Manitoba Alvar Initiative

Alvars in Manitoba: A Description of their Extent, Characteristics and Land Use

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ABSTRACT

Alvar is a globally uncommon ecological community. A number of biologists have identified sites in Manitoba's Interlake region with characteristics resembling alvar. The Manitoba Alvar Initiative's 2012 objectives included the systematic mapping and description of potential alvar sites. Approximately 3930 hectares (9720 acres) of alvar were identified, broken down into four major types: (a) alvar grassland, (b) alvar shrubland, (c) alvar savannah and (d) alvar wetland. Alvar shrubland was further subdivided into four putative community subtypes and alvar savannah into three putative subtypes. Associated inland cliff communities were also identified and mapped. A number of provincially, nationally and globally rare species associated with alvar and inland cliff communities were identified, including *Pellaea gastonyi* (Gastony's cliffbrake), *Pellaea glabella* subsp. *occidentalis* (Western Dwarf Cliffbrake) and *Grimmia teretinervis* (Grimmia Dry Rock Moss). Two-thirds of the extent of alvar in Manitoba occurs on Crown land. More than three-quarters is grazed. Approximately 30% of the extent of alvar in Manitoba is overlain by some form of mineral resource development allocation (mining claim or quarry lease). The results of 2012 inventories represent an important dataset to be used in the development of a formal community classification, and in conservation outreach and action.

INTRODUCTION

Status

Alvar is a globally uncommon habitat characterized by a thin or absent layer of soil over a limestone or dolomite bedrock pavement (Reschke et al. 1999, Catling & Brownell 1995). The bedrock restricts water drainage and retention, which can cause periodic flooding and drought conditions. This harsh growing environment results in a unique composition of plants, lichen and bryophytes. The karst topography associated with alvar sites also supports features such as limestone cliffs and sinkholes which contain provincially, nationally and globally rare species.

In Canada, alvar is found in the Great Lakes Region, Manitoba's Interlake, the West Coast of Newfoundland, Quebec and the Northwest Territories (Catling 2009, Reschke et al. 1999). The distribution of alvar is fragmented and loosely follows the edge of the Canadian Shield where postglacial meltwaters exposed limestone bedrock. The exact extent of these communities is not yet known. (Catling 2009).

Alvars are considered distinct habitat because of the unusual composition of species found within them. The harsh conditions created by the thin soil mantle results in a high cover of mosses and lichens in some alvars. Although the plant species present are often similar to those of a prairie, their relative abundance is quite different. In other alvars, there may be a mixture of boreal and prairie species that are not usually closely associated with each other and distinguish them from forest and grassland ecosystems. Like forest and grassland, alvar can be differentiated into community types. The Great Lakes alvars, for example, have been differentiated into 13 types (Reschke et al. 1999).

Prior to this study, alvar-like ecosystems in Manitoba were thought to occur in the Interlake region between the southern basins of Lakes Manitoba and Winnipeg (Hamel & Foster 2004)(Fig. 1). Their full extent, variation and conservation status was not known, however, and suspected sites were limited to the central portion of the Interlake region, associated with near-surface dolomitic limestone pavement.

Manitoba Alvar Initiative

In 2010 The Nature Conservancy of Canada (NCC) began developing a landscape-scale conservation plan for the southern Interlake. The planning process highlighted the unique contribution of these alvar-like communities to the overall biodiversity of the Interlake, but also highlighted the lack of knowledge regarding the extent, condition and classification of the community. Manitoba Conservation & Water Stewardship as well as the Manitoba Association of Plant Biologists shared a similar interest in the community type, and jointly and separately held several field reconnaissance trips to various sites in the Interlake. NCC's Chief Science Officer, John Riley participated in one of these trips, and concluded that most sites of interest had physical and biological attributes similar to other North American alvar sites, and could be referred to as 'alvar'. Subsequently, the Manitoba Association of Plant Biologists (MAPB) nominated a site for designation as a provincial Ecological Reserve.

The ‘Manitoba Alvar Initiative’ was developed in 2012 in order to provide a multi-partner framework through which key questions about alvar status and ecology could be answered. The Initiative’s steering committee is made up of representatives from the Nature Conservancy of Canada, Manitoba Conservation & Water Stewardship and, the Manitoba Association of Plant Biologists. Objectives of the Initiative were threefold: 1) survey all known and potential alvar and inland cliff sites, delimit site boundaries and determine degree of private vs public ownership; 2) identify first-approximation alvar subtypes using information collected on site structure, vegetation cover and land use 3)conduct detailed site assessments (structure and vegetation cover, site health and field-test collection methods and health or Element Occurrence (EO) ranking criteria.

