
Magnolia Warbler	*Setophaga magnolia*	11	0.20	0.40	48	Below
Marbled Godwit	*Limosa fedoa*	52	1.65	1.08	65	Above
McCown's Longspur	*Rhynchophanes mccownii*	18	0.53	0.59	91	Below
Mourning Dove	*Zenaida macroura*	24	0.60	0.24	41	Above
Nelson's Sparrow	*Ammodramus nelsoni*	9	0.19	0.18	98	Below
Northern Flicker	*Colaptes auratus*	10	0.20	0.14	64	Above
Pileated Woodpecker	*Dryocopus pileatus*	7	0.10	0.27	38	Below
Pine Siskin	*Spinus pinus*	8	0.12	0.10	75	Above
Red-eyed Vireo	*Vireo olivaceus*	8	0.26	0.53	51	Below
Red-winged Blackbird	*Agelaius phoeniceus*	88	5.23	3.16	60	Above
Savannah Sparrow	*Passerculus sandwichensis*	95	6.14	6.69	91	Below
Sharp-tailed Grouse	*Tympanuchus phasianellus*	8	0.09	0.25	39	Below
Song Sparrow	*Melospiza melodia*	24	1.66	0.57	34	Above
Sora	*Porzana carolina*	44	1.32	1.38	96	Below
Spotted Sandpiper	*Actitis macularius*	15	0.39	0.09	22	Above
Sprague's Pipit	*Anthus spragueii*	46	1.68	4.88	34	Below
Tree Swallow	*Tachycineta bicolor*	22	0.50	0.32	63	Above
Upland Sandpiper	*Bartramia longicauda*	26	0.60	0.67	90	Below
Vesper Sparrow	*Pooecetes gramineus*	91	6.20	4.99	81	Above
Warbling Vireo	*Vireo gilvus*	18	0.44	0.94	47	Below
Western Meadowlark	*Sturnella neglecta*	80	5.61	6.23	90	Below
White-throated Sparrow	*Zonotrichia albicollis*	10	0.30	1.19	26	Below
Willet	*Tringa semipalmatus*	54	1.52	2.30	64	Below
Wilson's Snipe	*Gallinago delicata*	39	1.40	0.97	69	Above
Yellow-bellied Sapsucker	*Sphyrapicus varius*	9	0.15	0.36	43	Below
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	27	0.81	0.34	43	Above
Yellow Warbler	*Setophaga petechia*	34	1.51	1.89	80	Below
Non-HVL						
American Crow	*Corvus brachyrhynchos*		4.88	2.81	57	Above
American Goldfinch	*Spinus tristis*		1.70	2.17	79	Below
American Robin	*Turdus migratorius*		2.35	1.32	56	Above
Baird's Sparrow	*Ammodramus bairdii*		0.20	1.84	11	Below
Baltimore Oriole	*Icterus galbula*		0.87	0.94	87	Below

Bank Swallow	*Riparia riparia*	0.19	0.32	53	Below
Barn Swallow	*Hirundo rustica*	0.47	0.16	33	Above
Black-billed Magpie	*Pica hudsonia*	3.42	1.65	49	Above
Black-capped Chickadee		0.47	0.47	98	Below
Brewer's Blackbird	*Euphagus cyanocephalus*	0.62	0.31	49	Above
Brown-headed Cowbird	*Molothrus ater*	3.89	3.47	88	Above
Cedar Waxwing	*Bombycilla cedrorum*	0.46	0.32	71	Above
Chestnut-collared Longspur	*Calcarius ornatus*	0.32	1.21	26	Below
Chipping Sparrow	*Spizella passerina*	0.26	0.04	15	Above
Clay-colored Sparrow	*Spizella pallida*	4.61	6.14	75	Below
Cliff Swallow	*Petrochelidon pyrrhonota*	0.13	0.23	54	Below
Common Raven	*Corvus corax*	1.08	2.05	53	Below
Eastern Kingbird	*Tyrannus tyrannus*	0.27	0.26	95	Above
Grasshopper Sparrow	*Ammodramus savannarum*	0.04	0.14	31	Below
Gray Catbird	*Dumetella carolinensis*	0.27	0.49	61	Below
Horned Lark	*Eremophila alpestris*	3.97	2.18	55	Above
House Wren	*Troglodytes aedon*	3.29	3.33	99	Above
Killdeer	*Charadrius vociferus*	1.43	0.59	42	Above
Lark Sparrow	*Chondestes grammacus*	0.09	0.13	69	Below
Least Flycatcher	*Empidonax minimus*	0.60	2.67	22	Below
Le Conte's Sparrow	*Ammodramus leconteii*	0.31	0.31	96	Above
Lincoln's Sparrow	*Melospiza lincolnii*	0.17	0.19	86	Below
Long-billed Curlew	*Numenius americanus*	0.94	0.44	45	Above
Magnolia Warbler	*Setophaga magnolia*	0.24	0.50	46	Below
Marbled Godwit	*Limosa fedoa*	1.55	0.78	50	Above
McCown's Longspur	*Rhynchophanes mccownii*	0.39	0.40	96	Below
Mourning Dove	*Zenaida macroura*	0.59	0.17	29	Above
Nelson's Sparrow	*Ammodramus nelsoni*	0.21	0.21	98	Above
Northern Flicker	*Colaptes auratus*	0.24	0.16	64	Above
Pileated Woodpecker	*Dryocopus pileatus*	0.10	0.34	33	Below
Pine Siskin	*Spinus pinus*	0.13	0.12	76	Above
Red-eyed Vireo	*Vireo olivaceus*	0.28	0.69	41	Below
Red-winged Blackbird	*Agelaius phoeniceus*	5.75	3.31	57	Above
Savannah Sparrow	*Passerculus sandwichensis*	6.20	6.79	92	Below
Sharp-tailed Grouse	*Tympanuchus phasianellus*	0.06	0.21	28	Below
Song Sparrow	*Melospiza melodia*	2.30	0.76	33	Above

Sora	*Porzana carolina*	1.47	1.54	96	Below
Spotted Sandpiper	*Actitis macularius*	0.42	0.08	20	Above
Sprague's Pipit	*Anthus spragueii*	0.53	4.20	13	Below
Tree Swallow	*Tachycineta bicolor*	0.62	0.39	63	Above
Upland Sandpiper	*Bartramia longicauda*	0.45	0.50	86	Below
Vesper Sparrow	*Pooecetes gramineus*	6.28	4.61	73	Above
Warbling Vireo	*Vireo gilvus*	0.56	1.25	43	Below
Western Meadowlark	*Sturnella neglecta*	4.55	5.35	85	Below
White-throated Sparrow	*Zonotrichia albicollis*	0.33	1.68	20	Below
Willet	*Tringa semipalmatus*	1.12	1.94	57	Below
Wilson's Snipe	*Gallinago delicata*	1.58	1.09	70	Above
Yellow-bellied Sapsucker	*Sphyrapicus varius*	0.18	0.47	35	Below
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	0.91	0.34	39	Above
Yellow Warbler	*Setophaga petechia*	1.67	2.33	70	Below
HVL					
American Crow	*Corvus brachyrhynchos*	2.98	2.19	74	Above
American Goldfinch	*Spinus tristis*	1.24	1.46	85	Below
American Robin	*Turdus migratorius*	1.46	0.81	55	Above
Baird's Sparrow	*Ammodramus bairdii*	1.99	4.08	50	Below
Baltimore Oriole	*Icterus galbula*	0.42	0.45	90	Below
Bank Swallow	*Riparia riparia*	0.21	0.37	55	Below
Barn Swallow	*Hirundo rustica*	0.30	0.14	47	Above
Black-billed Magpie	*Pica hudsonia*	2.14	1.33	63	Above
Black-capped Chickadee		0.21	0.18	89	Above
Brewer's Blackbird	*Euphagus cyanocephalus*	0.65	0.42	64	Above
Brown-headed Cowbird	*Molothrus ater*	4.29	3.47	81	Above
Cedar Waxwing	*Bombycilla cedrorum*	0.27	0.15	53	Above
Chestnut-collared Longspur	*Calcarius ornatus*	2.08	3.03	69	Below
Chipping Sparrow	*Spizella passerina*	0.12	0.02	13	Above
Clay-colored Sparrow	*Spizella pallida*	4.34	4.61	95	Below
Cliff Swallow	*Petrochelidon pyrrhonota*	0.22	0.28	80	Below
Common Raven	*Corvus corax*	0.77	1.15	68	Below
Eastern Kingbird	*Tyrannus tyrannus*	0.41	0.31	73	Above
Grasshopper Sparrow	*Ammodramus savannarum*	0.39	0.56	73	Below
Gray Catbird	*Dumetella carolinensis*	0.45	0.33	74	Above
Horned Lark	*Eremophila alpestris*	4.92	4.35	88	Above
House Wren	*Troglodytes aedon*	1.66	1.60	94	Above

Killdeer	*Charadrius vociferus*	1.53	0.83	54	Above
Lark Sparrow	*Chondestes grammacus*	0.21	0.24	85	Below
Least Flycatcher	*Empidonax minimus*	0.44	0.97	46	Below
Le Conte's Sparrow	*Ammodramus leconteii*	0.28	0.21	72	Above
Lincoln's Sparrow	*Melospiza lincolnii*	0.08	0.07	88	Above
Long-billed Curlew	*Numenius americanus*	1.20	0.92	77	Above
Magnolia Warbler	*Setophaga magnolia*	0.15	0.25	58	Below
Marbled Godwit	*Limosa fedoa*	1.81	1.54	85	Above
McCown's Longspur	*Rhynchophanes mccownii*	0.76	0.87	83	Below
Mourning Dove	*Zenaida macroura*	0.61	0.35	58	Above
Nelson's Sparrow	*Ammodramus nelsoni*	0.15	0.14	98	Above
Northern Flicker	*Colaptes auratus*	0.16	0.11	68	Above
Pileated Woodpecker	*Dryocopus pileatus*	0.10	0.19	53	Below
Pine Siskin	*Spinus pinus*	0.09	0.07	76	Above
Red-eyed Vireo	*Vireo olivaceus*	0.23	0.25	92	Below
Red-winged Blackbird	*Agelaius phoeniceus*	4.45	2.97	66	Above
Savannah Sparrow	*Passerculus sandwichensis*	6.05	6.59	91	Below
Sharp-tailed Grouse	*Tympanuchus phasianellus*	0.15	0.30	51	Below
Song Sparrow	*Melospiza melodia*	0.73	0.27	37	Above
Sora	*Porzana carolina*	1.10	1.12	98	Below
Spotted Sandpiper	*Actitis macularius*	0.36	0.09	25	Above
Sprague's Pipit	*Anthus spragueii*	3.42	5.95	58	Below
Tree Swallow	*Tachycineta bicolor*	0.34	0.22	63	Above
Upland Sandpiper	*Bartramia longicauda*	0.83	0.91	94	Below
Vesper Sparrow	*Pooecetes gramineus*	6.01	5.56	93	Above
Warbling Vireo	*Vireo gilvus*	0.29	0.47	61	Below
Western Meadowlark	*Sturnella neglecta*	7.19	7.56	95	Below
White-throated Sparrow	*Zonotrichia albicollis*	0.25	0.47	54	Below
Willet	*Tringa semipalmatus*	2.07	2.87	72	Below
Wilson's Snipe	*Gallinago delicata*	1.12	0.77	69	Above
Yellow-bellied Sapsucker	*Sphyrapicus varius*	0.12	0.18	65	Below
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	0.69	0.34	53	Above
Yellow Warbler	*Setophaga petechia*	1.28	1.16	92	Above

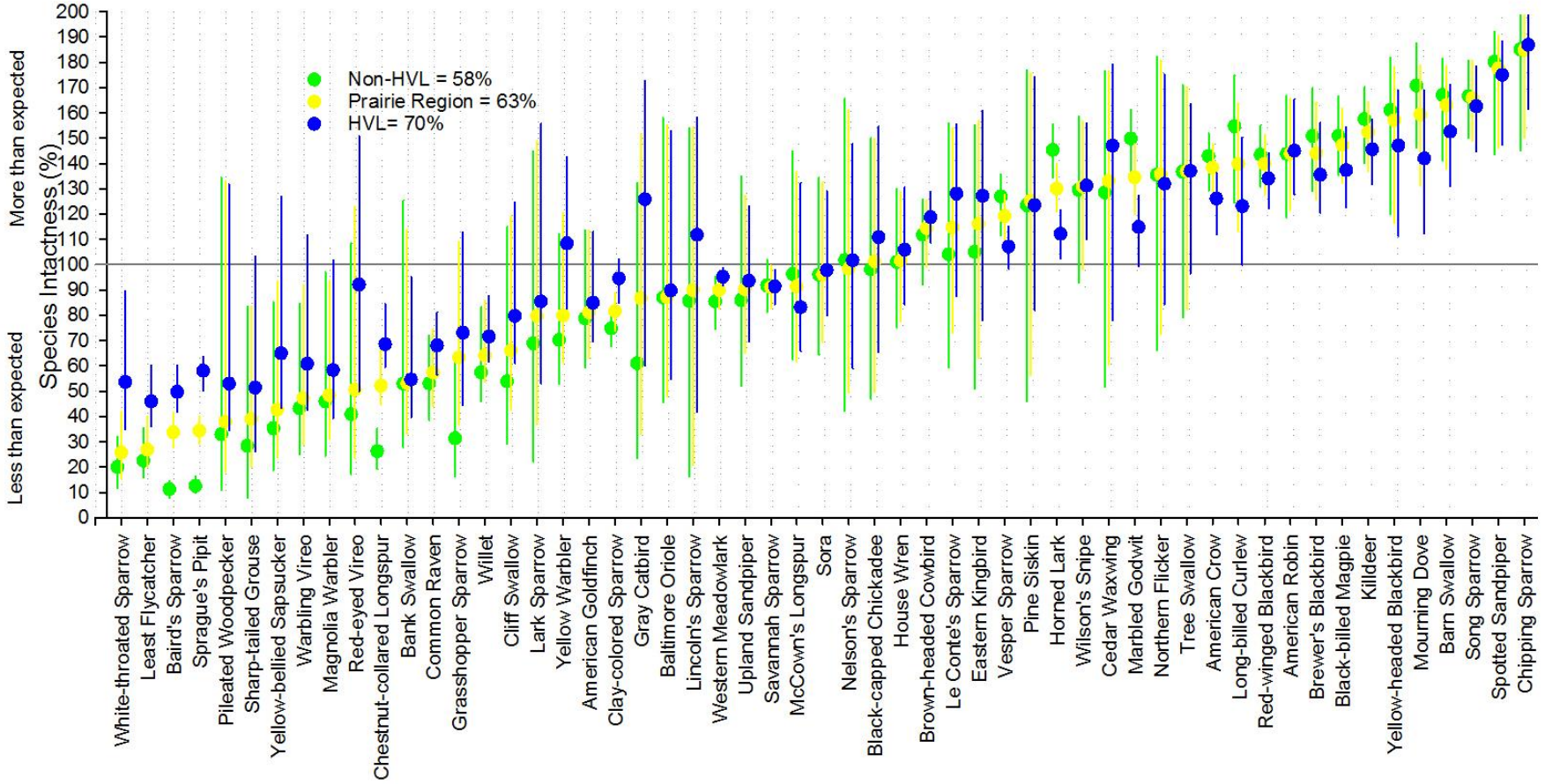

Figure 9. Intactness (with 90% confidence intervals) of 55 native bird species in the Prairie Region, non-HVL, and HVL between 2003 and 2012. The order in which bird intactness results are presented is determined by results for the Prairie Region. Detailed statistics available in The Status of Biodiversity in the Grassland and Parkland Region: Supplementary Data File. 2015. Available at: www.abmi.ca.

11.0 Armoured Mites - Methods and Results

11.1 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 10). 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.

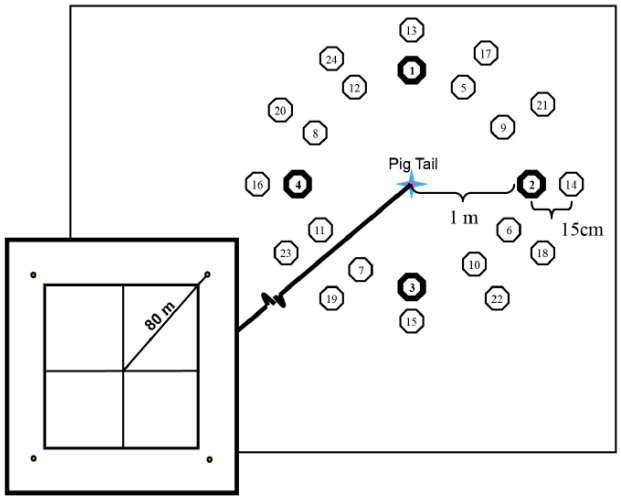

Figure 10. Soil core protocol – note the location outside of 1 ha plot and the circular arrangement of soil cores.

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. 2014. Terrestrial field data collection protocols (abridged version) 2015-02-19. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca [accessed 2016-01-06].

Detailed laboratory processing manuals are available at www.abmi.ca.

11.2 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 Prairie and Parkland Natural Regions south of 53.5 N, the area we used for fitting the models. We summarized intactness for armoured mites in the Prairie Region (Table 7, Figure 11). A comprehensive description of the scientific methods used in analyses of data for this report is described in:

- Alberta Biodiversity Monitoring Institute. 2015. Manual for Species Modeling and Intactness (20029), Version 2015-11-27. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca [accessed 2016-01-20].Armoured Mite Results

11.2.1 Intactness of armoured mites in the Prairie Region

Table 7. The ABMI detected 17 armoured mite species with enough frequency to calculate intactness. The following is a complete list of armoured mite species analyzed in the Prairie Region, outside the HVL (non-HVL), and inside the HVL including: species common name, species scientific name, percent (%) occurrence (in the Prairie Region only), relative abundance, reference abundance, intactness, whether it was more abundant (Above) or less abundant (Below) than expected compared to reference conditions. Detailed statistics are available in The Status of Biodiversity in the Prairie Region: Supplementary Data File. 2016. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

Species (Scientific Name)	Species (Common Name)	Region	Occurrence in the Prairie 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
Anachipteria howardi	Howard's Knifeless Mite	Prairie	18	0.34	0.79	44	Below
Camisia biverrucata	Twin Butte Nightgown Mite; Double-warted Nightgown Mite	Prairie Region	21	0.20	0.52	39	Below
Ceratozetes gracilis	Gracefull Ceramic Mite	Prairie	10	0.18	0.62	31	Below
Eueremaeus masinasin	Writing-on-Stone Hermit Mite	Prairie	37	0.50	1.24	40	Below
Galumna sp. 1 DEW	Bald Boreal Elephant-ear Mite	Prairie	9	0.13	0.23	61	Below
Gymnodamaeus ornatus	Ornate Hatless Mite	Prairie	7	0.10	0.44	21	Below
Nothrus anauniensis	Slow Eruptor Nothrus	Prairie	8	0.13	0.08	59	Above
Oribatula sp. 1 DEW	Field Roamer	Prairie	47	0.98	0.79	81	Above
Peloptulus sp. 1 DEW	Grassland Little Dark-eye	Prairie	38	0.68	1.33	50	Below
Peloribates pilosus	Hairy Dusky Roamer	Prairie	24	0.46	0.77	63	Below
Peloribates sp. 4 DEW	Fescue Dusky Roamer	Prairie Region	16	0.19	0.31	64	Below
Pergalumna sp. 1 DEW	Tacked Elephant-ear Mite	Prairie	11	0.14	0.36	37	Below
Propelops canadensis	Canadian Dark-eye	Prairie	28	0.48	0.86	55	Below
Tectocepheus sarekensis	Six-dimpled Northern Mite	Prairie	27	0.41	0.32	76	Above
Trhypochthonius	Shelved Mother-eating Mite	Prairie	21	0.26	0.67	41	Below

tectorum							
Zygoribatula sp. 1 DEW	Saamis Yoked-Roamer	Prairie	26	0.49	0.33	64	Above
Zygoribatula sp. 2 DEW	Sweet Grass Yoked-Roamer	Prairie	22	0.29	0.67	43	Below
Anachipteria howardi	Howard's Knifeless Mite	HVL		0.41	0.65	63	Below
Camisia biverrucata	Twin Butte Nightgown Mite; Double-warted Nightgown Mite	HVL		0.34	0.59	59	Below
Ceratozetes gracilis	Gracefull Ceramic Mite	HVL		0.14	0.29	52	Below
Eueremaeus masinasin	Writing-on-Stone Hermit Mite	HVL		0.92	1.46	64	Below
Galumna sp. 1 DEW	Bald Boreal Elephant-ear Mite	HVL		0.13	0.18	68	Below
Gymnodamaeus ornatus	Ornate Hatless Mite	HVL		0.09	0.20	42	Below
Nothrus anauniensis	Slow Eruptor Nothrus	HVL		0.08	0.05	81	Above
Oribatula sp. 1 DEW	Field Roamer	HVL		0.77	0.67	90	Above
Peloptulus sp. 1 DEW	Grassland Little Dark-eye	HVL		0.88	1.18	74	Below
Peloribates pilosus	Hairy Dusky Roamer	HVL		0.46	0.64	73	Below
Peloribates sp. 4 DEW	Fescue Dusky Roamer	HVL		0.41	0.53	70	Below
Pergalumna sp. 1 DEW	Tacked Elephant-ear Mite	HVL		0.16	0.23	60	Below
Propelops canadensis	Canadian Dark-eye	HVL		0.56	0.77	71	Below
Tectocepheus sarekensis	Six-dimpled Northern Mite	HVL		0.36	0.31	88	Above
Trhypochthonius tectorum	Shelved Mother-eating Mite	HVL		0.49	0.82	59	Below
Zygoribatula sp. 1 DEW	Saamis Yoked-Roamer	HVL		0.65	0.50	76	Above
Zygoribatula sp. 2 DEW	Sweet Grass Yoked-Roamer	HVL		0.55	0.78	67	Below
Anachipteria howardi	Howard's Knifeless Mite	nonHVL		0.31	0.90	34	Below
Camisia biverrucata	Twin Butte Nightgown Mite; Double-warted Nightgown Mite	nonHVL		0.11	0.46	23	Below
Ceratozetes gracilis	Gracefull Ceramic Mite	nonHVL		0.21	0.85	25	Below
Eueremaeus masinasin	Writing-on-Stone Hermit Mite	nonHVL		0.20	1.10	19	Below
Galumna sp. 1 DEW	Bald Boreal Elephant-ear Mite	nonHVL		0.13	0.25	50	Below
Gymnodamaeus ornatus	Ornate Hatless Mite	nonHVL		0.11	0.59	18	Below
Nothrus anauniensis	Slow Eruptor Nothrus	nonHVL		0.16	0.10	60	Above

Oribatula sp. 1 DEW	Field Roamer	nonHVL	1.09	0.86	79	Above
Peloptulus sp. 1 DEW	Grassland Little Dark-eye	nonHVL	0.56	1.41	40	Below
Peloribates pilosus	Hairy Dusky Roamer	nonHVL	0.46	0.86	53	Below
Peloribates sp. 4 DEW	Fescue Dusky Roamer	nonHVL	0.06	0.16	38	Below
Pergalumna sp. 1 DEW	Tacked Elephant-ear Mite	nonHVL	0.12	0.44	28	Below
Propelops canadensis	Canadian Dark-eye	nonHVL	0.45	0.93	48	Below
Tectocepheus sarekensis	Six-dimpled Northern Mite	nonHVL	0.45	0.33	72	Above
Trhypochthonius tectorum	Shelved Mother-eating Mite	nonHVL	0.13	0.56	23	Below
Zygoribatula sp. 1 DEW	Saamis Yoked-Roamer	nonHVL	0.40	0.20	48	Above
Zygoribatula sp. 2 DEW	Sweet Grass Yoked-Roamer	nonHVL	0.12	0.60	19	Below

