Characterizing Biodiversity Impacts of Saskatchewan's Beef Industry

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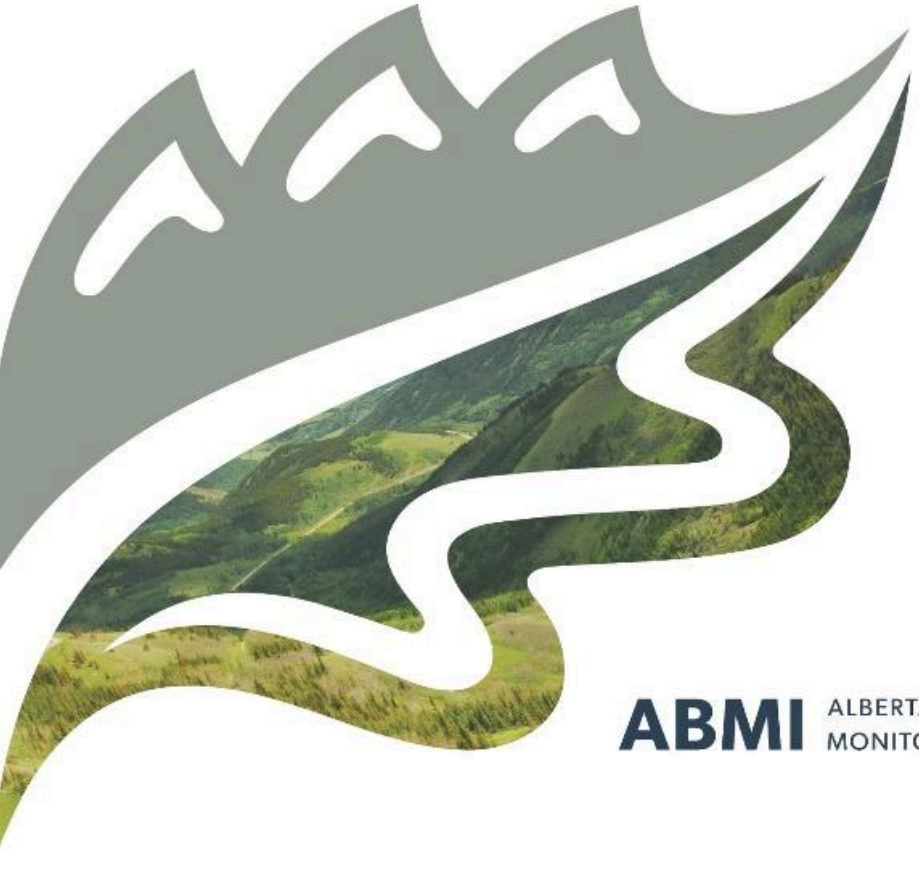

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About This Document

Title

Characterizing Biodiversity Impacts of Saskatchewan's Beef Industry

Purpose

This document summarises the impacts of the beef cattle industry on biodiversity in Saskatchewan's non-forested region, using a geospatially driven extrapolation approach based on existing species modelling from the neighbouring province of Alberta.

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Executive Summary

Increasing global attention has focused on the role of biodiversity and the importance of integrating it into the policies, strategies, and practices of key public and private sectors that both affect and depend on it. As one of the largest land users in Saskatchewan, the beef cattle industry is particularly important because producers manage vast areas of rangeland and thus play a critical role in biodiversity conservation. Consequently, the impacts of beef production on biodiversity must be quantified and understood.

This project characterizes the impact of beef cattle production on biodiversity in southern Saskatchewan via an empirical-statistical species modelling approach, where we project existing species–habitat models into southern Saskatchewan to evaluate how beef production affects plant diversity. Our specific objectives were to: (1) map the land-use footprint of the Saskatchewan beef industry; (2) generate land-use and habitat data to support biodiversity assessments; (3) assess impacts of beef production on local and regional biodiversity; and (4) communicate the contribution of beef producers to biodiversity stewardship.

To assess the beef industry's footprint and associated biodiversity impact across southern Saskatchewan, we compiled and processed data on cattle production, land use, and land cover in the region. These data were used to create land and habitat information layers for projecting biodiversity models originally developed in Alberta. We generated two scenarios: (1) a "current conditions" layer describing present-day land use and human footprint; and (2) a "reference conditions" layer representing the natural landscape without large-scale human development. Predictive habitat models were developed by combining these landcover layers with plant occurrence data. We then compared predicted species' relative abundance under current versus reference conditions to calculate *biodiversity intactness*, a measure of how well a community of species persists under contemporary land use.

Our analysis indicates that most habitats in southern Saskatchewan remain ecologically intact, with plant species persisting at levels comparable to those in reference conditions. Intactness was higher in areas dominated by pasture when compared to other human footprint types, suggesting that cattle grazing may support biodiversity more effectively than other land uses. While human footprint reduced intactness overall across the region, pastures had less negative impact compared to cropland or urban development. These findings highlight the role that grazing systems play in maintaining habitats for plants and, by association, animals.

Overall, our results suggest that the beef industry contributes to the conservation of grassland habitats in Saskatchewan. However, our analysis primarily addresses land conversion and not finer-scale measures of habitat quality such as specific measures of ecosystem health or maintenance of ecosystem services. Thus, we recommend further study on the ecological value of grazed landscapes to evaluate effects on habitat quality, ecosystem processes, and long-term

biodiversity outcomes. A critical next step to achieve this would be the collection of spatially explicit data on grazing intensity throughout the Canadian Prairies.

Introduction

The monitoring and protection of habitats and species is of critical importance across the natural resource sector as industries incorporate biodiversity into their policies and practices (Scherr & McNeely, 2008). The same is true in global food markets (Read et al., 2022), and Canadian beef producers play an important role in creating diverse agricultural landscapes and managing biodiversity in livestock systems for resilience. As the rising global demand for beef compounds with additional environmental challenges such as climate change, beef producers must balance production with conservation (Cordeiro et al., 2022; Merida et al., 2022; Pozo et al., 2021). A critical aspect of conservation is the preservation of biodiversity, an issue that has gained growing attention in both public and political spheres.

To meet this challenge, Canadian beef producers need reliable information on the potential impacts of beef production on plant and animal species and their habitats. This information must be assessed across a wide breadth of taxa, as focusing only on highly vulnerable species or other focal species may not fully capture beef production's wider biodiversity impacts and may thus miss management or restoration opportunities.

Efforts have been made to gather data on biodiversity outcomes of beef production, but many studies fail to link biodiversity with the entire beef life cycle, and the lack of ecologically based indicators has been noted as a barrier (Crenna et al., 2020). A beef cattle life cycle assessment approach has been used elsewhere in the world to understand industry-wide effects (Angerer et al., 2021; de Vries et al., 2015), but assessing biodiversity remains challenging due to the complexity of ecosystems and varying species responses (Read et al., 2022; Vrasdonk et al., 2019). Existing tools rely on proxies like land conversion rates, often lacking local biodiversity data (Chaudhary & Brooks, 2018).

This current project is intended to characterise the impact of beef cattle production on biodiversity via an empirical approach of applying well-established species habitat models — sensitive to land-use pressures in grassland environments and built on decades worth of systematic species monitoring data — to quantify impacts of beef cattle production in Saskatchewan. The area of interest within which to capture beef impacts on biodiversity is the grassland, parkland, and southern boreal transitional ecoregion areas of Saskatchewan (Figure 1), many of which are also agriculture-intensive.

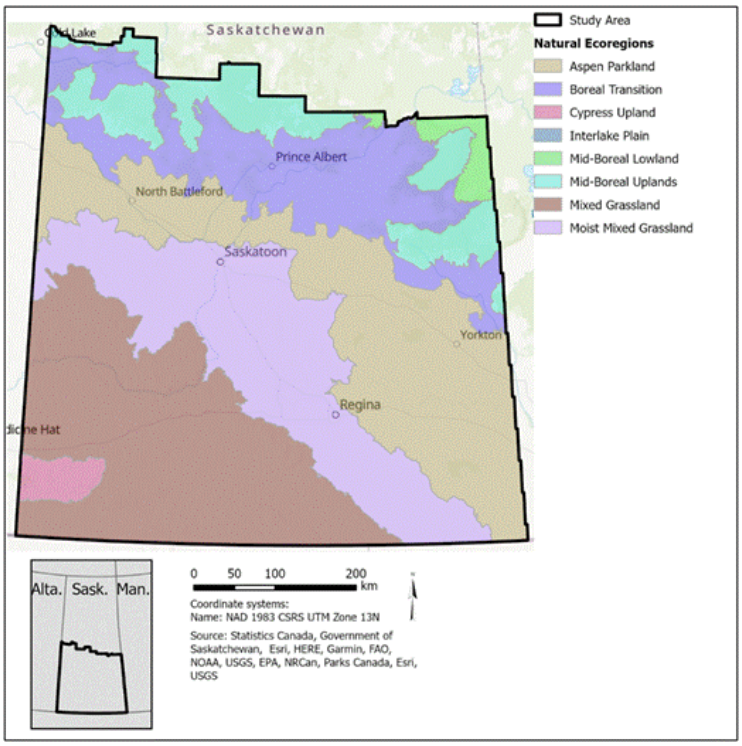

Figure 1. *The study area (black outline) and associated natural ecoregions in southern Saskatchewan (Government of Saskatchewan, 2007).*

Methods

Extended methods are provided in Appendix S1.

Quantifying beef cattle land-use footprint in Saskatchewan

We obtained population statistics for all livestock and poultry species from the 2021 Census of Agriculture (Statistics Canada, 2021), which reported animal populations prior to May 2021. Cattle statistics included population numbers at the Census Consolidated Subdivision (CCS) level for different categories, including beef cows, dairy cows, total calves under one year of age, bulls, replacement heifers (beef and dairy), steers, and heifers for slaughter. The 2021 census of agriculture did not fully account for the recorded provincial populations of various livestock at the CCS level. Reports for some livestock categories were assessed as too unreliable to be published or suppressed for privacy. To account for these gaps in data, we adapted equations published in Cordeiro et al. (2022) to estimate the number of animals in each county with suppressed or insufficient data.

To determine beef cattle feed requirements, we extracted preliminary livestock diets from previous Canadian studies in Alberta (Cordeiro et al., 2022) and Canada (Legesse et al., 2015). We determined

animal categories for each species based on differing nutritional demands and feeding practices. We also extracted feeding practices of provincial cow-calf operations from the Canfax Cow-calf cost of production network benchmark farms (Canfax Research Services, 2022).

Cattle population statistics were collected from the 2021 Census of Agriculture (Statistics Canada, 2021a) at the census consolidated subdivision level (CCS), mapped, and then reviewed by Saskatchewan provincial livestock specialists for accuracy of animal population estimates and dispersion. Population estimates for slaughter steers and heifers (backgrounded and finished/feedlot animals) were also supplemented with additional information provided by the Saskatchewan Department of Agriculture.

We mapped the spatial distribution of different beef cattle classes across Saskatchewan to assess the geographic scope of the beef industry in the province (Figure 2).

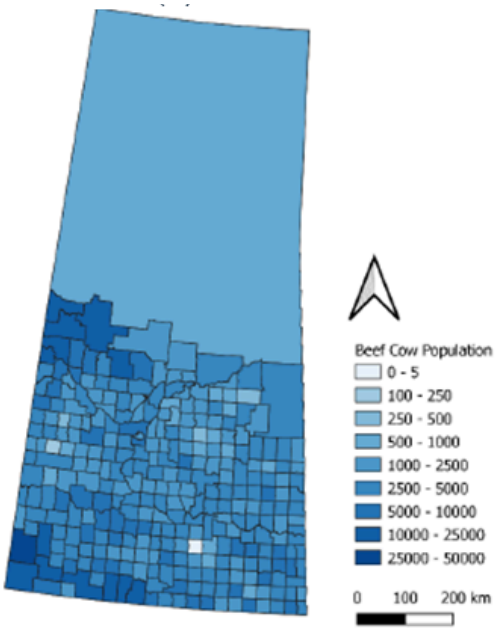

Figure 2. *Spatial distribution of beef cow inventories at the CCS level in Saskatchewan.*

Due to the limited number of beef production activities in the northern part of the province, our focus for biodiversity analysis was on the southern part of the province or the extent of rural municipalities in Saskatchewan (Figure 1).

Land use estimates for cattle feed distributions

Feeding practices of provincial cow-calf operations were extracted from the Canfax cow-calf cost of production network benchmark farms (Canfax, 2024) to serve as a baseline for representing regional feeding practices within Saskatchewan. Feeding practices were assigned to individual CCS based on the predominant prairie ecozones and available feedstuffs in the local areas. Canadian postal codes and GPS coordinates of Canfax benchmark survey participants were obtained from Canfax Research Services and used to spatially assign and distribute animal feeding practices to all CCS within the province based on proximity to the nearest farm coordinate (Table S1, Figure S1). Once animal diets were assigned, feed demand for each CCS (Figure S2) was estimated based on animal populations for each class.

To estimate land-use requirements of cattle feed production, ten-year averages of crop and forage yields were collected from the Government of Saskatchewan crop reports for each required feed. These averages were used to estimate productivity for each respective crop within each CCS. Land-use requirements were then estimated from animal feed demand and local productivity. For validation, land-use estimates were compared to reported land cover found in the 2021 Annual Crop Inventory (ACI) dataset published by Agriculture and Agri-Food Canada and the 2021 Census of Agriculture (Statistics Canada, 2021b) reporting seeded acreage of field crops and hay.

Land cover data for biodiversity assessment

Currently, Saskatchewan does not have a standardized map of land use and habitat types suitable for consistent biodiversity impact assessment across the province. We created two Geographical Information Systems (GIS) layers to support the application of species-specific predictive habitat models to assess biodiversity impacts from beef production practices in Saskatchewan. The first layer describes the current land-use and anthropogenic disturbances or human footprint types, referred to as the 'current conditions' layer. The second GIS layer describes the natural landscape and land cover, referred to as the 'reference conditions' layer. Below, details of the process leading to the creation of these two layers are explained.

Data collection and model input requirements

We collected land cover geospatial datasets (vegetation, wetlands, human footprint, ecosites, soils) available in Saskatchewan from various sources through networking, online searches, and ABMI geospatial data repository exploration (Table S2). From these data, we built two land-use layers for Saskatchewan:

1. Reference condition (Figure 3, left panel), which represents the undisturbed landcover if no human footprint were to exist on the landscape; and
2. Current land use (Figure 3, right panel), which represents the human footprint on the landscape today.

The reference condition layer (**Figure 3, left panel**) was developed using the rangeland ecosite layer (Government of Saskatchewan, 2014; Thorpe, 2014) and the predictive soil texture layer (Sorenson et al., 2022), following the approach developed for Alberta (ABMI, 2017b). After analysing the resulting layer from the combination of the Rangeland ecosite and the predicted soil texture layer, we identified the need for a more accurate representation of the open water classes. To improve water body representation, we prioritized data sources: (1) ABMI wetlands (southwest), (2) Ducks Unlimited Canada wetlands (southwest & central), and (3) CanVec water bodies and streams (all of Canada). The CanVec stream layer defined the entire study area's stream network. This reference layer provides a basis for comparison for models of current species distribution, allowing a quantitative assessment of human disturbance impacts on species.

To map human footprint from agriculture, settlements, and roads in the current conditions layer (**Figure 3, right panel**), we compiled specific land cover classifications. For the agricultural region, the required classes for species modelling are cropland, tame, or cultivated grassland and perennial forages, mixed grassland, and native grassland. We identified two primary raster-based datasets in Saskatchewan that provide reliable geospatial information with reasonable accuracy for these land classes. These were: (1) The Annual Crop Inventory (ACI) 2021 (Agriculture and Agri-Food Canada, 2021b) for the entire prairie region with detailed information on crop types, (2) the Prairie Landscape Inventory (PLI) for the mixed grassland and moist mixed grassland ecoregions (Badreldin et al., 2021; Government of Saskatchewan, 2021; 2023). Settlements and roads were both derived from the 2020 AAFC Semi-Decadal Land Use Time Series (Agriculture and Agri-Food Canada, 2021a), ensuring spatial consistency between these human infrastructure features. We created a base map with the agriculture class layers and overlaid the settlement and road layers onto it to create the current conditions layer.

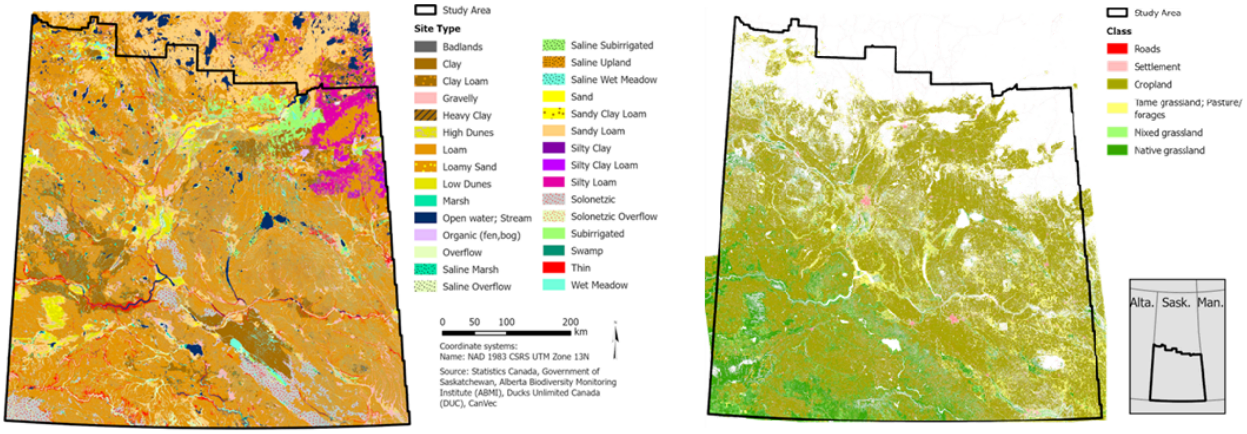

Figure 3. *(left) Reference condition layer for the Saskatchewan study area, representing the assumed undisturbed landcover if no human footprint were to exist on the landscape.* ***(right)*** *Composite map of land use and human footprint within the Saskatchewan study area.*

Model validation data from Saskatchewan

Within the province of Saskatchewan, we identified species monitoring data, comprising ~60,000 unique locations throughout the province with records on ~1,200 individual species. These data come from The Saskatchewan Conservation Data Centre (34,280 records; http://biodiversity.sk.ca/) and from the Global Biodiversity Information Facility (GBIF: 25,670 records; https://www.gbif.org/) (Figure 4).