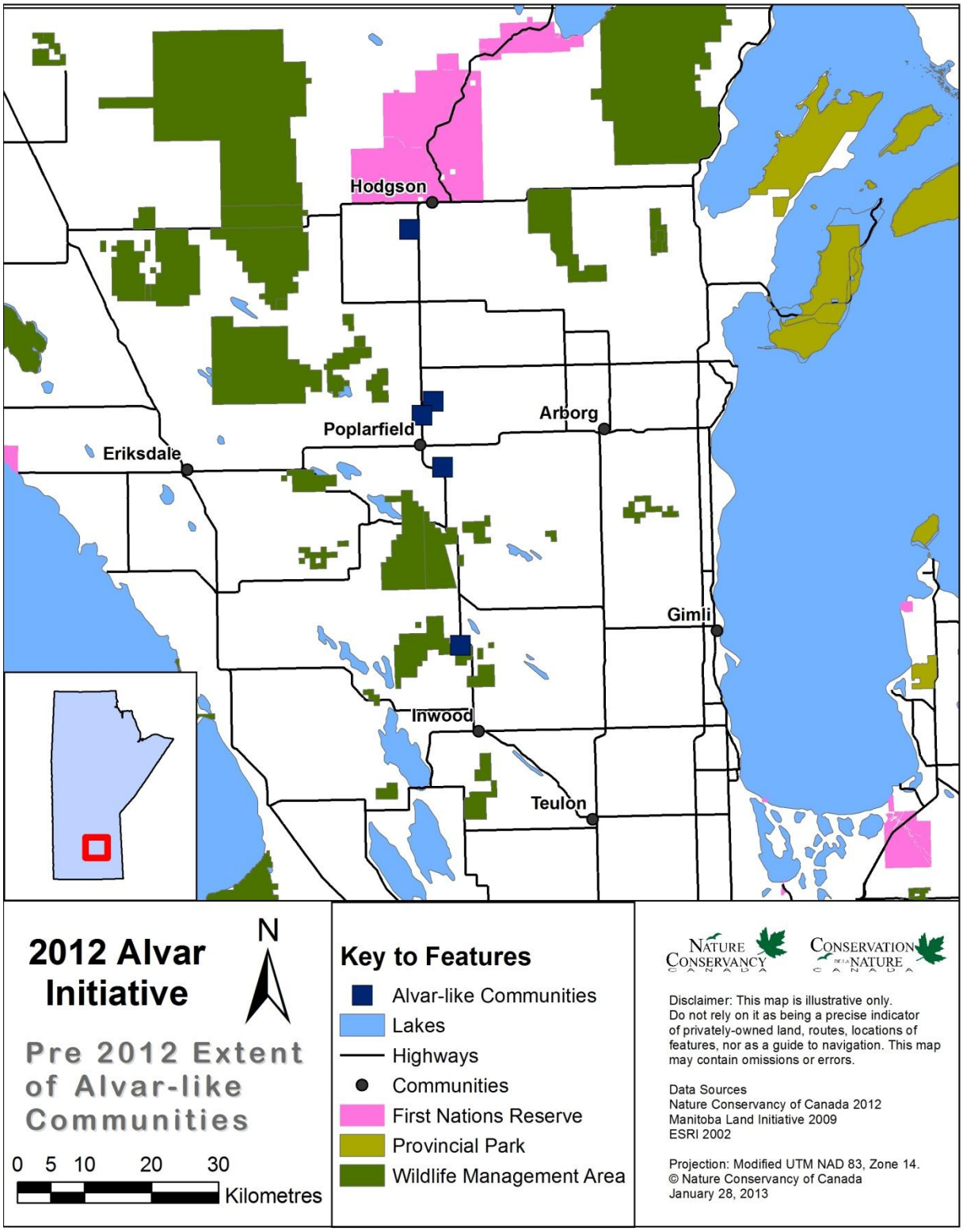

Figure 1. Pre- 2012 extent of alvar-like communities, adapted from Hamel and Foster (2004)

METHODS

Several dozen potential alvar sites in the south Interlake and adjacent regions were identified using GIS by overlaying orthophotos with Manitoba soil classification layers that indicated the occurrence of limestone bedrock at or near the surface (Manitoba Land Initiative 2009). A digital elevation model (DEM) (Manitoba Land Initiative 2009) was examined and areas of relatively rapid elevation change were noted as potential sites for alvar/inland cliff complexes and then compared with the soil classification layers to determine if limestone bedrock coincided with the elevation change. These potential sites were then examined on the orthophotos to see if they matched alvar characteristics in land cover. A total of 67 potential sites in the south Interlake and adjacent regions were identified, encompassing 6313 hectares (15, 602 acres) (Fig. 2).

After this identification, the sites were ground-truthed for the presence or absence of alvar and limestone cliffs. For this study, alvar was defined as a community growing in 10cm or less soil over limestone or dolomite bedrock pavement that was not the result of mechanical removal. Landowner permission was obtained for access to all sites on private lands. Crown land sites include Wildlife Management Areas and leased Crown land. Permission is not required for accessing these Crown lands for non-consumptive uses like hiking (Manitoba Agriculture, Food & Rural Initiatives 2008; Manitoba Conservation 2012).

At each site, GPS coordinates were collected and basic information was recorded for the dominant species, soil characteristics, hydrological information and unique topological characteristics. Information was recorded using a standardized field data sheet taken from the NatureServe Wetland Ecological Integrity Assessment Field Manual (Faber-Langendoen, 2010, see Appendix C). A reference voucher plant collection was made and is currently housed at the Manitoba Conservation Data Centre.

Using orthophotos and GPS coordinates collected in the field, the extent of each alvar site was mapped using GIS. Due to restrictions in time and accessibility not every part of every site could be visited and much the mapping was based on an interpretation of the orthophotography. The mapped alvar communities indicate the maximum extent in which the alvar is found. Within the polygons there may be areas without alvar, or an area may represent a mosaic of alvar and other communities

Sites were assigned a qualitative classification based on the descriptive qualities of the dominant plant species, soil depth, hydrology, and topological characteristics such as plateaus, exposed outcrops or limestone boulder fields. These classifications are meant to help identify some unique qualities of each type in order to prioritize further study and conservation efforts.

A quantitative statistical analysis and classification of alvar types in Manitoba will require a more intensive sampling method. In 2012, nine sites were selected to test the collection methodology for a detailed site assessment which may meet this requirement. The methods were adapted from the NatureServe Wetland Ecological Integrity Assessment Field Manual (Faber-Langendoen, 2010, see Appendix C). These methods were chosen in consultation with several Great Lakes alvar experts.

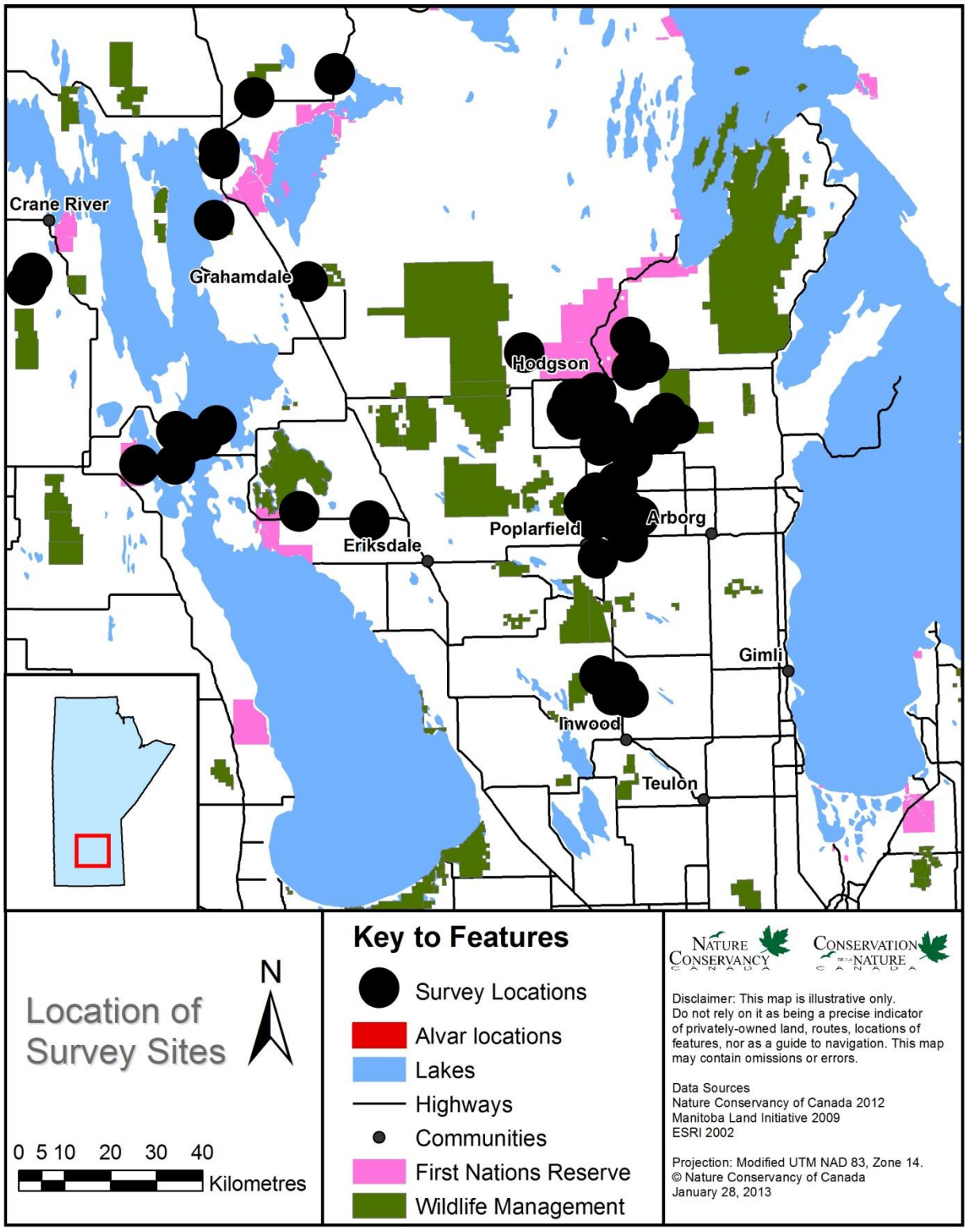

Figure 2. 2012 Manitoba Alvar Initiative survey sites. **LOCATIONS HAVE BEEN INTENTIONALLY OBSCURED – EXACT LOCATIONS AVAILABLE UPON REQUEST.**

RESULTS

Sixty-one of the 67 GIS-identified potential alvar sites were ground-truthed. The remaining six could not be visited due to time restrictions or the inability to contact landowners to access or cross private property. Based on the orthophotographs and ground-truthing on nearby sites, the unvisited sites are not suspected to have alvar.

Alvar was confirmed at 28 of the 61 surveyed sites. The confirmed alvar communities extend over no more than 3934 hectares (9721 acres) covering all or portions of 168 quarter-sections. Some relatively large mapped sites represent a matrix of alvar, within which patches of non-alvar community types like forest or prairie occur over soils with a depth greater than 10 cm.

One hundred and one patches of alvar have been mapped, varying from 0.4 to almost 809 hectares(1 to 2000 acres). These patches can be grouped into 5 geographically distinct alvar regions based on shared characteristics (Fig 3). Three of the sites referred to as “Marble Ridge ‘A’, ‘B’ and ‘C’ Alvar follow a limestone formation of the same name, along which inland cliffs are found. The “Peguis Alvar” borders the Peguis First Nation Reserve to the east, and the “Sylvan Alvar” is almost completely within the boundaries of the Sylvan Dale PFRA Community Pasture. The “Poplarfield Alvar” is a group of small, isolated patches of alvar in which the community structure is variable. The “Clematis Alvar” is located in and around the Clematis and Sandridge Wildlife Management Areas and the adjacent private lands.

BEDROCK GEOLOGY

Potential sites were surveyed on bedrocks of five different geologic periods (Fig 4), and alvar was only located on bedrock laid during the Silurian and Ordovician periods, which consists primarily of dolomite (Province of Manitoba Mineral Resources Division 2012).

The Clematis Alvar and two patches of the Poplarfield Alvar occur on Silurian bedrock, which consists of mictric, fossiliferous, stromatolitic and biostromal dolomites. The other alvar groups occur on bedrock of the Ordovician period which are comprised of various dolomites including argillaceous, nodular, and laminated dolomite (Province of Manitoba Mineral Resources Division 2012).

There were multiple formations during the Ordovician Period and alvar occurs on four of them. The Marble Ridge site and the rest of the Poplarfield Alvar are primarily located within the western Stony Mountain Formation and the East Arm Formation, while the Peguis and Sylvan Alvars fall into the eastern Stony Mountain Formation and the Red River Formation. The inland cliffs of Marble Ridge and Sylvan follow the eastern boundaries of the two Stony Mountain Formations. The type of alvar present at a site may be related, at least in part, to the specific bedrock characteristics. For example, the cliffs adjacent to the Sylvan alvar exhibited noticeably different colouration and fracturing patterns, as well as vegetation composition, compared to those adjacent to Marble Ridge alvars.

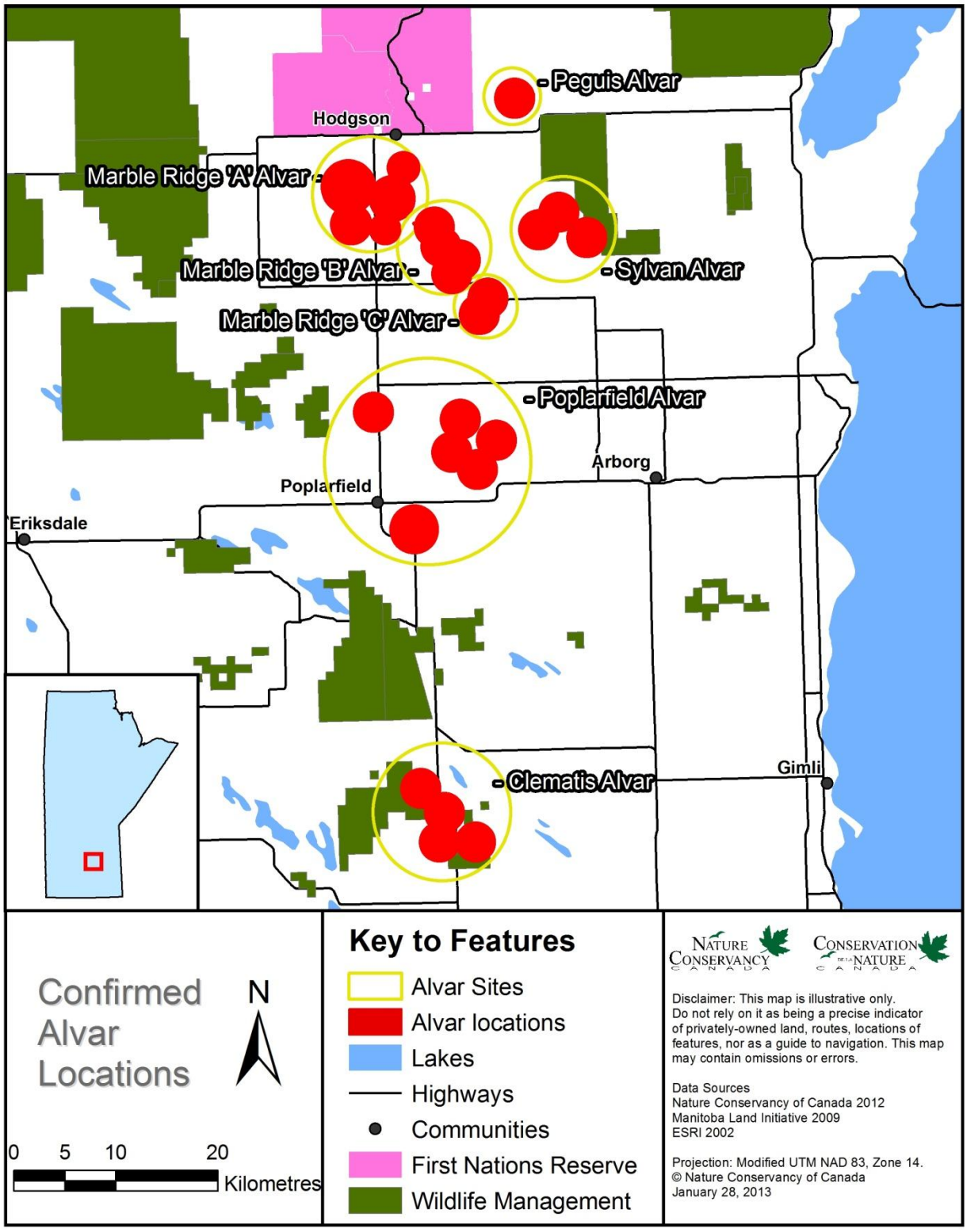

Figure 3. Confirmed alvar locations and regions. **LOCATIONS HAVE BEEN INTENTIONALLY OBSCURED – EXACT LOCATIONS AVAILABLE UPON REQUEST.**

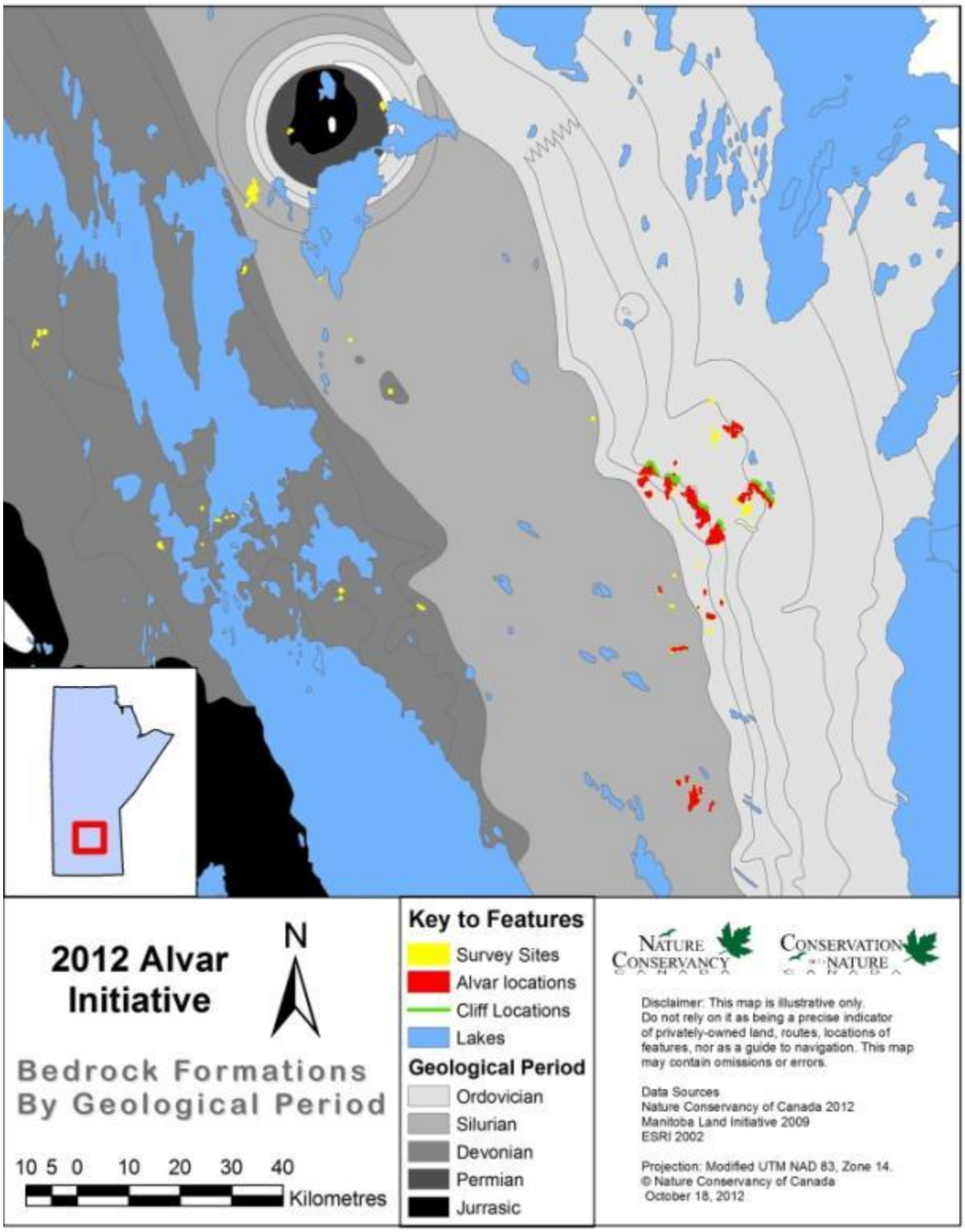

Figure 4. Geological formation of bedrock in the Interlake and the locations of alvar, cliffs and survey sites.

CONSERVATION CONTEXT & LAND USE

Alvar and inland cliffs extend across three Rural Municipalities in the Interlake. Approximately one third (1261 ha, 3117 ac) of alvar in Manitoba occurs on privately-owned land, with the remainder on Crown land that is designated as Wildlife Management Area, Community Pasture, and other types of leased and un-leased parcels (Fig. 5).

None of the alvar sites are located within the boundaries of Protected Areas (IUCN Protected Areas Classification level IV or higher)(Manitoba Conservation & Water Stewardship 2012).

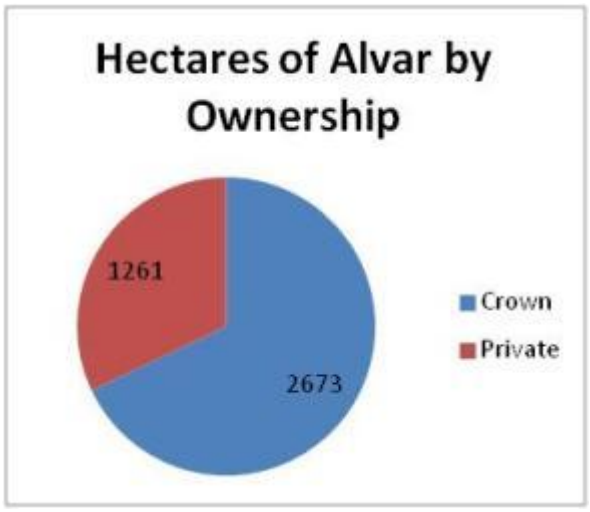

Figure 5. Hectares of alvar by ownership.

The majority of alvar on both private and Crown land is currently being grazed, or has been grazed recently. Approximately seventy-six percent or 2985 hectares (7378 acres) of alvar is at least partially grazed – some portions of a site may be outside of a fenceline or not used by cattle. Approximately eleven percent – 432 hectares (1067 acres) – are not grazed, and the land use of the remaining 516 hectares (1275 acres) could not be determined (Fig. 6). Most observed grazing animals were cattle, but horses and bison were also observed.

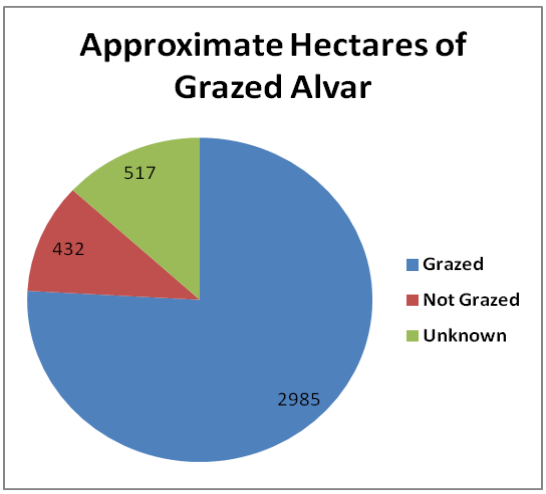

Figure 6. Hectares of grazed alvar.

Near-surface dolomitic limestone has been extracted immediately adjacent to and within some alvar sites. It is not known if all of these sites supported alvar prior to quarrying or extraction actvities. Twenty-six percent (1027 ha, 2538 ac) of Manitoba's alvar is under mining claim or quarry lease or both (Province of Manitoba Mineral Resources Division 2012) (Fig. 7).

Figure 7. Hectares of alvar under mining claims.

INLAND CLIFFS

There are approximately 18km of inland limestone cliff associated with alvar in the Interlake. The height of these cliffs is variable – ranging from 1 to 4.5 m. The cliff face is often discontinuous, receding into relatively gently sloping wooded areas and then becoming prominent again. Some of the survey sites were located on private land for which permission to access was not granted; however the landowners confirmed the presence of the cliffs and their approximate height. Cliffs contribute to habitat heterogeneity to the landscape and provide specific habitats for specialist species such as the

provincially rare *Pellaea glabella* subsp. *occidentalis* (Western dwarf cliffbrake) and for species of rare mosses.

Cliffs are located on the edge of the Marble Ridge Alvar and the Sylvan Alvar. The structure and chemical composition of the dolomitic limestone cliffs adjacent to the Sylvan Alvar appear to differ from those at Marble Ridge, and moss and lichen species also differs between these two cliff sites.

Figure 8. Inland Limestone Cliff along the Marble Ridge Formation. Photo by NCC.

ALVAR TYPES

Four types of alvar were identified based on the characteristics of surveyed sites, two of these types were subdivided further based on dominant vegetation:

- **Grassland**
- **-Shrubland**
    - Prairie Shrubland
    - Boreal Shrubland
    - Praire/Boreal Intermediate Shrubland
    - Boulder/Exposed Ridge Shrubland
- **Savannah**
    - Bur Oak Savannah
    - White Spruce Savannah
    - Jack Pine Savannah
- **Wetland.**

Many sites supported multiple types of alvar; due to time limitations the extent of each type within a given alvar site could not always be mapped (See Appendix A for area of alvar types). A GIS shapefile and associated table was created to document which alvar types were observed at which surveyed sites (Table 1). A list of species associated with each alvar type and subtype is presented in Appendix B.

ALVAR GRASSLAND

This type of alvar is characterized by a dominant cover of graminoid species including *Danthonia spicata* (Poverty Oat Grass), *Bromus porter*i. (Porter's Chess), *Elymus trachycaulus* (Slender Wild Rye, also known as Awned Wheatgrass.), *Poa annua* (Annual Bluegrass), *Poa* sp. (Poa species), and *Koeleria macrantha* (Prairie Junegrass). Other dominant species include *Juncus dudleyi* (Dudley's Rush), *Geum triflorum* (Prairie-smoke) and *Antennaria* spp. (Pussytoes). Trees are typically absent or restricted to the periphery, and shrub cover is very low and typically limited to *Juniperus horizontalis* (Creeping Juniper) and *Dasiphora fruticosa* -subsp. *floribunda* (Shrubby Cinquefoil). Forb cover is not high and has a lower diversity of species than other alvar types. Most of these sites were grazed.

Soil depth typically ranges from 5 to 10 cm, with occasional patches of bare rock with a few mosses. Some areas have small exposed outcrops along the edge of a plateau formation, typically less than 1 m in height and on this exposed limestone *Pellaea glabella* subsp. *occidentalis* has been observed in some sites.

Figure 9. Grazed grassland alvar at the Sylvan Site. Photo by NCC.

ALVAR SHRUBLAND

This type of alvar is characterized by bare limestone pavement with a dominant cover of shrubs, few stunted trees, and a high cover of mosses and lichens. Soil is typically <5 cm deep or absent over the bedrock and plant growth is restricted to cracks and seams in the pavement. There is little or no drainage, and after rain water is trapped and temporarily floods the area. This is followed by drought-like conditions in which some species of lichens and mosses can flourish.

This category is the most abundant type of alvar and has been divided into four sub-types based on changes in the dominant plant species and unique karst characteristics.

Alvar Shrubland – Prairie Subtype

The dominant shrub species are Creeping Juniper and *Arctostaphylos uva-ursi* (Bearberry). The dominant grass species are *Andropogon gerardii* (Big Bluestem), Poverty Oat Grass and *Festuca halli* (Rough Fescue). Other commonly found species include *Betula pumilla* (Swamp Birch), Shrubby Cinquefoil, *Corylus cornuta* (Beaked Hazelnut), Prairie-smoke, *Solidago* spp. (Goldenrods), *Gallium boreale* (Northern Bedstraw) and many other prairie species as well as the grass species found in grassland alvars. Tree species include *Populus tremuloides* (Quaking Aspen*), Quercus macrocarpus* (Bur

Oak) and *Picea glauca* (White Spruce), but they are often stunted in size and not common. The dominant lichen species are *Cladonia* spp., and the main mosses are *Tortella tororsa* (Twisted Moss) and *Abietinella abietina* (Abietinella Moss).

This is the only shrubland alvar type found in the Clematis site, and it occurs in the Poplarfield and Marble Ridge 'A' sites that fall into the East Arm Formation of the Ordovician period.

Figure 10. Prairie Shrubland alvar at Clematis WMA. Photo by NCC

Alvar Shrubland – Boreal Subtype

This alvar is found farther north and has a different composition of species. *Juniperus communis* (Ground Juniper) becomes equally or more dominant than Creeping Juniper and Bearberry*; Viburnum rafinquesianum* (Downy Arrow-wood) and *Betula occidentalis* (River Birch) replace Swamp Birch and Beaked Hazlenut; and Poverty Oat Grass becomes the dominant grass with Big Bluestem being absent. A *Cladina* species of lichen also becomes dominant in addition to the *Cladonia* species and *Pinus banksiana* (Jack Pine) are present.

Figure 11. Boreal type shrubland alvar at Marble Ridge C Site. Photo by NCC.

Alvar Shrubland – Prairie/Boreal Intermediate Subtype

Some shrubland alvars seem to possess characteristics of both of the previous shrubland types. Downy Arrow-wood and both species of lichen are present, but Ground Juniper is not dominant and River Birch is scarce. Hazelnut, Big Bluestem and Swamp Birch are absent.

This intermediate type occurs in alvars of the Marble Ridge region, and is more closely associated with the boreal type.

Figure 12. Prairie/boreal intermediate shrubland alvar at Marble Ridge C Site. Photo by NCC

Alvar Shrubland – Boulder/Exposed Ridge Subtype

This alvar type is differentiated by the prevalence of limestone boulders and/or exposed ridges or outcrops. The major difference from the boreal and intermediate types of shrublands is the habitat created by the limestone features. Two species of cliffbrakes, provincially rare *Pellaea glabella* subsp. *occidentalis* and globally rare *Pellaea gastonyi* grow in the crevices on the vertical face of exposed limestone. The globally rare moss *Grimmia teretinervis* grows on the exposed surface of the limestone boulders or outcrops. These species do not grow on ground-level limestone surfaces, and are restricted to this specific type of alvar.

This type of alvar is often found adjacent to the inland limestone cliffs, but is only found in the Marble Ridge 'A' and Marble Ridge 'C' Alvar Sites, within the western Stony Mountain formation.

Figure 13. Exposed ridge/boulder alvar at Marble Ridge A Site. Photo by NCC.

ALVAR SAVANNAH

These alvars have a regular distribution of trees that are not severely stunted, but maintain an open canopy of less than 60% cover. There tends to be less bare pavement at the surface than in the shrubland alvars, but the soil is still usually thinner than 5cm except in the cracks or seams where the trees are found. Lichens and mosses are somewhat less dominant, and there is a very high cover of shrubs. In some cases the trees create a microhabitat around them in which less common alvar species such as *Toxicodendron rydbergii* (Northern Poison-oak, commonly known as "Western Poison-ivy"), *Thalictrum venulosum* (Veiny Meadowrue) and Maianthemum canadense (Wild Lily-of-the-Valley) grow in clumps. Trees may capture more snow cover in winter and provide some protection from the elements. This category is divided into three subtypes based on the dominant tree species.

Alvar Savannah – Oak Savannah Subtype

In this type Bur Oak is the only mature tree found, Quaking Aspen remain stunted and White Spruce are scarce or absent. The dominant ground cover species composition is similar to those of the Prairie Shrubland. This alvar type is not common, and Oak are often intermixed in with the trees of the other

savannah types. One patch of alvar in the Poplarfield site is the only mapped location of the oak savannah subtype, and may reflect areas with deeper soil. The treed peripheries of many of the other shrubland alvars could possibly be considered oak savannah communities, in which case the oak savannah exists with alvar as a mosaic of communities.

Figure 14. Bur oak savannah alvar at one of the Poplarfield alvars. Photo by NCC.

Alvar Savannah – White Spruce Savannah

White Spruce is the dominant tree in this alvar type - but Bur Oak and Quaking Aspen are still present. Species composition is also very similar to the prairie shrubland type, except that the *Cladina* lichen species is equally as common as the *Cladonia* species, and big bluestem is less abundant.

This alvar type is not very common and is only found in the Clematis Alvar and one patch of the Poplarfield alvar.

Figure 15. White spruce savannah alvar at the Clematis WMA. Photo by NCC.

Alvar Savannah – Jack Pine Savannah Subtype

Jack Pine Savannah alvars often have both Bur Oak and White Spruce within them, but in much smaller numbers. Aside from the tree cover, the species composition is like that of the Boreal Shrubland alvar. Additional species of unidentified moss grow in this alvar and *Linnaea borealis* (Twinflower) grows in sheltered areas.

The Jack Pine Savannah Alvar is more common than the other two savannah types, and is mostly found in Marble Ridge 'A' and 'C', with a small amount in the Sylvan Alvar.

Figure 16. Jack Pine Savannah alvar at Marble Ridge A Site. Photos by NCC.

ALVAR WETLAND

These alvars average about 5cm of soil with the occasional patch of bare limestone bedrock. The dominant species include *Carex* spp. (Sedges), *Juncus* spp. (Rushes), *Eleocharis* spp. (Spike Rushes), *Deschampsia caespitosa* (Tufted Hairgrass) and mosses. These are low areas compared to the surrounding topography and are bordered partially by other wetland types. Where bare limestone occurs there is only moss and occasionally Creeping Juniper, on slightly raised patches other grasses and Shrubby Cinquefoil are present.

This alvar is found in the Marble Ridge 'A' and 'B' sites, and often grades into a drier type; it is not as common as the other types.

Figure 17. Wetland Alvar at Marble Ridge A Site. Photos by NCC.

ALVAR BY SITE			
Site Name	**Hectares**	**Acres**	**Types/Subtypes of Alvar**
Clematis	476	1176	Prairie Shrubland, White Spruce Savannah
Marble Ridge 'A'	891	2202	Grassland, Boreal Shrubland, Prairie Shrubland, Prairie/Boreal Intermediate Shrubland, Exposed/Boulder Shrubland, Jack Pine Savannah, Wetland
Marble Ridge 'B'	977	2414	Grassland, Prairie/Boreal Intermediate Shrubland, Boreal Shrubland, Wetland
Marble Ridge 'C'	647	1599	Boreal Shrubland, Prairie/Boreal Intermediate Shrubland, Jack pine Savannah, Exposed Ridge Boulder Shrubland
Peguis	213	526	Grassland
Poplarfield	216	534	Grassland, White spruce Savannah, Prairie Shrubland, Bur Oak Savannah
Sylvan	514	1270	Grassland, Jack Pine Savannah, Prairie Shrubland

Table 1. Area and type of alvar present at each site.

BIODIVERSITY AND SIGNIFICANT SPECIES

The alvar communities of the Interlake support a wide range of species, some of them restricted to particular alvar types. Each type of alvar is structurally unique and provides different habitat niches. The grassland, wetland and shrubland alvars are open and exposed, while the savannah alvars provide vertical structure and shelter, which provides habitat for a different set ofplant and, likely, insect and bird species. The shrubland alvars have very little soil over bedrock pavement and are much more prone to standing water than the grassland alvars which have deeper soil and may support a different set of burrowing mammals and insects. Some alvars also create unique wetland conditions. The wetland type supports some wetland plant species, and the shrubland and savannah alvars are also flooded periodically, with late-season drought conditions following. In all three types of these alvars freshwater mussels and gastropods were observed in areas with trapped standing water. It is uncertain if there are any rare or at risk animal or insect species found exclusively in Manitoba's alvars. Faunal surveys of these sites is recommended.

Documented rare and uncommon (global, national and subnational status ranks taken from Natureserve 2012) species at survey sites ore reported by Caners (2011), include the following:

***Allium textile* (Wild White Onion)**

This species is uncommon in Manitoba (G5?, N5, S3?) and is usually found in dry habitats. It was observed in the Prairie Shrubland Subtype Alvar.

***Bromus porteri* (Porter's Chess)**

This grass occurs in nearly all alvars, though never as a dominant. It is not common in Manitoba (G5, N4N5, S3?).

***Festuca hallii* (Rough Fescue)**

This grass is found in dry prairie habitats and was observed in the Prairie, Boreal and Intermediate Shrubland Alvars. It is uncommon in Manitoba and Canada (G4, N3N4, S3).

***Pellaea gastonyi* (Gastony's cliffbrake)**

This globally uncommon (G2G3, N2N3, S1) fern is found growing on limestone cliffs and boulders. In Manitoba it is restricted to the interlake region on alvars along the Marble Ridge formation. It was first documented by Bruce Ford, Elizabeth Punter, Dave Punter and Michelle Piercey Normore in July 2001 and May 2005. This fern grows up to 30 cm tall and grows in sheltered crevices in the limestone.

Figure 18. Gastony's Cliffbrake on an exposed alvar outcrop. Photo by NCC.

***Pellaea glabella* subsp. *occidentalis* (Dwarf Western Cliffbrake)**

This species of fern is provincially uncommon in Manitoba (G5T4, N3, S2) and is associated with alvar cliffs and boulders. It is often associated with P. *gastonyi* but is typically more locally abundant and reaches a height of less than 15 cm. It grows on the vertical cliff or boulder face of limestone in small crevices and is often found in less sheltered places than P. *gastonyi*.

Figure 19. Smooth Cliffbrake on limestone boulder. Photo by NCC.

***Selaginella densa* (Dense Spikemoss)**

This spikemoss is a provincially uncommon (G5, N5, S3) species that is found in dry prairie soils and on rocky substrates. It was observed at the Marble Ridge 'A 'alvar site growing on the limestone pavement. The Marble Ridge area is at the northern limit of the species in Manitoba, which is usually found in sandhills and on sandy soils.

***Grimmia teretinervis* (Grimmia dry rock moss)**

This globally uncommon moss (G3G5, NNR) is scattered across North America. It is associated with calcareous bedrock and, in Manitoba, has only been found on limestone cliffs and boulders associated with alvar. This moss was first discovered and documented in the Manitoba Interlake by Richard Caners (2011).

Figure 20. Grimmia Dry Rock Moss on limestone outcrop. Photo by NCC.

***Schistidium frigidum* (moss)**

This moss is newly documented in Manitoba and not ranked for Canada (GNR, NNR) but is rare in Quebec (S1S2). It was found on vertical ledges on the Marble Ridge cliffs (Caners 2011).

***Seligeria donniana* (Donn's Small Limestone Moss)**

This moss was also newly discovered in Manitoba and found on the vertical ledges on the Marble Ridge cliffs (Caners 2011). It is ranked S1 or S2 (G4G5, NNR) in most provinces.

***Athalamia hyaline* (Hyaline Liverwort)**

This liverwort is nationally rare (G5, N2N3) and newly documented in Manitoba, found on shaded rock ledges on the Marble Ridge limestone cliffs (Caners 2011).

***Frullania inflata* (Inflated scalewort)**

This liverwort was collected from the cliffs at the Sylvan Alvar site and was identified by Richard Caners. It is a nationally rare species (G5, N2), but is currently unranked in Manitoba.

***Mannia fragans* (Fragrant macewort)**

Nationally rare (G5, N3N4) liverwort newly documented in Manitoba, found on limestone pavement in alvar (Caners 2011).

***Mannia sibirica* (liverwort)**

This liverwort is critically imperilled in Ontario (S1), but not ranked for the rest of Canada (G4?, NNR), and is newly discovered in Manitoba on rock ledges on the Marble Ridge cliffs (Caners 2011)

INVASIVE SPECIES

Six invasive, exotic plant species were observed in alvars. *Phleum pretense* (Timothy) was observed often, but never as a dominant species. *Poa pratensis* (Kentucky Bluegrass) was observed in some grass-dominated alvars, but more in-depth surveys are required to determine its dominance this species is and if the subsp. found is native or introduced. *Poa annua* was observed in all but the Prairie Shrubland, Oak Savannah and White Spruce Savannah alvars, often occurring on sparsely vegetated patches of shallow, bare soil. *Lotus corniculatus* (Garden Bird's-foot-trefoil) was found on the periphery of two alvars and at a third site there were a few scattered plants on the alvar itself. *Bromus inermis* (Awnless Brome) and *Agrostis stolonifera* (Creeping Bentgrass) were each observed once in grazed alvars. Overall it appears that invasives in Manitoba alvars are infrequent at the present time.

MANAGEMENT/CONSERVATION RECOMMENDATIONS

Most alvar sites are grazed. The effects of grazing and other land use on alvar in Manitoba is not known, and each type of alvar may respond differently. A study to determine compatible stocking rates/rotations for each alvar type would assist conservation land managers in decision making.

None of the documented alvar in Manitoba is currently protected from development (IUCN I-IV), although one site has been recommended by MAPB for designation as an Ecological Reserve and the nomination is being considered by the provincial Ecological Reserves Advisory Committee (Helios Hernandez, pers. Comm., 2012). Incompatible mining activities may represent a threat to alvar communities; 26% of Manitoba alvars are under mining and/or quarry leases. Some alvar types/subtypes are limited in extent and as such could undergo substantial loss in the event of individual development projects.

Extending over no more than 3934 ha, alvar communities make up only 0.3% of the south Interlake. Inland cliffs are rarer still. Each alvar and associated cliff community type supports its own complement of organisms and contributes to the biological diversity of Manitoba. Protection and conservation efforts should initially focus on preserving representatives of each type and subtype.

The present mix of public and private land ownership and the economic potential of alvar sites for grazing and mineral resources highlights the need for the continued involvement and co-operation of a range of conservation partners in the Manitoba Alvar Initiative. Conservation success at a meaningful scale can only be achieved through partnership with grazers, the mineral extraction industry, public agencies and private landowners to protect, manage and accommodate the compatible economic development and conservation of alvar and inland cliffs.

NEXT STEPS

The study reported here has produced key information regarding the extent and conservation status of alvar in Manitoba. A quantitative data-based classification scheme would help to refine the conservation status of alvar types/subtypes, establish site-condition metrics, recommend compatible land-management activities, and advance conservation activities. Faunal surveys to further assess the biodiversity of these sites and reviews of past and present aerial photography and land surveys to gain perspective on the successional patterns of alvar in response to grazing and fire suppression are also recommended. This information would support an ecosystem-based approach to protecting endangered species subject to the Manitoba *Endangered Species Act*. The data collected in 2012 will provide the foundation for this work, and needs to be supplemented with detailed site assessments and multivariate statistical analyses that incorporate structure, biophysical characteristics and biodiversity.

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APPENDIX A: Extent and Distribution of Alvar in the Interlake

Area of Alvar by Type and Mixtures of Type		
Acres	**Hectares**	**Type of alvar**
1517	614	Grassland
334	135	Grassland Savannah - Jack Pine type
230	93	Grassland Savannah - Jack Pine type Shrubland - Boulder/Exposed Ridge Type
321	130	Grassland Shrubland - Boreal Type
1626	658	Grassland Shrubland - Boreal Type Wetland
467	189	Grassland Shrubland - Prairie type
314	127	Grassland Shrubland - Prairie/Boreal Intermediate Type
106	43	Grassland Shrubland - Prairie/Boreal Type Shrubland - Boulder Exposed Ridge Type
89	36	Savannah - White Spruce Type
42	17	Shrubland - Boreal Type
462	187	Shrubland - Boreal Type Savannah - Jack Pine Type
615	249	Shrubland - Boreal Type Shrubland - Boulder Exposed Ridge Type Savannah - