Isolated Habitats – Assessment of native grasslands in Alberta for isolation, values, and management implications

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Table of Contents

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In 2015, the United Nations (UN) released a report entitled Transforming our world: the 2030 Agenda for Sustainable Development (UN General Assembly, 2015). This document outlined 17 goals to help to achieve sustainability at a global level. Although the goals are broad, they have direct connections to activities and actions across multiple jurisdictions – global, national, regional, and local. Of direct interest to this report is the connection to Goal 15 "Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, and combat desertification, and halt and reverse land degradation and halt biodiversity loss" (UN General Assembly, 2015, p. 25).

The Great Plains Ecoregion of North America encompasses over 3.5 million km^2 (Commission for Environmental Cooperation, 1997). More specifically, the Northwestern Glaciated Plains (Level III) is found within the northern end of the Central Grasslands of North America. It represents the mixed and short grass prairies of North America across four states and two provinces (Wiken, Jimenez Nava, & Griffith, 2011). The portion of this ecoregion within Alberta is referred to as the Grassland Natural Region (Natural Regions Committee, 2006) and currently has about 48% of native cover remaining (Prairie Conservation Forum, 2019).

This Natural Region encompasses many of the traditional lands of the Blackfoot Confederacy including the Siksika, Kainai, Piikani, as well as the Îyâxe Nakoda and Tsuut'ina nations. The prairie landscape provided food and resources through large wide ranging ungulates, specialized plants, and unique landscapes and features. During the settlement and colonization of the Canadian prairies, agriculture became the dominant industry in the form of annual crops and livestock production which contributed to loss and degradation of natural grassland communities. Following World Wars, mechanization and industrialization of agriculture sector further exacerbated the loss and degradation of native grasslands that created separation of the natural landscape. Oil and gas exploration and development increased pressures through additional infrastructure that replaced grassland ecosystems with transportation corridors and small installations.

In order to help offset the pressures on native flora and fauna of a rapidly changing landscape due to anthropogenic causes, the Prairie Conservation Forum (PCF) has been working with many partners and agencies across the grassland and parkland areas of Alberta for over 30 years (Prairie Conservation Forum, 2022). In its most recent Prairie Conservation Action Plan (PCAP), three primary outcomes were identified as a focus from 2021 to 2025: 1) Maintain Large Native Prairie and Parkland Landscapes, 2) Conserve Connecting Corridors for Biodiversity, and 3) Protect Isolated Native Habitats (Prairie Conservation Forum, 2021). These three outcomes build off previous PCAP outcomes (Prairie Conservation Forum, 2016; Prairie Conservation Forum, 2011) as well as align and interact with one another. Protecting isolated native habitats for grassland species aligns with further defining what large native prairies landscapes and where and connecting corridors are required. The objective of this report is to expand on Outcome 3) Protect Isolated Native Habitats. In order to accomplish this outcome, 3 approaches have been identified to be completed – 1) Define "Isolated" Habitats/Fragments, 2)

Identify locations of isolated native prairie habitats, and 3) Identify the value or values of those isolated parcels (Prairie Conservation Forum, 2021).

This document is the first in a series of reports and communications to initially define a framework for examining what are isolated habitats and also defining how to begin to identify where they are. This will lay the foundation for the Approach 2 and ultimately Approach 3.

Context

Alberta Prairie Conservation Forum (PCF) has already contracted an overarching literature review on connectivity within the native grasslands and parklands of Alberta (see (O2 Planning + Design Inc. (O2), 2017)). That report provides a strong foundation for many of the concepts expanded upon within this document. At the outset it is important to define the terms and scope of this review. Defining "isolated habitats" is complex and it is important to apply the definition at appropriate spatial and temporal scales and varying degrees of isolation along a continuum of isolation to connected.

Habitat

The term "habitat" seems to be a fairly easily understood concept, but unfortunately, even within the realm of scientific and biological research, varying definitions or contexts have been used (Darracq & Tandy, 2019; Hall et al., 1997; Kirk et al., 2018). These inconsistencies are still persisting with approximately 55% of the term incorrectly or inconsistently used in journals (Hall et al., 1997; Kirk et al., 2018; Krausman & Morrison, 2016) and academic institutions and conservation agencies (Darracq & Tandy, 2019). In order to promote consistency and address the importance of this term, every effort will be made to adhere to the following definition.
For the purposes of this paper, "habitat" will refer to the "the resources and conditions present in an area that produce occupancy - including survival and reproduction - by a given organism. Habitat is organism-specific; it relates the presence of a species, population, or individual (animal or plant) to an area's physical and biological characteristics. Habitat implies more than vegetation or vegetation structure; it is the sum of the specific resources that are needed by organisms." (Hall et al., 1997 p. 175)

Isolated

MacArthur and Wilson (1967), identified the strong relationships between patch size and distance to patches and its impacts on the number of species in the form of a species area curve. Since this seminal work on Island Biogeography Theory, many researchers have contributed to this body of research addressing connectivity in both landscape ecology and metapopulation dynamics (e.g., Levins, 1969) in terrestrial ecosystems. From a landscape ecology perspective, degradation and loss of natural cover types can reduce the size of terrestrial patches, the utility of that patch for individual species and populations, and for availability for biodiversity (Purvis, et al., 2019; Millenium Ecosystem Assessment, 2005). With respect to metapopulation dynamics, many sub populations can interact through interconnected patches to enhance flow of genetic materials, acquire resources to enhance fitness. When patches become isolated or disconnected from other patches, species may suffer increased extinction/extirpation risk (MacArthur & Wilson, 1967). Envisioning a spectrum of connectivity of can be difficult, but is vital to comprehend the issue with isolation. Patches of natural grasslands may lose value to the plants

and wildlife within the larger landscape due to barriers or inaccessibility, inability to contribute to life requisites, or even functioning as population sinks and preventing species from leaving to more productive areas (Millenium Ecosystem Assessment, 2005). The further the patch is from another, then the opportunity for a species to use the site or a subpopulation to recolonize a site is decreased (e.g., Levins, 1969)

Even though there may be increased risk of extirpation/extinction of species within smaller individual patches, some patches provide meaningful value for many species and should continue to be a focus on conservation actions to maintain biodiversity (Wintle et al., 2019). Krausman and Morrison (2016) provide a further reminder that both temporal and spatial scales are important in defining or describing species-habitat relationships. Breeding territories, movements, and home ranges are included as part of the species specific appendices at the end of this document.

Current Patch Status

The most recent State of the Prairie report identifies approximately 48% of native or natural cover types remain across the entire Grasslands Natural Region (PCF 2020). No definitive work was identified that explored the composition and arrangement of these areas or patches and the report did include a recommendation for more analysis of patch dynamics and trends. To create a sense of context for isolation, a preliminary patch analysis of Annual Crop Inventory Data 2019 (AAFC 2020), was completed (Figure 1). Land cover classification data (30m x30m) was converted to vector shapefiles and summarized according to three levels of classification. Level 3 categories were the original data embedded in the Annual Crop Inventory, Level 2 are broader categories that represent aggregations of Level 3 data (e.g., Level 2 – Pulses – Level 3 – Beans, Lentils, Peas, etc.). Level 1 was the most coarse and was comprised of either natural or anthropogenic cover types.

Vector shapefiles were dissolved and clipped to the Grasslands Natural Region boundary. Area, Perimeter, Fractal Dimension Index (see McGarigal, 2015), and Shape Index (see McGarigal, 2015) were calculated for each polygon (patch) and summarized at the three scale levels. Please note that due to differences in base data sets (raster vs. vector), some variation in areas compared to PCF (2019) may exist. This analysis should be considered preliminary in nature and limited in scope to help provide context for patches of natural cover. Refer to PCF (2019) for a more detailed technical analysis of the current State of the Prairie.

Without resampling or modifying the base information, there are over two million patches of natural cover types ranging in size from 0.09 ha to over 970,000 ha with a mean patch size of approximately 2.4 ha (Table 1).

Isolated Habitats

Isolation is effectively the inverse of connected (Moilanen & Nieminen, 2002) and when we consider that habitat refers to all of the resources used by a species, we can start to define “habitats”. Using home range or distribution distances (e.g., plants), we can begin to identify habitat patches for individual species and subsequently identify the distances between them. Lindenmayer and Fischer (2006) defined Habitat isolation as “functional separation of habitat patches for a given species: a species-specific entity and the opposite of habitat connectivity.” (p.

128). For the context of this report, “Isolated Habitats”, will represent species-specific resources that are disconnected from other patches of the same resources in such a way as to be unavailable to an individual due to some form of barrier whether distance or physical. Consequently in order to define the habitats, species need to be defined along with the parameters that allow for survival (e.g., cover types and resources, range and distribution areas, and distribution distances).

Species Selection

It is suggested that across its diverse landscape, Alberta hosts approximately 616 mammals, birds, reptiles, amphibians, and fish (Alberta Environment and Parks, 2020). In addition, there are also approximately, 4,414 species of plants, mosses, lichens, and fungi and an additional 4,848 invertebrates (Alberta Conservation Information Management System, 2017).

The most recent PCAP (Prairie Conservation Forum, 2021) prioritized grassland obligate species or species that are considered under various provincial or national wildlife or species at risk legislation due to their population status. This yielded a large list of species that encompassed a wide variety of species that can be found across the prairies during various times including migration. In order to try to focus the efforts, a prioritization matrix was developed to help refine the list to reduce the number of species to include as part of the initial report.