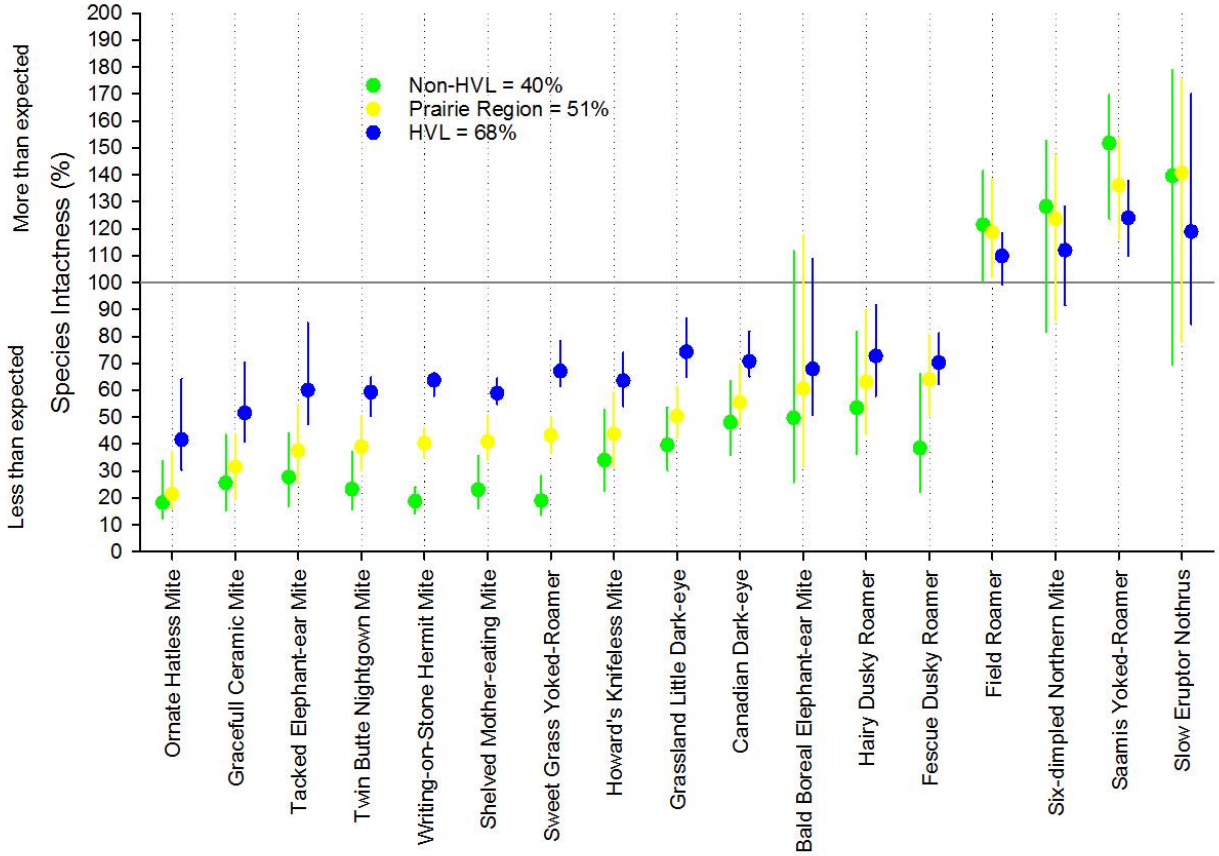

Figure 11. Intactness (with 90% confidence intervals) of 17 mite species in the Prairie Region, non-HVL, and HVL between 2003 and 2012. The order in which bird intactness results are presented is determined by intactness results for the Prairie Region. Detailed statistics available in The Status of Biodiversity in the Prairie Region: Supplementary Data File. 2015. Available at: www.abmi.ca.

12.0 Vascular Plants – Methods and Results

12.1 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 12). 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).

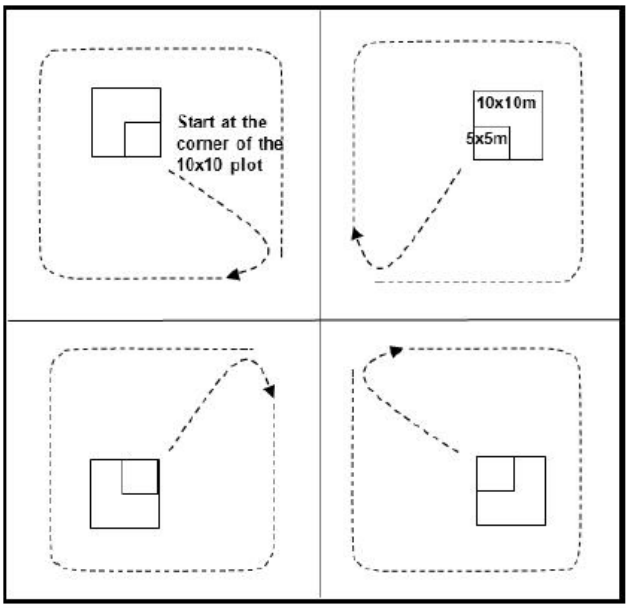

Figure 12. Vascular plant survey protocol.

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.

12.2 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 species that was detected at a minimum of 20 sites in the Prairie and Parkland Natural Regions south of 53.5 N, the area we used for fitting the models. We summarize intactness for native vascular plants in the Prairie Region (Table 8, Figure 13). A complete list of non-

native species that were detected in the Prairie Region is also presented, along with per cent occurrence of each species (Table 9), and a visual presentation of the predicted number of non-native species per 1 ha plot in each quarter section of the Prairie 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. 2015. Manual for Species Modeling and Intactness (20029), Version 2015-11-27. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca.

12.1 Vascular Plant Results

12.1.1 Intactness of native vascular plants in the Prairie Region

Table 8. The ABMI detected 113 native vascular plant species with enough frequency to calculate intactness. The following is a complete list of native vascular plant species analyzed analyzed in the Prairie Region, outside the HVL (non-HVL), and inside the HVL including: species common name, species scientific name, percent (%) occurrence (in the Prairie Region only), relative abundance, reference abundance, intactness, whether it was more abundant (Above) or less abundant (Below) than expected compared to reference conditions. Detailed statistics are available in The Status of Biodiversity in the Prairie Region: Supplementary Data File. 2016. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

Species (Scientific Name)	Species (Common Name)	Region	Occurrence in the Prairie 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
Achillea millefolium	Common Yarrow	Prairie	60	1.65	3.34	49	Below
Agoseris glauca	Yellow False Dandelion	Prairie	15	0.22	0.75	30	Below
Agrostis scabra	Rough Hair Grass	Prairie	24	0.45	1.23	37	Below
Amelanchier alnifolia	Saskatoon	Prairie	13	0.30	0.85	37	Below
Androsace septentrionalis	Northern Fairy Candelabra	Prairie	19	0.49	0.68	73	Below
Anemone canadensis	Canada Anemone	Prairie	12	0.23	0.54	41	Below
Anemone multifida	Cut-leaved Anemone	Prairie	9	0.18	0.32	54	Below
Anemone patens	Prairie Crocus	Prairie	20	0.47	1.29	36	Below
Antennaria neglecta	Broad-leaved Everlasting	Prairie	9	0.16	0.40	43	Below
Antennaria parvifolia	Small-leaved Everlasting	Prairie	31	0.64	1.84	36	Below
Artemisia campestris	Plains Wormwood	Prairie	8	0.15	0.32	43	Below
Artemisia cana	Silver Sagebrush	Prairie	23	0.59	1.05	56	Below
Artemisia frigida	Pasture Sagewort	Prairie	51	1.38	3.04	46	Below
Artemisia ludoviciana	Prairie Sagewort	Prairie	43	0.92	2.06	45	Below
Astragalus agrestis	Purple Milkvetch	Prairie	12	0.25	0.59	41	Below
Astragalus flexuosus	Slender Milk Vetch	Prairie	11	0.15	0.62	24	Below
Astragalus laxmannii	Prairie milkvetch	Prairie	14	0.24	0.66	37	Below
Astragalus pectinatus	Narrow-leaved Milk Vetch	Prairie	18	0.34	0.77	45	Below

Avenula hookeri	Spikeoat	Prairie	13	0.31	0.74	40	Below
Beckmannia syzigachne	Slough Grass	Prairie	9	0.16	0.15	91	Above
Bouteloua gracilis	Blue Grama	Prairie	30	0.72	1.68	43	Below
Calamagrostis canadensis	Bluejoint	Prairie	6	0.13	0.76	18	Below
Calamagrostis montanensis	Plains Reed Grass	Prairie	11	0.25	0.53	46	Below
Campanula rotundifolia	Harebell	Prairie	24	0.47	1.41	34	Below
Carex duriuscula	Needleleaf Sedge	Prairie	18	0.44	0.95	48	Below
Carex inops	Sun Loving Sedge	Prairie	9	0.19	0.46	40	Below
Cerastium arvense	Field Mouse Ear Chickweed	Prairie	17	0.31	0.87	38	Below
Chamerion angustifolium	Fireweed	Prairie	8	0.16	0.24	74	Below
Chenopodium pratericola	Goosefoot	Prairie	8	0.13	0.30	42	Below
Cirsium flodmanii	Flodman's Thistle	Prairie	18	0.35	0.56	60	Below
Cirsium undulatum	Wavy-leaved Thistle	Prairie	12	0.22	0.46	48	Below
Comandra umbellata	Bastard Toadflax	Prairie	23	0.42	1.23	35	Below
Cornus sericea	Silky Dogwood	Prairie	7	0.19	0.63	29	Below
Drymocallis arguta	Tall Cinquefoil	Prairie	9	0.13	0.38	31	Below
Elymus lanceolatus	Northern Wheat Grass	Prairie	15	0.33	0.63	54	Below
Elymus trachycaulus	Slender Wheat Grass	Prairie	22	0.45	1.17	39	Below
Equisetum arvense	Common Horsetail	Prairie	12	0.32	0.20	63	Above
Erigeron caespitosus	Tufted Fleabane	Prairie	22	0.44	0.99	45	Below
Erysimum capitatum	Sanddune Wallflower	Prairie	13	0.29	0.43	66	Below
Erysimum inconspicuum	Small-flowered Rocket	Prairie	8	0.10	0.35	29	Below
Escobaria vivipara	Cushion Cactus	Prairie	12	0.13	0.28	52	Below
Eurybia conspicua	Showy Aster	Prairie	5	0.13	0.38	37	Below
Festuca hallii	Plains Rough Fescue	Prairie	16	0.28	1.27	22	Below
Festuca saximontana	Rocky Mountain Fescue	Prairie	13	0.31	0.87	35	Below
Fragaria virginiana	Wild Strawberry	Prairie	15	0.37	1.29	29	Below
Gaillardia aristata	Gaillardia	Prairie	30	0.54	1.63	34	Below
Galium boreale	Northern Bedstraw	Prairie	33	0.79	1.92	41	Below
Gaura coccinea	Scarlet Butterflyweed	Prairie	27	0.54	1.10	51	Below

Geum triflorum	Three-flowered Avens	Prairie	26	0.46	1.53	30	Below
Glycyrrhiza lepidota	Wild Licorice	Prairie	8	0.16	0.20	83	Below
Grindelia squarrosa	Gumweed	Prairie	25	0.67	0.84	78	Below
Gutierrezia sarothrae	Broomweed	Prairie	22	0.58	0.96	59	Below
Hesperostipa comata	Needle and Thread Grass	Prairie	34	0.82	2.13	38	Below
Hesperostipa curtiseta	Shortbristle Needle and Thread	Prairie	12	0.25	0.77	36	Below
Heterotheca villosa	Golden Aster	Prairie	35	0.81	1.56	51	Below
Heuchera richardsonii	Richardson's Alumroot	Prairie	7	0.12	0.33	36	Below
Hieracium umbellatum	Narrow-leaved Hawkweed	Prairie	10	0.31	0.21	71	Above
Hordeum jubatum	Foxtail Barley	Prairie	47	1.32	0.79	58	Above
Juncus arcticus	Arctic Rush	Prairie	15	0.33	0.77	44	Below
Koeleria macrantha	June Grass	Prairie	41	1.02	2.48	42	Below
Lathyrus ochroleucus	Cream-colored Vetchling	Prairie	9	0.20	0.71	30	Below
Lepidium densiflorum	Common Pepper-grass	Prairie	24	0.52	0.46	92	Above
Liatris punctata	Dotted Blazingstar	Prairie	8	0.19	0.35	56	Below
Lygodesmia juncea	Skeletonweed	Prairie	16	0.26	0.51	52	Below
Maianthemum stellatum	Star-flowered Solomon's Seal	Prairie	11	0.25	0.73	33	Below
Mentha arvensis	Wild Mint	Prairie	13	0.25	0.34	72	Below
Mulgedium oblongifolium	Tartarian Lettuce	Prairie	9	0.23	0.20	85	Above
Nassella viridula	Green Needlegrass	Prairie	22	0.37	0.90	43	Below
Opuntia polyacantha	Prickly Pear	Prairie	13	0.21	0.43	50	Below
Orthocarpus luteus	Owl Clover	Prairie	8	0.11	0.23	47	Below
Oxytropis monticola	Late Yellow Locoweed	Prairie	10	0.16	0.76	21	Below
Oxytropis sericea	Early Yellow Locoweed	Prairie	8	0.13	0.44	29	Below
Packera cana	Woolly Groundsel	Prairie	9	0.29	0.27	95	Above
Pascopyrum smithii	Western Wheat Grass	Prairie	52	1.49	2.63	57	Below
Penstemon procerus	Slender Blue Beardtongue	Prairie	11	0.19	0.36	51	Below
Phlox hoodii	Moss Phlox	Prairie	24	0.49	1.06	45	Below
Plantago patagonica	Pursh's Plantain	Prairie	9	0.26	0.37	69	Below
Poa palustris	Fowl Bluegrass	Prairie	20	0.58	0.81	69	Below