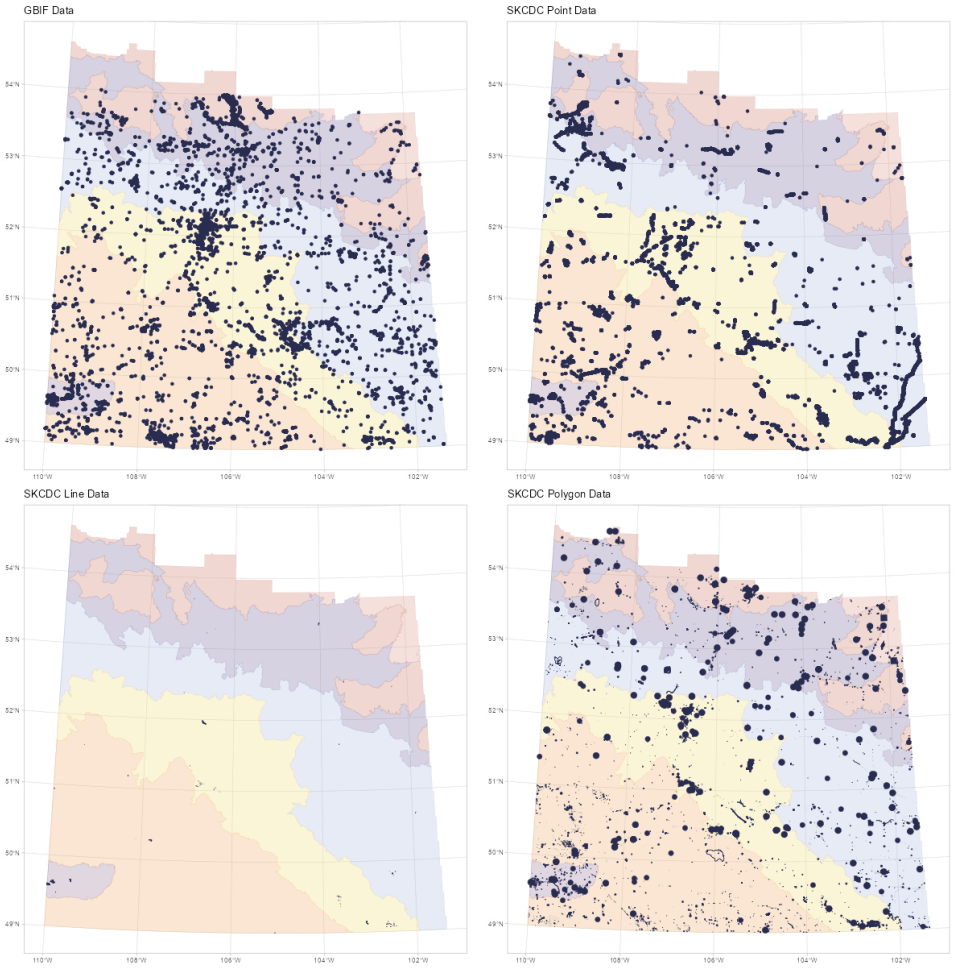

Figure 4. *Biodiversity data from Saskatchewan used for validation of Alberta-based model projections. Data are presence-only from (top left) the Global Biodiversity Information Facility (GBIF: 25,670 records; https://www.gbif.org/) and (top right; bottom row) the Saskatchewan Conservation Data Centre (34,280 records; http://biodiversity.sk.ca/).*

The biodiversity data compiled for the province of Saskatchewan are presence-only records (i.e., absence of observations of particular species cannot be interpreted as the true absence of the species, rather just the failure to observe the species). This is in contrast to ABMI's provincial monitoring data for Alberta, (upon which the existing species models are built) which is treated statistically as presence-absence data (implying exhaustive searches for species and thus true zeros). The presence-only treatment of the Saskatchewan biodiversity data introduces a slightly modified validation process for the projected species models, (see additional details below under "*Evaluate and identify existing species-specific predictive models relevant to the province's habitats*").

When we completed our initial survey of existing, available biodiversity data in Saskatchewan, we found that sufficient data were only available to model vascular plants. For other taxonomic groups, there was either insufficient data (e.g. for bryophytes, lichens, and soil mites), incompatible data (e.g. no remote camera data for mammals), or other challenges, some statistical, to translating Alberta models into Saskatchewan (e.g., for birds). We note that national predictions of bird abundance and responses to industry do exist (e.g., from the Boreal Avian Modelling Centre: https://borealbirds.ca/), but the underlying models and landcover layers utilised in these models differ from those created for this project.

Adapting ABMI's Alberta vascular plant models for Saskatchewan

The ABMI currently has reliable southern (i.e., grassland) distribution models for 265 unique vascular plant species, 244 of which have detected occurrences within Saskatchewan (i.e., appear in the compiled Saskatchewan biodiversity data) and passed expert evaluation (see section "*Visual evaluation of candidate models*"). These existing Alberta plant models were created using a suite of land cover, climatic, probability-of-aspen, and spatial data products. However, not all data layers extend to Saskatchewan.

To reduce jurisdictional artifacts in our predictions due to mismatching data layers (i.e., unrealistic prediction patterns at the inter-provincial boundaries where datasets change from Alberta- to Saskatchewan-based layers), we updated our species models to include national data for several layers, including downscaled climate data and aspen cover, among other layers.

Downscaled climate data

The ABMI's Alberta models use spatially explicit climate data as predictor variables. These statistically downscaled climate data are generated using the software package ClimateNA version 7.4 (https://climatena.ca/) (Wang et al., 2016), which takes geographic coordinates and paired elevations as inputs. The ClimateNA software covers all of North America, and new downscaled climate data were generated for Alberta and Saskatchewan together.

Aspen cover

For grassland environments, while abiotic environmental variables are also important, the presence of aspen is a strong predictor of habitat suitability for many other species (Chong et al. 2001, Kuhn et

al. 2011). For this reason, the ABMI models for the unforested region of Alberta use a probability-of-aspen layer as a predictor in our other species models. However, this layer is restricted to Alberta (based largely on ABMI's historic field monitoring data). To extend this predictor in Saskatchewan, we incorporated a national-level probability-of-aspen model to replace the Alberta model. The national aspen model was created externally to the ABMI by a team from the US National Forest Service, Canadian Forest Service, and University of Alberta (Worrall et al., 2013).

Validating new modelling layers

To ensure that we did not undermine the validity of the Alberta models by changing the supporting climate and aspen data, we compared the model covariates of each predictor within Alberta for all considered species between the existing Alberta-specific species models and the new models generated for projection into Saskatchewan. In general, changing the source of our model covariates without retraining the model resulted in decreased model performance (Figure 5, left panel). However, our new models for projection into Saskatchewan had similar fits compared to the existing Alberta-specific species models (Figure 5, right panel).

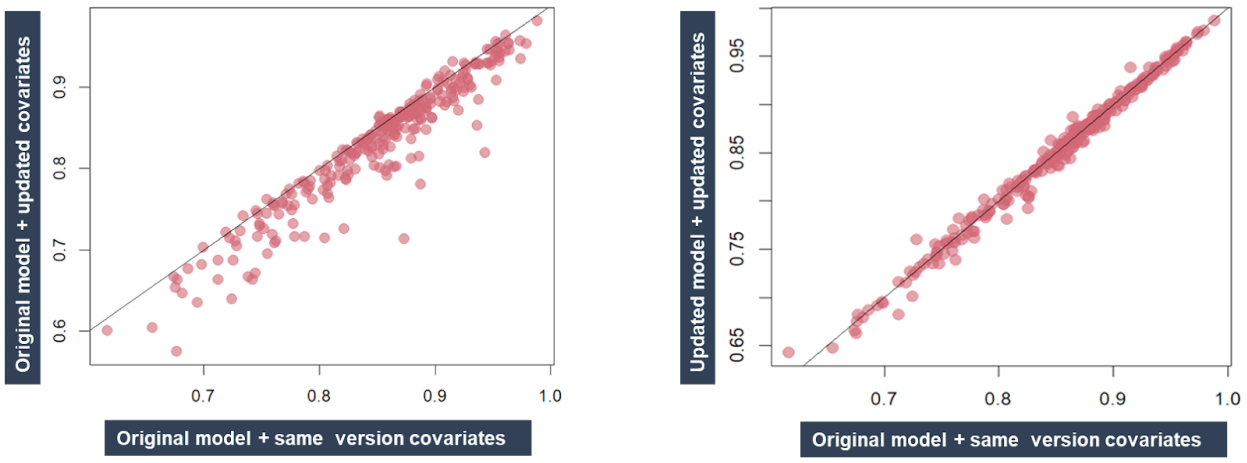

Figure 5. *Internal evaluation of change in covariates (probability-of-aspen and climate) on model performance. The variables in the X and Y axes are the area under the curve* (AUC), *which was used as the performance metric for model assessment. Changing the source of model covariates without retraining the models resulted in decreased model performance (**left panel**), while models retrained for projection into Saskatchewan had similar fits compared to the existing Alberta-specific species models (**right panel**).*

Candidate model projections for Saskatchewan

Using different combinations of the new suite of predictor layers for Alberta and Saskatchewan, we generated projections with each candidate model where the species was detected in Saskatchewan based on the following model structures for comparison:

1. Land Cover + Aspen
2. Land Cover + Climate
3. Land Cover + Aspen + Climate
4. Land Cover + Aspen + Climate + Spatial XY

We chose these combinations of predictors based on (1) evidence that they drive or correlate with plant species' occurrence, (2) expectations that these variables drive uncertainty in model predictions, and (3) prior experience creating predictive models in Alberta, acknowledging the strength and patterns of predictor-occurrence combinations may differ in the Saskatchewan context. Note that we created models only for species occurring at ≥20 sites in the Alberta models before they were extrapolated to Saskatchewan. We then evaluated these candidate model projections using the Saskatchewan biodiversity data.

Visual evaluation of candidate models

Visual inspections of the candidate models were performed to assess two goals: 1) identify which of the four candidate model structures aligned best with the observational data; and 2) remove species from reporting if the model predictions appear unreasonable.

While performing the visual inspection, we assessed the following:

1. Are predictions similar across the candidate model structures?
2. Are there obvious biases in predictions due to spatial or climatic gradients?
3. As we only had presence-only information in Saskatchewan, do the candidate models predict high abundance for those observations?
4. For species with known associations with native grasslands, do the candidate predictions align with the distribution of native grasslands in Saskatchewan?

Evaluating existing species-specific predictive models relevant to Saskatchewan habitats

Not all models built on data from one location are appropriately parameterized for new locations, as relationships between predictor and response variables do not necessarily remain consistent over space — a phenomenon known as non-stationarity. For this reason, to ensure robust testing of model extrapolation or transferability when using Alberta-based models for predictions into Saskatchewan, we needed to go beyond internal model validation (i.e., beyond Akaike Information Criterion [AIC]) and beyond cross-validation using splits of training data, as internal cross-validation will favour model fit to training data at the expense of model transferability. Instead, we must assess model performance using different approaches, such as validation with independent data from the new region.

We assessed model realism in Saskatchewan by:

1. Independent statistical validation using a Continuous Boyce Index (CBI; Boyce et al., 2002), which compares predictions in presence data vs. background information;
2. Visually comparing the projected distribution in Saskatchewan to the modelled species' distribution in Alberta to ensure conceptual realism (i.e., species predicted to be found in southern, drier grasslands in Alberta also were predicted to be found in more arid grasslands in Saskatchewan);
3. Visually comparing probabilities of species' occurrence to actual occurrences (i.e., vegetation monitoring data from Saskatchewan); and
4. Using references from the literature to confirm that the species' ecology matched the environmental conditions where they were expected to occur in Saskatchewan.

After reviewing the species model projections into Saskatchewan, we determined species for which at least one candidate model was of sufficient reliability to include in our analysis. If none of the candidate models were of sufficient reliability, we removed that species from the analysis.

Model projections for all species (including all candidate models with the selected best model identified) are provided in Appendix S4.

Quantifying plant species responses to beef production

Intactness and Attribution

The ABMI assessed change between reference and observed land use, including calculating general metrics of intactness for modelled species with sufficient model accuracy. This metric, known as the 'Biodiversity Intactness Index' (hereafter 'intactness'), compares the predicted current relative abundance of a species in a given region to its predicted reference relative abundance in that region if there were no human footprint. An intactness of 100% represents a current abundance equal to that expected under reference conditions. Intactness declines when a species' abundance deviates from its expected value, either positively or negatively. Species that are more abundant or less abundant than expected both have lowered intactness; the bigger the difference between current and reference abundances, the lower the intactness (ABMI, 2017a).

With land use assigned to specific human uses, including industrial sectors (i.e., sectorised human footprint), it is possible to attribute changes in modelled relative abundance to specific sectors operating on the landscape. We can report on both the local scale effects (i.e., how habitat suitability is impacted in the immediate area) and regional scale effects (i.e., how habitat suitability is impacted regionally based on the type of disturbance and where it is placed).

We calculated intactness across southern Saskatchewan for all species with acceptably accurate model projections in the region, then attributed changes in species' relative abundance values to specific human uses, including pastures, cultivation, urban-industrial, and transportation sectors. Additionally, to estimate the impacts of cattle grazing on intactness, we used cattle population and

feeding requirement estimates generated in year two of the project as predictor variables in two generalised linear mixed models with intactness as the response variable. Both models used a Poisson error distribution and a log link function. We included census consolidated subdivision (CCS) as random intercepts in the models to account for non-independence among observations within the same region.

Deviation From Expected Trends

Species distribution models are an effective tool for understanding the impacts of anthropogenic disturbance on habitat suitability. However, the effectiveness of these models depends on their ability to accurately reflect the cumulative impacts of disturbance, including complex interactions between different disturbance types. To evaluate this assumption, we calculated the deviation between our predictive models and observed field data from Saskatchewan and analyzed whether any differences could be explained by grazing pressure (cattle density and grassland usage) within census consolidated units (Appendix S3).

Quantifying impacts of beef production

We quantified the impacts of beef production on biodiversity by focusing on the local and regional effects of agriculture and tame pasture on intactness and deviation from expected trends. By focusing on these sectors, we assumed that changes in biodiversity resulting from these sectors are associated with beef production. We believe this assumption is justified as tame pasture is predominantly associated with livestock grazing and cattle are the most numerous livestock in Saskatchewan (Statistics Canada, 2021).

We acknowledge that cultivation contributes to the beef sector's impact. However, the feed data we had available indicated that the relative proportion of cultivated agricultural lands directly producing feed or silage is very small (Appendix S2), so we chose to not combine the weighted regional cultivation effects with tame pasture effects shown below. Instead, we focus only on the regional effects of tame pasture to estimate the corresponding sector effects of the beef industry.

Results

Relative abundances of vascular plants under current and reference land uses

Intactness

Overall, the 244 vascular plant species' modelled relative abundances in the current landscape were similar to those in the reference landscape, resulting in high intactness values (Figures 6 and 7). The mean overall intactness across all vascular plant species for southern Saskatchewan was 96.82% ± 0.22%. Intactness values for individual species ranged from 83% to 99%, reflecting small to

negligible changes in predicted abundance due to land-use changes in the region (Figures 6 and 7). Though determining thresholds is challenging, the literature currently suggests that declines of more than 10% intactness (i.e., less than 90% intact) may have crossed safe planetary boundaries (Newbold et al. 2016). Consequently, though intactness in the study area was generally high, these values may represent significant negative habitat losses for some species.

We observed some variation in intactness among species. As a typical example, Slender Wheatgrass (*Elymus trachycaulus*) was predicted to have moderate probabilities of occurrence in both the reference and current habitats (Figure 6). Slender Wheatgrass is a rhizomatous grass that is good forage and found frequently in moist sites and rich soils (Tannas, 2001). These habitats are common in both the current and reference landscape; consequently, the fescue's predicted abundance is similar between the reference and current habitats, leading to high intactness values (Figure 6). Hairy Golden Aster (*Heterotheca villosa*) is an example of a species that showed lower intactness across the study area (Figure 7). Habitat suitability for this species was predicted to be low across the reference landscape and decrease in the current landscape, resulting in lower intactness scores for the species (Figure 7). This is a typical open grassland species (Tannas, 2001b) and may be primarily impacted by the conversion of grassland pasture to cultivation or other land uses such as resource extraction (e.g., well pads).

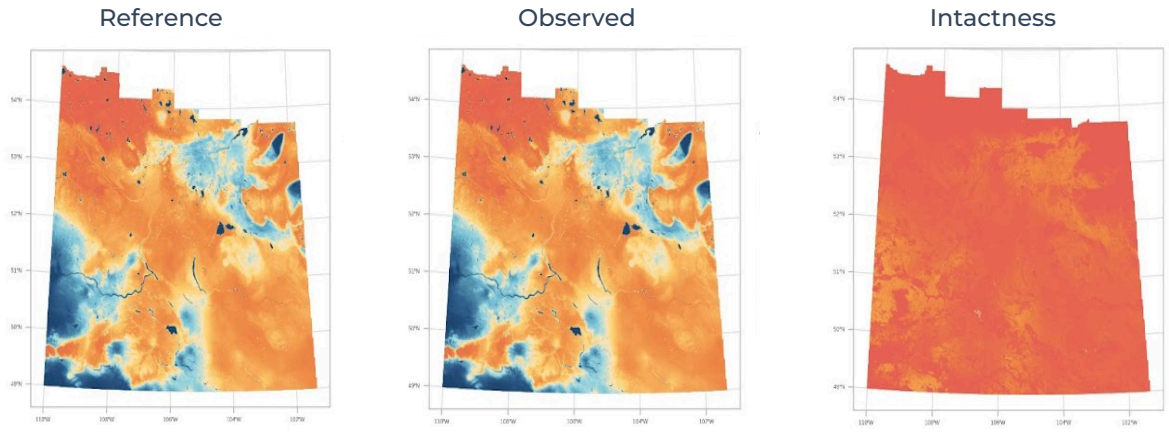

Figure 6. *Modelled habitat suitability in the reference landscape **(left)** and the observed landscape **(middle)**, and the resulting intactness **(right)**, for an example species* Elymus trachycaulus *(Slender Wheatgrass), for the Saskatchewan study area. For this species, we see slight differences between the modelled reference and current landscapes, resulting in high intactness values across the study area. In all figures, blue to yellow to red represents low to medium to high values, respectively.*

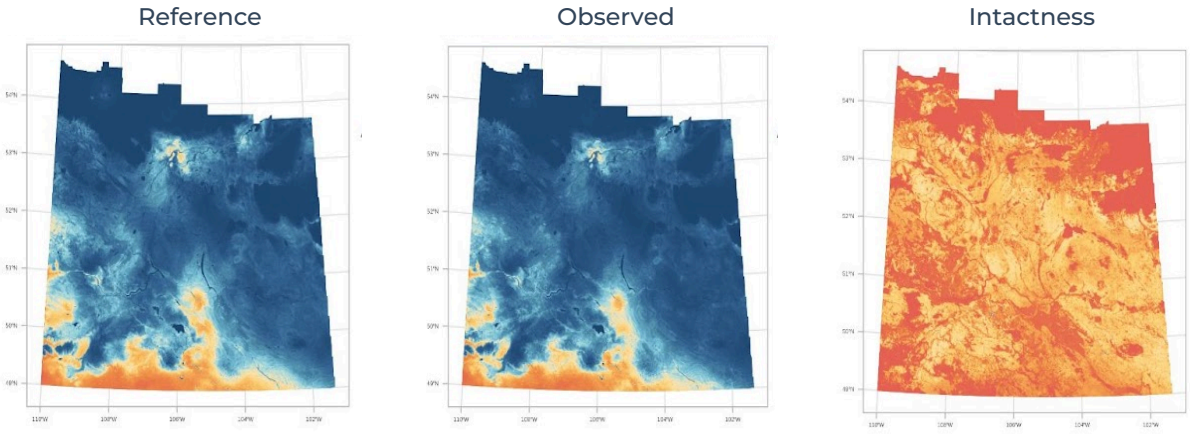

Figure 7. *Modelled habitat suitability in the reference landscape (left) and the observed landscape (middle), and the resulting intactness (right), for an example species* Heterotheca villosa *(Hairy Golden Aster) for the Saskatchewan study area. This species shows lower intactness across the study region. In all figures, blue to yellow to red represents low to medium to high values, respectively.*

Responses of vascular plant species to beef production

Grazing Effects on Intactness

When considering the direct effects of beef production on intactness, increased counts of beef cattle and greater grassland use resulted in greater intactness (Figures 8 and 9). The number of beef cattle per census area increased intactness (estimate = 1.23E-5 ± 2.01E-6, z = 6.12, $p < 0.001$; Figure 8). Similarly, greater grassland land use, based on the weighted average productivity of tame, mixed and native grasslands within a polygon (Appendix S3), increased intactness (estimate = 5.123E-6 ± 5.918E-7, z = 8.67, $p < 0.001$; Figure 9).

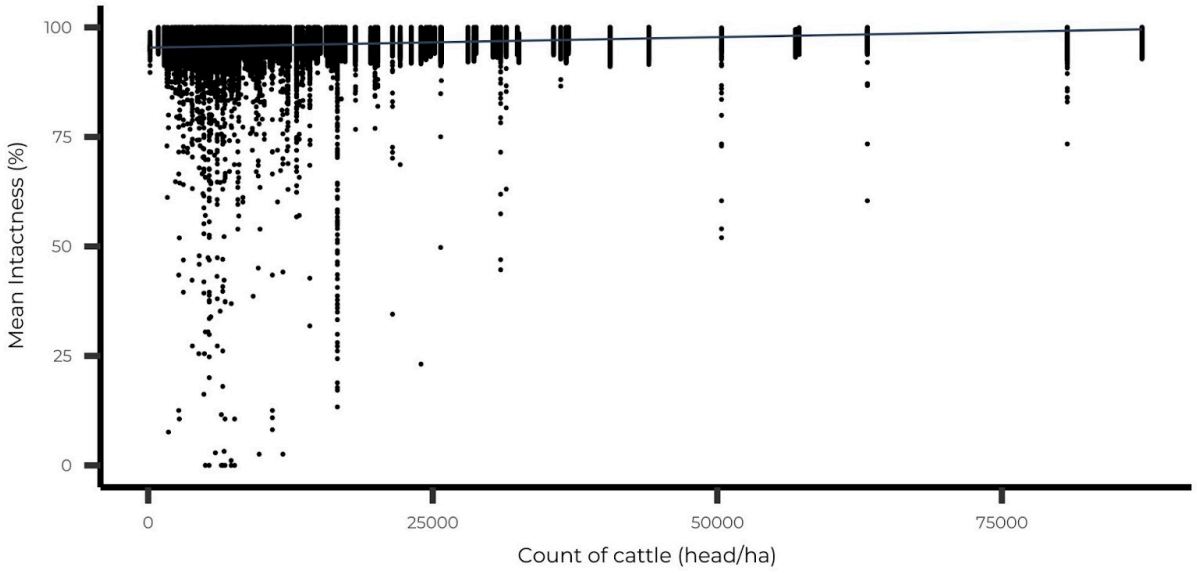

Figure 8. *Relationship between mean intactness values and the count of beef cattle per unit area, with each data point representing a census consolidated subdivision (CCS).*

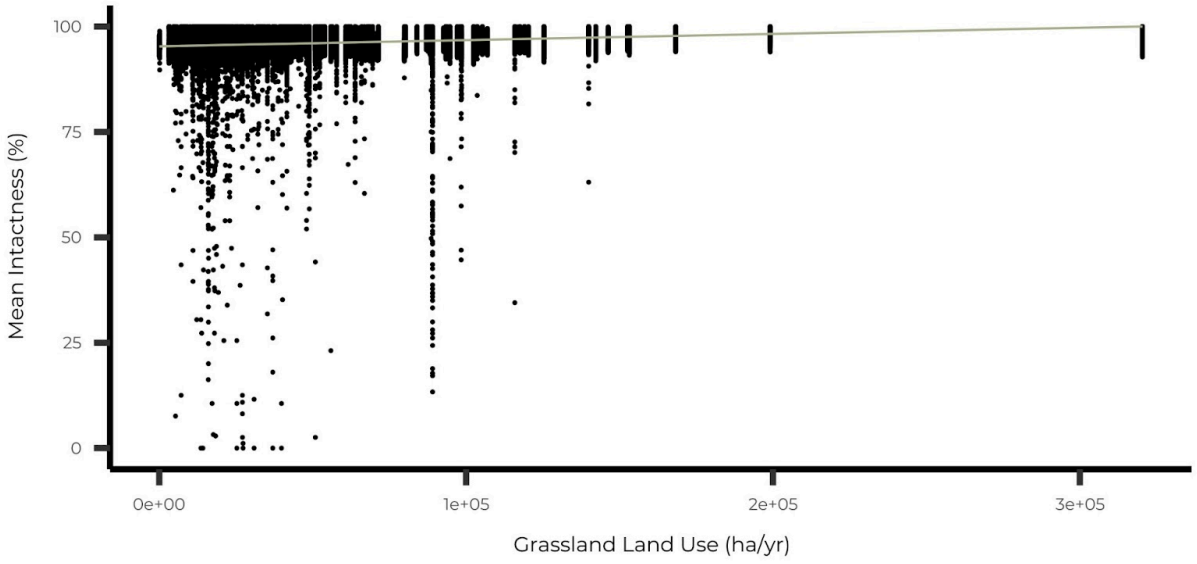

Figure 9. *Relationship between mean intactness values and grassland land use. Grassland land use is based on the weighted average productivity of tame, mixed and native grasslands within the census consolidated subdivision (CCS) of a land parcel.*

The positive association between increased stocking densities and higher intactness may seem counterintuitive, as larger herds are typically thought to increase degradation through overgrazing and erosion (e.g. Pulido et al. 2018, Turnbull et al. 2010). However, higher stocking densities might be a simple reflection of feed availability, and higher densities may still reflect sustainable use of forage resources. Further, rotational grazing approaches commonly used in Saskatchewan, which are largely seen as a best management practice, can support higher stocking densities. Additionally, the species models used in the intactness analyses respond only to direct habitat conversion and not to the quality of impacted or remaining habitat, for which data are much scarcer. Therefore, the observed relationships show that cattle densities are higher in areas with more native grasslands (i.e., increased forage availability), but we are unable to assess how the associated increased grazing pressure is impacting local biodiversity.

Intactness is generally higher in pasture because that land is most like the reference land use (i.e., not converted into cultivated, industrial, or urban land), leading to the positive relationship we observed between intactness and grassland use values. In this approach, however, intactness does not capture grazing pressure, highlighting a need for measures of direct grazing within habitats. To accurately capture the impacts of the beef sector on plant species, further monitoring should be established to assess habitat quality in addition to land conversion, including direct monitoring of grazing pressure. We are unable to provide a conclusive comment on the role of grazing management in mitigating the impacts of beef production on biodiversity but we encourage future work to engage with producers and document how grazing management affects biodiversity and intactness.

Human Footprint Effects on Habitat Suitability

On average, human footprint decreased predicted habitat suitability (Table 2). This is to be expected, as any change from reference land use will reduce predicted habitat suitability, regardless of whether species have positive or negative responses to the change. Sectors had variable effects among species (Figure 10), but, generally, land use associated with cattle grazing (i.e., pasture) resulted in moderately less negative local effect than all other anthropogenic land uses and much less negative regional effect than agricultural conversion (Table 2). This is likely because pastures are typically unplowed and thus remain available as habitat to grassland plant species. This is in contrast to cultivated lands, which are typically plowed and planted as monocultures, resulting in lost habitat for species previously present or the creation of new habitat for weedy species along the edges of planted fields.

Table 2. *Mean effects of industrial sectors on overall vascular plant intactness in the study area. "Regional Scale Sector Effects" estimates reflect how habitat suitability is impacted across the study region based on the type of disturbance and where it is placed. "Local Scale Sector Effects" estimates reflect how habitat suitability is changed by each sector in the immediate location of footprint features when compared to the reference landscape. SE = standard error.*

Land Use	Regional Scale Sector Effects			Local Scale Sector Effects		
	Estimate Mean ± SE (%)	Minimum Effect (% change)	Maximum Effect (% change)	Estimate Mean ± SE	Minimum Effect (% change)	Maximum Effect (% change)
Cultivation	-1.562 ± 0.246	-14	18	-3.088 ± 0.463	-26	32
Pasture	-0.142 ± 0.030	-2	1	-1.872 ± 0.369	-24	16
Urban Industrial	-0.019 ± 0.006	0	0	-1.148 ± 0.477	-27	37
Transportation	-0.057 ± 0.011	-1	1	-1.823 ± 0.483	-27	32

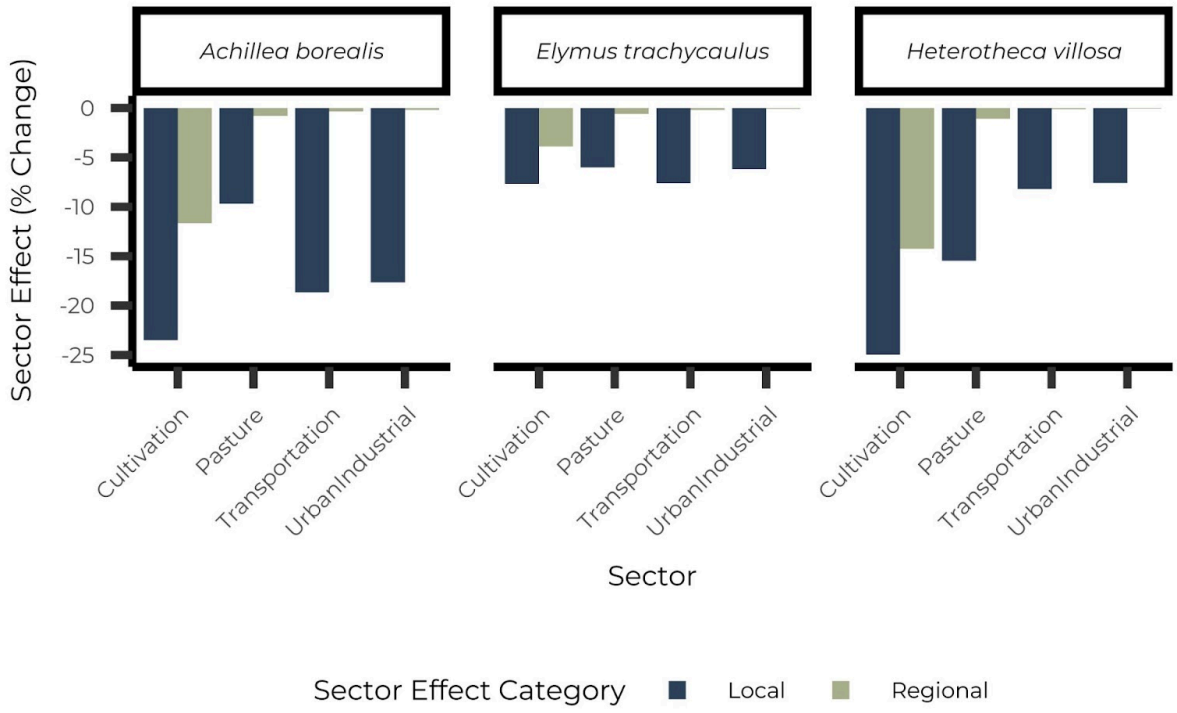

Figure 10. *Sector effects for* Achillea borealis *(Common Yarrow),* Amelanchier alnifolia *(Saskatoon), and* Festuca saximontana *(Rocky Mountain Fescue). Graphs show the regional effects of sectors and the effects under human footprint. Sector effect values lower than 0% indicate habitat suitability is reduced (i.e., the predicted abundance is lower than reference) compared to reference conditions.*

Deviation From Expected Trends

Cattle grazing explained a significant amount of residual variation for all species considered (Table S3). However, species had variable associations with grazing. The majority of species' predicted abundances decreased with increased cattle density, whereas only twelve species' abundances were predicted to increase with cattle density (Figure 11). These twelve species included *Agoseris glauca*, *Artemisia campestris*, *Bromus cillatus*, and *Rumex triangulivalvis*. These are (mostly) weedy species that thrive in open spaces left after disturbances, such as grazing (Del-val & Crawley, 2005, Pellaton et al. 2023). Species whose abundances were predicted to decrease with cattle grazing were more variable but included species such as *Calamagrostis montanensis*, *Eleagnus commutata*, *Festuca saximontana*, and *Sphaeralcea coccinea.* The decreaser species may respond negatively to cattle grazing because they are preferred forage species or known to be sensitive to disturbance (Jonson, 2025).

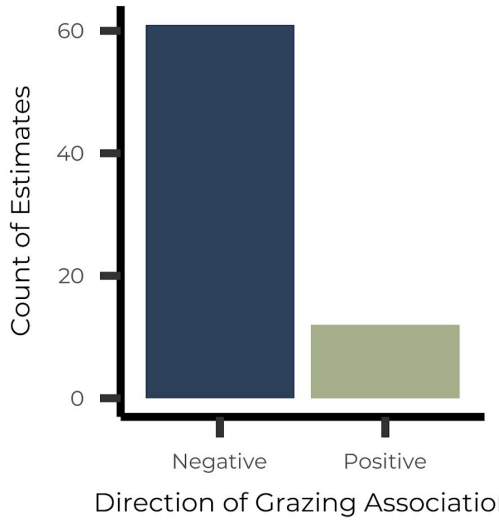

Figure 11. *Number of species for which positive and negative associations with cattle grazing were observed. Estimates come from deviation-from-expected models.*

Implications for multi-taxa biodiversity

Given that vascular plants form habitats for other taxa, there is potential that the marginal effects of pasture on vascular plant intactness (i.e., relative to other human land uses) extend to other taxa, though this is not directly measured in our study. For example, grassland bird species often use pasture lands as migratory stopovers or as nesting habitat, even though cattle grazing is present on the landscape. Beyond direct habitat impacts, cattle grazing may influence species indirectly through changes in plant community composition or resource availability. For example, shifts in grass structure or flower abundance could affect insect populations, which in turn influence higher trophic levels, such as insectivorous birds or small mammals, but additional targeted monitoring would be required to assess these relationships.

The effects of beef production on biodiversity are likely scale dependent. Regional differences in pasture management, stocking density, or landscape connectivity may modify the degree to which local populations of plants, birds, or other taxa are affected, highlighting the importance of considering both local and broader-scale patterns. The role of cattle grazing in maintaining heterogeneous pasture landscapes could help sustain ecological resilience in Saskatchewan grasslands. Even where the beef sector has some negative effects on specific species, they may still provide valuable ecosystem services, such as pollinator habitat or nutrient cycling, that support multi-taxa biodiversity.

Conclusions

Overall, we found that intactness was high throughout the study region, meaning that, at large scales, species' modelled abundances in the current southern Saskatchewan landscape were similar to those in the reference models. We found intactness increased with cattle density and the use of grasslands for forage. However, these trends may not hold at lower spatial resolutions as we observed regions with higher and lower agricultural impact, which may reduce plant abundance and/or intactness at smaller scales. While all types of human footprint decreased intactness, footprint associated with beef production (i.e., pasture) decreased intactness to a lesser extent than other sectors.

Our results suggest the Saskatchewan beef industry plays a vital role in maintaining habitat for plant species. However, further research is required to understand the impacts of beef production on habitat quality and its effects on biodiversity in other taxa. Our results support producers and policymakers in making informed, evidence-based choices in a context of rising global demand and environmental pressures.

Study Limitations

A key limitation of the existing Saskatchewan biodiversity data and models is the lack of comprehensive provincial-scale models and monitoring programs. Current datasets are often subject to sampling bias, with opportunistic surveys disproportionately conducted along linear features such as roads or trails and with common species overrepresented relative to rarer taxa. Additionally, the available data do not allow differentiation of the effects of specific cattle management practices, as information on operations such as feedlots or grazing intensity is largely absent. This lack of integration between biodiversity data and detailed management information limits our ability to link observed patterns to particular production practices, reducing the accuracy and applicability of our models for characterizing the impact of the Saskatchewan beef industry on biodiversity. Further, there is taxonomic bias in existing biodiversity data. Specific groups, such as bryophytes, lichens, and mammals, do not currently have public data available for modelling and analysis, which limits our ability to understand the impacts of the beef sector on multi-taxa biodiversity.

Our measure of multi-species biodiversity impacts (intactness) emphasizes effects of habitat loss due to land conversion and may not capture the effects of beef production on habitat quality or ecosystem health. Additionally, our focus on pasture lands did not capture the full life cycle of the beef cattle industry (e.g., supplement of agricultural feed, water usage, slaughterhouses). These other components of the beef cattle industry will also impact biodiversity and should be investigated. Finally, our models were unable to capture the effects of grazing intensity. As grazing intensity varies spatially based on grazing management and cattle forage preferences, our results cannot predict the impacts of individual ranches on biodiversity.

Despite these limitations, by applying empirical species habitat models sensitive to land-use pressures, we have provided a spatially explicit insight, based on empirical data and validated statistical models, into how beef cattle production relates to biodiversity across Saskatchewan's grassland ecosystems. These results offer valuable indicators of habitat condition and species abundance that can inform management decisions aimed at balancing beef production with conservation goals. By quantifying impacts across a broad range of species rather than only highly vulnerable or indicator species, our findings provide a more comprehensive picture of beef production's ecological footprint and help identify potential opportunities for targeted management or restoration. This work highlights the need for integrating systematic monitoring data into decision-making by addressing gaps in current assessments.

Suggested Next Steps

Comprehensive and unbiased biodiversity data collection in Saskatchewan should be a provincial priority. The Saskatchewan biodiversity data used for model validation does not have consistent spatial coverage over the study area and, as with most opportunistic species occurrence data, is biased towards roads and populated areas. For this reason, statistical validations of model projections using these data may favour models that are more accurate in areas of good data coverage and may inadequately penalize models that perform poorly in regions without good data coverage. Collecting presence-absence biodiversity data from randomly or systematically selected locations and incorporating these data into predictive models could increase the confidence of model predictions. Species data collected using a random or systematic approach will increase confidence in model predictions, as we observed artifacts in model outputs, likely resulting from sampling bias in the opportunistic observations available to us. The models we present are extrapolated from Alberta into Saskatchewan, but local models would perform better and provide more valuable insights into the beef sector's impacts on biodiversity.

Collection or increased availability of data on grazing intensity would benefit biodiversity assessments and inform land-use planning and management. To better understand the impacts of beef production, additional biodiversity monitoring and systematic data on grazing management are essential. Industry investment will likely be necessary to support these efforts. This could be achieved through focused, targeted monitoring in grasslands to improve the resolution and applicability of models. Such data would help identify management practices that promote both production and conservation outcomes. Further, making government-collected biodiversity datasets publicly available would enhance transparency and enable broader use in research and decision-making.

Together, these efforts would provide the information necessary to guide sustainable management and conservation practices across beef-producing landscapes.

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Supplementary Material

Appendix S1: Detailed Methods

Beef cattle production practices and distribution

We assumed all bulls (cattle) reported in the census to be from beef operations, as most dairy operations use artificial insemination for breeding cows and replacement heifers (Cordeiro et al. 2022). The census only reported total calves under one year of age and did not discriminate between beef and dairy calves. Therefore, we made estimates based on the number of beef and dairy cows and their expected calf crop, assuming (i) weaning rates of 85% and 90%, respectively, and (ii) a 1:1 male-to-female sex ratio. Livestock species were reported in varying categories within species. Only a single category was reported in the census for bison, turkeys and horses (ponies). To better estimate the feed demand of bison, we divided this species into three major categories: i) bulls and cows, ii) replacements, and iii) feeder/finishing animals. We used the 2023/2025 Manitoba Bison Cow-Calf Production Guide (Government of Manitoba, 2022) to estimate each category from the reported number of bison. We assumed that a total of 7.5% of animals were kept on the farm as replacements (Cordeiro et al. 2022), while another 10% were treated as feeding/finishing bison, based on past trends in annual slaughter (Agriculture and Agri-Food Canada, 2021a; Canadian Bison Association, n.d.). The 2021 census of agriculture did not fully account for the recorded provincial populations of various livestock at the CCS level. Reports for some livestock categories were assessed as too unreliable to be published or suppressed for privacy. To account for these gaps in data, we adapted equations published in Cordeiro et al. (2022) to estimate the number of animals in each county with suppressed or insufficient data:

$$Bulls = \left(SK_{bulls} - UD_{bulls}\right) \frac{Farms_{bulls}}{SD\ Farms_{bulls}} \quad (1)$$

$$Beef\ cows = \left(SK_{beef\ cows} - UD_{beef\ cows}\right) \frac{County_{beef\ cows}}{SD_{beef\ cows}} \quad (2)$$

$$Dairy\ cows = SK_{dairy\ cows} - County_{beef\ cows} \quad (3)$$

$$Beef\ replacement\ heifers\ (BRHs) = \left(SK_{BRHs} - UD_{BRHs}\right) \frac{County_{beef\ cows}}{SD_{beef\ cows}} \quad (4)$$

$$Dairy\ replacement\ heifers\ (DRHs) = \left(SK_{DRHs} - UD_{DRHs}\right) \frac{County_{dairy\ cows}}{SD_{dairy\ cows}} \quad (5)$$

$$Slaughter\ or\ feeder\ heifers\ (SFHs) = \left(\left(SK_{heifers} - SK_{BRHs} - SK_{DRHs}\right) - UD_{SFHs}\right) \frac{County_{heifers} - County_{BRHs} - County_{DRHs}}{SD_{heifers,\ BRHs,\ DRHs}} \quad (6)$$

$$Steers = \left(SK_{steers} - UD_{steers}\right) \frac{Farms_{steers}}{SD\ Farms_{steers}} \quad (7)$$

$$Other\ livestock\ species\ (OLS) = \left(SK_{OLS} - UD_{OLS}\right) \frac{Farms_{OLS}}{SD\ Farms_{OLS}} \quad (8)$$

where SK = cattle or other livestock species inventory for Saskatchewan, UD = the sum of the unsuppressed county cattle or other livestock species data, Farms = the number of farms reporting the livestock species in a specific county, SD = the sum of the suppressed county data for different livestock groups and categories, SD Farms = the sum of the farms reporting for all counties with suppressed livestock species data, and County = the total number of beef or dairy cattle in a specific county.

We estimated the number of undocumented animals at the CCS level by subtracting the sum of animals at the CCS level from the reported provincial totals for each respective livestock category. The undocumented animals were then dispersed between the CCS with suppressed data based on the number of criteria befitting the respective animal class. Beef and dairy cow estimates were based on the total number of cows. Replacement heifer estimates for beef, and dairy considered the number of beef and dairy cows within the county. The formula for slaughter heifers utilized the counts of total dairy and beef heifers when estimating populations. Bull, steer, and all other livestock estimates were based on the number of farms reporting animals in their respective county and the number of farms with suppressed data.

Beef cattle feed requirements

To determine beef cattle feed requirements, we extracted preliminary livestock diets from previous Canadian studies in Alberta (Cordeiro et al., 2022) and Canada (Legesse et al., 2015). We determined animal categories for each species based on differing nutritional demands and feeding practices. We extracted additional sub-categories to account for physiological changes and accommodate seasonal shifts in nutrient demand. For beef cattle, we used previous studies (Cordeiro et al., 2022; Legesse et al., 2015) to identify categories and sub-categories of cattle feeding scenarios. We extracted feeding practices and duration for each category as starting points for diet formulation for Saskatchewan operations (Cordeiro et al., 2022). We also extracted feeding practices of provincial cow-calf operations from the Canfax Cowcalf cost of production network benchmark farms (Canfax Research Services, 2022).

In total, ten typology farms were consulted for their feeding practices as potential starting points for winter feeding strategies of cow-calf operations in the province. The typology farms were developed by aggregating information provided by farms participating in the program, aggregated based on similar characteristics, practices, and locations to create each benchmark farm. These hypothetical farms only accounted for winter grazing feeding strategies of cows and replacement heifers and did not present any additional classes or species. For all other livestock, we extracted categories from Cordeiro et al. (2022), as well as other academic and government resources (Government of Saskatchewan, Government of Manitoba, Government of Alberta, National Research Council). These categories accounted for seasonal changes in diets and physiology, animal sex, and life stages of each respective species.

Cattle populations and distributions

Cattle population statistics were collected from the 2021 Census of Agriculture (Statistics Canada, 2021) at the census consolidated subdivision level (CCS), mapped, and then reviewed by Saskatchewan provincial livestock specialists for accuracy of animal population estimates and dispersion. Specialists identified two classes of cattle (steers and heifers for slaughter) for which the population estimates reported were suspected to not accurately represent actual animal populations. This discrepancy was due to the frequent provincial and interprovincial exchange experienced by animals destined for slaughter. To adjust cattle inventories for the steer and heifers for slaughter classes, additional cattle export information was requested and received from provincial specialists, which documented the total interprovincial exchange of animals by animal class. This information was then used to supplement the Statistics Canada data.

We mapped the spatial distribution of different beef cattle classes across Saskatchewan to assess the geographic scope of the beef industry in the province (Figure S1). Populations for all the cattle classes appear to be concentrated in the central and southwestern areas of the province bordering the province of Alberta and the US, with other areas of varying concentration spread throughout the rest of the province (Figure S1 and Figure S2). This may be due to the high number of finishing and slaughter facilities in Alberta and the ease of access to international trade with the United States. There is a significant difference in the slaughter steer and heifer populations (Figure S2), as well as a contrasting dispersal of these populations across the provincial CCS.

We also mapped steer and heifer distribution to assess the results of the gap-filling process (Figure S2). Issues arose when gap-filling inventories for slaughter heifers. For some CCS, the estimate of total heifers was less than the sum of beef and dairy heifers, yielding negative inventories. This occurred for 33 of 297 CCS in Saskatchewan, accounting for 2% of the total slaughter heifer population. For these 33 CCS where negative values occurred, we assumed that actual slaughter heifer numbers were small, and a value of 3 was assigned (determined in consultation with Dr. Getahun Legesse, personal communication). We then recalculated inventories for the remaining CCS with suppressed slaughter heifer data to ‘redistribute’ the suppressed animals.

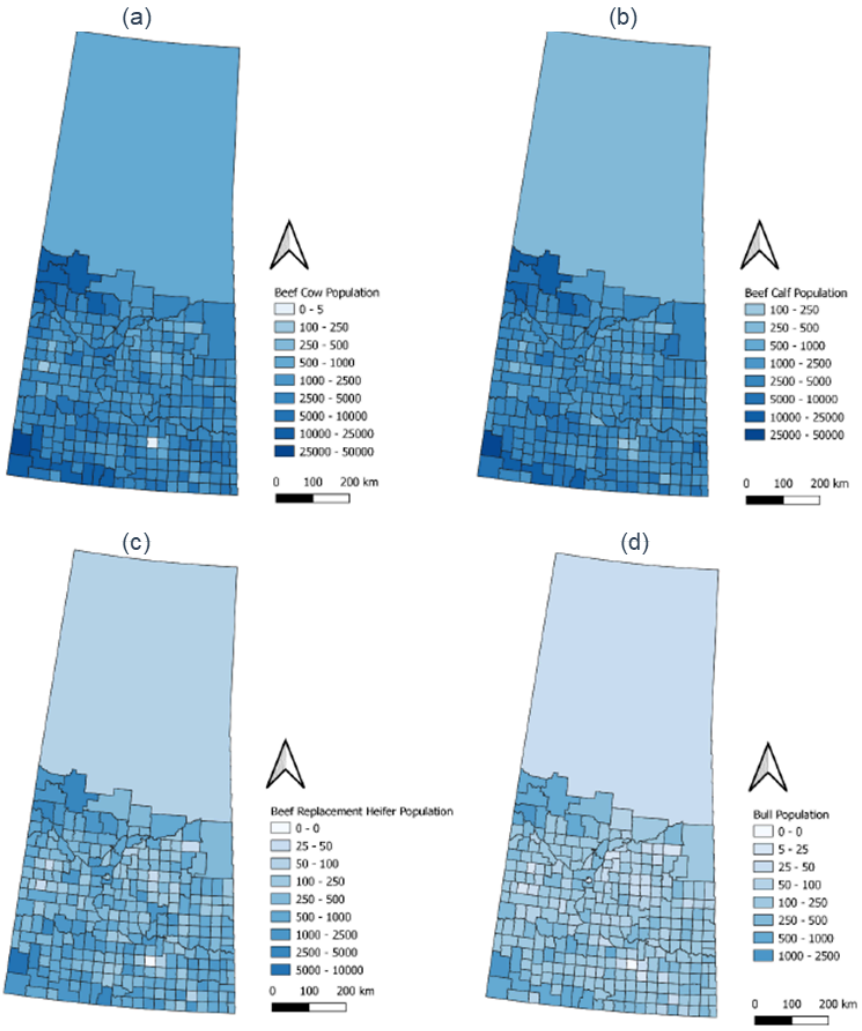

Figure S1. *Spatial distribution of (a) beef cow, (b) beef calf, (c) beef replacement heifer, and (d) bull populations (d) inventories at the CCS level in Saskatchewan.*

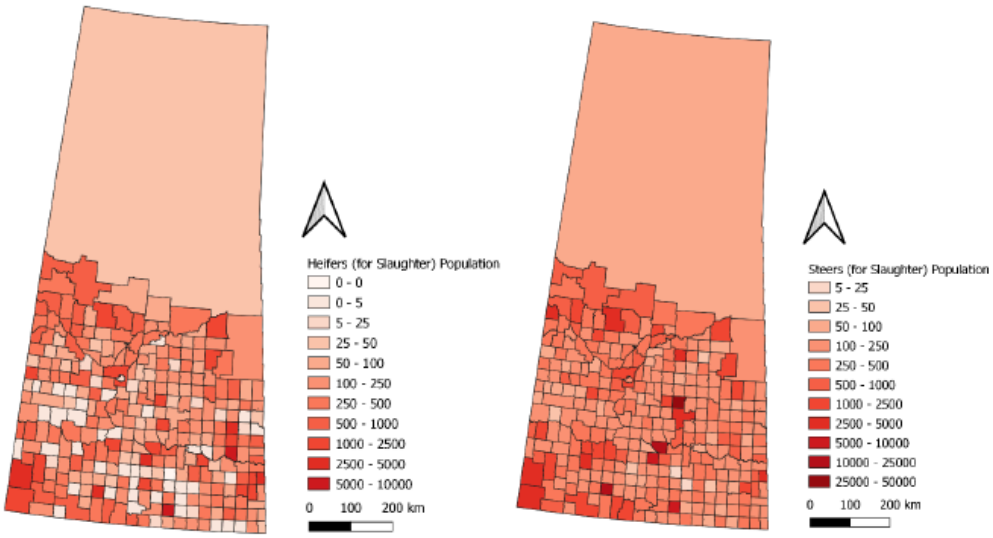

Figure S2. *Spatial distribution of (a) steer and (b) heifers for slaughter populations at the CCS level in Saskatchewan.*

Quantifying cattle feed distributions

The typology farms were developed through the aggregation of survey information provided by farms participating in the Canfax cost of production program. Each unique typology farm was created by pairing together farms with similar feeding and operational practices to create a benchmark that represented multiple feeding strategies. Diets of benchmark farms consisted of hay, cereal silage and cereal swath, supplemented with straw, barley grain, pellets and minerals (Table S1). These hypothetical farms only accounted for winter grazing feeding strategies of cows, replacement heifers and some backgrounding of feeder animals, and did not consider any additional classes of cattle. Feeding practices of the missing classes were extracted from previous studies with similar methods and objectives in Alberta (Cordeiro et al., 2022) and Canada (Legesse et al., 2015).

Table S1. *Canfax benchmark farm winter feeding practices (Canfax, 2024).*

Canfax Benchmark Farm ID	Ecoregion	Major Feedstuffs
Sk-1a	Aspen Parkland	Swath, Corn, Hay
Sk-1b	Boreal Transition	Hay
Sk-3	Mixed Grassland	Hay, Barley Pellets
Sk-4	Aspen Parkland	Bale, Corn, Greenfeed, Hay
Sk-5	Moist Mixed Grassland	Silage/Hay, Cereal Screenings
Sk-6	Aspen Parkland	Silage/Hay, Barley Grain
Sk-7	Aspen Parkland	Silage/Hay
Sk-8a	Mixed Grassland	Hay
Sk-8b	Mixed Grassland	Swath, Silage
Sk-9	Mixed Grassland	Hay, Barley Silage, Barley Straw
Sk-10	Mixed Grassland	Hay, Barley Grain
Sk-11	Moist Mixed Grassland	Barley Silage, Hay
Sk-12	Aspen Parkland	Greenfeed, Hay, Cereal Swath
Sk-13	Mixed Grassland	Greenfeed, Hay, Straw, Pellets
Mb-3a &b	Boreal Transition	Hay, Greenfeed, Barley Grain
AB-12	Moist Mixed Grassland	Barley Silage, Hay

Distribution of Feeding Practices

Feeding practices were assigned to individual CCS based on the predominant prairie ecozones and available feedstuffs in the local areas (Table S1). Canadian postal codes and GPS coordinates of Canfax benchmark survey participants were obtained from Canfax Research Services and used to spatially assign and distribute animal feeding practices to all CCS within the province based on proximity to the nearest farm coordinate (Figure S3). Once animal diets were assigned, feed demand for each CCS (Figure S4) was estimated based on animal populations for each class.

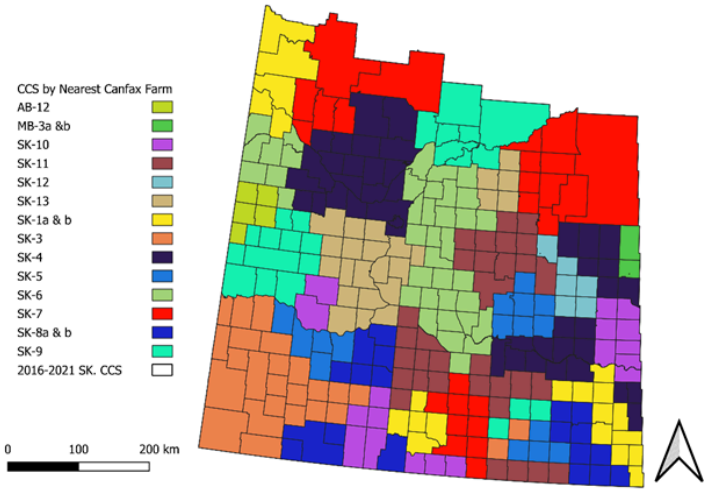

Figure S3. *Map of the agricultural region in Saskatchewan showing feeding practice assignment by census consolidated subdivision (CCS).*

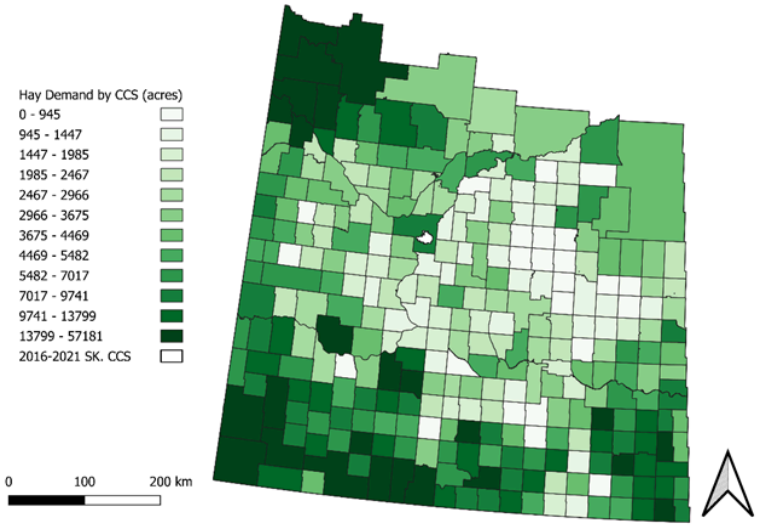

Figure S4. *Land use requirements for hay production for cows in the agricultural region of Saskatchewan. Similar maps were prepared for the other feedstuffs shown in Table S1.*

Land cover data

We collected land cover geospatial datasets (vegetation, wetlands, human footprint, ecosites, soils) available in Saskatchewan from various sources through networking, online searches, and ABMI geospatial data repository exploration (Table S2). We worked with the Government of Saskatchewan to acquire the necessary GIS products and contacted Natural Resources of Canada and Ducks Unlimited Canada to acquire layers not yet publicly available. We searched broadly online but also targeted specific organizations' websites known for providing land cover data. We then identified the most suitable layers to create reference conditions (natural landscape) and current conditions (anthropogenic disturbances or human footprint related to agricultural activities) layers based on the ABMI's internal expertise in creating a similar reference land cover layer for Alberta (ABMI, 2017b). We aligned the input layers to the extent feasible with those used by the ABMI predictive habitat models in Alberta because this would facilitate transferability of the current habitat models into Saskatchewan.

Table S2. *Geospatial layers included in the current land use mapping for Saskatchewan and subsequently used for species model projections.*

Product	Source	Citation
Reference Land Use Mapping		
Saskatchewan Wetland Inventory and Hydroperiod	Alberta Biodiversity Monitoring Institute (ABMI)	Alberta Biodiversity Monitoring Institute (ABMI). (2022). Moderate Resolution Wetland Mapping in Southern Saskatchewan. Report & dataset for Ducks Unlimited Canada (DUC).
Wetland Inventory	Ducks Unlimited Canada	Ducks Unlimited Canada. (2023). Canadian Wetland Inventory [dataset]. https://www.ducks.ca/initiatives/canadian-wetland-inventory/
Predicted Soil Texture Data	Government of Saskatchewan	Sorenson, P. T., Kiss, J., Bedard-Haughn, A. K., & Shirtliffe, S. (2022). Multi-Horizon Predictive Soil Mapping of Historical Soil Properties Using Remote Sensing Imagery. Remote Sensing, 14(22), Article 22.
Rangeland Ecosites	Government of Saskatchewan	Government of Saskatchewan. (2014). Rangeland Ecosites [SDE Feature Class]. Thorpe, J. (2014). Ecoregions and Ecosites (Publication 1; Saskatchewan Rangeland Ecosystems, p. 48). Government of Saskatchewan & Saskatchewan Prairie Conservation Action Plan. https://gisappl.saskatchewan.ca/metadata/RangelandEcosites.htm
Stream and waterbody - CanVec	Natural Resources Canada	Natural Resources Canada. (2019). Lakes, Rivers and Glaciers in Canada—CanVec Series—Hydrographic Features [dataset]. Government of Canada. https://open.canada.ca/data/en/dataset/9d96e8c9-22fe-4ad2-b5e8-94a6991b744b
Tree species probabilities – climate-based model	US Forest Service (USFS); Canadian Forest Service (CFS); University of Alberta	Worrall, J. J., Rehfeldt, G. E., Hamann, A., Hogg, E. H., Marchetti, S. B., Michaelian, M., & Gray, L. K. (2013). Recent declines of *Populus tremuloides* in North America linked to climate. Forest Ecology and Management, 299, 35–51.
Current Land Use Mapping		
Semi-Decadal Land Use Time Series	Agriculture and Agri-Food Canada	Agriculture and Agri-Food Canada. (2021). AAFC Land Use [dataset]. Government of Canada. https://open.canada.ca/data/dataset/fa84a70f-03ad-4946-b0f8-a3b481dd5248
Annual Crop Inventory	Agriculture and Agri-Food Canada	Agriculture and Agri-Food Canada. (2021). Annual Crop Inventory 2021 [dataset]. Government of Canada. https://open.canada.ca/data/en/dataset/199e4ab6-832b-4434-ac39-e4887d7cc4e5

Product	Source	Citation
Prairie Landscape Inventory (PLI) Mixed Grassland Classification	Government of Saskatchewan	Badreldin, N., Prieto, B., & Fisher, R. (2021). Mapping Grasslands in Mixed Grassland Ecoregion of Saskatchewan Using Big Remote Sensing Data and Machine Learning. Remote Sensing, 13(24), Article 24. Government of Saskatchewan. (2021). Prairie Landscape Inventory (PLI)—Mixed Grassland Classification [Raster]. https://geohub.saskatchewan.ca/maps/96741383666c4ba994a40216e7ff2460/
Prairie Landscape Inventory (PLI) Moist Mixed Grassland Classification	Government of Saskatchewan	Government of Saskatchewan. (2023). Prairie Landscape Inventory (PLI)—Moist Mixed Grassland Classification [Raster]. https://geohub.saskatchewan.ca/maps/96741383666c4ba994a40216e7ff2460

Current conditions layer

Since the PLI layers were up-to-date with an accuracy comparable to that of the ACI data, we used PLI layers for these two grassland ecoregions to create the current conditions layer for the area covered by these two ecoregions. We used ACI 2021 data to develop the current conditions layer for the rest of the study area or area outside these two regions.

Reference conditions layer

In Alberta, the ABMI has created a reference conditions layer to populate predictive habitat models developed for the parkland and grassland ecoregions (ABMI, 2017b). This continually improving layer has been developed based on the native ecosites associated with different soil types that were extracted from the Agricultural Regions of Alberta Soil Inventory Database (AGRASID) layer. We used a similar approach to create a reference conditions layer for Saskatchewan based on the existing soil information in the province. We found two relevant layers with soil information in Saskatchewan: (1) the rangeland ecosites layer, and (2) the predictive soil texture layer. Both layers had a classification system like the Grassland Vegetation Inventory (GVI) classification included in the AGRASID layer. We thoroughly compared the GVI classes derived from the AGRASID layer and the rangeland ecosite classes from the Saskatchewan layer at the border between Alberta and Saskatchewan. We found a reassuringly high consistency between both datasets. We identified three issues with the ecosite layer: (1) it didn't cover the entire study area, (2) a region was classified as "Unknown", and (3) a few classes (Urban, Gravel Pits, Mine Spoils) referred to Human Footprint (HF) and not natural ecosites. We used the predictive soil texture layer (30 m resolution) to fill these gaps. This attempt was primarily successful, with some data gaps remaining that were addressed later in the data cleaning

and merging process. We found three layers that described the water bodies in Saskatchewan: (1) The ABMI wetland inventory for the Southwest part of Saskatchewan, (2) the Ducks Unlimited Canada wetland layer for the southwest and central part of Saskatchewan and (3) the CanVec waterbody and stream layers for the entire Canada. We noted that the CanVec Waterbody layer was a less accurate representation of the water bodies than the ABMI and the DUC layers. We combined the ABMI and DUC layers and filled gaps in the study area with the CanVec water body layers. We used the CanVec stream layer to represent the stream network in the entire study area. We buffered the streams following the approach previously developed for Alberta (ABMI, 2017b), as the CanVec layer contains polylines and not polygons.

Appendix S2: Grazing Estimates

Table S3. *Grazing estimates, z- and p values for species from the deviation from expected models. In these models, we calculated the deviation between predictive models and observed field data from Saskatchewan and analyzed whether any differences could be explained by grazing pressure (cattle density and grassland usage) within generalised linear mixed models. Positive estimates indicate species are associated with grazing, whereas negative estimates represent species that are not associated with grazing. P values indicate whether estimates are significantly different from zero. SE = standard error.*

Species	Grazing Estimate ± SE	z value	p value
Agoseris glauca	2.795e-05±5.865e-06	4.77E+00	1.88E-06
Agrimonia striata	-1.803e-05±1.232e-05	-1.46E+00	1.43E-01
Aralia nudicaulis	1.777e-05±3.582e-06	4.96E+00	7.04E-07
Artemisia absinthium	-3.098e-05±4.698e-06	-6.60E+00	4.27E-11
Artemisia biennis	2.606e-05±3.673e-05	7.10E-01	4.78E-01
Artemisia campestris	3.565e-06±1.014e-05	3.52E-01	7.25E-01
Artemisia ludoviciana	-4.000e-05±3.659e-05	-1.09E+00	2.74E-01
Astragalus crassicarpus	-2.178e-05±8.882e-05	-2.45E-01	8.06E-01
Astragalus flexuosus	-3.780e-04±8.773e-04	-4.31E-01	6.67E-01
Axyris amaranthoides	-1.799e-05±1.271e-05	-1.42E+00	1.57E-01
Beckmannia syzigachne	-3.425e-05±5.171e-06	-6.62E+00	3.54E-11
Brassica napus	3.152e-06±7.036e-06	4.48E-01	6.54E-01

Species	Grazing Estimate ± SE	z value	p value
Brassica rapa	-9.367e-05±1.149e-04	-8.15E-01	4.15E-01
Bromus ciliatus	1.835e-05±3.833e-06	4.79E+00	1.69E-06
Calamagrostis montanensis	-9.325e-05±4.336e-05	-2.15E+00	3.15E-02
Carex filifolia	-9.233e-05±2.386e-05	-3.87E+00	1.09E-04
Carex obtusata	2.648e-05±5.487e-06	4.83E+00	1.39E-06
Carex pellita	-1.604e-05±8.144e-06	-1.97E+00	4.90E-02
Chenopodium album	-1.475e-05±2.546e-05	-5.79E-01	5.62E-01
Crepis tectorum	-2.184e-06±3.005e-06	-7.27E-01	4.67E-01
Distichlis spicata	-5.081e-05±1.994e-05	-2.55E+00	1.09E-02
Elaeagnus commutata	-2.093e-05±3.209e-06	-6.52E+00	6.88E-11
Elymus trachycaulus	-9.419e-06±6.186e-06	-1.52E+00	1.28E-01
Epilobium ciliatum	-3.005e-04±1.299e-04	-2.31E+00	2.07E-02
Equisetum arvense	-7.927e-06±4.358e-06	-1.82E+00	6.89E-02
Equisetum hyemale	-4.112e-04±5.364e-04	-7.67E-01	4.43E-01
Erigeron philadelphicus	-4.227e-04±6.818e-04	-6.20E-01	5.35E-01
Erysimum cheiranthoides	-2.133e-05±1.527e-05	-1.40E+00	1.62E-01
Erysimum inconspicuum	-2.540e-05±8.434e-06	-3.01E+00	2.60E-03
Escobaria vivipara	-2.878e-04±5.989e-04	-4.81E-01	6.31E-01
Fallopia convolvulus	-1.991e-06±4.353e-06	-4.57E-01	6.47E-01
Festuca saximontana	-3.478e-05±1.572e-04	-2.21E-01	8.25E-01
Geranium viscosissimum	4.174e-04±1.469e-01	2.84E-03	9.98E-01
Glyceria grandis	-3.697e-05±1.463e-04	-2.53E-01	8.01E-01
Grindelia squarrosa	-2.481e-05±4.869e-06	-5.10E+00	3.49E-07
Gutierrezia sarothrae	-2.455e-05±6.571e-06	-3.74E+00	1.87E-04

Species	Grazing Estimate ± SE	z value	p value
Hordeum jubatum	-3.108e-05±4.664e-06	-6.66E+00	2.66E-11
Hordeum vulgare	-1.098e-05±1.335e-05	-8.22E-01	4.11E-01
Hymenoxys richardsonii	-5.225e-05±1.848e-04	-2.83E-01	7.77E-01
Juncus balticus	-1.674e-05±3.276e-06	-5.11E+00	3.22E-07
Krascheninnikovia lanata	-8.902e-05±2.328e-05	-3.82E+00	1.31E-04
Lappula squarrosa	-4.085e-05±1.337e-05	-3.06E+00	2.24E-03
Lithospermum incisum	-5.524e-05±1.820e-05	-3.04E+00	2.41E-03
Lithospermum ruderale	6.383e-04±4.096e-01	1.56E-03	9.99E-01
Lygodesmia juncea	-2.721e-05±6.938e-06	-3.92E+00	8.80E-05
Lysimachia ciliata	-8.338e-06±6.467e-06	-1.29E+00	1.97E-01
Medicago lupulina	-3.494e-05±9.369e-06	-3.73E+00	1.92E-04
Melilotus albus	-2.439e-05±4.871e-06	-5.01E+00	5.50E-07
Melilotus officinalis	-2.854e-05±4.091e-06	-6.98E+00	3.02E-12
Oenothera suffrutescens	-5.245e-05±1.611e-05	-3.26E+00	1.13E-03
Orthocarpus luteus	-8.953e-06±7.615e-06	-1.18E+00	2.40E-01
Pascopyrum smithii	-3.193e-05±4.363e-06	-7.32E+00	2.53E-13
Phlox hoodii	-5.480e-05±2.172e-04	-2.52E-01	8.01E-01
Plantago patagonica	-1.852e-04±1.638e-04	-1.13E+00	2.58E-01
Polygonum aviculare	-8.620e-05±1.440e-04	-5.99E-01	5.49E-01
Potentilla bipinnatifida	-1.475e-05±7.151e-06	-2.06E+00	3.91E-02
Potentilla concinna	7.646e-05±3.501e-05	2.18E+00	2.90E-02
Puccinellia nuttalliana	-3.240e-05±1.466e-05	-2.21E+00	2.71E-02
Ranunculus macounii	-2.241e-05±1.402e-05	-1.60E+00	1.10E-01
Ratibida columnifera	-2.718e-05±6.527e-06	-4.16E+00	3.13E-05

Species	Grazing Estimate ± SE	z value	p value
Rumex triangulivalvis	2.825e-07±1.332e-05	2.12E-02	9.83E-01
Scutellaria galericulata	-1.034e-05±8.805e-06	-1.17E+00	2.40E-01
Selaginella densa	-2.498e-04±1.238e-04	-2.02E+00	4.36E-02
Solanum triflorum	-3.912e-05±2.873e-05	-1.36E+00	1.73E-01
Solidago missouriensis	-1.594e-05±4.076e-06	-3.91E+00	9.16E-05
Sphaeralcea coccinea	-4.550e-05±8.952e-05	-5.08E-01	6.11E-01
Stellaria longifolia	-2.967e-06±6.214e-06	-4.78E-01	6.33E-01
Symphoricarpos occidentalis	-2.423e-05±2.161e-06	-1.12E+01	3.49E-29
Tragopogon dubius	-2.835e-05±5.017e-06	-5.65E+00	1.59E-08
Trifolium hybridum	9.648e-07±5.271e-06	1.83E-01	8.55E-01
Trifolium pratense	-9.268e-06±1.636e-05	-5.66E-01	5.71E-01
Veronica peregrina	-4.265e-05±1.522e-04	-2.80E-01	7.79E-01
Xanthisma spinulosum	-4.708e-04±2.658e-04	-1.77E+00	7.66E-02

Appendix S3: Cattle Stocking and Forage Data for Census Consolidated Units (CCS)

Data in this Appendix was compiled by Nolan Dyck (U. of Manitoba), Dr. Marcos Cordeiro (U. of Manitoba), Dr. Gabriel Ribeiro (U. of Saskatchewan), Dr. Kim Ominski (U. of Manitoba), and Dr. Tim McAllister (Agriculture and Agri-Foods Canada). Detailed methods describing the compilation and calculations of these estimates can be found in the Year 1 and Year 2 Project Reports under Objectives a3 and a4.

Table S4. *Metadata for cattle population estimates for the beef production sector in Saskatchewan.*

Animal Category	Animal Condition	Feeding Period	Major Feedstuffs
Beef Cows	Dry (extended grazing) and early lactating	November - April	Grass-legume hay, barley silage, cereal greenfeed, cereal swath, corn grazing, barley grain, cereal byproducts
	Lactating	May - October	Tame/native pasture
Beef Replacement Heifers	-	April - October	Tame/native pasture
	-	November - March	Grass-legume hay, barley silage, cereal greenfeed, barley/oat grain, cereal byproducts
Bulls	-	April - October	Tame/native pasture
		November - March	Grass-legume hay, barley grain
Beef Calves	-	July - October	Tame/native pasture
Backgrounded Steers and Heifers	Backgrounded in confinement	November - April	Grass-legume hay, barley silage, barley grain, cereal greenfeed, cereal byproducts
	Backgrounded on pasture	May - August	Tame/native pasture
Finished Steers and Heifers	Calf-fed	November - June	Barley silage, barley/wheat grain
	Backgrounded in confinement	May - September	Barley silage, barley/wheat grain
	Backgrounded in confinement and pasture	September - December	Barley silage, barley/wheat grain

Table S5. *Metadata for land use estimates for the entire beef production sector in Saskatchewan. All units are reported in hectares for each census consolidated subdivision. Saskatoon (CCSUID 4711066) was excluded from this estimate as no crop production information was available on account of being a city. Variables can be divided into two groups: Primary feed and byproduct feed. The primary feed group is most likely to be grown and harvested locally (on farm) and requires little to no processing. Byproduct feed requires additional processing/refining and is not likely to be produced locally and may have been purchased from a feed distributor.*

CCUID	Census consolidated subdivision ID
CCSNAME	CCS name
RM	Rural Municipality Number
Grassland (ha/yr)	Grassland land use based on weighted average productivity of tame, mixed and native grasslands within CCS
Tame Hay (ha/yr)	Tame hay land use
Cereal Greenfeed (ha/yr)	Barley and/or oat greenfeed land use (estimates based on barley grain yields)
Barley Silage (ha/yr)	Barley silage land use (estimates based on barley grain yields)
Barley Grain (ha/yr)	Barley grain land use
Cereal Swath (ha/yr)	Cereal swath land use (estimates based on barley grain yields)
Corn Grazing (ha/yr)	Corn land used for grazing
Wheat Grain (ha/yr)	Wheat grain land use
Oat Grain (ha/yr)	Oat grain land use
Cereal Straw (ha/yr)	Cereal straw land use (estimate based on barley grain yields)
Barley Screening Pellets (ha/yr)	pelleted barley grain screenings with 35% barley grain component (estimate based on barley grain yields)
Cereal Screenings (ha/yr)	Cereal grain screenings with 35% cereal grain component (barley grain used for estimate)
Camelina Meal (ha/yr)	Camelina yield estimates and land use based on Canola yields
WDDGS (ha/yr)	Wheat dried distillers' grains (land use estimate based on red spring wheat yields)

Table S6. *Cattle population estimates for the beef production sector in Saskatchewan. All units are reported in hectares for each census consolidated subdivision (CCS). Detailed methods describing the compilation and calculations of these estimates can be found in the Year 1 and Year 2 Project Reports under Objectives a3 and a4.*

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4701001	Argyle No. 1	1	3268	429	169	2824	382	86	0	0
4701006	Mount Pleasant No. 2	2	6283	866	342	5903	843	653	0	0
4701011	Enniskillen No. 3	3	4179	673	219	3243	573	14	5	428
4701016	Coalfields No. 4	4	2092	402	100	1558	153	10	0	0
4701022	Estevan No. 5	5	5623	1040	353	5874	746	9	3	556
4701027	Benson No. 35	35	793	97	41	372	115	234	0	0
4701031	Browning No. 34	34	2213	397	118	2192	537	1925	0	0
4701036	Moose Creek No. 33	33	4446	790	217	3305	690	1457	0	0
4701039	Reciprocity No. 32	32	3007	331	175	2416	306	381	0	0
4701043	Storthoaks No. 31	31	2467	523	190	2196	267	208	0	0
4701047	Antler No. 61	61	4365	650	211	3640	499	285	0	0
4701053	Moose Mountain No. 63	63	4727	679	280	4193	919	961	0	0
4701058	Brock No. 64	64	5352	1111	375	4590	537	452	0	0
4701063	Tecumseh No. 65	65	2230	277	157	1580	267	993	0	0
4701069	Golden West No. 95	95	3701	585	192	2656	420	1429	0	0
4701072	Hazelwood No. 94	94	4421	699	234	3723	153	173	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4701076	Wawken No. 93	93	5763	850	281	4489	2544	5275	2009	1897
4701091	Walpole No. 92	92	6290	936	311	4821	1327	3532	1346	990
4701094	Maryfield No. 91	91	3499	345	147	2876	229	293	111	171
4702001	Cambria No. 6	6	1667	204	64	1419	153	388	0	0
4702006	Souris Valley No. 7	7	2079	254	103	1859	306	346	0	0
4702011	Lake Alma No. 8	8	6663	1163	359	5800	690	464	0	0
4702014	Surprise Valley No. 9	9	7154	1137	386	5591	382	307	0	0
4702018	Happy Valley No. 10	10	4719	787	261	4143	344	32	0	0
4702024	Bengough No. 40	40	7132	1453	365	9641	766	753	0	0
4702026	The Gap No. 39	39	2793	562	376	3204	9840	23720	9035	7337
4702029	Laurier No. 38	38	4108	394	197	2937	191	10	0	0
4702033	Lomond No. 37	37	3587	502	173	2652	345	36	14	257
4702037	Cymri No. 36	36	6297	1188	377	5008	461	897	0	0
4702042	Griffin No. 66	66	2041	322	119	2009	306	570	0	0
4702044	Weyburn No. 67	67	4961	716	232	4082	1034	618	0	0
4702051	Brokenshell No. 68	68	4109	614	199	3050	344	10	0	0
4702052	Norton No. 69	69	3778	697	183	3083	652	833	0	0
4702057	Key West No. 70	70	3324	442	215	3042	344	10	0	0
4702061	Elmsthorpe No. 100	100	3787	737	141	3300	614	1028	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4702066	Caledonia No. 99	99	2132	342	178	1899	314	9	3	235
4702069	Scott No. 98	98	998	122	24	496	38	10	0	0
4702073	Wellington No. 97	97	3074	544	109	2218	575	6	0	0
4702076	Fillmore No. 96	96	1195	146	48	1075	76	554	0	0
4703001	Hart Butte No. 11	11	3479	544	151	2963	229	906	0	0
4703006	Poplar Valley No. 12	12	6014	583	258	4895	652	2165	0	0
4703011	Old Post No. 43	43	14818	2716	880	11255	3268	1127	429	2437
4703016	Glen McPherson No. 46	46	3450	571	149	3596	306	199	0	0
4703018	Mankota No. 45	45	11287	2103	568	8604	1072	1022	0	0
4703022	Waverley No. 44	44	11560	2228	669	8764	3203	2383	0	0
4703026	Willow Bunch No. 42	42	3158	645	142	2593	728	10	0	0
4703029	Excel No. 71	71	3694	470	198	3393	575	692	0	0
4703034	Lake of the Rivers No. 72	72	2677	327	129	2280	229	10	0	0
4703038	Stonehenge No. 73	73	1789	219	105	1442	258	339	129	192
4703042	Wood River No. 74	74	3059	354	131	2561	382	10	0	0
4703048	Pinto Creek No. 75	75	5685	1556	345	5833	17434	9660	3680	12999
4703054	Auvergne No. 76	76	6651	1385	340	6254	690	314	0	0
4703059	Whiska Creek No. 106	106	2775	447	152	2535	402	246	94	300
4703064	Glen Bain No. 105	105	2107	257	115	1627	258	156	59	192

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4703068	Gravelbourg No. 104	104	2292	280	114	2087	344	119	0	0
4703074	Sutton No. 103	103	1083	132	67	1142	191	874	0	0
4703093	Lake Johnston No. 102	102	1784	218	94	1388	191	10	0	0
4703096	Terrell No. 101	101	8314	1233	389	7567	344	7322	0	0
4704003	Val Marie No. 17	17	11549	1758	530	10909	2856	1952	744	2129
4704006	Lone Tree No. 18	18	1563	326	84	1516	229	10	0	0
4704011	Frontier No. 19	19	5430	990	264	4275	2196	343	0	0
4704019	Reno No. 51	51	12923	1827	638	8696	6630	4904	0	0
4704024	White Valley No. 49	49	12258	1941	563	10789	631	2636	1004	471
4704028	Wise Creek No. 77	77	3056	505	196	2522	344	10	0	0
4704034	Grassy Creek No. 78	78	5070	658	204	4157	652	1512	0	0
4704038	Arlington No. 79	79	4304	1005	259	2666	286	823	314	213
4704045	Maple Creek No. 111	111	30160	5320	1656	25637	7095	8802	3353	5290
4704050	Piapot No. 110	110	11859	2646	739	9454	2418	4343	0	0
4704054	Carmichael No. 109	109	4749	465	243	4052	766	769	0	0
4704058	Bone Creek No. 108	108	2700	589	145	2592	344	852	0	0
4704061	Lac Pelletier No. 107	107	3815	817	174	3372	461	307	0	0
4705001	Moosomin No. 121	121	3979	791	235	3523	6139	9653	3677	4577
4705007	Martin No. 122	122	4639	1070	202	12337	1497	5239	1996	1117

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4705011	Silverwood No. 123	123	5991	1552	386	4368	345	1381	526	257
4705014	Kingsley No. 124	124	3083	511	145	2312	461	10	0	0
4705018	Chester No. 125	125	6373	1401	259	4695	345	189	72	257
4705027	Wolseley No. 155	155	3195	446	164	2738	382	99	0	0
4705028	Elcapo No. 154	154	3144	532	182	2926	499	365	0	0
4705033	Willowdale No. 153	153	2344	286	115	1406	229	561	0	0
4705037	Rocanville No. 151	151	4917	700	259	3435	420	1111	0	0
4705041	Spy Hill No. 152	152	4238	635	221	4261	1910	1774	0	0
4705047	Langenburg No. 181	181	1950	303	160	1564	344	612	0	0
4705051	Fertile Belt No. 183	183	1917	269	136	1354	420	356	0	0
4705057	Grayson No. 184	184	4350	644	197	2409	1542	19484	0	0
4705063	McLeod No. 185	185	3415	563	177	2808	314	325	124	235
4705067	Stanley No. 215	215	2175	425	132	1339	1101	1334	508	821
4705073	Cana No. 214	214	4653	703	251	3543	1094	6598	2513	816
4705077	Saltcoats No. 213	213	3010	448	118	2263	191	1124	0	0
4705093	Churchbridge No. 211	211	3208	510	151	2369	545	1703	649	407
4706001	Montmartre No. 126	126	5563	621	422	3993	652	1035	0	0
4706004	Francis No. 127	127	4264	571	238	4076	575	2479	0	0
4706011	Lajord No. 128	128	710	87	27	437	306	221	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4706013	Bratt's Lake No. 129	129	3	0	0	124	38	0	0	0
4706016	Redburn No. 130	130	1341	164	40	1263	306	144	0	0
4706021	Pense No. 160	160	2658	575	186	2672	1224	1045	398	912
4706026	Sherwood No. 159	159	2078	254	59	1075	258	295	112	192
4706029	Edenwold No. 158	158	2809	569	207	2272	919	625	0	0
4706034	South Qu'Appelle No. 157	157	2906	442	149	2331	1034	282	0	0
4706038	Indian Head No. 156	156	1530	198	72	1187	430	2794	1064	321
4706042	Abernethy No. 186	186	3403	443	186	2401	306	10	0	0
4706048	North Qu'Appelle No. 187	187	1387	220	63	905	153	10	0	0
4706053	Lumsden No. 189	189	4420	1357	333	3411	573	1993	759	428
4706059	Dufferin No. 190	190	4664	760	230	3811	49832	3888	0	0
4706063	Sarnia No. 221	221	2264	379	103	1926	382	211	0	0
4706070	Longlaketon No. 219	219	3838	739	346	3618	1148	519	0	0
4706071	McKillop No. 220	220	2127	383	234	1655	344	279	0	0
4706091	Cupar No. 218	218	3733	612	259	2552	728	599	0	0
4706096	Lipton No. 217	217	3493	519	148	2688	575	202	0	0
4706099	Tullymet No. 216	216	1432	229	72	786	191	266	0	0
4707001	Baildon No. 131	131	2819	507	179	2672	267	29	0	0
4707004	Hillsborough No. 132	132	2967	445	146	2377	382	10	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4707006	Rodgers No. 133	133	2430	297	126	2547	76	10	0	0
4707011	Shamrock No. 134	134	2796	438	101	2555	382	279	0	0
4707014	Lawtonia No. 135	135	5022	682	222	4795	575	10	0	0
4707018	Coulee No. 136	136	4911	746	319	4481	575	461	0	0
4707021	Excelsior No. 166	166	8686	1486	493	7204	1863	2669	1017	1389
4707024	Morse No. 165	165	8668	1417	568	6784	1697	773	295	1265
4707029	Chaplin No. 164	164	6424	1111	299	5746	1762	1281	0	0
4707032	Wheatlands No. 163	163	5416	579	259	4169	499	86	0	0
4707036	Caron No. 162	162	3402	503	179	2811	267	141	0	0
4707038	Moose Jaw No. 161	161	4665	1217	632	3750	15639	9278	3534	11660
4707042	Marquis No. 191	191	1293	158	44	455	115	180	69	85
4707047	Eyebrow No. 193	193	1993	244	95	1481	344	583	0	0
4707053	Enfield No. 194	194	4627	896	252	5107	537	4667	0	0
4707058	Canaan No. 225	225	2671	326	94	2248	306	10	0	0
4707063	Victory No. 226	226	6349	1220	286	5368	881	561	0	0
4707066	King George No. 256	256	3914	548	140	2686	306	810	0	0
4707067	Coteau No. 255	255	2410	295	89	2160	344	538	0	0
4707071	Maple Bush No. 224	224	2678	551	149	2257	229	9	3	171
4707076	Huron No. 223	223	2979	554	146	2339	258	216	82	192

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4707091	Craik No. 222	222	2605	446	155	1739	306	263	0	0
4708001	Swift Current No. 137	137	9893	1301	548	8127	4666	1914	729	3479
4708006	Webb No. 138	138	4927	735	319	4346	728	573	0	0
4708009	Gull Lake No. 139	139	4431	673	250	3993	382	22	0	0
4708016	Big Stick No. 141	141	3826	494	182	3400	1791	2216	0	0
4708021	Enterprise No. 142	142	2286	257	107	1754	267	10	0	0
4708024	Fox Valley No. 171	171	4712	572	239	3935	344	448	0	0
4708028	Pittville No. 169	169	3520	430	153	2745	374	9	3	279
4708031	Riverside No. 168	168	4011	765	206	3588	603	552	210	449
4708038	Saskatchewan Landing No. 167	167	1357	410	106	1062	1752	9	3	1306
4708042	Lacadena No. 228	228	7501	1016	324	6116	843	1176	0	0
4708046	Miry Creek No. 229	229	5649	3179	287	3989	306	1230	0	0
4708053	Clinworth No. 230	230	4615	626	210	3100	267	375	0	0
4708056	Happyland No. 231	231	4100	359	203	3238	2160	2255	859	1610
4708061	Deer Forks No. 232	232	3187	512	155	2248	1600	2307	879	1193
4708065	Chesterfield No. 261	261	4904	682	286	2710	258	429	164	192
4708071	Newcombe No. 260	260	922	173	63	862	76	10	0	0
4708074	Snipe Lake No. 259	259	1429	282	71	1207	229	9	3	171
4708092	Monet No. 257	257	2174	266	101	2082	267	10	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4709001	Calder No. 241	241	2873	510	146	2322	306	10	0	0
4709006	Wallace No. 243	243	2003	298	116	1894	314	57	22	235
4709011	Orkney No. 244	244	6737	991	361	4910	746	8296	3160	556
4709019	Garry No. 245	245	3263	395	166	5699	460	825	315	343
4709023	Insinger No. 275	275	4568	707	166	3755	420	19	0	0
4709029	Good Lake No. 274	274	2698	233	106	2099	382	663	0	0
4709033	Sliding Hills No. 273	273	1362	233	321	579	760	10	0	0
4709037	Cote No. 271	271	2981	354	163	2031	267	112	0	0
4709042	St. Philips No. 301	301	1461	190	73	1212	267	480	0	0
4709046	Keys No. 303	303	2584	335	93	2226	267	1403	0	0
4709049	Buchanan No. 304	304	931	115	32	743	115	183	0	0
4709054	Invermay No. 305	305	2422	381	113	2224	420	340	0	0
4709060	Hazel Dell No. 335	335	3402	507	251	2792	843	1003	0	0
4709062	Preeceville No. 334	334	4411	853	235	3457	2962	2114	0	0
4709067	Clayton No. 333	333	4415	630	247	3637	652	291	0	0
4709075	Livingston No. 331	331	1325	236	53	1034	267	551	0	0
4710003	Ituna Bon Accord No. 246	246	2972	245	104	2477	345	410	156	257
4710008	Kellross No. 247	247	4970	1103	253	3480	499	496	0	0
4710014	Touchwood No. 248	248	4262	669	206	3221	382	1095	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4710024	Mount Hope No. 279	279	3582	1795	215	3360	5160	189	72	3847
4710031	Emerald No. 277	277	1671	213	101	1150	420	445	0	0
4710036	Foam Lake No. 276	276	4603	706	233	4863	843	586	0	0
4710041	Elfros No. 307	307	1337	229	69	1110	267	61	0	0
4710046	Big Quill No. 308	308	1485	191	78	1103	344	580	0	0
4710052	Prairie Rose No. 309	309	1908	220	74	1206	44233	91	34	32980
4710056	Leroy No. 339	339	819	100	32	801	344	173	0	0
4710061	Lakeside No. 338	338	1367	254	50	1209	382	192	0	0
4710066	Lakeview No. 337	337	699	85	51	710	229	676	0	0
4710071	Sasman No. 336	336	3348	631	196	2952	382	2242	0	0
4711003	Last Mountain Valley No. 250	250	1591	194	59	1222	382	3222	0	0
4711006	Big Arm No. 251	251	1625	302	100	1180	382	266	0	0
4711011	Arm River No. 252	252	2463	321	90	1990	575	154	0	0
4711016	Willner No. 253	253	1574	225	71	1274	306	372	0	0
4711018	Loreburn No. 254	254	2242	294	348	2231	200	434	166	149
4711026	Rudy No. 284	284	3567	724	223	2689	746	959	366	556
4711031	Rosedale No. 283	283	3219	548	170	2972	652	1589	0	0
4711034	McCraney No. 282	282	4126	521	192	3196	420	266	0	0
4711039	Wood Creek No. 281	281	1934	406	149	1680	306	10	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4711042	Wreford No. 280	280	2856	349	130	2371	499	224	0	0
4711046	Usborne No. 310	310	7565	1564	351	5623	3149	3888	0	0
4711052	Morris No. 312	312	2904	439	135	2563	537	993	0	0
4711059	Lost River No. 313	313	1983	488	72	1683	143	123	47	107
4711061	Dundurn No. 314	314	2847	495	171	2345	537	195	0	0
4711065	Corman Park No. 344	344	6939	1292	456	4863	3104	7761	0	0
4711066	Saskatoon	NA	1623	198	35	1272	267	42	0	0
4711069	Blucher No. 343	343	1996	535	214	1576	488	60	23	364
4711076	Colonsay No. 342	342	1170	217	55	985	267	215	0	0
4711091	Viscount No. 341	341	3265	738	186	2453	402	465	177	300
4711096	Wolverine No. 340	340	1647	272	175	1520	382	500	0	0
4712001	Pleasant Valley No. 288	288	2422	283	169	1954	420	125	0	0
4712004	St. Andrews No. 287	287	2339	541	64	2053	200	9	3	149
4712011	Milden No. 286	286	1582	193	40	1399	153	215	0	0
4712020	Fertile Valley No. 285	285	3086	416	202	2902	420	852	0	0
4712026	Montrose No. 315	315	4732	697	214	3682	690	10	0	0
4712029	Harris No. 316	316	2586	267	132	2500	614	2040	0	0
4712034	Marriott No. 317	317	2498	460	102	1802	2991	234	0	0
4712038	Mountain View No. 318	318	1565	191	116	967	115	16	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4712042	Biggar No. 347	347	6210	1159	375	5152	803	2103	801	599
4712050	Perdue No. 346	346	1873	229	90	1795	344	61	0	0
4712054	Vanscoy No. 345	345	4692	668	257	3968	1263	1204	0	0
4712064	Eagle Creek No. 376	376	2554	277	152	2690	430	382	146	321
4712069	Glenside No. 377	377	1648	431	88	1325	153	64	0	0
4712072	Rosemount No. 378	378	1980	421	156	1775	420	496	0	0
4712078	Battle River No. 438	438	3125	502	245	2957	652	1685	0	0
4713006	Kindersley No. 290	290	2699	534	135	2541	461	208	0	0
4713011	Milton No. 292	292	2596	462	125	1990	115	666	0	0
4713016	Antelope Park No. 322	322	1742	329	188	1874	306	86	0	0
4713019	Prairiedale No. 321	321	1430	175	70	1395	153	13	0	0
4713024	Oakdale No. 320	320	228	28	11	284	115	227	0	0
4713028	Winslow No. 319	319	858	105	32	538	153	10	0	0
4713032	Grandview No. 349	349	1478	318	97	1257	955	983	0	0
4713038	Mariposa No. 350	350	1749	417	134	1555	1665	1095	0	0
4713041	Progress No. 351	351	2777	389	139	2554	344	471	0	0
4713046	Heart's Hill No. 352	352	3217	366	149	2669	200	2841	1082	149
4713049	Eye Hill No. 382	382	3598	503	193	2756	517	79	30	385
4713056	Grass Lake No. 381	381	2027	248	120	1870	537	468	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4713059	Tramping Lake No. 380	380	359	44	24	446	153	388	0	0
4713064	Reford No. 379	379	1110	203	63	1010	229	135	0	0
4713068	Buffalo No. 409	409	2425	406	219	2344	420	167	0	0
4713072	Round Valley No. 410	410	3166	480	154	2677	652	160	0	0
4713076	Senlac No. 411	411	5082	722	313	4489	191	996	0	0
4713079	Manitou Lake No. 442	442	4210	631	225	3402	957	1941	0	0
4713092	Hillsdale No. 440	440	5669	872	367	4568	803	913	348	599
4713096	Cut Knife No. 439	439	2451	441	202	1847	344	93	0	0
4714001	Hudson Bay No. 394	394	2887	371	145	3323	499	727	0	0
4714006	Porcupine No. 395	395	2470	294	109	7351	2911	809	308	2171
4714021	Kelvington No. 366	366	2138	325	96	1617	420	657	0	0
4714023	Ponass Lake No. 367	367	1736	295	111	1505	420	743	0	0
4714026	Spalding No. 368	368	862	105	37	758	461	570	0	0
4714034	Barrier Valley No. 397	397	3274	575	229	2706	652	243	0	0
4714035	Pleasantdale No. 398	398	2408	381	125	1973	115	1121	427	85
4714038	Bjorkdale No. 426	426	3589	556	151	2541	345	6376	2429	257
4714043	Tisdale No. 427	427	848	104	37	1012	76	420	0	0
4714047	Star City No. 428	428	2578	365	155	1702	614	493	0	0
4714053	Willow Creek No. 458	458	973	163	46	649	267	250	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4714056	Connaught No. 457	457	927	113	39	770	420	493	0	0
4714059	Arborfield No. 456	456	391	48	21	445	191	324	0	0
4714067	Moose Range No. 486	486	4527	672	273	3459	4048	5218	0	0
4714072	Nipawin No. 487	487	1054	129	103	869	229	298	0	0
4714077	Torch River No. 488	488	2649	572	161	2639	614	817	0	0
4715001	St. Peter No. 369	369	397	49	35	775	191	637	0	0
4715007	Humboldt No. 370	370	1532	187	83	1365	461	692	0	0
4715011	Bayne No. 371	371	2539	327	123	2028	344	157	0	0
4715014	Grant No. 372	372	1501	183	45	1079	229	90	0	0
4715018	Aberdeen No. 373	373	1038	127	62	920	575	660	0	0
4715026	Laird No. 404	404	1849	226	91	1352	1034	362	0	0
4715031	Rosthern No. 403	403	3797	773	296	2510	1533	922	0	0
4715036	Fish Creek No. 402	402	1372	267	79	1025	191	391	0	0
4715039	Hoodoo No. 401	401	990	121	43	1034	267	320	0	0
4715044	Three Lakes No. 400	400	2039	283	111	1635	575	1432	0	0
4715048	Lake Lenore No. 399	399	1604	312	72	1497	382	19	0	0
4715051	Flett's Springs No. 429	429	1697	232	71	1448	5059	911	347	3772
4715054	Invergordon No. 430	430	1436	175	61	1364	614	625	0	0
4715057	St. Louis No. 431	431	770	94	21	538	115	243	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4715061	Duck Lake No. 463	463	4744	663	288	4092	460	771	294	343
4715064	Prince Albert No. 461	461	4248	680	206	3666	1187	926	0	0
4715067	Birch Hills No. 460	460	1079	227	54	1018	306	6	0	0
4715071	Kinistino No. 459	459	2399	663	118	2064	728	516	0	0
4715079	Garden River No. 490	490	1172	255	71	1013	306	400	0	0
4715094	Buckland No. 491	491	2242	415	115	1532	4594	602	0	0
4715099	Paddockwood No. 520	520	2007	473	87	1179	575	243	0	0
4716005	Mayfield No. 406	406	2180	457	159	2116	575	644	0	0
4716008	Great Bend No. 405	405	4093	1158	227	3254	728	368	0	0
4716013	Blaine Lake No. 434	434	2250	386	126	2305	460	410	156	343
4716018	Redberry No. 435	435	3536	460	149	2744	537	263	0	0
4716023	Douglas No. 436	436	2375	516	128	2027	267	125	0	0
4716028	North Battleford No. 437	437	2224	272	104	1882	652	1166	0	0
4716033	Round Hill No. 467	467	3300	471	140	2549	3504	746	0	0
4716038	Meeting Lake No. 466	466	4070	580	217	3547	652	167	0	0
4716041	Leask No. 464	464	3898	523	198	3808	499	830	0	0
4716046	Shellbrook No. 493	493	2395	579	132	1741	537	1954	0	0
4716051	Canwood No. 494	494	7938	1319	400	5756	1176	1782	679	877
4716056	Spiritwood No. 496	496	13173	2084	725	10793	7970	5836	0	0

CCSUID	CCSNAME	RM	Beef Cows	Bred Replace-ment Heifers	Bulls	Beef Calves	Back-grounded Steers	Back-grounded Heifers	Finished Heifers	Finished Steers
4716062	Medstead No. 497	497	3724	726	220	3080	575	279	0	0
4716075	Big River No. 555	555	2473	432	351	2132	1533	221	0	0
4717001	Meota No. 468	468	2343	281	128	2095	499	2386	0	0
4717008	Turtle River No. 469	469	6104	1050	324	5864	1434	2530	0	0
4717013	Paynton No. 470	470	2108	450	99	1792	306	596	0	0
4717017	Eldon No. 471	471	6748	1112	377	5993	957	1451	0	0
4717022	Wilton No. 472	472	4225	644	234	4327	843	804	0	0
4717028	Britannia No. 502	502	10397	2092	529	9258	6717	1627	620	5008
4717032	Frenchman Butte No. 501	501	19477	3021	1080	15665	1724	3017	0	0
4717045	Mervin No. 499	499	8484	1435	583	8630	3434	1403	0	0
4717047	Parkdale No. 498	498	5813	894	233	4812	774	1941	739	577
4717054	Meadow Lake No. 588	588	15763	2594	868	12292	2223	2985	0	0
4717056	Loon Lake No. 561	561	11177	1985	701	9398	881	1557	0	0
4717062	Beaver River No. 622	622	13282	1959	809	11627	1304	1983	0	0

Table S7. *Forage land use estimates for the beef production sector in Saskatchewan. All units are reported in hectares per year for each census consolidated subdivision (CCS). Detailed methods describing the compilation and calculations of these estimates can be found in the Year 1 and Year 2 Project Reports under Objectives a3 and a4.*

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4701001	Argyle No. 1	1	30085	2341	0	36	0	138	0	0	0	180	0	849	0	0
4701006	Mount Pleasant No. 2	2	67204	4043	2200	153	21	505	0	111	0	0	0	530	0	0
4701011	Enniskillen No. 3	3	37828	2723	1334	55	13	358	0	67	0	0	0	321	62	0
4701016	Coalfields No. 4	4	18611	1353	835	14	4	90	0	42	0	0	0	201	0	0
4701022	Estevan No. 5	5	35260	2148	810	1596	48	478	0	0	0	0	0	0	96	0
4701027	Benson No. 35	35	6183	253	0	147	0	139	100	36	194	0	0	0	0	0
4701031	Browning No. 34	34	28329	1588	745	298	13	880	0	37	0	0	0	180	0	0
4701036	Moose Creek No. 33	33	51610	2987	1400	229	15	715	0	70	0	0	0	337	0	0
4701039	Reciprocity No. 32	32	25308	2154	0	72	0	242	0	0	0	165	0	811	0	0
4701043	Storthoaks No. 31	31	25173	1890	0	44	0	179	0	0	0	136	0	642	0	0
4701047	Antler No. 61	61	42139	3139	0	69	0	250	0	0	0	240	0	1129	0	0
4701053	Moose Mountain No. 63	63	45435	3532	0	166	0	518	0	0	0	260	0	1107	0	0
4701058	Brock No. 64	64	52306	3674	1663	91	12	374	0	84	0	0	0	401	0	0
4701063	Tecumseh No. 65	65	22160	1468	882	180	7	557	0	44	0	0	0	212	0	0
4701069	Golden West No. 95	95	35324	2424	1181	211	10	665	0	59	0	0	0	285	0	0
4701072	Hazelwood No. 94	94	42255	2759	1435	33	4	185	0	72	0	0	0	346	0	0
4701076	Wawken No. 93	93	68615	4644	0	951	0	4065	0	0	0	317	0	1459	474	0
4701091	Walpole No. 92	92	64235	4738	0	559	0	2398	0	0	0	346	0	1475	273	0
4701094	Maryfield No. 91	91	42317	2101	465	77	0	291	0	0	0	340	0	0	35	46

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4702001	Cambria No. 6	6	8727	587	263	532	10	212	0	0	0	0	0	0	0	0
4702006	Souris Valley No. 7	7	18352	900	329	664	13	235	0	0	0	0	0	0	0	0
4702011	Lake Alma No. 8	8	92650	2958	1388	2724	77	545	0	0	0	0	0	0	0	0
4702014	Surprise Valley No. 9	9	87574	7780	0	1773	0	507	0	0	0	0	74	0	0	0
4702018	Happy Valley No. 10	10	67863	5261	0	96	0	1143	0	0	0	0	0	0	0	0
4702024	Bengough No. 40	40	98010	7984	0	2202	0	1005	0	0	0	0	161	0	0	0
4702026	The Gap No. 39	39	106970	5032	0	6391	0	20667	0	0	0	0	1586	0	2946	0
4702029	Laurier No. 38	38	27278	4701	0	40	151	97	0	0	0	0	0	0	0	0
4702033	Lomond No. 37	37	14522	1101	0	584	0	325	536	197	1011	0	0	0	53	0
4702037	Cymri No. 36	36	28821	2062	0	1040	0	612	859	320	1595	0	0	0	0	0
4702042	Griffin No. 66	66	16021	672	0	379	0	346	258	95	512	0	0	0	0	0
4702044	Weyburn No. 67	67	23308	4902	0	261	158	544	0	0	0	0	0	0	0	0
4702051	Brokenshell No. 68	68	17390	3224	0	66	0	1219	924	0	0	0	0	0	0	0
4702052	Norton No. 69	69	26363	3530	0	1486	0	962	0	0	0	0	131	0	0	0
4702057	Key West No. 70	70	40214	3610	0	898	0	203	0	0	0	0	60	0	0	0
4702061	Elmsthorpe No. 100	100	32307	3520	0	1104	0	788	0	0	0	0	99	0	0	0
4702066	Caledonia No. 99	99	10069	2020	0	581	0	333	0	0	0	0	59	0	52	0
4702069	Scott No. 98	98	4618	329	144	253	6	15	0	0	0	0	0	0	0	0
4702073	Wellington No. 97	97	17098	2422	0	106	0	968	682	0	0	0	0	0	0	0
4702076	Fillmore No. 96	96	11018	929	0	96	0	546	232	0	0	0	0	0	0	0
4703001	Hart Butte No. 11	11	50799	3842	0	198	0	1041	0	0	0	0	0	0	0	0
4703006	Poplar Valley No. 12	12	87026	6475	0	500	0	2172	0	0	0	0	0	0	0	0
4703011	Old Post No. 43	43	199084	12278	8030	779	126	4150	0	404	0	0	0	1934	603	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4703016	Glen McPherson No. 46	46	45018	3224	1758	73	11	290	0	88	0	0	0	423	0	0
4703018	Mankota No. 45	45	152640	15695	0	446	0	3014	0	0	0	0	0	0	0	0
4703022	Waverley No. 44	44	168286	13268	0	1323	0	5041	0	0	0	0	0	0	0	0
4703026	Willow Bunch No. 42	42	35772	2832	0	66	0	226	0	0	0	174	0	1105	0	0
4703029	Excel No. 71	71	41836	3210	0	167	0	527	0	0	0	203	0	1265	0	0
4703034	Lake of the Rivers No. 72	72	28481	2245	0	21	0	97	0	0	0	147	0	893	0	0
4703038	Stonehenge No. 73	73	19952	1558	0	102	0	481	0	0	0	98	0	663	52	0
4703042	Wood River No. 74	74	42713	3287	0	89	0	674	0	0	0	0	0	0	0	0
4703048	Pinto Creek No. 75	75	146301	9611	0	6625	0	23824	0	0	0	0	0	0	3146	0
4703054	Auvergne No. 76	76	83997	9934	0	202	289	443	0	0	0	0	0	0	0	0
4703059	Whiska Creek No. 106	106	34601	4091	0	136	104	496	0	0	0	0	0	0	73	0
4703064	Glen Bain No. 105	105	25054	3052	0	93	81	342	0	0	0	0	0	0	47	0
4703068	Gravelbourg No. 104	104	32888	3088	0	103	0	595	0	0	0	0	0	0	0	0
4703074	Sutton No. 103	103	16941	632	196	518	8	495	0	0	0	0	0	0	0	0
4703093	Lake Johnston No. 102	102	18928	1873	0	15	0	65	0	0	0	98	0	516	0	0
4703096	Terrell No. 101	101	116702	11338	0	3665	0	4884	0	0	0	0	65	0	0	0
4704003	Val Marie No. 17	17	119028	11505	4844	706	85	3370	0	243	0	0	0	1167	545	0
4704006	Lone Tree No. 18	18	15145	1570	757	25	8	106	0	38	0	0	0	182	0	0
4704011	Frontier No. 19	19	48361	8094	0	592	261	1001	0	0	0	0	0	0	0	0
4704019	Reno No. 51	51	117531	19214	0	2491	565	5162	0	0	0	0	0	0	0	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4704024	White Valley No. 49	49	153196	17907	0	651	468	2517	0	0	0	0	0	0	242	0
4704028	Wise Creek No. 77	77	37296	4538	0	78	134	154	0	0	0	0	0	0	0	0
4704034	Grassy Creek No. 78	78	62346	7317	0	372	179	946	0	0	0	0	0	0	0	0
4704038	Arlington No. 79	79	51243	6571	0	221	176	858	0	0	0	0	0	0	93	0
4704045	Maple Creek No. 111	111	320404	45171	0	3086	1095	11237	0	0	0	0	0	0	1521	0
4704050	Piapot No. 110	110	139941	18245	0	1276	505	3147	0	0	0	0	0	0	0	0
4704054	Carmichael No. 109	109	48678	6815	0	236	141	540	0	0	0	0	0	0	0	0
4704058	Bone Creek No. 108	108	36049	4095	0	193	98	501	0	0	0	0	0	0	0	0
4704061	Lac Pelletier No. 107	107	48203	5691	0	118	128	261	0	0	0	0	0	0	0	0
4705001	Moosomin No. 121	121	71145	3043	559	2217	0	7970	0	0	0	386	0	0	958	100
4705007	Martin No. 122	122	71413	3130	753	1033	0	3837	0	0	0	451	0	0	385	149
4705011	Silverwood No. 123	123	60794	4572	0	239	0	1137	0	0	0	330	0	1645	102	0
4705014	Kingsley No. 124	124	30048	2243	0	35	0	135	0	0	0	170	0	883	0	0
4705018	Chester No. 125	125	60791	4595	0	57	0	396	0	0	0	351	0	1622	44	0
4705027	Wolseley No. 155	155	41453	1980	426	62	0	126	0	0	0	310	0	0	0	58
4705028	Elcapo No. 154	154	39676	2003	467	118	0	263	0	0	0	305	0	0	0	74
4705033	Willowdale No. 153	153	21050	1673	0	93	0	298	0	0	0	129	0	650	0	0
4705037	Rocanville No. 151	151	51526	4566	0	218	0	1146	0	0	0	0	0	0	0	0
4705041	Spy Hill No. 152	152	48902	4228	0	520	0	1598	0	0	0	0	0	0	0	0
4705047	Langenburg No. 181	181	25862	1984	0	118	0	492	0	0	0	0	0	0	0	0
4705051	Fertile Belt No. 183	183	25285	1910	0	109	0	458	0	0	0	0	0	0	0	0
4705057	Grayson No. 184	184	93387	3474	732	3166	0	8944	0	0	0	422	0	0	0	100
4705063	McLeod No. 185	185	41587	2249	526	103	0	390	0	0	0	332	0	0	48	74

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4705067	Stanley No. 215	215	32213	1538	350	397	0	1427	0	0	0	211	0	0	194	54
4705073	Cana No. 214	214	65882	3281	743	1226	0	4619	0	0	0	452	0	0	460	99
4705077	Saltcoats No. 213	213	37830	2914	0	180	0	838	0	0	0	0	0	0	0	0
4705093	Churchbridge No. 211	211	43007	3176	0	307	0	1466	0	0	0	0	0	0	125	0
4706001	Montmartre No. 126	126	63837	2150	828	1645	29	623	0	0	0	0	0	0	0	0
4706004	Francis No. 127	127	48566	1636	614	1479	26	1130	0	0	0	0	0	0	0	0
4706011	Lajord No. 128	128	5897	260	91	223	4	138	0	0	0	0	0	0	0	0
4706013	Bratt's Lake No. 129	129	144	2	0	7	0	9	0	0	0	0	0	0	0	0
4706016	Redburn No. 130	130	6345	1184	0	308	0	138	0	0	0	0	37	0	0	0
4706021	Pense No. 160	160	16058	1697	0	980	0	1342	0	0	0	0	0	0	169	0
4706026	Sherwood No. 159	159	13068	708	312	625	12	334	0	0	0	0	0	0	41	0
4706029	Edenwold No. 158	158	34156	1882	446	220	0	466	0	0	0	273	0	0	0	84
4706034	South Qu'Appelle No. 157	157	39858	1839	435	188	0	341	0	0	0	282	0	0	0	70
4706038	Indian Head No. 156	156	25289	1031	234	500	0	1884	0	0	0	149	0	0	168	27
4706042	Abernethy No. 186	186	39844	2211	425	39	0	79	0	0	0	331	0	0	0	53
4706048	North Qu'Appelle No. 187	187	17233	899	202	23	0	42	0	0	0	135	0	0	0	29
4706053	Lumsden No. 189	189	32127	3128	0	1702	0	1851	0	0	0	0	0	0	158	0
4706059	Dufferin No. 190	190	66867	4725	0	11119	0	14832	0	0	0	0	0	0	0	0
4706063	Sarnia No. 221	221	12212	1362	0	818	0	406	0	0	0	0	0	0	0	0
4706070	Longlaketon No. 219	219	38755	2554	0	1333	0	807	0	0	0	0	0	0	0	0
4706071	McKillop No. 220	220	13576	1435	0	738	0	414	0	0	0	0	0	0	0	0
4706091	Cupar No. 218	218	33728	1327	0	606	0	445	437	162	833	0	0	0	0	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4706096	Lipton No. 217	217	35069	1123	0	476	0	221	392	144	763	0	0	0	0	0
4706099	Tullymet No. 216	216	13813	478	0	218	0	158	163	60	327	0	0	0	0	0
4707001	Baildon No. 131	131	30392	1073	456	870	26	103	0	0	0	0	0	0	0	0
4707004	Hillsborough No. 132	132	40176	1585	549	1037	26	133	0	0	0	0	0	0	0	0
4707006	Rodgers No. 133	133	33626	1277	454	793	18	49	0	0	0	0	0	0	0	0
4707011	Shamrock No. 134	134	36993	2624	1306	89	13	292	0	66	0	0	0	315	0	0
4707014	Lawtonia No. 135	135	64455	4622	2132	52	17	209	0	107	0	0	0	514	0	0
4707018	Coulee No. 136	136	65201	4755	1872	116	16	415	0	94	0	0	0	451	0	0
4707021	Excelsior No. 166	166	105310	4258	0	1759	0	2847	1049	389	2084	0	0	0	404	0
4707024	Morse No. 165	165	115869	8749	3741	358	52	1875	0	188	0	0	0	901	259	0
4707029	Chaplin No. 164	164	89069	6589	3775	516	74	1481	0	190	0	0	0	909	0	0
4707032	Wheatlands No. 163	163	46234	2813	1092	1961	37	243	0	0	0	0	0	0	0	0
4707036	Caron No. 162	162	19273	1240	542	1012	25	151	0	0	0	0	0	0	0	0
4707038	Moose Jaw No. 161	161	48011	2988	617	4953	51	13040	0	0	0	0	0	0	1968	0
4707042	Marquis No. 191	191	6643	446	185	362	7	172	0	0	0	0	0	0	19	0
4707047	Eyebrow No. 193	193	12956	1076	375	810	15	411	0	0	0	0	0	0	0	0
4707053	Enfield No. 194	194	69518	4753	2227	958	18	2923	0	112	0	0	0	537	0	0
4707058	Canaan No. 225	225	34113	1546	925	28	99	103	423	0	0	0	0	0	0	0
4707063	Victory No. 226	226	88283	4161	2167	167	237	587	986	0	0	0	0	0	0	0
4707066	King George No. 256	256	41401	2341	1581	190	165	627	726	0	0	0	0	0	0	0
4707067	Coteau No. 255	255	23989	1435	859	123	94	372	391	0	0	0	0	0	0	0
4707071	Maple Bush No. 224	224	20658	1796	1114	35	117	286	511	0	0	0	0	0	27	0
4707076	Huron No. 223	223	18110	1354	586	1165	35	394	0	0	0	0	0	0	46	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4707091	Craik No. 222	222	15682	1605	0	765	0	373	0	0	0	0	0	0	0	0
4708001	Swift Current No. 137	137	120312	4842	0	2134	0	3856	1110	406	2189	0	0	0	645	0
4708006	Webb No. 138	138	61563	7307	0	189	146	432	0	0	0	0	0	0	0	0
4708009	Gull Lake No. 139	139	53608	6489	0	67	145	138	0	0	0	0	0	0	0	0
4708016	Big Stick No. 141	141	34400	5676	0	828	160	1870	0	0	0	0	0	0	0	0
4708021	Enterprise No. 142	142	16643	3265	0	51	80	94	0	0	0	0	0	0	0	0
4708024	Fox Valley No. 171	171	43314	6790	0	143	170	363	0	0	0	0	0	0	0	0
4708028	Pittville No. 169	169	40885	5029	0	89	132	319	0	0	0	0	0	0	46	0
4708031	Riverside No. 168	168	47447	1905	0	706	0	788	519	194	951	0	0	0	126	0
4708038	Saskatchewan Landing No. 167	167	20430	795	0	520	0	1142	176	68	296	0	0	0	214	0
4708042	Lacadena No. 228	228	103626	10124	0	363	0	1951	0	0	0	0	0	0	0	0
4708046	Miry Creek No. 229	229	80242	3042	0	1136	0	703	820	338	1270	0	0	0	0	0
4708053	Clinworth No. 230	230	53883	6649	0	106	155	275	0	0	0	0	0	0	0	0
4708056	Happyland No. 231	231	44424	5998	0	819	128	2919	0	0	0	0	0	0	393	0
4708061	Deer Forks No. 232	232	28775	4820	0	775	117	2793	0	0	0	0	0	0	367	0
4708065	Chesterfield No. 261	261	46147	4775	0	134	0	1780	1060	0	0	0	0	0	59	0
4708071	Newcombe No. 260	260	11032	932	0	14	0	248	185	0	0	0	0	0	0	0
4708074	Snipe Lake No. 259	259	17078	1425	0	47	0	511	296	0	0	0	0	0	26	0
4708092	Monet No. 257	257	15972	2911	0	49	0	377	0	0	0	0	0	0	0	0
4709001	Calder No. 241	241	30423	2826	0	48	0	431	0	0	0	0	0	0	0	0
4709006	Wallace No. 243	243	22440	1962	0	59	0	424	0	0	0	0	0	0	33	0
4709011	Orkney No. 244	244	79872	2130	3270	1280	0	4981	0	0	0	0	0	1121	442	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4709019	Garry No. 245	245	37398	875	1734	209	0	821	0	0	0	0	0	595	92	0
4709023	Insinger No. 275	275	42721	1199	2202	61	0	180	0	0	0	0	0	755	0	0
4709029	Good Lake No. 274	274	26393	638	1248	131	0	342	0	0	0	0	0	428	0	0
4709033	Sliding Hills No. 273	273	16213	1176	188	102	0	185	0	0	0	132	0	0	0	27
4709037	Cote No. 271	271	18369	1931	368	46	0	103	0	0	0	290	0	0	0	38
4709042	St. Philips No. 301	301	8203	1886	278	75	0	257	0	0	0	0	127	0	0	0
4709046	Keys No. 303	303	19672	1675	306	182	0	496	0	0	0	251	0	0	0	36
4709049	Buchanan No. 304	304	10179	591	121	37	0	89	0	0	0	90	0	0	0	12
4709054	Invermay No. 305	305	18835	683	1219	106	0	271	0	0	0	0	0	418	0	0
4709060	Hazel Dell No. 335	335	23430	2345	469	236	0	552	0	0	0	330	0	0	0	56
4709062	Preeceville No. 334	334	32676	3091	599	622	0	1275	0	0	0	428	0	0	0	81
4709067	Clayton No. 333	333	28596	2906	520	106	0	223	0	0	0	429	0	0	0	62
4709075	Livingston No. 331	331	7135	1740	277	92	0	308	0	0	0	0	111	0	0	0
4710003	Ituna Bon Accord No. 246	246	25254	910	0	416	0	444	327	118	699	0	0	0	61	0
4710008	Kellross No. 247	247	51140	1682	0	710	0	351	588	222	1138	0	0	0	0	0
4710014	Touchwood No. 248	248	41259	1416	0	710	0	594	522	193	1023	0	0	0	0	0
4710024	Mount Hope No. 279	279	52304	1820	588	2409	93	3488	0	0	0	0	0	0	608	0
4710031	Emerald No. 277	277	16982	580	0	332	0	314	210	77	400	0	0	0	0	0
4710036	Foam Lake No. 276	276	50884	1788	671	1387	33	444	0	0	0	0	0	0	0	0
4710041	Elfros No. 307	307	12688	522	199	405	11	92	0	0	0	0	0	0	0	0
4710046	Big Quill No. 308	308	15318	588	204	474	8	297	0	0	0	0	0	0	0	0
4710052	Prairie Rose No. 309	309	98530	2309	258	7711	9	23616	0	0	0	0	0	0	3978	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4710056	Leroy No. 339	339	10508	313	114	268	4	139	0	0	0	0	0	0	0	0
4710061	Lakeside No. 338	338	13652	525	166	369	10	136	0	0	0	0	0	0	0	0
4710066	Lakeview No. 337	337	7727	306	91	268	4	290	0	0	0	0	0	0	0	0
4710071	Sasman No. 336	336	27141	1093	1510	314	0	930	0	0	0	0	0	518	0	0
4711003	Last Mountain Valley No. 250	250	17619	1013	0	1050	0	1723	0	0	0	0	0	0	0	0
4711006	Big Arm No. 251	251	14426	1026	0	577	0	345	0	0	0	0	0	0	0	0
4711011	Arm River No. 252	252	25625	1420	0	777	0	383	0	0	0	0	0	0	0	0
4711016	Willner No. 253	253	13491	1099	0	551	0	362	0	0	0	0	0	0	0	0
4711018	Loreburn No. 254	254	17168	1430	767	103	81	519	351	0	0	0	0	0	48	0
4711026	Rudy No. 284	284	21466	2104	1127	240	129	1118	508	0	0	0	0	0	144	0
4711031	Rosedale No. 283	283	32478	1817	1155	330	132	990	521	0	0	0	0	0	0	0
4711034	McCraney No. 282	282	41064	2393	0	1313	0	577	0	0	0	0	0	0	0	0
4711039	Wood Creek No. 281	281	18629	1258	0	590	0	238	0	0	0	0	0	0	0	0
4711042	Wreford No. 280	280	30915	1657	0	811	0	398	0	0	0	0	0	0	0	0
4711046	Usborne No. 310	310	94735	3141	1075	2953	71	2202	0	0	0	0	0	0	0	0
4711052	Morris No. 312	312	30422	1753	0	974	0	730	0	0	0	0	0	0	0	0
4711059	Lost River No. 313	313	21992	953	606	35	63	219	279	0	0	0	0	0	24	0
4711061	Dundurn No. 314	314	25177	1588	942	74	107	244	426	0	0	0	0	0	0	0
4711065	Corman Park No. 344	344	97136	5892	1295	1791	0	4498	0	0	0	674	0	0	0	186
4711066	Saskatoon	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4711069	Blucher No. 343	343	23560	1423	0	671	0	499	0	0	0	0	0	0	55	0
4711076	Colonsay No. 342	342	13364	722	0	404	0	246	0	0	0	0	0	0	0	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4711091	Viscount No. 341	341	36912	2092	0	1134	0	827	0	0	0	0	0	0	67	0
4711096	Wolverine No. 340	340	19069	750	243	558	13	308	0	0	0	0	0	0	0	0
4712001	Pleasant Valley No. 288	288	20613	2371	0	90	0	746	476	0	0	0	0	0	0	0
4712004	St. Andrews No. 287	287	14232	1268	684	22	72	172	314	0	0	0	0	0	23	0
4712011	Milden No. 286	286	9143	750	573	52	61	165	262	0	0	0	0	0	0	0
4712020	Fertile Valley No. 285	285	22947	1668	1077	180	117	566	490	0	0	0	0	0	0	0
4712026	Montrose No. 315	315	23827	2438	1625	60	178	218	739	0	0	0	0	0	0	0
4712029	Harris No. 316	316	16461	1379	862	374	101	1080	387	0	0	0	0	0	0	0
4712034	Marriott No. 317	317	19843	1635	955	281	176	541	376	0	0	0	0	0	0	0
4712038	Mountain View No. 318	318	9101	1535	0	21	0	393	291	0	0	0	0	0	0	0
4712042	Biggar No. 347	347	66033	3541	1900	426	206	1910	866	0	0	0	0	0	190	0
4712050	Perdue No. 346	346	19145	950	523	32	59	95	237	0	0	0	0	0	0	0
4712054	Vanscoy No. 345	345	43910	2565	1403	262	168	748	627	0	0	0	0	0	0	0
4712064	Eagle Creek No. 376	376	29268	1967	400	141	0	519	0	0	0	248	0	0	74	46
4712069	Glenside No. 377	377	17762	1319	279	32	0	71	0	0	0	160	0	0	0	74
4712072	Rosemount No. 378	378	21720	1643	371	151	0	357	0	0	0	192	0	0	0	67
4712078	Battle River No. 438	438	33496	2121	451	304	0	788	0	0	0	304	0	0	0	62
4713006	Kindersley No. 290	290	33234	2703	0	103	0	833	531	0	0	0	0	0	0	0
4713011	Milton No. 292	292	29416	2568	0	137	0	1095	600	0	0	0	0	0	0	0
4713016	Antelope Park No. 322	322	13444	2058	0	706	0	192	0	0	0	0	0	0	0	0
4713019	Prairiedale No. 321	321	15974	1362	0	28	0	396	289	0	0	0	0	0	0	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4713024	Oakdale No. 320	320	3412	229	0	55	0	187	46	0	0	0	0	0	0	0
4713028	Winslow No. 319	319	5298	808	0	25	0	223	154	0	0	0	0	0	0	0
4713032	Grandview No. 349	349	15996	1585	0	318	0	1069	318	0	0	0	0	0	0	0
4713038	Mariposa No. 350	350	21143	1942	0	450	0	1348	376	0	0	0	0	0	0	0
4713041	Progress No. 351	351	23685	3049	0	881	0	313	0	0	0	0	0	0	0	0
4713046	Heart's Hill No. 352	352	30119	3568	0	1465	0	2002	0	0	0	0	0	0	182	0
4713049	Eye Hill No. 382	382	25270	3948	0	1146	0	432	0	0	0	0	0	0	62	0
4713056	Grass Lake No. 381	381	19045	2253	0	696	0	339	0	0	0	0	0	0	0	0
4713059	Tramping Lake No. 380	380	4711	271	0	157	0	201	0	0	0	0	0	0	0	0
4713064	Reford No. 379	379	12359	876	178	54	0	113	0	0	0	108	0	0	0	31
4713068	Buffalo No. 409	409	25522	1993	370	84	0	182	0	0	0	236	0	0	0	49
4713072	Round Valley No. 410	410	27320	2218	0	1006	0	473	0	0	0	0	0	0	0	0
4713076	Senlac No. 411	411	43646	3604	0	1452	0	820	0	0	0	0	0	0	0	0
4713079	Manitou Lake No. 442	442	40165	2501	0	1390	0	1198	0	0	0	0	0	0	0	0
4713092	Hillsdale No. 440	440	52974	3371	0	1555	0	1261	0	0	0	0	0	0	113	0
4713096	Cut Knife No. 439	439	23378	1520	0	647	0	284	0	0	0	0	0	0	0	0
4714001	Hudson Bay No. 394	394	16137	2019	0	581	0	387	0	0	0	0	50	0	0	0
4714006	Porcupine No. 395	395	23528	1842	0	935	0	1786	0	0	0	0	315	0	310	0
4714021	Kelvington No. 366	366	12969	2060	0	447	0	336	0	0	0	0	45	0	0	0
4714023	Ponass Lake No. 367	367	17497	724	222	539	12	351	0	0	0	0	0	0	0	0
4714026	Spalding No. 368	368	11666	349	104	300	4	273	0	0	0	0	0	0	0	0
4714034	Barrier Valley No. 397	397	20789	2393	0	628	0	274	0	0	0	0	71	0	0	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4714035	Pleasantdale No. 398	398	20234	810	583	156	59	657	269	0	0	0	0	0	57	0
4714038	Bjorkdale No. 426	426	28947	2642	0	1470	0	3617	0	0	0	0	36	0	306	0
4714043	Tisdale No. 427	427	5643	588	0	172	0	165	0	0	0	0	8	0	0	0
4714047	Star City No. 428	428	18082	883	646	96	76	281	290	0	0	0	0	0	0	0
4714053	Willow Creek No. 458	458	7107	338	251	47	30	135	112	0	0	0	0	0	0	0
4714056	Connaught No. 457	457	6639	660	0	251	0	247	0	0	0	0	47	0	0	0
4714059	Arborfield No. 456	456	3182	285	0	138	0	168	0	0	0	0	21	0	0	0
4714067	Moose Range No. 486	486	39266	3506	0	1838	0	2488	0	0	0	0	418	0	0	0
4714072	Nipawin No. 487	487	7148	775	0	207	0	154	0	0	0	0	24	0	0	0
4714077	Torch River No. 488	488	18124	1952	0	183	0	955	448	0	0	0	0	0	0	0
4715001	St. Peter No. 369	369	4779	200	0	170	0	256	0	0	0	0	0	0	0	0
4715007	Humboldt No. 370	370	18115	682	0	478	0	421	0	0	0	0	0	0	0	0
4715011	Bayne No. 371	371	26882	1090	0	676	0	307	0	0	0	0	0	0	0	0
4715014	Grant No. 372	372	14821	620	0	477	0	215	0	0	0	0	0	0	0	0
4715018	Aberdeen No. 373	373	11655	478	0	461	0	483	0	0	0	0	0	0	0	0
4715026	Laird No. 404	404	20371	1443	228	168	0	308	0	0	0	180	0	0	0	24
4715031	Rosthern No. 403	403	41180	2962	0	1197	0	866	0	0	0	0	0	0	0	0
4715036	Fish Creek No. 402	402	14742	637	0	447	0	302	0	0	0	0	0	0	0	0
4715039	Hoodoo No. 401	401	10871	429	0	290	0	222	0	0	0	0	0	0	0	0
4715044	Three Lakes No. 400	400	18008	930	0	734	0	768	0	0	0	0	0	0	0	0
4715048	Lake Lenore No. 399	399	13819	559	417	26	49	82	187	0	0	0	0	0	0	0
4715051	Flett's Springs No. 429	429	18414	893	612	566	167	2639	196	0	0	0	0	0	513	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4715054	Invergordon No. 430	430	11456	630	0	508	0	452	0	0	0	0	0	0	0	0
4715057	St. Louis No. 431	431	5317	321	0	218	0	156	0	0	0	0	0	0	0	0
4715061	Duck Lake No. 463	463	32568	2390	0	1312	0	988	0	0	0	0	0	0	83	0
4715064	Prince Albert No. 461	461	27118	2986	0	293	0	1494	739	0	0	0	0	0	0	0
4715067	Birch Hills No. 460	460	7133	683	0	41	0	271	177	0	0	0	0	0	0	0
4715071	Kinistino No. 459	459	16322	1586	0	159	0	813	414	0	0	0	0	0	0	0
4715079	Garden River No. 490	490	7737	866	0	96	0	470	210	0	0	0	0	0	0	0
4715094	Buckland No. 491	491	18333	1728	0	752	0	1659	402	0	0	0	0	0	0	0
4715099	Paddockwood No. 520	520	12529	1458	0	110	0	620	351	0	0	0	0	0	0	0
4716005	Mayfield No. 406	406	23975	1280	368	181	0	418	0	0	0	212	0	0	0	63
4716008	Great Bend No. 405	405	43363	2372	760	172	0	359	0	0	0	398	0	0	0	175
4716013	Blaine Lake No. 434	434	24864	1260	321	130	0	472	0	0	0	219	0	0	63	43
4716018	Redberry No. 435	435	34201	1891	561	122	0	252	0	0	0	343	0	0	0	63
4716023	Douglas No. 436	436	23357	1333	369	54	0	119	0	0	0	231	0	0	0	61
4716028	North Battleford No. 437	437	24019	1231	315	243	0	585	0	0	0	216	0	0	0	32
4716033	Round Hill No. 467	467	37425	1880	472	587	0	984	0	0	0	321	0	0	0	56
4716038	Meeting Lake No. 466	466	32291	2224	591	114	0	223	0	0	0	395	0	0	0	70
4716041	Leask No. 464	464	31863	2129	562	179	0	443	0	0	0	379	0	0	0	51
4716046	Shellbrook No. 493	493	16082	1810	0	287	0	1196	378	0	0	0	0	0	0	0
4716051	Canwood No. 494	494	57795	4393	1103	423	0	1566	0	0	0	771	0	0	187	137
4716056	Spiritwood No. 496	496	102452	7583	1822	1777	0	3670	0	0	0	1279	0	0	0	199
4716062	Medstead No. 497	497	22974	3080	0	685	0	289	0	0	0	0	63	0	0	0

CCSUID	CCSNAME	RM	Grass-land	Tame Hay	Cereal Green-feed	Barley Silage	Barley Screen-ing Pellets	Barley Grain	Cereal Straw	Cereal Screen-ings	Cam-elina meal	Corn Grazing	WDDGS	Cereal Swath	Wheat grain	Oat grain
4716075	Big River No. 555	555	21555	2267	0	754	0	467	0	0	0	0	160	0	0	0
4717001	Meota No. 468	468	27388	1547	317	362	0	976	0	0	0	228	0	0	0	32
4717008	Turtle River No. 469	469	37045	5827	0	1450	0	1299	0	0	0	0	148	0	0	0
4717013	Paynton No. 470	470	19877	1281	0	595	0	396	0	0	0	0	0	0	0	0
4717017	Eldon No. 471	471	56363	5065	0	228	0	741	0	0	0	371	0	1607	0	0
4717022	Wilton No. 472	472	38179	2483	0	1212	0	748	0	0	0	0	0	0	0	0
4717028	Britannia No. 502	502	93827	8835	0	834	0	4276	0	0	0	572	0	2667	690	0
4717032	Frenchman Butte No. 501	501	125397	14322	0	491	0	1705	0	0	0	1072	0	4967	0	0
4717045	Mervin No. 499	499	55927	8251	0	1856	0	1163	0	0	0	0	343	0	0	0
4717047	Parkdale No. 498	498	33379	5361	0	1287	0	1549	0	0	0	0	84	0	160	0
4717054	Meadow Lake No. 588	588	142247	14801	0	2828	0	1663	0	0	0	0	233	0	0	0
4717056	Loon Lake No. 561	561	88604	8352	0	273	0	1002	0	0	0	615	0	3077	0	0
4717062	Beaver River No. 622	622	98382	9829	0	349	0	1206	0	0	0	731	0	3537	0	0

Appendix S4: Species Model Projections

Species model projections into Saskatchewan are found below. The best model for each species is highlighted by a red box. Black dots on each map represent presence observations for each species.

Sask prediction maps with best model highlighted.pdf