The matrix was created to help sort through the large number of species that can be found throughout the prairies at differing times of the year. For example, during the spring migration, many different species rely on the prairie ecosystem to transition to the breeding ranges in the Boreal Natural Region or further north into the Tundra. In addition to these factors, species were also included if they represented unique landscape features that are naturally prone to isolation (e.g., badlands/cliffs/etc.). Each criteria was assigned a series of scores for each category within and a final score was developed.

Criteria

Endemism to Grasslands

Endemism refers to species that are associated with particular geographic or ecological regions and may occur at various spatial scales (Morrone, 2008). This criteria is used to meet the specific objective of identifying isolated habitats of grasslands species. Many species were removed from the prioritization matrix at this stage if the species was not present in the Grassland Natural Region or did not require grassland ecosystems to persist. Of the species remaining, three factors were examined as part of this criteria: Year round, Multiseason, and Single Use.

- ***Year Round (5)***
  Year round grassland obligates rely on prairie or grassland ecosystems to fulfill all of their survival and reproductive needs.

- ***Multiseason (3)***
  Multiseason grassland obligates rely on prairie or grassland ecosystems to fulfill key lifestage cycles such as reproduction. This would include any migratory birds that use grasslands as breeding areas.

- ***Single Use (0)***
  Single use will refer to species that have life history requirements that may or may not need to be fulfilled by grassland topographical or cover types (e.g., wetlands for stop over, annual crops for foraging, fish bearing waters).

Provincial Rank and Status

General Rank (S1=5, S2=4, S3=3, S4=2, S5=1)

Alberta participates in the general assessment of biodiversity through Alberta Conservation Information Management System (ACIMS) which uses the NatureServe methodology for general assessment (NATURE SERVE REF). Provincial (Subnational) species ranks for inversely ranked. For example, a "Secure" species with a rank of S5 was provided a score of 1. Species with multiple ranks received averaged scores.

Status

Alberta maintains a list of wild species and population status as part of its provincial responsibility for wildlife protection and management. Priority is placed on those provincial species that are represented under general status ***(Government of Alberta, 2011)*** of concern (i.e., Sensitive, May Be At Risk, At Risk) and detailed status (Threatened, Endangered) or listed under Schedule 6 of the Wildlife Regulation (1997) of Alberta.

- ***Secure (0)***
  Species that were assessed as secure within the Province of Alberta were not generally included.

- ***Undetermined (1)***
  Species that were assessed as undetermined within the Province of Alberta were not generally included. Those included were given a score of 1.

- ***Sensitive (1), May Be At Risk (2), At Risk (3)***
  These categories represent general status based on ongoing assessment processes. In some cases species may be considered "May Be At Risk" or "At Risk" but may not have accompanying legal designations due to time frames for each process. Species that fell within these categories received a score of 1, 2, or 3.

- ***Threatened (2) / Endangered (3)***
  Detailed status reports are created for those species that receive an "At Risk" or "May Be At Risk" designation under the general status process. Species that are listed under Schedule 6 of Alberta Wildlife Regulation (1997) represent the highest concern and priority as these are legally designated within the province of Alberta.

Federal Rank and Status

In Canada, the federal government also has a responsibility for the protection and management of wildlife; however, this responsibility is focused on migratory birds, species of national concern, and species at risk (Wildlife Act, Species at Risk Act). To assist with assessment and status process, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) prepares assessments.

- ***General Rank (N1=5, N2=4, N3=3, N4=2, N5=1)***
  National rank scores were used following the Nature Serve methodology. Scores were also inversely weighted with National ranks. For example, "Secure" species with a rank of N5 received a score of 1. Species with multiple ranks were averaged.

- ***COSEWIC Assessment***
  COSEWIC represents various categories of assessment similar to detailed status reports from Alberta and follows a process of identification of candidate species, assessment of eligibility, assessment of priority, development of status report and finally assessment and designation (COSEWIC, 2019c). Species that fell under the following categories were prioritized – Endangered (3), Threatened (2), Special Concern (1), Data Deficient (1). All other categories received a score of 0.

- ***SARA listed***
  Species that are list under Schedule 1, Part 2 of the Species at Risk Act (YEAR) represent the highest concern and priority. These represent "Endangered" species and were given a score of 3. Schedule 1, Part 3 (SARA, 2000) represents "Threatened" species and were given a score of 2. Schedule 1, Part 4 (SARA, 2000) represents "Special Concern" species and were given a score of 1.

Unique Needs or Specialized Relationships

Although some species were not specific to grasslands, those that required rare or unique topographical features (e.g., cliffs/crevices, riparian features) to meet life requisites were included.

Taxonomic Family

Although all taxonomic groups and families will need to be included within the analysis at some point, priority was initially placed on birds, mammals, and herptiles due to information more readily available. Plants and invertebrates were included, but broad based information is lacking and further work is required to help to identify isolated habitats for those species. Futhermore, plants and invertebrates may also require more site/local scale management and assessment due to relatively more limited distribution potential.

Calculations

Tables of species were compiled to pull together and assess the various criteria for each of the species. Calculation of a final score was a simple additive function to determine the sum total of the scores. Final scores of each taxonomic grouping were compiled and 95% confidence intervals were calculated. Any scores that met or exceed the upper limit was considered a priority for initial identification of habitats.

Species Prioritized for Isolated Habitats Mapping

Birds

Alberta has approximately 434 species of birds that occupy and/or transition throughout the entire province (Alberta Environment and Parks, 2020). Many of the species only use the prairies as stop over areas while migrating to and from breeding areas in Boreal or Tundra ecosystems. To assist with generalized classifications and dominant cover types, species were broken into ecological life history subcategories of Grassland, Shrub and Forest, and Lakes, Ponds and Wetlands which represent a primary land cover niche.

- ***Grassland***
  Species associated with the grasslands tend to prefer areas with very low canopies (i.e., grasses and short shrubs). Of the 434 species, 21 birds were selected that were associated with grassland cover (Table 2). Following prioritization, 12 species exceeded the 95% confidence interval of the prioritization scores related to all birds. Species with particularly strong grassland associations include greater sage-grouse (*Centrocercus urophasianus*), mountain plover (*Charadrius montanus*), and burrowing owl (*Athene cunicularia*).
  Species lists and general habitat information is listed in Appendix A.

- ***Shrub and Forest***
  Species associated with the shrub and forest land cover tend to associate with taller scrub type vegetation or trees in either an open woodland or forested matrix. Of the 434 species, 16 birds were selected that were associated with shrub and forest cover types (Table 2). Following prioritization, 3 species exceeded the 95% confidence interval. These species include loggerhead shrike (*Lanius ludovicianus*), olive-sided flycatcher (*Contopus cooperi*), and sage thrasher (*Oreoscoptes montanus*).

- ***Lakes, Ponds, and Wetlands***
  Species associated with lakes, ponds, and wetlands require cover types associated with varying sizes of water bodies. Of the 434 species, 23 birds were selected that were associated with lakes, ponds, or wetlands cover types (Table 2). Following prioritization, 5 species exceeded the 95% confidence interval. These species include Clarke's grebe (*Aechmophorus clarkii*), peregrine falcon (*Falco peregrinus*), piping plover (*Charadrius melodus*), western grebe (*Aechmophorus occidentalis*), and white-faced ibis (*Plegadis chihi*).

Herptiles

Alberta has approximately ten species of amphibians and nine species of amphibians (Alberta Environment and Parks, 2020). While amphibians require water or wetland features, reptiles tend to be more associated with climatic and topographical conditions that allow for overwintering habitat or hibernacula.

- ***Amphibians***
  Of the nine species of amphibians, only two prioritized for further examination (Table 3). The great plains toad (*Anaxyrus cognatus*) and northern leopard from (*Lithobates pipiens*). Northern leopard frog are not exclusive to the prairies but have been removed from significant portions of their range in Alberta (Wagner, 1997). Great plains toad is a prairie obligate that is reliant on clean ponds and wetlands across the prairies (COSEWIC, 2010b).

- ***Reptiles***
  Of the ten species of reptiles, three were prioritized. Greater short-horned lizard (*Phrynosoma hernandesi*), plains hog-nosed snake (*Heterodon nasicu*), and Eastern yellow-bellied racer (*Coluber constrictor flaviventris*) scored high on the criteria (Table 3). Prairie rattlesnake (*Crotalus viridis viridis*) was near the threshold for prioritization, but was not included.

Mammals

Alberta has approximately 99 species of mammals (Alberta Environment and Parks, 2020).

- ***Large Mammals***
  Large mammals have faced direct impacts and conflicts associated with settlement of the prairies. Several species are already extirpated from the prairies including plains bison (*Bos bison*) and Black-footed Ferret (*Mustela nigripes*) (Alberta Environment and Parks, 2020). Many efforts have been undertaken to begin to recover populations or enhanced monitoring has been initiated. Of the large mammals included in the list, only swift fox (*Vulpes velox*) met the threshold for prioritization (Table 4).

- ***Small Mammals***
  Small mammals are also increasing threats across the prairies and beyond. Unique species such as the Ord's kangaroo rat (*Dipodomys ordii*) are restricted to very specific locations due to their evolutionary history (Table 4). Western small footed myotis, northern long-eared myotis, and little brown myotis are subject to loss of habitat and habitat quality but also new threats such as white nose syndrome. The last species included under the small mammals category for priorities is the western harvest mouse.

Invertebrates

Alberta has a wide range of invertebrates that occur through each of its natural regions. Alberta Conservation Information Management System (2017) has identified approximately 2,498 butterflies and moths, 25 crustaceans, 181 flies, 705 beetles, 633 spiders, 124 snails, molluscs and sponges, and 682 other invertebrates in Alberta.

Within the Grasslands Natural Region, ACIMS only tracks about 46 invertebrates. Of these species, ten were selected for further prioritization (Table 5).

Plants and Fungi

Alberta has a wide range of plants that occur through each of its natural regions. Alberta Conservation Information Management System has identified approximately 2,343 vascular plants, 761 mosses and liverworts, 847 lichen, and 463 fungi; however, only about 123 are tracked within the Grasslands Natural Region (Alberta Conservation Information Management System, 2017).

Over 120 species of plants and fungi were included in the initial assessment of plants that could be found within the Grasslands Natural Region. Of these species, 24 were identified for prioritization for isolated habitat analysis (Table 6).

Next Steps

Action 2: Mapping

Next steps will be to begin mapping isolated habitats for each species and identify natural groupings. As mentioned at the start, scale will be a factor, it is suggested that the connectivity project focus on larger landscape connectivity and on species that have large home ranges. Mapping for isolated habitats should start at the regional scale, then local scale, then landscape (to integrate with connectivity).

Across the Grasslands Natural Region (Natural Regions Committee, 2006), a lot of work has gone into the mapping of natural vegetation. In 1991, the Native Prairie Vegetation Inventory (NPVI) assessed 1:30,000 aerial photography to determine proportions of land covers per quarter section (Prairie Conservation Forum, 2022). This initial work formed the foundation for the more robust Grasslands Vegetation Inventory (GVI) in 2006. GVI will be an instrumental tool in helping to further define isolated habitats within a geographic information system.

Action 3: Values

Values are variable and subject to many perspectives. The Isolated Habitats Committee will need to pursue and identify the needs and perspectives to view this issue. It may be worth while to investigate a sustainability approach and incorporate social and economic information into this ecological issue.

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Figures

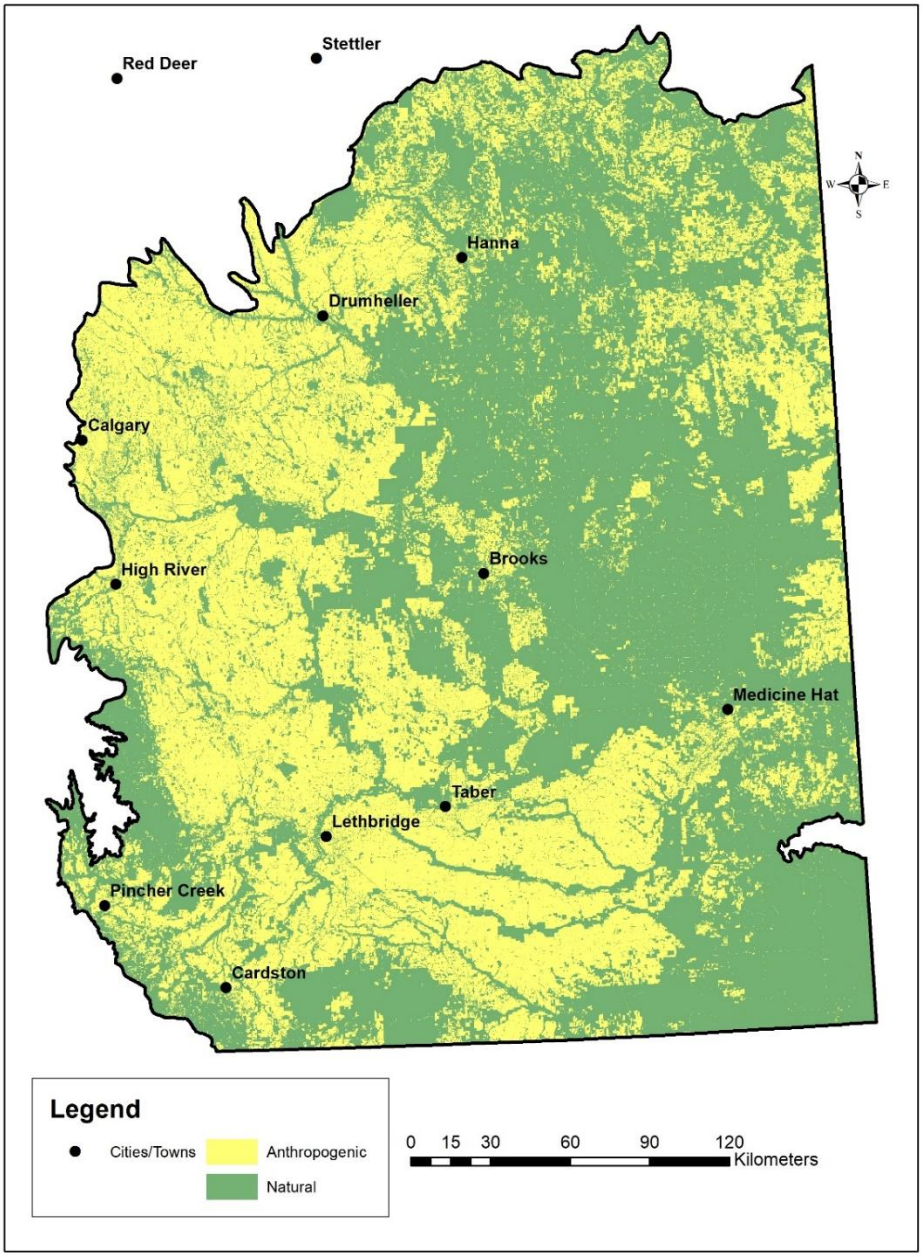


Figure 1 - Anthropogenic vs natural cover types within Grasslands Natural Region (derived from Annual Crop Inventory 2019, AAFC, 2020).

Tables

Table 1 – Generalized patch characteristics derived from Annual Crop Inventory 2019 (AAFC, 2020).

Class	Number of Polygons (patches)	Mean Area (ha/ac)	Mean Perimeter (m)	Mean Patch Fractal Dimension
NATURAL	**2,242,942**	**2.4/5.9**	**389.3**	**1.022**
Broadleaf	133,608	0.3/0.7	224.1	1.019
Coniferous	63,221	0.2/0.6	194.2	1.014
Exposed land/barren	176,096	0.7/1.7	320.7	1.023
Grassland	649,684	7.0/17.2	676.8	1.023
Mixedwood	8,418	0.2/0.5	180.3	1.013
Shrubland	509,721	0.4/0.9	251.1	1.022
Water	69,097	2.4/6.0	471.3	1.027
Wetland	633,097	0.5/1.2	271.7	1.022
ANTHROPOGENIC	**722,321**	**5.8/14.4**	**858.1**	**1.048**
Barley	58,761	10.9/27.0	1,437.0	1.059
Beans	7,591	6.7/16.5	1,228.5	1.064
Canaryseed	47	9.9/24.5	1,431.1	1.071
Canola/rapeseed	30,447	22.2/54.8	1,883.3	1.052
Chickpeas	1,329	19.0/47.0	1,691.4	1.060
Corn	6,194	12.8/31.6	1,625.7	1.060
Fababeans	129	8.4/20.8	1,279.5	1.063
Fallow	6,113	8.5/21.0	1,619.1	1.070
Flaxseed	1,724	12.4/30.6	1,540.4	1.063
Greenhouses	68	0.7/1.8	348.5	1.030
Hemp	454	11.1/27.3	1,428.5	1.059
Herbs	83	9.1/22.6	1,557.1	1.068
Lentils	7,113	17.8/44.1	1,761.0	1.063
Millet	39	7.0/17.3	1,050.8	1.058
Mustard	1,464	12.9/31.9	1,632.6	1.062
Oats	3,821	5.3/13.1	1,160.5	1.066
Other vegetables	8	19.4/47.9	2,805.0	1.094
Pasture/forages	74,015	4.0/9.9	1,162.9	1.066
Peas	15,649	22.0/54.3	1,996.4	1.057
Potatoes	1,801	14.4/35.5	1,584.2	1.053
Rye	1,085	5.2/12.9	1,022.2	1.059
Soybeans	5	1.0/2.5	420.0	1.023
Spring wheat	94,084	16.3/40.2	1,731.7	1.054
Sugarbeets	820	16.3/40.3	1,674.9	1.051
Sunflower	24	10.1/25.0	1,375.0	1.065
Triticale	689	6.3/15.5	1,101.1	1.060
Winter wheat	2,788	11.3/27.8	1,490.3	1.060
Urban/Developed	405,966	0.6/1.4	327.3	1.039

Table 2 - Bird Prioritization Matrix

Common Name	Scientific Name(Chesser et al., n.d.)	Endemism Score	Provincial Status Score	Federal Status Score	Final
		GRASSLAND			
American Kestrel	*Falco sparverius*	3	3	1.5	7.5
Baird's Sparrow	*Centronyx bairdii (prev Ammodramus bairdii)*	3	4	3.5	10.5
Bobolink	*Dolichonyx oryzivorus*	3	5	5.5	13.5
Burrowing Owl	*Athene cunicularia*	3	10	10.5	23.5
Chestnut-collared Longspur	*Calcarius ornatus*	3	5	8	16
Common Nighthawk	*Chordeiles minor*	3	3.5	6	12.5
Eastern Kingbird	*Tyrannus tyrannus*	3	3	1	7
Ferrugionous Hawk	*Buteo regalis*	3	9.5	6	18.5
Golden Eagle	*Aquila chrysaetos*	3	4	1.5	8.5
Grasshopper Sparrow	*Ammodramus savannarum*	3	3.5	1.5	8
Greater Sage-grouse	*Centrocercus urophasianus*	5	11	11	27
Lark Bunting	*Calamospiza melanocorys*	3	3	6	12
Long-billed Curlew	*Numenius americanus*	3	5	4	12
Mountain Plover	*Charadrius montanus*	3	11	11	25
Prairie Falcon	*Falco mexicanus*	3	4.5	2.5	10
Sedge Wren	*Cistothorus platensis*	3	4	1	8
Sharp-tailed Grouse	*Tympanuchus phasianellus*	5	3.5	1	9.5
Short Eared Owl	*Asio flammeus*	3	5	5.5	13.5

Common Name	Scientific Name(Chesser et al., n.d.)	Endemism Score	Provincial Status Score	Federal Status Score	Final
Sprague's Pipit	*Anthus spragueii*	3	4.5	6.5	14
Thick-billed Longspur (prev. McCown's)	*Rhynchophanes mccownii (prev. Calcarius mccownii)*	3	4.5	6.5	14
Upland Sandpiper	*Bartramia longicauda*	3	4	1	8
		SHRUB AND FOREST			
Alder Flycatcher	*Empidonax alnorum*	3	1.5	1	5.5
Baltimore Oriole	*Icterus galbula*	3	2	1	6
Brewer's Sparrow	*Spizella breweri*	3	3.5	1.5	8
Brown Creeper	*Certhia americana*	3	3.5	1	7.5
Common Poorwill	*Phalaenoptilus nuttallii*	3	4	3	10
Common Yellowthroat	*Geothlypis trichas*	3	2	1	6
Least Flycatcher	*Empidonax minimus*	3	1.5	1	5.5
Loggerhead Shrike	*Lanius ludovicianus*	3	5	7	15
Northern Goshawk	*Accipiter gentilis*	3	3.5	2	8.5
Olive-sided Flycatcher	*Contopus cooperi*	3	5	6	14
Pileated Woodpecker	*Dryocopus pileatus*	3	2	1	6
Red-naped Sapsucker	*Sphyrapicus nuchalis*	3	3	1	7
Sage Thrasher	*Oreoscoptes montanus*	3	4	11	18
Western Tanager	*Piranga ludoviciana*	3	3	1	7
Western Wood-pewee	*Contopus sordidulus*	3	4.5	1.5	9
Yellow-bellied Flycatcher	*Empidonax flaviventris*	3	2	1	6
		LAKES, PONDS, AND WETLANDS			

Common Name	Scientific Name(Chesser et al., n.d.)	Endemism Score	Provincial Status Score	Federal Status Score	Final
American Bittern	*Botaurus lentiginosus*	3	3.5	2	8.5
Bank Swallow	*Riparia riparia*	3	3	5	11
Black Tern	*Chlidonias niger*	3	2	1	6
Black-crowned Night-heron	*Nycticorax nycticorax*	3	4	1.5	8.5
Black-necked Stilt	*Himantopus mexicanus*	3	3	2	8
Caspian Tern	*Hydroprogne caspia*	3	4	3	10
Clark's Grebe	*Aechmophorus clarkii*	3	5	4.5	12.5
Eared Grebe	*Podiceps nigricollis*	3	2	1	6
Forster's Tern	*Sterna forsteri*	3	2	2	7
Great Blue Heron	*Ardea herodias*	3	4	2	9
Horned Grebe	*Podiceps auritus*	3	2	3	8
Osprey	*Pandion haliaetus*	3	2	1	6
Peregrine Falcon	*Falco peregrinus*	3	10	3.5	16.5
Pied-billed Grebe	*Podilymbus podiceps*	3	3	1.5	7.5
Piping Plover	*Charadrius melodus*	3	10	9.5	22.5
Purple Martin	*Progne subis*	3	3	1	7
Sandhill Crane	*Antigone canadensis (prev. Grus canadensis)*	3	3	1	7
Sora	*Porzana carolina*	3	2	1	6
Virginia Rail	*Rallus limicola*	3	4	1	8
Western Grebe	*Aechmophorus occidentalis*	3	8	5	16
White-faced Ibis	*Plegadis chihi*	3	5	4	12
White-winged Scoter	*Melanitta deglandi (prev.*	3	4.5	1	8.5

Common Name	Scientific Name(Chesser et al., n.d.)	Endemism Score	Provincial Status Score	Federal Status Score	Final
	Melanitta fusca)				
Yellow Rail	*Coturnicops noveboracensis*	3	4	2.5	9.5

Table 3 - Herptiles Prioritization Matrix

Common Name	Scientific Name[1]	Endemism Score	Provincial Status Score	Federal Status Score	Final
		AMPHIBIANS			
Canadian Toad	*Anaxyrus hemiophrys*	5	6	1	12
Great Plains Toad	*Anaxyrus cognatus*	5	5.5	5	15.5
Northern Leopard Frog	*Lithobates pipiens*	5	8.5	3	16.5
Plains Spadefoot	*Spea bombifrons*	5	5	2.5	12.5
Western Toad	*Anaxyrus boreas*	5	3.5	4.5	13
		REPTILES			
Bullsnake	*Pituophis catenifer sayi*	5	4	3.5	12.5
Greater Short-horned Lizard	*Phrynosoma hernandesi*	5	10	8	23
Plains Gartersnake	*Thamnophis radix*	5	3	1	9
Plains Hog-nosed Snake	*Heterodon nasicu*	5	6	4.5	15.5
Prairie Rattlesnake	*Crotalus viridis viridis*	5	5	4.5	14.5
Red-sided Gartersnake	*Thamnophis sirtalis parietalis*	5	3	1	9
Wandering Gartersnake	*Thamnophis elegans vagrans*	5	3	1	9
Western Painted Turtle	*Chrysemys picta bellii*	5	4.5	1	10.5
Eastern Yellow-bellied Racer	*Coluber constrictor flaviventris*	5	4	7	16

[1] Bonett, R. M., Boundy, J., Burbrink, F. T., Crother, B. I., De Queiroz, K., Frost, D. R., Highton, R., Iverson, J. B., Jockusch, E. L., Kraus, F., Krysko, K. L., Leaché, A. D., Lemmon, E. M., Mcdiarmid, R. W., Mendelson, J. R., Meylan, P. A., Reeder, T. W., Ruane, S., & Seidel, M. E. (2017). SCIENTIFIC AND STANDARD ENGLISH NAMES OF AMPHIBIANS AND REPTILES OF NORTH AMERICA NORTH OF MEXICO, WITH COMMENTS REGARDING CONFIDENCE IN OUR UNDERSTANDING EIGHTH EDITION COMMITTEE ON STANDARD ENGLISH AND SCIENTIFIC NAMES. http://www.ssarherps.org

Table 4 - Mammals Prioritization Matrix

Common Name	Scientific Name[2]	Endemism Score	Provincial Status Score	Federal Status Score	Final
		LARGE MAMMALS			
American Badger	*Taxidea taxus*	5	3	4	12
Bobcat	*Lynx rufus*	5	4	1	10
Long-tailed Weasel	*Mustela frenata*	5	4.5	1	10.5
American bison	*Bos bison*	5	5	3	13
Pronghorn	*Antilocapra americana*	5	2.5	2.5	10
Swift Fox	*Vulpes velox*	5	10.5	8	23.5
		SMALL MAMMALS			
Eastern Red Bat	*Lasiurus borealis*	3	4	1	8
Franklin's Ground Squirrel	*Poliocitellus franklinii (prev. Spermophilus franklinii)*	5	4	1	10
Hoary Bat	*Lasiurus cinereus*	3	4	1	8
Little Brown Myotis	*Myotis lucifugus*	3	4.5	9	16.5
Long-legged Myotis	*Myotis volans*	5	5	1.5	11.5
Northern Grasshopper Mouse	*Onychomys leucogaster*	5	3	1.5	9.5
Northern Long-eared Myotis	*Myotis septentrionalis*	5	5.5	9	19.5
Olive-backed Pocket Mouse	*Perognathus fasciatus*	5	4.5	2.5	12
Ord's Kangaroo Rat	*Dipodomys ordii*	5	11	11	27
Prairie Vole	*Microtus ochrogaster*	5	2.5	1.5	9

[2] Bradley, R.D., L.K. Ammerman, R.J. Baker, L.C. Bradley, J.A. Cook, R.C. Dowler, C. Jones, D.J. Schmidly, F.B. Stangl, Jr., R.A. Van Den Bussche, and B. Würsig. 2014. Revised Checklist of North American Mammals North of Mexico, 2014. Museum of Texas Tech University, Lubbock, Texas, USA.

Common Name	Scientific Name[2]	Endemism Score	Provincial Status Score	Federal Status Score	Final
Silver-haired Bat	*Lasionycteris noctivagans*	3	3.5	1	7.5
Thirteen-lined Ground Squirrel	*Ictidomys tridecemlineatus (prev. Spermophilus tridecemlineatus)*	5	4	1	10
Vagrant Shrew	*Sorex vagrans*	5	7	1	13
Water Vole	*Microtus richardsoni*	5	3	1	9
Western Harvest Mouse	*Reithrodontomys megalotis*	5	6	9	20
Western Small-footed Myotis	*Myotis ciliolabrum*	5	6	3.5	14.5
Yellow-bellied Marmot	*Marmota flaviventris*	5	3	1	9

Table 5 - Invertebrate Prioritization Matrix

Common Name	Scientific Name[3]	Endemism Score	Provincial Status Score	Federal Status Score	Final
beautiful tiger beetle	*Cicindela formosa*	5	3.5	1	9.5
salt creek tiger beetle	*Cicindela nevadica*	5	3	2	10
ghost tiger beetle	*Ellipsoptera lepida*	5	3	3.5	11.5
Bert's Predaceous Diving Beetle	*Sanfilippodytes bertae*	5	5	11	21
A Water Scorpion	*Ranatra fusca*	5	0	0	5
Non-pollinating Yucca Moth	*Tegeticula corruptrix*	5	5	11	21
Yucca Moth	*Tegeticula yuccasella*	5	5	11	21
Five-spotted Bogus Yucca Moth	*Prodoxus quinquepunctella*	5	5	11	21
Small Checkered-skipper	*Pyrgus scriptura*	5	3	5	13
Leonard's skipper	*Hesperia leonardus*	5	5	1	11
Rhesus Skipper	*Polites rhesus*	5	3	5	13
Delaware Skipper	*Anatrytone logan*	5	3	1	9
Woodland Skipper	*Ochlodes sylvanoides*	5	4	1	10
Oslar's Roadside-skipper	*Amblyscirtes oslari*	5	5	4	14
Strecker's giant-skipper	*Megathymus streckeri*	5	5	5	15

[3] Alberta Conservation Information Management System. (2017). Alberta Conservation Information Management System (ACIMS)/Download Data. Retrieved from AlbertaParks.ca: https://www.albertaparks.ca/albertaparksca/management-land-use/alberta-conservation-information-management-system-acims/download-data/

Common Name	Scientific Name[3]	Endemism Score	Provincial Status Score	Federal Status Score	Final
Two-tailed Swallowtail	*Papilio multicaudata*	5	4.5	2	11.5
Edith's copper	*Lycaena editha*	5	3	4.5	12.5
Ruddy Copper	*Lycaena rubidus*	5	4	1	10
Acadian Hairstreak	*Satyrium acadica*	5	4	1	10
Summer Azure	*Celastrina neglecta*	5	3	1	9
Rocky Mountain Dotted Blue	*Euphilotes ancilla*	5	4	3.5	12.5
Arrowhead Blue	*Glaucopsyche piasus*	5	4	2	11
Icarioides Blue	*Plebejus icarioides*	5	3.5	1	9.5
Shasta Blue	*Plebejus shasta*	5	3	1	9
Egleis fritillary	*Speyeria egleis*	5	3	3	11
Gorgone Checkerspot	*Chlosyne gorgone*	5	3.5	1	9.5
Carlota Checkerspot	*Chlosyne gorgone carlota*	5	4	1	10
Sagebrush (Acastus) Checkerspot	*Chlosyne acastus*	5	4	1.5	10.5
Weidemeyer's Admiral	*Limenitis weidemeyerii*	5	7	7	19
Sagebrush Sheep Moth	*Hemileuca hera*	5	4	2.5	11.5
Pale Yellow Dune Moth	*Copablepharon grandis*	5	4.5	6	15.5
Noctuid Moth	*Copablepharon viridisparsa*	5	4	3.5	12.5
Dusky Dune Moth	*Copablepharon longipenne*	5	4	10.5	19.5
Gold-edged Gem Moth	*Schinia avemensis*	5	3.5	11	19.5
Verna Flower Moth	*Schinia verna*	5	4.5	9	18.5
Common Green Darner	*Anax junius*	5	3	1	9
Twelve-spotted Skimmer	*Libellula pulchella*	5	4.5	1	10.5

Common Name	Scientific Name[3]	Endemism Score	Provincial Status Score	Federal Status Score	Final
Striped Meadowhawk	*Sympetrum pallipes*	5	3	1	9
Tule Bluet	*Enallagma carunculatum*	5	3	1	9
River Bluet	*Enallagma anna*	5	4.5	3	12.5
Eastern Forktail	*Ischnura verticalis*	5	3	1	9
Pacific Forktail	*Ischnura cervula*	5	3.5	1	9.5
Western Forktail	*Ischnura perparva*	5	4	1	10
Western Red Damsel	*Amphiagrion abbreviatum*	5	3	2	10
Brimstone Clubtail	*Stylurus intricatus*	5	3.5	4	12.5
Creeping Ancylid	*Ferrissia rivularis*	5	3	1	9

Table 6 - Plant Prioritization Matrix

Common Name	Scientific Name[4]	Endemism Score	Provincial Status Score	Federal Status Score	Final
American bugseed	*Corispermum americanum var. americanum*	5	4	2	11
annual dropseed	*Sporobolus neglectus*	5	4	1.5	10.5
annual skeletonweed	*Shinnersoseris rostrata*	5	3	3.5	11.5
arctic bladderpod	*Physaria arctica*	5	3	1.5	9.5
aridland goosefoot	*Chenopodium desiccatum*	5	3	2.5	10.5
awned nut-grass	*Cyperus squarrosus*	5	4	1.5	10.5
biscuit-root	*Lomatium cous*	5	5	1.5	11.5
blister sedge	*Carex vesicaria*	5	5	1	11
blue camas	*Camassia quamash var. quamash*	5	3	2	10
blue phlox	*Phlox alyssifolia*	5	4	3	12
blunt-leaved watercress	*Rorippa curvipes*	5	3	1	9
buff fleabane	*Erigeron ochroleucus*	5	5	4	14
bur ragweed	*Ambrosia acanthicarpa*	5	3	1	9
Californian amaranth	*Amaranthus californicus*	5	3.5	1	9.5
Canada toad-flax	*Nuttallanthus texanus*	5	4	3	12
Canada waterweed	*Elodea canadensis*	5	4	1	10
Canada wood-nettle	*Laportea canadensis*	5	5	1	11
Castlegar hawthorn	*Crataegus castlegarensis*	5	5	1	11

[4] Alberta Conservation Information Management System. (2017). Alberta Conservation Information Management System (ACIMS)/Download Data. Retrieved from AlbertaParks.ca: https://www.albertaparks.ca/albertaparksca/management-land-use/alberta-conservation-information-management-system-acims/download-data/

Common Name	Scientific Name[4]	Endemism Score	Provincial Status Score	Federal Status Score	Final
chaffweed	*Lysimachia minima*	5	3.5	2.5	11
clammy hedge-hyssop	*Gratiola neglecta*	5	3	1	9
cock's-comb cryptantha	*Euphilotes ancilla*	5	4	3.5	12.5
Collins' rockcress	*Glaucopsyche piasus*	5	4	2	11
common beggarticks	*Cryptantha celosioides*	5	3.5	2	10.5
conimitella	*Boechera collinsii*	5	5	1	11
corymbose everlasting	*Bidens frondosa*	5	3	1	9
Crawe's sedge	*Conimitella williamsii*	5	4	4	13
creeping draba	*Antennaria corymbosa*	5	4	3.5	12.5
crested beardtongue	*Carex crawei*	5	3	2	10
crowfoot violet	*Draba reptans*	5	4	3	12
cushion everlasting	*Penstemon eriantherus*	5	4	2.5	11.5
downingia	*Viola pedatifida*	5	3	2	10
downy paintbrush	*Antennaria dimorpha*	5	4	2	11
dwarf fleabane	*Downingia laeta*	5	3	4	12
dwarf woollyheads	*Castilleja sessiliflora*	5	5	1	11
early buttercup	*Erigeron radicatus*	5	3	3.5	11.5
Engelmann's spike-rush	*Psilocarphus brevissimus var. brevissimus*	5	4	5.5	14.5
false buffalo grass	*Ranunculus glaberrimus*	5	3	1	9
few-flowered aster	*Eleocharis engelmannii*	5	4	4	13
field grape fern	*Munroa squarrosa*	5	3	4	12
flowering-quillwort	*Almutaster pauciflorus*	5	3	2	10

Common Name	Scientific Name[4]	Endemism Score	Provincial Status Score	Federal Status Score	Final
Fremont's goosefoot	Chenopodium fremontii	5	4	1	10
green milkweed	Asclepias viridiflora	5	5	1	11
hairy bugseed	*Corispermum villosum*	5	4	2.5	11.5
hairy pepperwort	*Marsilea vestita*	5	3	3.5	11.5
hare-footed locoweed	*Oxytropis lagopus var. conjugans*	5	8	9	22
Hooker's bugseed	*Corispermum hookeri var. hookeri*	5	4	1.5	10.5
Kelsey's cat's eye	*Cryptantha kelseyana*	5	3	4	12
lance-leaved loosestrife	*Lysimachia hybrida*	5	3	1	9
lance-leaved lungwort	*Mertensia lanceolata*	5	4	3	12
Lemmon's rockcress	*Boechera lemmonii*	5	3	1	9
limber pine	*Pinus flexilis*	5	9	6.5	20.5
linear-leaved montia	*Montia linearis*	5	4	2	11
linear-leaved scorpionweed	*Phacelia linearis*	5	3	1	9
little barley	*Hordeum pusillum*	5	1	2	8
low cinquefoil	*Potentilla plattensis*	5	4	2	11
low yellow evening-primrose	*Oenothera flava*	5	3	3	11
mealy goosefoot	*Chenopodium incanum var. incanum*	5	5	1	11
Moquin's sea-blite	*Suaeda nigra*	5	3	3	11
mountain gooseberry	*Ribes inerme var. inerme*	5	4	2	11
mountain lady's-slipper	*Cypripedium montanum*	5	4	2.5	11.5

Common Name	Scientific Name[4]	Endemism Score	Provincial Status Score	Federal Status Score	Final
mouse-ear cress	*Eutrema salsugineum*	5	5	1	11
narrowleaf umbrella-wort	*Mirabilis linearis*	5	4	3	12
Navajo tea	*Thelesperma subnudum var. marginatum*	5	5	5	15
Nebraska sedge	*Carex nebrascensis*	5	3	4	12
Nevada rush	*Juncus nevadensis*	5	5	2	12
nodding microseris	*Microseris nutans*	5	4	1	10
nodding umbrella-plant	*Eriogonum cernuum*	5	3	4	12
northern linanthus	*Leptosiphon septentrionalis*	5	4	2	11
northern wild rice	*Zizania palustris var. palustris*	5	5	1.5	11.5
pale bulrush	*Scirpus pallidus*	5	5	2	12
Pallas' bugseed	*Corispermum pallasii*	5	4	2.5	11.5
pasture sedge	*Carex petasata*	5	3	1	9
picradeniopsis	*Picradeniopsis oppositifolia*	5	5	4.5	14.5
pinesap	*Hypopitys monotropa*	5	3	1	9
poison suckleya	*Suckleya suckleyana*	5	3	2	10
Powell's saltbush	*Atriplex powellii*	5	4	4.5	13.5
prairie cord grass	*Spartina pectinata*	5	4	1	10
prairie false dandelion	*Nothocalais cuspidata*	5	4	3.5	12.5
prickly milk vetch	*Astragalus kentrophyta var. kentrophyta*	5	4	4	13
red three-awn	*Aristida purpurea var. longiseta*	5	3	2	10
rockstar	*Lithophragma glabrum*	5	4	1	10

Common Name	Scientific Name[4]	Endemism Score	Provincial Status Score	Federal Status Score	Final
rough barnyard grass	*Echinochloa muricata var. microstachya*	5	5	1	11
saltbush	*Atriplex truncata*	5	5	2	12
sand verbena	*Tripterocalyx micranthus*	5	9	10.5	24.5
sandhills cinquefoil	*Potentilla lasiodonta*	5	3	3	11
short-stalk mouse-ear chickweed	*Cerastium brachypodum*	5	3	2	10
shrubby evening-primrose	*Oenothera serrulata*	5	3	1	9
side-oats grama	*Bouteloua curtipendula*	5	5	3	13
slender cress	*Rorippa tenerrima*	5	3	2.5	10.5
slender hawk's-beard	*Crepis atribarba*	5	4	1	10
slender mouse-ear-cress	*Transberingia bursifolia ssp. virgata*	5	10	8.5	23.5
slender phlox	*Microsteris gracilis ssp. gracilis*	5	5	1.5	11.5
small baby-blue-eyes	*Nemophila breviflora*	5	3	2	10
small-flowered rockstar	*Lithophragma parviflorum*	5	4	1	10
smooth boisduvalia	*Epilobium campestre*	5	3	3.5	11.5
smooth cliff brake	*Pellaea glabella ssp. simplex*	5	4	2.5	11.5
smooth goosefoot	*Chenopodium subglabrum*	5	4	7	16
smooth sweet cicely	*Osmorhiza longistylis*	5	3	4.5	12.5
soapweed	*Yucca glauca*	5	11	9	25
spatulate bladderpod	*Physaria spatulata*	5	3.5	3	11.5

Common Name	Scientific Name[4]	Endemism Score	Provincial Status Score	Federal Status Score	Final
spatulate-leaved heliotrope	*Heliotropium curassavicum*	5	3	2	10
spiked lobelia	*Lobelia spicata*	5	5	1	11
spreading pearlwort	*Sagina decumbens*	5	1	1	7
spreading yellow cress	*Rorippa sinuata*	5	4	2	11
squirreltail	*Elymus elymoides ssp. elymoides*	5	3.5	2	10.5
swamp dodder	*Cuscuta gronovii*	5	5	1	11
tall beggarticks	*Bidens vulgata*	5	5	1	11
Taraxia	*Taraxia breviflora*	5	5	4.5	14.5
thorough-wax	*Bupleurum americanum*	5	4	1.5	10.5
tiny cryptantha	*Cryptantha minima*	5	10	7	22
tumble grass	*Schedonnardus paniculatus*	5	4	3	12
two-leaved waterweed	*Elodea bifoliata*	5	4	3.5	12.5
upland evening-primrose	*Neoholmgrenia andina*	5	5	4	14
water hyssop	*Bacopa rotundifolia*	5	5	5	15
water-thread pondweed	*Potamogeton diversifolius*	5	1	1	7
waterwort	*Elatine triandra*	5	4	2.5	11.5
Watson's goosefoot	*Chenopodium watsonii*	5	4	4	13
western bistort	*Polygonum bistortoides*	5	4	2.5	11.5
western blue flag	*Iris missouriensis*	5	8	6	19
western false gromwell	*Lithospermum occidentale*	5	3	1	9
western false-asphodel	*Triantha occidentalis ssp. montana*	5	5	1	11

Common Name	Scientific Name[4]	Endemism Score	Provincial Status Score	Federal Status Score	Final
western spiderwort	*Tradescantia occidentalis*	5	11	8	24
widgeon-grass	*Ruppia cirrhosa*	5	3	2	10

Appendices

APPENDIX A: PRIORITIZED BIRD SPECIES GENERAL HABITAT ASSOCIATIONS

Common Name	Scientific Name	Primary Habitat	Foraging Needs	Nesting Needs	Winter Needs	Home Range/Foraging Range/Breeding Territory
Bobolink	*Dolichonyx oryzivorus*	Grassland	Seeds	Ground	Migratory - NA	0.45-2.0 ha SEE (COSEWIC, 2010a)
Burrowing Owl	*Athene cunicularia*	Grassland	Small Animals	Burrow	Migratory - NA	240 ha – 370 ha SEE (COSEWIC, 2017)
Chestnut-collared Longspur	*Calcarius ornatus*	Grassland	Insects	Ground	Migratory - NA	39 ha, area sensitive, avoided crop and wetland edges SEE (COSEWIC, 2019a)
Clark's Grebe	*Aechmophorus clarkii*	Marshes	Fish	Floating	Migratory - NA	
Common Nighthawk	*Chordeiles minor*	Grassland	Insects	Ground	Migratory - NA	10 – 28.3 ha SEE (COSEWIC, 2007a)
Ferruginous Hawk	*Buteo regalis*	Grassland	Mammals	Tree	Migratory - NA	300-13600 ha SEE

Common Name	Scientific Name	Primary Habitat	Foraging Needs	Nesting Needs	Winter Needs	Home Range/Foraging Range/Breeding Territory
						(COSEWIC, 2021a)
Greater Sage-grouse	*Centrocercus urophasianus*	Grassland	Plants	Ground	Sage brush communities	Can move more than 10km SEE COSEWIC 2008
Lark Bunting	*Calamospiza melanocorys*	Grassland	Insects	Ground	Migratory	> 1000 ha native prairie SEE (COSEWIC, 2017a)
Loggerhead Shrike	*Lanius ludovicianus*	Open Woodlands	Insects	Tree	Migratory	2.9 – 47 ha SEE (COSEWIC, 2014a)
Long-billed Curlew	*Numenius americanus*	Grassland	Aquatic Invertebrates	Ground	Migratory	6-20 ha SEE (COSEWIC, 2002)
Mountain Plover	*Charadrius montanus*	Grassland	Insects	Ground (disturbed)	Migratory	3-50 ha (nesting) 28-243 ha (brood rearing) SEE (COSEWIC, 2009a)
Olive-sided Flycatcher	*Contopus cooperi*	Open Woodlands	Insects	Tree	Migratory	10-20 ha SEE (COSEWIC, 2018b)
Peregrine Falcon	*Falco peregrinus*	Shorelines	Birds	Cliff	Migratory	Foraging ~5 ha Mean 780 to 5000 ha SEE

Common Name	Scientific Name	Primary Habitat	Foraging Needs	Nesting Needs	Winter Needs	Home Range/Foraging Range/Breeding Territory
						(COSEWIC, 2017b)
Piping Plover	*Charadrius melodus*	Shorelines	Aquatic Invertebrates	Ground	Migratory	Not defined SEE (COSEWIC, 2013b)
Sage Thrasher	*Oreoscoptes montanus*	Scrub – sage brush	Insects	Shrub – large sage brush (>1m)	Migratory	0.5 – 8 ha SEE (COSEWIC, 2010c)
Short Eared Owl	*Asio flammeus*	Grassland	Mammals	Ground	Migratory	50-100 ha SEE (COSEWIC, 2021b)
Sprague's Pipit	*Anthus spragueii*	Grassland	Insects	Ground	Migratory	145 ha (60-314 ha) SEE (COSEWIC, 2010d)
Thick-billed Longspur (prev. McCown's)	*Rhynchophanes mccownii (prev. Calcarius mccownii)*	Grassland	Seeds	Ground	Migratory	0.6 – 1.4 ha SEE (COSEWIC, 2016a)
Western Grebe	*Aechmophorus occidentalis*	Lakes and Ponds (medium to large)	Fish	Floating (colonies)	Migratory	Lake size 75 to 11600 ha and 1.7 – 49.9m in depth SEE (COSEWIC, 2014b)
White-faced Ibis	*Plegadis chihi*	Marshes	Aquatic Invertebrates	Ground	Migratory	

APPENDIX B: PRIORITIZED HERPTILE SPECIES GENERAL HABITAT ASSOCIATIONS

Common Name	Scientific Name	Primary Habitat	Foraging Needs	Reproductive Needs	Winter Needs	Home Range
Eastern Yellow-bellied Racer	*Coluber constrictor flaviventris*	Grassland [RANGE EXTENT]	Mammals Adjacent (to dens) lowlands or riparian areas		Hibernacula South facing slopes of steep river valleys Slump zones	99-191 ha Up to 5km from den SEE (COSEWIC, 2015)
Great Plains Toad	*Anaxyrus cognatus*	Wetlands Clean, clear	Invertebrates	Permanent Water 0.5-1.5m Clear to semi-clear	Suitable soils for burrowing	Up to 914m from natal pond Up to 1600 km from nearest breeding site SEE (COSEWIC, 2010b)
Greater Short-horned Lizard	*Phrynosoma hernandesi*	Grassland Sparsely vegetated, south-facing slopes, friable soils, bare soil	Invertebrates		Not clear – hibernation sites, aspect may be important in Alberta	<0.01 – 0.4ha SEE (COSEWIC, 2018a)
Northern Leopard Frog	*Lithobates pipiens*	Wetlands	Invertebrates Fresh meadow, shallow marsh,	Permanent / Semi Permanent Water no deeper than 2m pH neutral, lack fish	Well oxygenated waterbodies that do not freeze to bottom	May travel up to 1.6 km <0.01-0.06ha SEE (COSEWIC, 2009d)

Common Name	Scientific Name	Primary Habitat	Foraging Needs	Reproductive Needs	Winter Needs	Home Range
Plains Hog-nosed Snake	*Heterodon nasicu*	Grassland Sandy soils	Mammals	Lowland sites, sandy soils	Sandy soils	Short movements <0.01-72 ha SEE (COSEWIC, 2019b)

APPENDIX C: PRIORITIZED MAMMAL SPECIES GENERAL HABITAT ASSOCIATIONS

Common Name	Scientific Name	Primary Habitat	Foraging Needs	Reproductive Needs	Winter Needs	Home Range
Little Brown Myotis	*Myotis lucifugus*	Grasslands and beyond	Within commuting distance of roosting/maternity areas Over still water, rivers, forest gaps Preference for deciduous over coniferous? Older forest Insects	Roosting/maternity areas Attics, bridges, rock crevices or cavities of canopy trees	Hibernacula Cave/mine	Foraging - <20ha Home Range - 30.1 ha SEE (COSEWIC, 2013a)
Northern Long-eared Myotis	*Myotis septentrionalis*	Northern Grasslands/Parklands and Boreal	Within commuting distance of roosting/maternity areas Over still water, rivers, forest gaps Preference for deciduous over coniferous? Older forest Insects	Strongly associated with density and characteristics of trees	Hibernacula Cave/mine	Home range – 65 ha SEE (COSEWIC, 2013a)
Ord's Kangaroo Rat	*Dipodomys ordii*	Arid grasslands and deserts				Juvenile dispersal - <500m Brands 2016

Common Name	Scientific Name	Primary Habitat	Foraging Needs	Reproductive Needs	Winter Needs	Home Range
		Open sparsely vegetated sandy habitats				Isolated >25km Severe fragmentation as per IUCN 2016
Swift Fox	*Vulpes velox*	Short or mixed-grass on level terrain or gently rolling hills Native over cropland Moisture, topography, cropland, and fragmentation are variables that explain presence (Moehrenschlager et al., 2007)	Fossorial mammals (water may not be required but enhances habitat quality) Birds, eggs, insects, plants, and carrion	Badgers and ground squirrels provide burrows for modification Use many dens within 100-200 ha area Short grass, well drained soils, tops of hills with gradual slopes		Habitat parameters affected occurrence more than 5km from release Juvenile dispersal <15km Home range correlated with prey abundance and mean of 3100ha SEE (COSEWIC, 2009c)
Western Harvest Mouse	*Reithrodontomys megalotis*	Tall herbaceous cover Grasslands/shrub steppe				DATA DEFICIENT 0.44-0.95 ha Dispersal ~300m

Common Name	Scientific Name	Primary Habitat	Foraging Needs	Reproductive Needs	Winter Needs	Home Range
		Dychei subspecies – low relief, flat or gently undulating grasslands, sandy soils				SEE (COSEWIC, 2019d)
Western Small-footed Myotis	*Myotis ciliolabrum*					ASRD/ACA 2008

APPENDIX D: PRIORITIZED INVERTEBRATE SPECIES GENERAL HABITAT ASSOCIATIONS

Common Name	Scientific Name	Primary Habitat	Home Range
Bert's Predaceous Diving Beetle	*Sanfilippodytes bertae*	Natural and relatively pristine spring and seep habitat along steep cliff edges or river banks	Only identified on 2 sites near Fort Macleod SEE (COSEWIC, 2009b)
Non-pollinating Yucca Moth	*Tegeticula corruptrix*	Soapweed stands restricted to Dry Mixedgrass Subregion Soapweed found on well-drained coulee slopes generally eroded, dry and sparsely vegetated Southfacing slopes Soils – alkaline and regosolic without shallow hardpan Eroding kame slopes dominated by sage brush	Two known locations in AB along Milk River and Lost River SEE (COSEWIC, 2013c)
Yucca Moth	*Tegeticula yuccasella*	Soapweed stands restricted to Dry Mixedgrass Subregion Soapweed found on well-drained coulee slopes generally eroded, dry and sparsely vegetated Southfacing slopes Soils – alkaline and regosolic without shallow hardpan Eroding kame slopes dominated by sage brush	Two known locations in AB along Milk River and Lost River SEE (COSEWIC, 2013c)
Five-spotted Bogus Yucca Moth	*Prodoxus quinquepunctella*	Soapweed stands restricted to Dry Mixedgrass Subregion Soapweed found on well-drained coulee slopes generally eroded, dry and sparsely vegetated Southfacing slopes Soils – alkaline and regosolic without shallow hardpan Eroding kame slopes dominated by sage brush	Two known locations in AB along Milk River and Lost River SEE

Common Name	Scientific Name	Primary Habitat	Home Range
			(COSEWIC, 2013c)
Oslar's Roadside-skipper	*Amblyscirtes oslari*		
Strecker's giant-skipper	*Megathymus streckeri*		
Pale Yellow Dune Moth	*Copablepharon grandis*	Sparsely vegetated grasslands with patches of open sand Transition zones between active and stable dunes Sandy blowouts, dune ridges, road cuts, unvegetated fire guards Glaciofluvial or glaciodeltaic sand deposits	Extends further north SEE (COSEWIC, 2018c)
Dusky Dune Moth	*Copablepharon longipenne*	Sparsely vegetated active sand dunes and blowouts (>75% open sand) Regosols	Min 0.5 ha SEE (COSEWIC, 2007b)
Gold-edged Gem Moth	*Schinia avemensis*	Obligate dune specialists within range of presumed host plant Prairie Sunflower (Helianthus petiolaris) Glaciofluvial or glaciodeltaic sand deposits Open, barren or sparsely vegetated sand dunes or sandy hill areas (actively eroding)	Min <1ha dunes or blowouts SEE (COSEWIC, 2016b)
Verna Flower Moth	*Schinia verna*	Grassland (parkland at northern extent) Broad-leaved Antennaria and Low Antennaria associations In AB – north facing, grassland valley slope, Antennaria common in association with avens and june grass	SEE (COSEWIC, 2017c)

APPENDIX E: PRIORITIZED PLANT SPECIES GENERAL HABITAT ASSOCIATIONS

Common Name	Scientific Name	Soils	Temperature	Moisture	Distribution Ability
buff fleabane	*Erigeron ochroleucus*				
Conimitella	*Conimitella williamsii*				
corymbose everlasting	*Antennaria corymbosa*				
dwarf woollyheads	*Psilocarphus brevissimus var. brevissimus*				
Engelmann's spike-rush	*Eleocharis engelmannii*				
hare-footed locoweed	*Oxytropis lagopus var. conjugans*				
limber pine	*Pinus flexilis*				
Navajo tea	*Thelesperma subnudum var. marginatum*				
picradeniopsis	*Picradeniopsis oppositifolia*				
Powell's saltbush	*Atriplex powellii*				
prairie false dandelion	*Nothocalais cuspidata*				

Common Name	Scientific Name	Soils	Temperature	Moisture	Distribution Ability
prickly milk vetch	*Astragalus kentrophyta var. kentrophyta*				
sand verbena	*Tripterocalyx micranthus*				
side-oats grama	*Bouteloua curtipendula*				
slender mouse-ear-cress	*Transberingia bursifolia ssp. virgata*				
smooth sweet cicely	*Osmorhiza longistylis*				
Soapweed	*Yucca glauca*				
Taraxia	*Taraxia breviflora*				
tiny cryptantha	*Cryptantha minima*				
two-leaved waterweed	*Elodea bifoliata*				
upland evening-primrose	*Neoholmgrenia andina*				
water hyssop	*Bacopa rotundifolia*				
western blue flag	*Iris missouriensis*				

Common Name	Scientific Name	Soils	Temperature	Moisture	Distribution Ability
western spiderwort	*Tradescantia occidentalis*				

APPENDIX F: PRELIMINARY LIST OF DATA SOURCES FOR ISOLATED HABITATS MAPPING

Agricultural Regions of Alberta Soil Inventory Database (AGRASID) –
Access - https://www.alberta.ca/agricultural-regions-of-alberta-soil-inventory-database.aspx
Viewer - https://www.alberta.ca/alberta-soil-information-viewer.aspx

Alberta Fish and Wildlife Management Information System (FWMIS)
Access - https://www.alberta.ca/fisheries-and-wildlife-management-information-system.aspx
Note – sensitive data and specific locations will require requests and permission

Alberta Conservation Information Management System (ACIMS) – includes element occurrence, protected areas, Crown reservations, environmentally significant areas, and natural regions
Access - https://www.albertaparks.ca/albertaparksca/management-land-use/alberta-conservation-information-management-system-acims/
Notes – Sensitive occurrences buffered to township level

Annual Crop Inventory – Agriculture and Agri-Food Canada
Access - https://open.canada.ca/data/en/dataset/ba2645d5-4458-414d-b196-6303ac06c1c9

Canadian Digital Elevation Model (CDEM) –
Access - https://www.nrcan.gc.ca/science-and-data/science-and-research/earth-sciences/geography/topographic-information/download-directory-documentation/17215

Canvec
Access - https://open.canada.ca/data/en/dataset/8ba2aa2a-7bb9-4448-b4d7-f164409fe056

GeoDiscover Alberta
Access - https://geodiscover.alberta.ca/geoportal/#homePanel

Grassland Vegetation Inventory (GVI) – 14 upland range site descriptions, 10 wetland/riparian feature classes, 4 anthropogenic agricultural classes, 2 industrial classes, 2 anthropogenic urban/rural classes
Specifications – ASRD 2011
Access - https://open.alberta.ca/opendata/gda-d3ab9031-8ec0-4589-9335-c1e50ae05992
Viewer - https://geodiscover.alberta.ca/geoportal/rest/metadata/item/9dea946a24314ca399b89723fcd857fc/html

Multi-species Conservation Value Modelling within the Grasslands Natural Region of Alberta
Report - http://multisar.ca/wp-content/uploads/2021/01/MULTISAR-MCV-Report_Final.pdf

National Hydro Network (NHN)
Access - https://open.canada.ca/data/en/dataset/a4b190fe-e090-4e6d-881e-b87956c07977

National Road Network (NRN)
Access - https://open.canada.ca/data/en/dataset/3d282116-e556-400c-9306-ca1a3cada77f

Quarternary Geology of Southern Alberta - Deposits

Access - https://open.alberta.ca/opendata/gda-dig_2007_0012

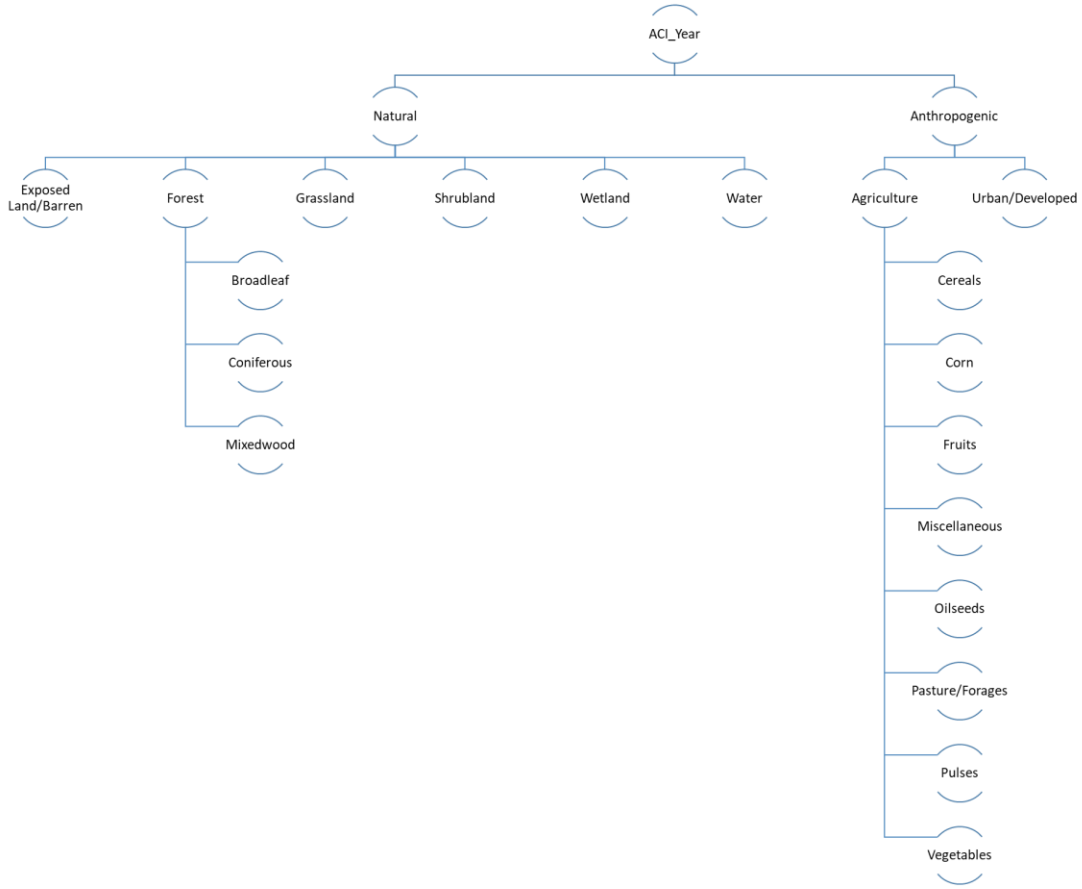
APPENDIX G: GIS STEPS FOR PRELIMINARY PATCH ANALYSIS

Set Projection to NAD83 – TTM (AEP)
Add Natural Regions (from ACIMS)
Add Annual Crop Inventory 2019 (available from ArcGIS Online as image server)

- Convert to Polygon
- Dissolve to CropType (AAFC primary class – Level 3)
- Clip Annual Crop Inventory 2019 to extent of Grasslands Natural Region
- Add Area/Perimeter (Calculate Geometry)
- Remove all edge polygons that are less than $900m^2$ (30m x 30m pixel)
- Add Field – Natural (Level 1)
- Select all natural cover types and use field calculator to create "Natural" Class
- Switch selection and use field calculator to create "Anthro" Class
- Calculate Fractal Patch Dimension (McGarigal, 2015) (Field Calculator)
- Calculate Shape Index (McGarigal, 2015) (Field Calculator)
- Add Field – Natural2 (Level 2)
- Create summary categories – Nat_wetland, trees, shrub, grass, exposed, wetland, water, Anthro_urban, crop
- *Note Level 3 is existing CropType column from original raster

- Use Patch Analyst – Dissolve Features – using Natural2 field
- Recalculate Area and Perimeter FRAC and SHAPEIND
- Summarize Data

Level 1	Level 2	Level 3
Anthropogenic	*AG_Cereals*	Cereals
		Barley
		Other Grains
		Millet
		Oats
		Rye
		Spelt
		Triticale
		Wheat
		Winter Wheat
		Spring Wheat
	AG_Corn	Corn
	AG_Misc	Agriculture (undifferentiated)
		Too Wet to be Seeded
		Fallow
		Herbs
		Nursery
		Canaryseed
		Hemp
		Other Crops
	AG_Oilseeds	Oilseeds
		Camelina
		Canola / Rapeseed
		Flaxseed
		Mustard
		Safflower
		Sunflower
		Soybeans
	Pasture / Forages	Pasture / Forages
	AG_Pulses	Pulses
		Other Pulses
		Peas
		Chickpeas
		Beans
		Fababeans
		Lentils
	AG_Vegetables	Vegetables
		Potatoes
		Sugarbeets
		Other Vegetables
	Urban / Developed	Urban / Developed
		Greenhouses
Natural	*Water*	Water
	Exposed Land / Barren	Exposed Land / Barren
	Shrubland	Shrubland
	Wetland	Wetland
	Grassland	Grassland
	Forest	Coniferous
		Broadleaf
		Mixedwood


ACI_Year
Natural
Anthropogenic
Exposed Land/Barren
Forest
Grassland
Shrubland
Wetland
Water
Agriculture
Urban/Developed
Broadleaf
Coniferous
Mixedwood
Cereals
Corn
Fruits
Miscellaneous
Oilseeds
Pasture/Forages
Pulses
Vegetables

Grass	Trees	Wheat	Wheat	Wheat	Wheat	Canola	Canola	Canola	Canola
Grass	Grass	Wheat	Wheat	Wheat	Wheat	Canola	Canola	Canola	Canola
Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed
Developed	Potatoes	Potatoes	Potatoes	Potatoes	Developed	Grass	Grass	Grass	Grass
Developed	Potatoes	Potatoes	Potatoes	Potatoes	Developed	Grass	Grass	Grass	Grass
Developed	Potatoes	Potatoes	Potatoes	Potatoes	Developed	Shrubs	Wetland	Wetland	Wetland
Developed	Potatoes	Potatoes	Potatoes	Potatoes	Developed	Trees	Wetland	Water	Wetland
Developed	Developed	Developed	Developed	Developed	Developed	Shrubs	Wetland	Water	Water

Grass	Trees	Wheat	Wheat	Wheat	Wheat	Canola	Canola	Canola	Canola
Grass	Grass	Wheat	Wheat	Wheat	Wheat	Canola	Canola	Canola	Canola
Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed
Developed	Potatoes	Potatoes	Potatoes	Potatoes	Developed	Grass	Grass	Grass	Grass
Developed	Potatoes	Potatoes	Potatoes	Potatoes	Developed	Grass	Grass	Grass	Grass
Developed	Potatoes	Potatoes	Potatoes	Potatoes	Developed	Shrubs	Wetland	Wetland	Wetland
Developed	Potatoes	Potatoes	Potatoes	Potatoes	Developed	Trees	Wetland	Water	Wetland
Developed	Developed	Developed	Developed	Developed	Developed	Shrubs	Wetland	Water	Water