Poa secunda	Sandberg Bluegrass	Prairie	12	0.26	0.50	52	Below
Populus balsamifera	Balsam Poplar	Prairie	9	0.19	0.42	47	Below
Populus tremuloides	Trembling Aspen	Prairie	16	0.44	1.11	39	Below
Potentilla anserina	Silverweed	Prairie	9	0.15	0.17	86	Below
Potentilla bipinnatifida	Plains Cinquefoil	Prairie	13	0.28	0.58	49	Below
Potentilla gracilis	Graceful Cinquefoil	Prairie	14	0.25	0.70	36	Below
Potentilla hippiana	Woolly Cinquefoil	Prairie	15	0.29	0.61	48	Below
Potentilla norvegica	Rough Cinquefoil	Prairie	15	0.47	0.31	67	Above
Potentilla pensylvanica	Prairie Cinquefoil	Prairie	25	0.52	1.44	37	Below
Prunus virginiana	Choke Cherry	Prairie	7	0.18	0.46	41	Below
Ratibida columnifera	Prairie Coneflower	Prairie	19	0.48	0.68	71	Below
Ribes oxyacanthoides	Northern Gooseberry	Prairie	13	0.22	0.84	27	Below
Rosa acicularis	Prickly Rose	Prairie	19	0.48	0.89	53	Below
Rosa arkansana	Prairie Rose	Prairie	27	0.62	1.33	49	Below
Rosa woodsii	Common Wild Rose	Prairie	24	0.54	1.51	39	Below
Rubus idaeus	Wild Red Raspberry	Prairie	13	0.29	0.77	38	Below
Salix bebbiana	Beaked Willow	Prairie	6	0.14	0.38	35	Below
Salix petiolaris	Basket Willow	Prairie	8	0.19	0.29	79	Below
Selaginella densa	Prairie Selaginella	Prairie	22	0.54	1.21	46	Below
Sisyrinchium montanum	Common Blue-eyed Grass	Prairie	16	0.30	0.78	38	Below
Solidago canadensis	Canada Goldenrod	Prairie	19	0.48	0.84	57	Below
Solidago missouriensis	Low Goldenrod	Prairie	25	0.54	1.32	41	Below
Sphaeralcea coccinea	Scarlet Mallow	Prairie	32	0.67	1.47	45	Below
Stachys palustris	Marsh Hedge Nettle	Prairie	9	0.21	0.36	56	Below
Stellaria longifolia	Long-leaved Chickweed	Prairie	9	0.19	0.37	50	Below
Symphoricarpos albus	Snowberry	Prairie	6	0.12	0.63	19	Below
Symphoricarpos occidentalis	Buckbrush	Prairie	43	1.13	2.30	49	Below
Symphyotrichum falcatum	White Prairie Aster	Prairie	22	0.61	1.23	48	Below
Symphyotrichum laeve	Smooth Blue Aster	Prairie	8	0.13	0.28	47	Below
Thalictrum venulosum	Veiny Meadow Rue	Prairie	13	0.25	0.83	30	Below

Thermopsis rhombifolia	Golden Bean	Prairie	36	0.77	2.06	38	Below
Urtica dioica	Common Nettle	Prairie	8	0.15	0.40	41	Below
Vicia americana	Wild Vetch	Prairie	41	0.94	2.18	44	Below
Xanthisma spinulosum	Spiny goldenweed	Prairie	12	0.29	0.51	59	Below
Zigadenus elegans	White Camas	Prairie	8	0.11	0.41	28	Below
Achillea millefolium	Common Yarrow	HVL		2.41	3.28	73	Below
Agoseris glauca	Yellow False Dandelion	HVL		0.39	0.65	62	Below
Agrostis scabra	Rough Hair Grass	HVL		0.63	1.10	58	Below
Amelanchier alnifolia	Saskatoon	HVL		0.27	0.44	57	Below
Androsace septentrionalis	Northern Fairy Candelabra	HVL		0.69	0.78	86	Below
Anemone canadensis	Canada Anemone	HVL		0.17	0.26	65	Below
Anemone multifida	Cut-leaved Anemone	HVL		0.36	0.34	91	Below
Anemone patens	Prairie Crocus	HVL		0.86	1.44	60	Below
Antennaria neglecta	Broad-leaved Everlasting	HVL		0.19	0.31	64	Below
Antennaria parvifolia	Small-leaved Everlasting	HVL		1.05	1.82	59	Below
Artemisia campestris	Plains Wormwood	HVL		0.21	0.28	65	Below
Artemisia cana	Silver Sagebrush	HVL		1.28	1.63	76	Below
Artemisia frigida	Pasture Sagewort	HVL		2.33	3.34	71	Below
Artemisia ludoviciana	Prairie Sagewort	HVL		1.37	2.04	69	Below
Astragalus agrestis	Purple Milkvetch	HVL		0.37	0.58	65	Below
Astragalus flexuosus	Slender Milk Vetch	HVL		0.22	0.48	51	Below
Astragalus laxmannii	Prairie milkvetch	HVL		0.52	0.74	63	Below
Astragalus pectinatus	Narrow-leaved Milk Vetch	HVL		0.72	1.08	68	Below
Avenula hookeri	Spikeoat	HVL		0.42	0.70	59	Below
Beckmannia syzigachne	Slough Grass	HVL		0.13	0.11	86	Above
Bouteloua gracilis	Blue Grama	HVL		1.42	2.25	63	Below
Calamagrostis canadensis	Bluejoint	HVL		0.08	0.25	30	Below
Calamagrostis montanensis	Plains Reed Grass	HVL		0.49	0.73	72	Below
Campanula rotundifolia	Harebell	HVL		0.71	1.21	58	Below
Carex duriuscula	Needleleaf Sedge	HVL		0.84	1.33	65	Below

Carex inops	Sun Loving Sedge	HVL	0.30	0.48	64	Below
Cerastium arvense	Field Mouse Ear Chickweed	HVL	0.47	0.71	63	Below
Chamerion angustifolium	Fireweed	HVL	0.13	0.12	77	Above
Chenopodium pratericola	Goosefoot	HVL	0.28	0.47	61	Below
Cirsium flodmanii	Flodman's Thistle	HVL	0.44	0.53	80	Below
Cirsium undulatum	Wavy-leaved Thistle	HVL	0.35	0.47	75	Below
Comandra umbellata	Bastard Toadflax	HVL	0.64	1.04	61	Below
Cornus sericea	Silky Dogwood	HVL	0.12	0.26	48	Below
Drymocallis arguta	Tall Cinquefoil	HVL	0.23	0.41	63	Below
Elymus lanceolatus	Northern Wheat Grass	HVL	0.53	0.71	73	Below
Elymus trachycaulus	Slender Wheat Grass	HVL	0.57	0.84	68	Below
Equisetum arvense	Common Horsetail	HVL	0.17	0.09	53	Above
Erigeron caespitosus	Tufted Fleabane	HVL	0.83	1.24	68	Below
Erysimum capitatum	Sanddune Wallflower	HVL	0.46	0.50	81	Below
Erysimum inconspicuum	Small-flowered Rocket	HVL	0.17	0.35	53	Below
Escobaria vivipara	Cushion Cactus	HVL	0.26	0.42	67	Below
Eurybia conspicua	Showy Aster	HVL	0.08	0.13	65	Below
Festuca hallii	Plains Rough Fescue	HVL	0.47	0.92	47	Below
Festuca saximontana	Rocky Mountain Fescue	HVL	0.37	0.72	53	Below
Fragaria virginiana	Wild Strawberry	HVL	0.30	0.62	49	Below
Gaillardia aristata	Gaillardia	HVL	0.99	1.69	57	Below
Galium boreale	Northern Bedstraw	HVL	0.85	1.35	62	Below
Gaura coccinea	Scarlet Butterflyweed	HVL	1.03	1.43	72	Below
Geum triflorum	Three-flowered Avens	HVL	0.85	1.48	56	Below
Glycyrrhiza lepidota	Wild Licorice	HVL	0.28	0.28	94	Below
Grindelia squarrosa	Gumweed	HVL	1.18	1.24	93	Below
Gutierrezia sarothrae	Broomweed	HVL	1.19	1.47	80	Below
Hesperostipa comata	Needle and Thread Grass	HVL	1.68	2.66	61	Below
Hesperostipa curtiseta	Shortbristle Needle and Thread	HVL	0.38	0.76	53	Below
Heterotheca villosa	Golden Aster	HVL	1.42	2.01	73	Below

Heuchera richardsonii	Richardson's Alumroot	HVL	0.17	0.23	66	Below
Hieracium umbellatum	Narrow-leaved Hawkweed	HVL	0.23	0.16	78	Above
Hordeum jubatum	Foxtail Barley	HVL	1.44	0.96	68	Above
Juncus arcticus	Arctic Rush	HVL	0.39	0.57	72	Below
Koeleria macrantha	June Grass	HVL	1.81	2.71	66	Below
Lathyrus ochroleucus	Cream-colored Vetchling	HVL	0.20	0.36	53	Below
Lepidium densiflorum	Common Pepper-grass	HVL	0.62	0.55	85	Above
Liatris punctata	Dotted Blazingstar	HVL	0.40	0.48	83	Below
Lygodesmia juncea	Skeletonweed	HVL	0.54	0.78	72	Below
Maianthemum stellatum	Star-flowered Solomon's Seal	HVL	0.23	0.39	54	Below
Mentha arvensis	Wild Mint	HVL	0.24	0.25	97	Above
Mulgedium oblongifolium	Tartarian Lettuce	HVL	0.22	0.17	78	Above
Nassella viridula	Green Needlegrass	HVL	0.70	1.02	71	Below
Opuntia polyacantha	Prickly Pear	HVL	0.47	0.75	65	Below
Orthocarpus luteus	Owl Clover	HVL	0.21	0.26	79	Below
Oxytropis monticola	Late Yellow Locoweed	HVL	0.21	0.56	41	Below
Oxytropis sericea	Early Yellow Locoweed	HVL	0.26	0.48	55	Below
Packera cana	Woolly Groundsel	HVL	0.38	0.36	96	Above
Pascopyrum smithii	Western Wheat Grass	HVL	2.09	2.72	78	Below
Penstemon procerus	Slender Blue Beardtongue	HVL	0.25	0.32	74	Below
Phlox hoodii	Moss Phlox	HVL	0.96	1.41	66	Below
Plantago patagonica	Pursh's Plantain	HVL	0.52	0.61	84	Below
Poa palustris	Fowl Bluegrass	HVL	0.54	0.57	93	Below
Poa secunda	Sandberg Bluegrass	HVL	0.44	0.63	70	Below
Populus balsamifera	Balsam Poplar	HVL	0.11	0.16	84	Below
Populus tremuloides	Trembling Aspen	HVL	0.31	0.54	58	Below
Potentilla anserina	Silverweed	HVL	0.12	0.12	96	Below
Potentilla bipinnatifida	Plains Cinquefoil	HVL	0.38	0.55	70	Below
Potentilla gracilis	Graceful Cinquefoil	HVL	0.33	0.52	66	Below
Potentilla hippiana	Woolly Cinquefoil	HVL	0.55	0.82	67	Below

Potentilla norvegica	Rough Cinquefoil	HVL	0.34	0.24	70	Above
Potentilla pensylvanica	Prairie Cinquefoil	HVL	0.86	1.52	55	Below
Prunus virginiana	Choke Cherry	HVL	0.17	0.27	62	Below
Ratibida columnifera	Prairie Coneflower	HVL	0.97	1.11	86	Below
Ribes oxyacanthoides	Northern Gooseberry	HVL	0.19	0.37	53	Below
Rosa acicularis	Prickly Rose	HVL	0.54	0.70	74	Below
Rosa arkansana	Prairie Rose	HVL	0.81	1.18	70	Below
Rosa woodsii	Common Wild Rose	HVL	0.75	1.29	61	Below
Rubus idaeus	Wild Red Raspberry	HVL	0.21	0.35	58	Below
Salix bebbiana	Beaked Willow	HVL	0.09	0.16	51	Below
Salix petiolaris	Basket Willow	HVL	0.11	0.13	87	Below
Selaginella densa	Prairie Selaginella	HVL	1.11	1.72	67	Below
Sisyrinchium montanum	Common Blue-eyed Grass	HVL	0.33	0.57	59	Below
Solidago canadensis	Canada Goldenrod	HVL	0.48	0.65	79	Below
Solidago missouriensis	Low Goldenrod	HVL	0.94	1.44	68	Below
Sphaeralcea coccinea	Scarlet Mallow	HVL	1.36	2.05	65	Below
Stachys palustris	Marsh Hedge Nettle	HVL	0.14	0.17	79	Below
Stellaria longifolia	Long-leaved Chickweed	HVL	0.21	0.26	77	Below
Symphoricarpos albus	Snowberry	HVL	0.08	0.20	42	Below
Symphoricarpos occidentalis	Buckbrush	HVL	1.55	2.16	73	Below
Symphyotrichum falcatum	White Prairie Aster	HVL	0.92	1.33	66	Below
Symphyotrichum laeve	Smooth Blue Aster	HVL	0.13	0.18	78	Below
Thalictrum venulosum	Veiny Meadow Rue	HVL	0.20	0.39	53	Below
Thermopsis rhombifolia	Golden Bean	HVL	1.17	1.94	62	Below
Urtica dioica	Common Nettle	HVL	0.15	0.20	69	Below
Vicia americana	Wild Vetch	HVL	1.10	1.81	64	Below
Xanthisma spinulosum	Spiny goldenweed	HVL	0.54	0.70	76	Below
Zigadenus elegans	White Camas	HVL	0.22	0.42	55	Below
Achillea millefolium	Common Yarrow	Non-HVL	1.17	3.39	35	Below
Agoseris glauca	Yellow False Dandelion	Non-HVL	0.11	0.79	14	Below

Agrostis scabra	Rough Hair Grass	Non-HVL	0.32	1.33	24	Below
Amelanchier alnifolia	Saskatoon	Non-HVL	0.32	1.11	29	Below
Androsace septentrionalis	Northern Fairy Candelabra	Non-HVL	0.38	0.62	60	Below
Anemone canadensis	Canada Anemone	Non-HVL	0.28	0.74	37	Below
Anemone multifida	Cut-leaved Anemone	Non-HVL	0.10	0.30	31	Below
Anemone patens	Prairie Crocus	Non-HVL	0.21	1.17	18	Below
Antennaria neglecta	Broad-leaved Everlasting	Non-HVL	0.14	0.45	31	Below
Antennaria parvifolia	Small-leaved Everlasting	Non-HVL	0.37	1.83	20	Below
Artemisia campestris	Plains Wormwood	Non-HVL	0.12	0.36	34	Below
Artemisia cana	Silver Sagebrush	Non-HVL	0.16	0.66	23	Below
Artemisia frigida	Pasture Sagewort	Non-HVL	0.73	2.80	26	Below
Artemisia ludoviciana	Prairie Sagewort	Non-HVL	0.62	2.08	30	Below
Astragalus agrestis	Purple Milkvetch	Non-HVL	0.16	0.60	27	Below
Astragalus flexuosus	Slender Milk Vetch	Non-HVL	0.09	0.71	13	Below
Astragalus laxmannii	Prairie milkvetch	Non-HVL	0.08	0.62	13	Below
Astragalus pectinatus	Narrow-leaved Milk Vetch	Non-HVL	0.11	0.57	19	Below
Avenula hookeri	Spikeoat	Non-HVL	0.23	0.76	29	Below
Beckmannia syzigachne	Slough Grass	Non-HVL	0.19	0.18	86	Above
Bouteloua gracilis	Blue Grama	Non-HVL	0.24	1.30	18	Below
Calamagrostis canadensis	Bluejoint	Non-HVL	0.16	1.09	16	Below
Calamagrostis montanensis	Plains Reed Grass	Non-HVL	0.08	0.39	18	Below
Campanula rotundifolia	Harebell	Non-HVL	0.31	1.55	21	Below
Carex duriuscula	Needleleaf Sedge	Non-HVL	0.16	0.69	24	Below
Carex inops	Sun Loving Sedge	Non-HVL	0.10	0.45	21	Below
Cerastium arvense	Field Mouse Ear Chickweed	Non-HVL	0.24	0.96	25	Below
Chamerion angustifolium	Fireweed	Non-HVL	0.17	0.33	60	Below
Chenopodium pratericola	Goosefoot	Non-HVL	0.03	0.19	15	Below
Cirsium flodmanii	Flodman's Thistle	Non-HVL	0.29	0.59	52	Below
Cirsium undulatum	Wavy-leaved Thistle	Non-HVL	0.12	0.43	28	Below
Comandra umbellata	Bastard Toadflax	Non-HVL	0.27	1.31	21	Below

Cornus sericea	Silky Dogwood	Non-HVL	0.23	0.88	26	Below
Drymocallis arguta	Tall Cinquefoil	Non-HVL	0.05	0.37	13	Below
Elymus lanceolatus	Northern Wheat Grass	Non-HVL	0.22	0.59	36	Below
Elymus trachycaulus	Slender Wheat Grass	Non-HVL	0.37	1.39	27	Below
Equisetum arvense	Common Horsetail	Non-HVL	0.43	0.27	64	Above
Erigeron caespitosus	Tufted Fleabane	Non-HVL	0.19	0.85	23	Below
Erysimum capitatum	Sanddune Wallflower	Non-HVL	0.18	0.39	46	Below
Erysimum inconspicuum	Small-flowered Rocket	Non-HVL	0.05	0.35	12	Below
Escobaria vivipara	Cushion Cactus	Non-HVL	0.04	0.17	22	Below
Eurybia conspicua	Showy Aster	Non-HVL	0.17	0.55	30	Below
Festuca hallii	Plains Rough Fescue	Non-HVL	0.19	1.48	12	Below
Festuca saximontana	Rocky Mountain Fescue	Non-HVL	0.25	0.96	24	Below
Fragaria virginiana	Wild Strawberry	Non-HVL	0.41	1.71	24	Below
Gaillardia aristata	Gaillardia	Non-HVL	0.27	1.57	18	Below
Galium boreale	Northern Bedstraw	Non-HVL	0.74	2.30	32	Below
Gaura coccinea	Scarlet Butterflyweed	Non-HVL	0.21	0.86	25	Below
Geum triflorum	Three-flowered Avens	Non-HVL	0.20	1.55	13	Below
Glycyrrhiza lepidota	Wild Licorice	Non-HVL	0.08	0.16	60	Below
Grindelia squarrosa	Gumweed	Non-HVL	0.33	0.59	54	Below
Gutierrezia sarothrae	Broomweed	Non-HVL	0.16	0.61	27	Below
Hesperostipa comata	Needle and Thread Grass	Non-HVL	0.27	1.78	15	Below
Hesperostipa curtiseta	Shortbristle Needle and Thread	Non-HVL	0.14	0.76	18	Below
Heterotheca villosa	Golden Aster	Non-HVL	0.37	1.24	29	Below
Heuchera richardsonii	Richardson's Alumroot	Non-HVL	0.09	0.39	22	Below
Hieracium umbellatum	Narrow-leaved Hawkweed	Non-HVL	0.38	0.25	64	Above
Hordeum jubatum	Foxtail Barley	Non-HVL	1.28	0.65	51	Above
Juncus arcticus	Arctic Rush	Non-HVL	0.29	0.90	32	Below
Koeleria macrantha	June Grass	Non-HVL	0.49	2.33	21	Below
Lathyrus ochroleucus	Cream-colored Vetchling	Non-HVL	0.21	0.93	23	Below
Lepidium densiflorum	Common Pepper-grass	Non-HVL	0.45	0.41	94	Above

Liatris punctata	Dotted Blazingstar	Non-HVL	0.04	0.25	18	Below
Lygodesmia juncea	Skeletonweed	Non-HVL	0.09	0.34	29	Below
Maianthemum stellatum	Star-flowered Solomon's Seal	Non-HVL	0.26	0.95	27	Below
Mentha arvensis	Wild Mint	Non-HVL	0.23	0.40	60	Below
Mulgedium oblongifolium	Tartarian Lettuce	Non-HVL	0.25	0.21	83	Above
Nassella viridula	Green Needlegrass	Non-HVL	0.14	0.82	17	Below
Opuntia polyacantha	Prickly Pear	Non-HVL	0.04	0.22	18	Below
Orthocarpus luteus	Owl Clover	Non-HVL	0.05	0.20	23	Below
Oxytropis monticola	Late Yellow Locoweed	Non-HVL	0.12	0.89	12	Below
Oxytropis sericea	Early Yellow Locoweed	Non-HVL	0.05	0.42	11	Below
Packera cana	Woolly Groundsel	Non-HVL	0.20	0.20	100	Below
Pascopyrum smithii	Western Wheat Grass	Non-HVL	1.10	2.57	42	Below
Penstemon procerus	Slender Blue Beardtongue	Non-HVL	0.13	0.39	33	Below
Phlox hoodii	Moss Phlox	Non-HVL	0.16	0.83	19	Below
Plantago patagonica	Pursh's Plantain	Non-HVL	0.07	0.22	31	Below
Poa palustris	Fowl Bluegrass	Non-HVL	0.57	0.97	58	Below
Poa secunda	Sandberg Bluegrass	Non-HVL	0.16	0.42	37	Below
Populus balsamifera	Balsam Poplar	Non-HVL	0.24	0.59	42	Below
Populus tremuloides	Trembling Aspen	Non-HVL	0.50	1.48	33	Below
Potentilla anserina	Silverweed	Non-HVL	0.16	0.19	79	Below
Potentilla bipinnatifida	Plains Cinquefoil	Non-HVL	0.21	0.60	36	Below
Potentilla gracilis	Graceful Cinquefoil	Non-HVL	0.19	0.81	24	Below
Potentilla hippiana	Woolly Cinquefoil	Non-HVL	0.11	0.46	25	Below
Potentilla norvegica	Rough Cinquefoil	Non-HVL	0.52	0.36	65	Above
Potentilla pensylvanica	Prairie Cinquefoil	Non-HVL	0.29	1.39	22	Below
Prunus virginiana	Choke Cherry	Non-HVL	0.17	0.58	31	Below
Ratibida columnifera	Prairie Coneflower	Non-HVL	0.17	0.40	43	Below
Ribes oxyacanthoides	Northern Gooseberry	Non-HVL	0.24	1.13	21	Below
Rosa acicularis	Prickly Rose	Non-HVL	0.42	1.02	41	Below
Rosa arkansana	Prairie Rose	Non-HVL	0.50	1.45	36	Below

Rosa woodsii	**Common Wild Rose**	**Non-HVL**	**0.42**	**1.62**	**26**	**Below**
Rubus idaeus	**Wild Red Raspberry**	**Non-HVL**	**0.36**	**1.04**	**34**	**Below**
Salix bebbiana	**Beaked Willow**	**Non-HVL**	**0.17**	**0.52**	**31**	**Below**
Salix petiolaris	**Basket Willow**	**Non-HVL**	**0.24**	**0.39**	**68**	**Below**
Selaginella densa	**Prairie Selaginella**	**Non-HVL**	**0.15**	**0.87**	**18**	**Below**
Sisyrinchium montanum	**Common Blue-eyed Grass**	**Non-HVL**	**0.28**	**0.91**	**30**	**Below**
Solidago canadensis	**Canada Goldenrod**	**Non-HVL**	**0.44**	**0.96**	**47**	**Below**
Solidago missouriensis	**Low Goldenrod**	**Non-HVL**	**0.25**	**1.23**	**20**	**Below**
Sphaeralcea coccinea	**Scarlet Mallow**	**Non-HVL**	**0.19**	**1.08**	**17**	**Below**
Stachys palustris	**Marsh Hedge Nettle**	**Non-HVL**	**0.24**	**0.47**	**49**	**Below**
Stellaria longifolia	**Long-leaved Chickweed**	**Non-HVL**	**0.17**	**0.42**	**41**	**Below**
Symphoricarpos albus	**Snowberry**	**Non-HVL**	**0.14**	**0.94**	**16**	**Below**
Symphoricarpos occidentalis	**Buckbrush**	**Non-HVL**	**0.84**	**2.41**	**35**	**Below**
Symphyotrichum falcatum	**White Prairie Aster**	**Non-HVL**	**0.40**	**1.17**	**34**	**Below**
Symphyotrichum laeve	**Smooth Blue Aster**	**Non-HVL**	**0.14**	**0.36**	**40**	**Below**
Thalictrum venulosum	**Veiny Meadow Rue**	**Non-HVL**	**0.28**	**1.13**	**25**	**Below**
Thermopsis rhombifolia	**Golden Bean**	**Non-HVL**	**0.48**	**2.13**	**23**	**Below**
Urtica dioica	**Common Nettle**	**Non-HVL**	**0.17**	**0.54**	**33**	**Below**
Vicia americana	**Wild Vetch**	**Non-HVL**	**0.79**	**2.44**	**33**	**Below**
Xanthisma spinulosum	**Spiny goldenweed**	**Non-HVL**	**0.12**	**0.39**	**32**	**Below**
Zigadenus elegans	**White Camas**	**Non-HVL**	**0.03**	**0.40**	**8**	**Below**

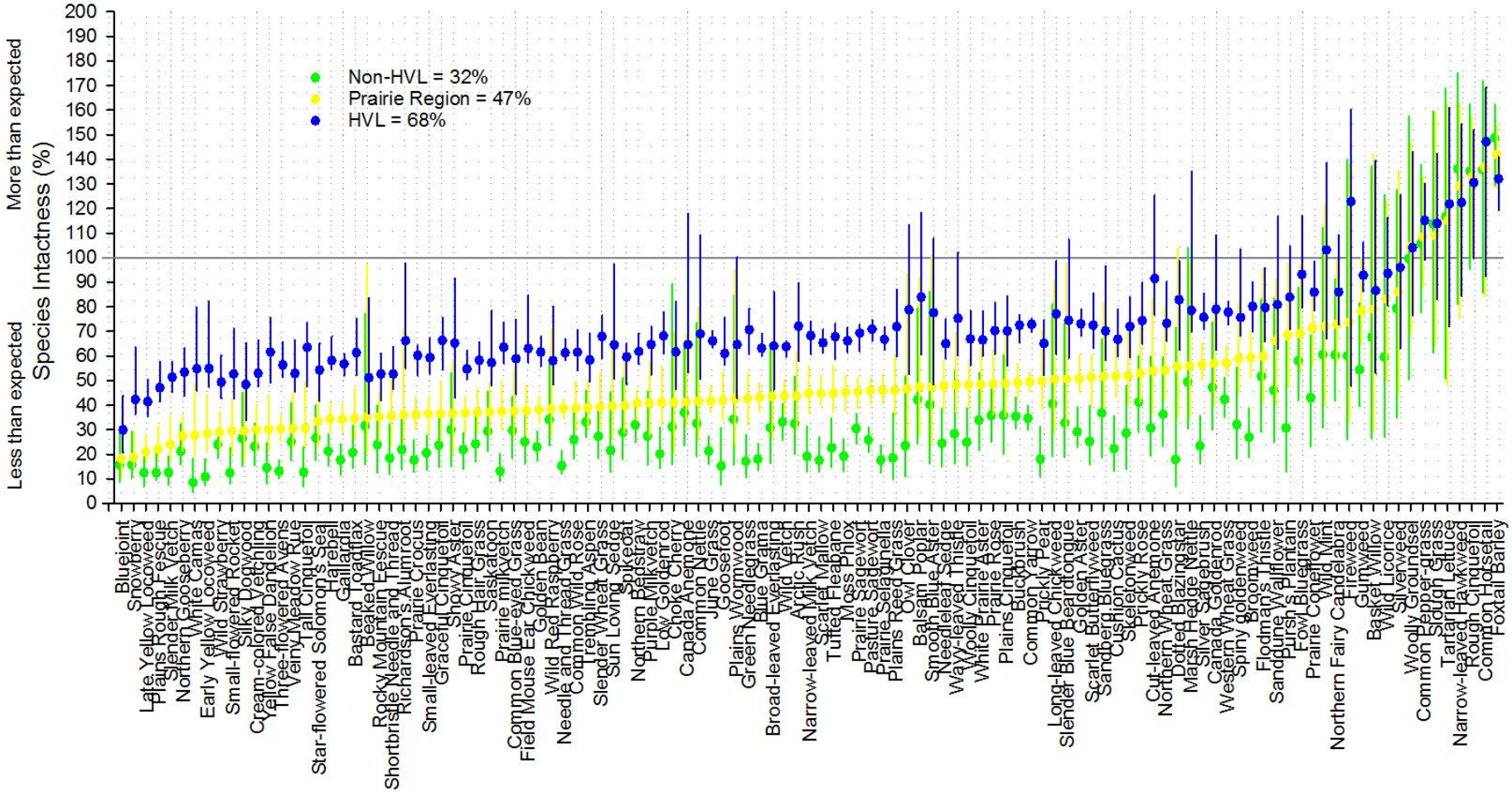

Figure 13. Intactness (with 90% confidence intervals) of 113 native vascular plant species in the Prairie Region, non-HVL, and HVL between 2003 and 2012. The order in which plant intactness results are presented is determined by results for the Prairie Region. Detailed statistics available in The Status of Biodiversity in the Grassland and Parkland Regions: Supplementary Data File. 2015. Available at: www.abmi.ca.

12.1.2 Non-native vascular plants occurrence in the Prairie Region

The ABMI found 35 non-native plants in the Prairie Region as of 2012 (Table 9). Combined, non-native plants were detected at all ABMI sites sampled in Prairie Region, and an average of 9 non-native species were present at each site. For each quarter section in the Prairie Region, the predicted number of non-native species per 1 ha plot was higher where there is agriculture footprint (Figure 14). In Alberta's Prairie Region, a number of non-native species have been intentionally introduced for agricultural purposes, either as crops or as forage for livestock, and are associated with agriculture footprint; these species are also included on the list of non-native species (Figure 14).

Common Dandelion was the most abundant non-native plant occurring at 86% of ABMI sites in the Prairie Region, followed by Common Goat's Beard (61%) and Flixweed (49%).

Two of the non-native species detected are listed under the Alberta Weed Control Act, Creeping Thistle (43%), and Perennial Sow-thistle (15%).

Table 9. Non-native vascular plants detected in the Prairie Region.

Common Name	Scientific Name	Percent Occurrence (%)	Alberta Weed Control Act
Common Dandelion	*Taraxacum officinale*	86	
Common Goat's Beard	*Tragopogon dubius*	61	
Flixweed	*Descurainia sophia*	49	
Creeping Thistle	*Cirsium arvense*	43	Noxious
Annual Hawk's Beard	*Crepis tectorum*	39	
Crested Wheatgrass	*Agropyron cristatum*	35	
Lamb's Quarters	*Chenopodium album*	33	
Alfalfa	*Medicago sativa*	32	
Awnless Brome	*Bromus inermis*	28	
Stinkweed	*Thlaspi arvense*	26	
Common Wheat	*Triticum aestivum*	25	
Prickly Lettuce	*Lactuca serriola*	24	
Wild Oat	*Avena fatua*	23	
Wormseed Mustard	*Erysimum cheiranthoides*	21	
Summer Cypress	*Kochia scoparia*	20	
Red Root Pigweed	*Amaranthus retroflexus*	19	
Perennial Sow Thistle	*Sonchus arvensis*	15	Noxious
Argentine Canola	*Brassica napus*	15	
Yellow Sweet Clover	*Melilotus officinalis*	14	
Cultivated Barley	*Hordeum vulgare*	14	
Knotweed	*Polygonum aviculare*	14	
Downy Chess	*Bromus tectorum*	13	
Prickly Russian Thistle	*Salsola tragus*	11	
Quack Grass	*Elymus repens*	10	
Timothy	*Phleum pratense*	10	
Tartary Buckwheat	*Fagopyrum tataricum*	10	

Black Medick	*Medicago lupulina*	9
Curled Dock	*Rumex crispus*	9
Bluebur	*Lappula squarrosa*	8
Common Plantain	*Plantago major*	8
White Sweet Clover	*Melilotus alba*	7
Cleavers	*Galium aparine*	5
Alsike Clover	*Trifolium hybridum*	4
Hemp Nettle	*Galeopsis tetrahit*	3
White Clover	*Trifolium repens*	3

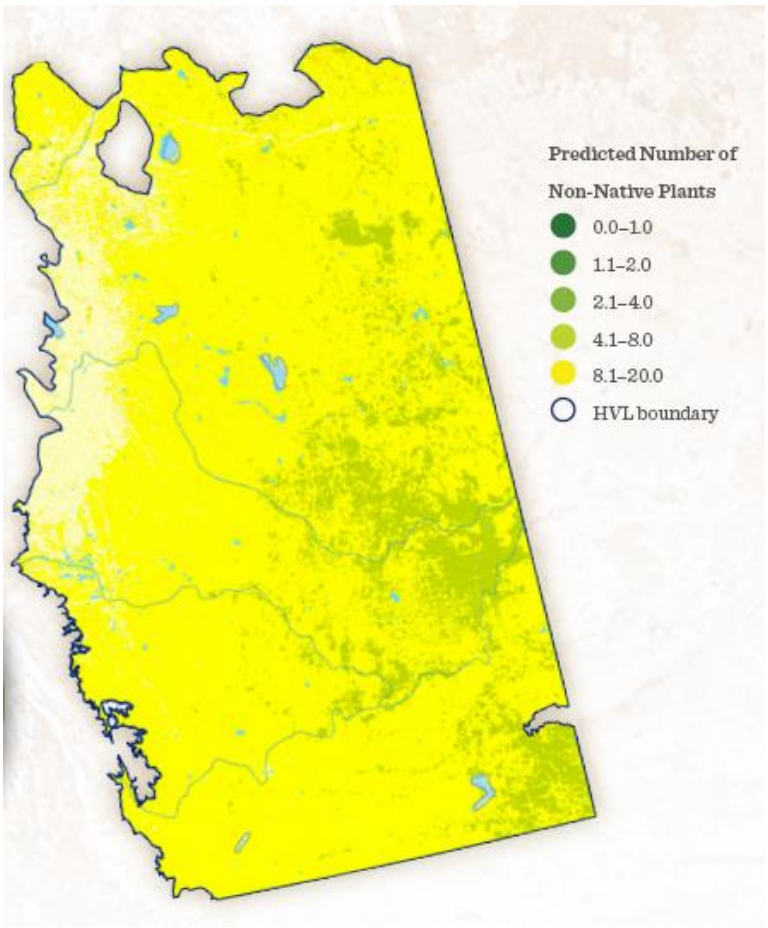

Figure 14. Predicted number of non-native plant species per 1 ha plot in each quarter section of the Prairie Region. Dark green indicates very low numbers of non-native plant species while yellow indicates high numbers of non-native species.

12.2 Moss (Bryophyte) Survey Methods

Bryophytes (hereafter referred to as mosses), 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 × 15 m plots (Figure 15). 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.

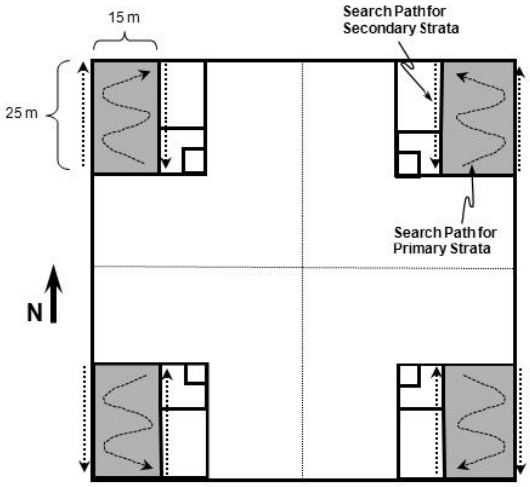

Figure 16. Moss survey protocol.

12.3 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 Prairie and Parkland Natural Regions south of 53.5 N, the area we used for fitting the models. We summarized intactness for mosses in the Prairie Region (Table 10, Figure 16). A comprehensive description of the scientific methods used in analyses of data for this report is described in:

- Alberta Biodiversity Monitoring Institute. 2015. Manual for Species Modeling and Intactness (20029), Version 2015-11-27. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca.

12.4 Moss Results

12.4.1 Intactness of mosses in the Prairie Region

Table 10. The ABMI detected 12 moss species with enough frequency to calculate intactness. The following is a complete list of moss species analyzed analyzed in the Prairie Region, outside the HVL (non-HVL), and inside the HVL including: species common name, species scientific name, percent (%) occurrence (in the Prairie Region only), relative abundance, reference abundance, intactness, whether it was more abundant (Above) or less abundant (Below) than expected compared to reference conditions. Detailed statistics are available in The Status of Biodiversity in the Prairie Region: Supplementary Data File. 2016. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Available at: www.abmi.ca.

Scientific Name	Species (Common Name)	Region	Occurrence in the Prairie Region (%)	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
Abietinella abietina	Tufted Moss	Prairie	8	0.13	0.32	39	Below
Amblystegium serpens	Creeping Feather Moss	Prairie	24	0.48	0.75	63	Below
Ceratodon purpureus	Fire Moss	Prairie	48	0.97	1.36	73	Below
Drepanocladus aduncus	Knieff's Hook Moss	Prairie	8	0.11	0.09	84	Above
Eurhynchiastrum pulchellum	Elegant Feather-moss	Prairie	7	0.08	0.30	28	Below
Plagiomnium cuspidatum	Woodsy Leafy Moss	Prairie	8	0.12	0.55	22	Below
Polytrichum juniperinum	Juniper Polytrichum Moss	Prairie	9	0.12	0.34	35	Below
Polytrichum piliferum	Bristly Haircap Moss	Prairie	12	0.20	0.36	56	Below
Pylaisia polyantha	Aspen Stocking Moss	Prairie	20	0.40	1.01	42	Below
Sanionia uncinata	Sickle-leaved Hook Moss	Prairie	7	0.09	0.19	41	Below
Syntrichia ruralis	Hairy Screw Moss	Prairie	30	0.45	1.25	37	Below
Tortula acaulon	Cuspidate Earth Moss	Prairie	24	0.46	0.37	71	Above
Abietinella abietina	Tufted Moss	HVL		0.13	0.18	57	Below
Amblystegium serpens	Creeping Feather Moss	HVL		0.32	0.39	82	Below
Ceratodon purpureus	Fire Moss	HVL		1.01	1.16	85	Below
Drepanocladus aduncus	Knieff's Hook Moss	HVL		0.06	0.06	93	Above

Eurhynchiastrum pulchellum	Elegant Feather-moss	HVL	0.05	0.11	48	Below
Plagiomnium cuspidatum	Woodsy Leafy Moss	HVL	0.07	0.19	46	Below
Polytrichum juniperinum	Juniper Polytrichum Moss	HVL	0.19	0.32	57	Below
Polytrichum piliferum	Bristly Haircap Moss	HVL	0.44	0.64	68	Below
Pylaisia polyantha	Aspen Stocking Moss	HVL	0.30	0.50	59	Below
Sanionia uncinata	Sickle-leaved Hook Moss	HVL	0.07	0.08	89	Below
Syntrichia ruralis	Hairy Screw Moss	HVL	0.83	1.27	65	Below
Tortula acaulon	Cuspidate Earth Moss	HVL	0.56	0.41	81	Above
Abietinella abietina	Tufted Moss	nonHVL	0.13	0.43	30	Below
Amblystegium serpens	Creeping Feather Moss	nonHVL	0.61	1.00	59	Below
Ceratodon purpureus	Fire Moss	nonHVL	0.96	1.48	66	Below
Drepanocladus aduncus	Knieff's Hook Moss	nonHVL	0.14	0.10	86	Above
Eurhynchiastrum pulchellum	Elegant Feather-moss	nonHVL	0.11	0.41	25	Below
Plagiomnium cuspidatum	Woodsy Leafy Moss	nonHVL	0.15	0.79	19	Below
Polytrichum juniperinum	Juniper Polytrichum Moss	nonHVL	0.07	0.33	20	Below
Polytrichum piliferum	Bristly Haircap Moss	nonHVL	0.04	0.17	25	Below
Pylaisia polyantha	Aspen Stocking Moss	nonHVL	0.49	1.35	38	Below
Sanionia uncinata	Sickle-leaved Hook Moss	nonHVL	0.09	0.27	32	Below
Syntrichia ruralis	Hairy Screw Moss	nonHVL	0.22	1.22	18	Below
Tortula acaulon	Cuspidate Earth Moss	nonHVL	0.46	0.35	75	Above

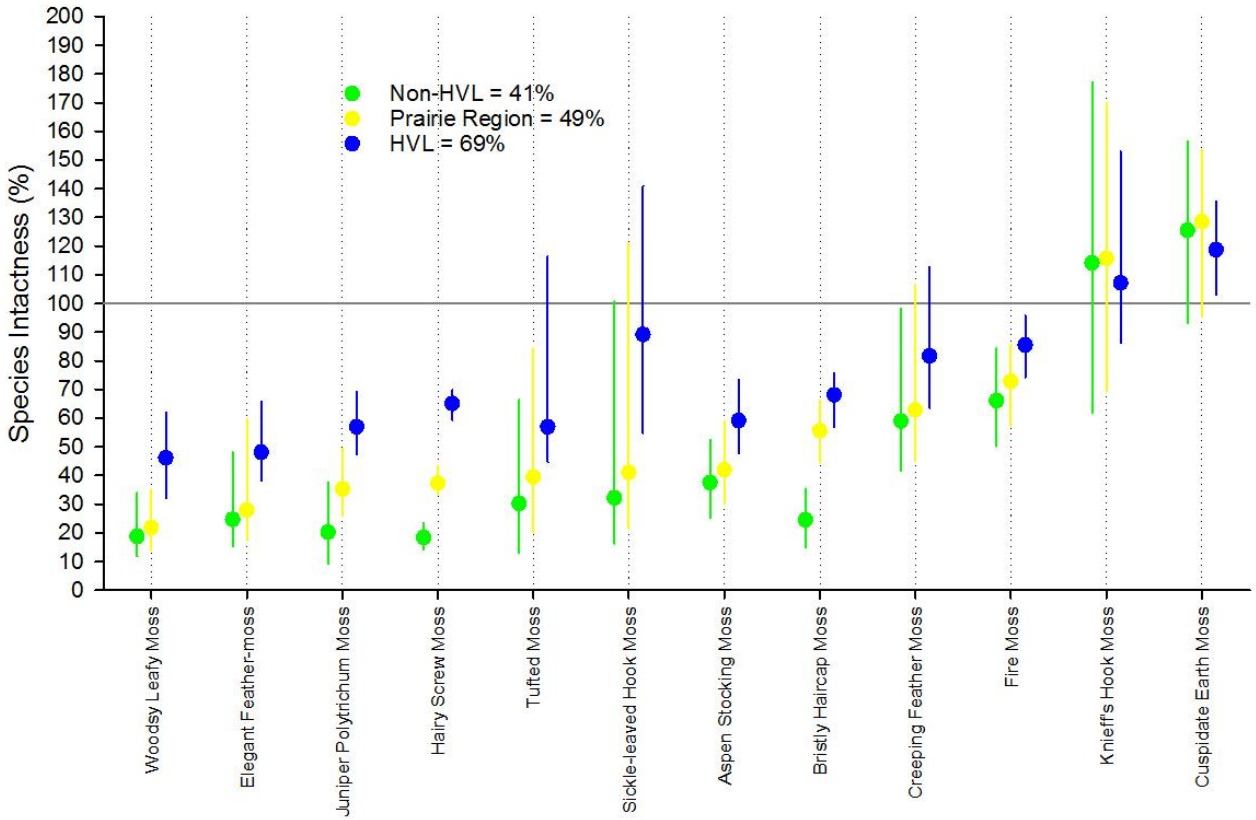

Figure 16. Intactness (with 90% confidence intervals) of 12 moss species in the Prairie Region, non-HVL, and HVL between 2003 and 2012. The order in which moss intactness results are presented is determined by results for the Prairie Region. Detailed statistics available in The Status of Biodiversity in the Grassland and Parkland Regions: Supplementary Data File. 2015. Available at: www.abmi.ca.

13.0 Species Designated as Sensitive or At Risk

We derived intactness values for sensitive species or species at risk that we detected with enough frequency to enable this calculation. Species at risk were designated by the following sources (Table 11):

1. General Status of Alberta Wild Species 2010, including those designated as AEP - May Be At Risk, At Risk, or Sensitive;
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.

The ABMI detected 88 species at risk in the Prairie Region. Nineteen of these species occurred with enough frequency to enable the calculation of the ABMI's intactness index, including seven species that are listed as endangered, threatened or of special concern by the Government of Canada and/or by the Government of Alberta (Table 11). Intactness ranged from 27% intact to 96% intact for decreaser species. Intactness ranged from 37% intact to 98% intact for increaser species.

Table 11. Summary of species at risk in the Prairie Region.

Scientific Name	Common Name	Status	Occurrence in the Prairie Region (%)	Intactness	Above/Below
Birds					
Ammodramus bairdii	Baird's Sparrow	COSEWIC - Special Concern | AEP - Sensitive	32	34	Below
Icterus galbula	Baltimore Oriole	AEP - Sensitive	18	87	Below
Hirundo rustica	Barn Swallow	COSEWIC - Threatened | AEP - Sensitive	25	37	Above
Calcarius ornatus	Chestnut-collared Longspur	COSEWIC - Threatened | AEP - Sensitive	34	52	Below
Ammodramus savannarum	Grasshopper Sparrow	COSEWIC - Special Concern | AEP - Sensitive	11	63	Below
Empidonax minimus	Least Flycatcher	AEP - Sensitive	21	27	Below
Numenius americanus	Long-billed Curlew	COSEWIC - Special Concern | AEP - Sensitive	36	60	Above
Rhynchophanes mccownii	McCown's Longspur	COSEWIC - Special Concern | AEP - Secure	18	91	Below
Dryocopus pileatus	Pileated Woodpecker	AEP - Sensitive	7	38	Below
Tympanuchus phasianellus	Sharp-tailed Grouse	AEP - Sensitive	8	39	Below
Porzana carolina	Sora	AEP - Sensitive	44	96	Below
Anthus spragueii	Sprague's Pipit	COSEWIC - Threatened | AEP - Sensitive	46	34	Below
Bartramia longicauda	Upland Sandpiper	AEP - Sensitive	26	90	Below
Vascular Plants					

Acer negundo	Manitoba Maple	AEP - Undetermined	2		
Achnatherum nelsonii	Dore's Needle Grass	AEP - Undetermined	<1		
Antennaria media	Sony Mountain Pussytoes	AEP - Undetermined	2		
Antennaria microphylla	Littleleaf Pussytoes	AEP - Undetermined	6		
Antennaria neglecta	Broad-leaved Everlasting	AEP - Undetermined	9	49	Below
Arnica sororia	Twin Arnica	AEP - Sensitive	4		
Astragalus lotiflorus	Low Milk Vetch	AEP - Sensitive	1		
Astragalus purshii	Pursh's Milk Vetch	AEP - Sensitive	<1		
Atriplex gardneri	Gardner's Saltbush	AEP - Undetermined	7		
Bistorta bistortoides	Bistort	AEP - Sensitive	<1		
Bromus latiglumis	Canada Brome	AEP - May Be At Risk	<1		
Bromus pumpellianus	Pumpelly	AEP - Undetermined	1		
Carex inops	Sun Loving Sedge	AEP - Undetermined	9	54	Below
Carex rostrata	Beaked Sedge	AEP - Sensitive	2		
Carex xerantica	White-scale Sedge	AEP - Sensitive	1		
Castilleja lutescens	Stiff Yellow Paintbrush	AEP - Sensitive	2		
Chenopodium leptophyllum	Narrow-leaed Goosefoot	AEP - Undetermined	1		
Crepis intermedia	Intermediate Hawk's Beard	AEP - May Be At Risk	<1		
Crepis occidentalis	Small-flowered Hawk's Beard	AEP - May Be At Risk	2		
Cryptantha celosioides	Cocks Comb Cat's Eye	AEP - Undetermined	<1		
Distichlis spicata	Salt Grass	AEP - Undetermined	3		
Eleocharis erythropoda	Bald Spikerush	AEP - Undetermined	1		
Elymus violaceus	Virginia Wild Rye	AEP - Undetermined	<1		
Epilobium glaberrimum	Smooth Willowweed	AEP - Sensitive	2		
Erigeron speciosus	Showy Fleabane	AEP - Undetermined	2		
Fraxinus pennsylvanica	Green Ash	AEP - May Be At Risk	2		
Gratiola neglecta	Clammy Hedge Hyssop	AEP - Sensitive	1		
Hesperostipa spartea	Porcupinegrass	AEP - Sensitive	4		
Heuchera parvifolia	Small-leaved Alumroot	AEP - Sensitive	5		
Iris missouriensis	Western Blue Flag	AEP - Sensitive	<1		
Juncus confusus	Few-flowered Rush	AEP - Sensitive	2		
Lactuca biennis	Tall Blue Lettuce	AEP - May Be At Risk	1		
Lathyrus venosus	Purple Peavine	AEP - Sensitive	4		

Liatris ligulistylis	Meadow Blazingstar	AEP - Sensitive	1		
Lomatium dissectum	Mountain Wild Parsnip	AEP - Sensitive	1		
Lomatium macrocarpum	Long-fruited Wild Parsley	AEP - Sensitive	1		
Marsilea vestita	Hairy Pepperwort	AEP - May Be At Risk	<1		
Muhlenbergia asperifolia	Scratch Grass	AEP - Sensitive	1		
Onosmodium molle	Western False Gromwell	AEP - May Be At Risk	1		
Osmorhiza longistylis	Smooth Sweet Cicely	AEP - May Be At Risk	<1		
Pediomelum argophyllum	Silvery Scurfpea	AEP - Sensitive	1		
Pediomelum esculentum	Indian Breadroot	AEP - Sensitive	2		
Penstemon albertinus	Blue Beardtongue	AEP - Sensitive	3		
Penstemon gracilis	Lilac-flowered Beardtongue	AEP - Sensitive	4		
Picradeniopsis oppositifolia	Picradeniopsis	AEP - May Be At Risk	<1		
Poa arida	Plains Bluegrass	AEP - Undetermined	4		
Polygonum erectum	Striate Knotweed	AEP - Undetermined	1		
Populus angustifolia	Narrow Leaf Cottonwood	AEP - Sensitive	1		
Populus deltoides	Plains Cottonwood	AEP - Sensitive	2		
Potentilla gracilis	Graceful Cinquefoil	AEP - Undetermined	14	41	Below
Puccinellia distans	Slender Salt Meadow Grass	AEP - May Be At Risk	<1		
Rumex venosus	Wild Begonia	AEP - Sensitive	<1		
Salix interior	Sandbar Willow	AEP - Undetermined	<1		
Shinnersoseris rostrata	Annual Skeletonweed	AEP - May Be At Risk	1		
Sisyrinchium septentrionale	Pale Blue-eyed Grass	AEP - Sensitive	<1		
Solidago canadensis	Canada Goldenrod	AEP - Undetermined	19	58	Below
Symphyotrichum ascendens	Wester Aster	AEP - Sensitive	<1		
Symphyotrichum eatonii	Eaton's Aster	AEP - May Be At Risk	<1		
Moss					
Tortula acaulon	Cuspidate Earth Moss	AEP - Undetermined	24	71	Above
Barbula convoluta	Lesser Bird's-claw Beard Moss	AEP - Sensitive	2		
Barbula unguiculata	Bird's-claw Beard Moss	AEP - Sensitive	1		
Callicladium haldanianum	Beautiful Branch Moss	AEP - Sensitive	< 1		

Cyrtomnium hymenophylloides	Short-pointed Lantern Moss	AEP - Sensitive	1		
Dicranella subulata	Awl-leaved Forklet Moss	AEP - Sensitive	1		
Hygrohypnum ochraceum	Claw Brook Moss	AEP - Sensitive	< 1		
Hypnum bambergeri	Bamberger's Golden Plait Moss	AEP - Sensitive	< 1		
Hypnum cupressiforme	Cypress-leaved Plait Moss	AEP - Sensitive	2		
Orthothecium chryseum		AEP - Sensitive	< 1		
Plagiomnium rostratum	Long-beaked Leafy Moss	AEP - Sensitive	< 1		
Platygyrium repens	Flat-brocade Moss	AEP - Sensitive	19	98	Above
Pogonatum dentatum	Mountain Hair Moss	AEP - Sensitive	< 1		
Pseudoleskea patens	Patent Leskea Moss	AEP - Sensitive	< 1		
Splachnum luteum	Yellow Dung Moss	AEP - Sensitive	1		
Splachnum rubrum	Red Dung Moss	AEP - Sensitive	4		
Thuidium delicatulum	Delicate Fern Moss	AEP - Sensitive	1		

14.0 Effective Mesh Size

14.1 Effective Mesh Size Methods

A complete description of the scientific methods used to calculate effective mesh size is described in:

Olson, L. 2014. Effective Mesh Size Analysis on the Fragmentation of Alberta's Natural Vegetation. Technical Report. Available at: www.abmi.ca.

14.2 Effective Mesh Size Results

The average effective mesh size of the Prairie Region is 5.0 km^2 when linear features like roads are included as human footprint that divides native patches (Table 12; Figure 17); effective mesh size is 13,789 km^2 when linear features are not counted as footprint separating patches of native vegetation (Table 12; Figure 17). The average effective mesh size in the High Value Landscape is 11.9 km^2 compared to only 0.4 km^2 outside, when linear features are counted as dividing native patches. This analysis shows that areas outside the HVL are very heavily fragmented by human footprint features such as agricultural fields, roads, and urban area. When linear features are excluded from the analysis, larger patches are identified (mainly along major rivers) that connect the large patches of native vegetation in the west of the Prairie Region to those in the east (Figure 17).

Table 12. Average effective mesh size for the Prairie Region, the High Value Landscape (HVL), outside the High Value Landscape (Non-HVL), Parkland Natural Region, and Grassland Natural Region. Average effective mesh size is calculated in two ways—counting linear features as human footprint that separates native patches, and not counting linear features as footprint that separates patches.

	Average Effective Mesh Size (km^2)	
	Linear Features Divide Native Patches	**Linear Features Do Not Divide Native Patches**
Prairie Region	5.0	13,789
HVL	11.9	30,396
Non-HVL	0.4	3,744
Parkland Natural Region	6.6	4,142
Grassland Natural Region	5.5	19,446

The largest patches of native vegetation occur in the HVL, where over 25% of the 1 km^2 hexagon reporting units have an effective mesh size > 5 km^2 when counting linear features as a footprint that fragments native vegetation patches (Figure 18). In contrast, almost 99% of the 1 km^2 hexagon reporting units outside the HVL have an effective mesh size of < 5 km^2, including 77% with an effective mesh size of < 0.1 km^2.

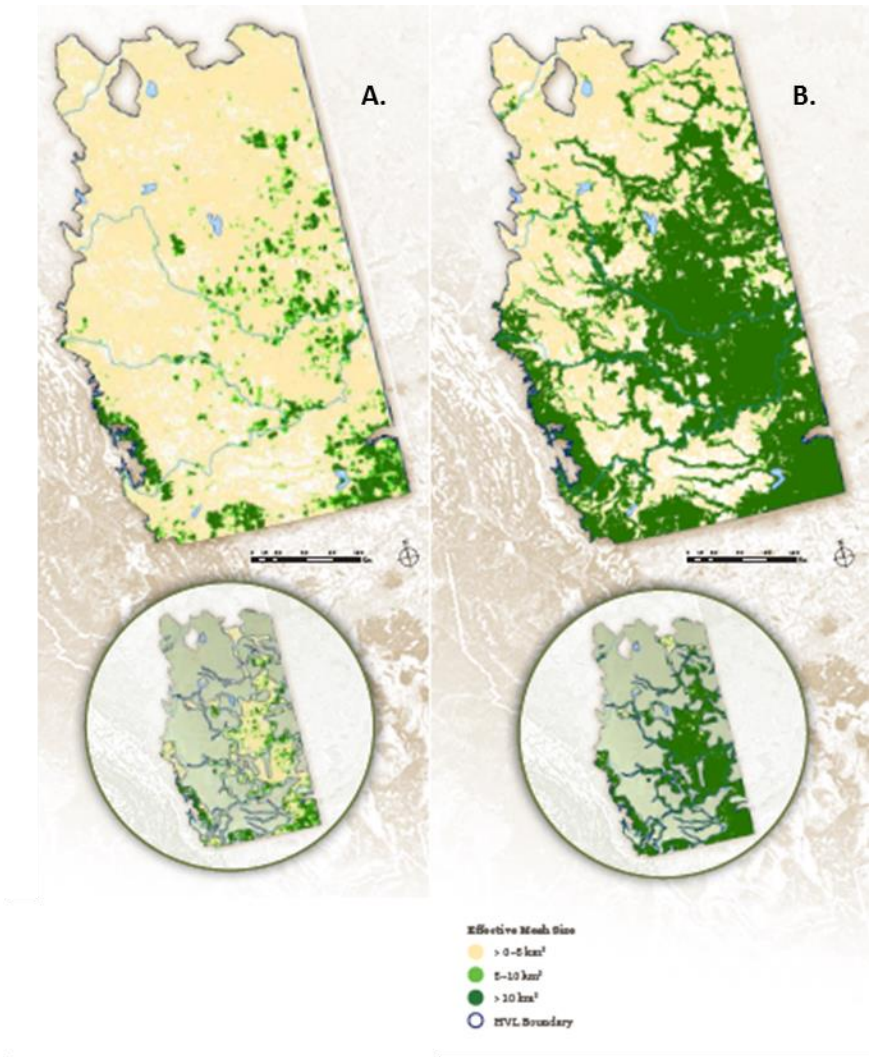

Figure 17. Distribution of large native vegetation patches in the Prairie Region (upper map) and inside the hvl (lower map) when A. linear features are included as footprint that divides native patches, and B. linear features are not counted as footprint that divides patches of native vegetation.

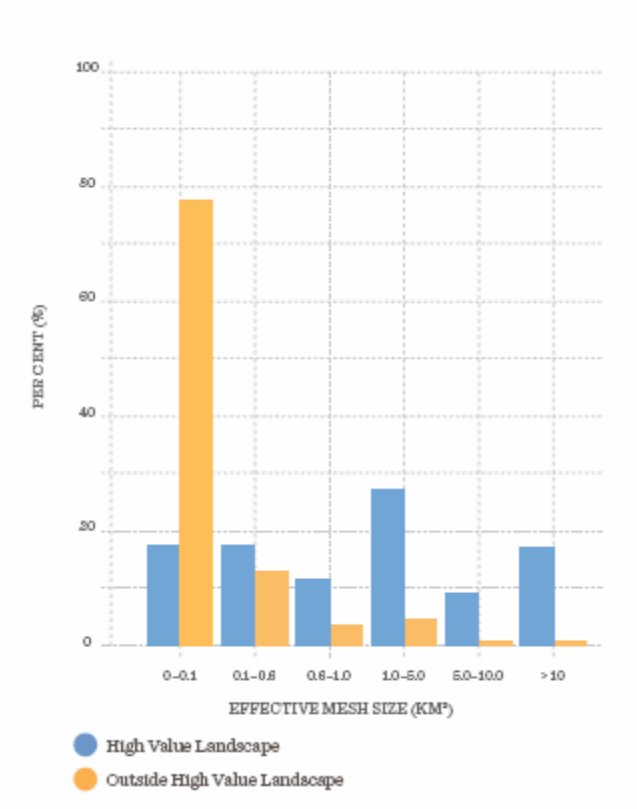

Figure 18. The percentage of 1 km^2 hexagon reporting units in six effective mesh size (km^2) size categories for the HVL and Non-HVL. Linear features are included as footprint that fragments native vegetation patches in this summary.

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:

Alberta Biodiversity Monitoring Institute. 2015. Manual for Species Modeling and Intactness (20029), Version 2015-11-27. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca [accessed 2016-01-20].

Alberta Biodiversity Monitoring Institute. 2014. Terrestrial field data collection protocols (abridged version) 2015-02-19. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca [accessed 2016-01-06].

Alberta Biodiversity Monitoring Institute. 2013. Wetland Field Data Collection Protocols (Abridged Version) 2014-03-02. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca [accessed 2016-01-07].

Alberta Biodiversity Monitoring Institute. Human Footprint Map Layer. 3x7 Areas Version 1.0 - Metadata. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca.

Appendix 1

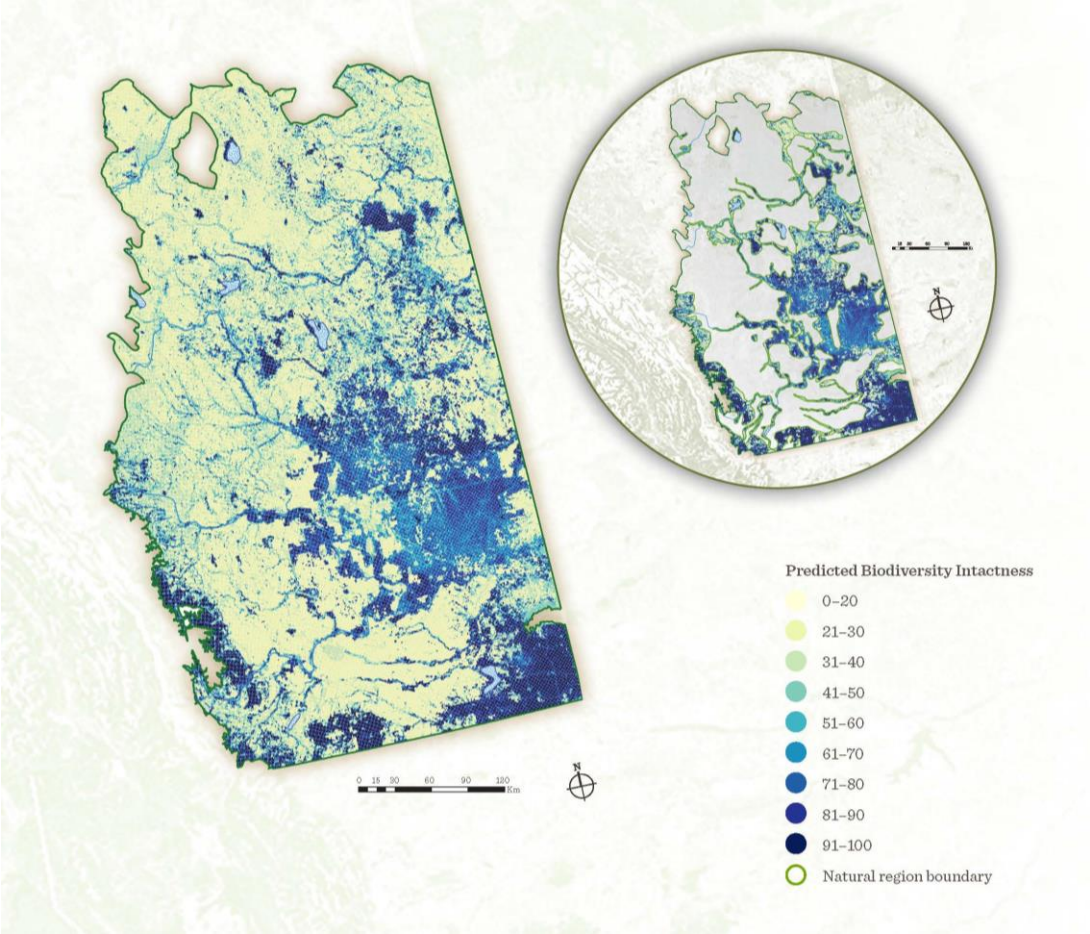

Figure A-1. Average predicted intactness for 194 species in the Prairie Region. Light areas identify the quarter sections that are predicted to have the lowest average biodiversity intactness values, and dark areas identifies quarter sections with the highest intactness.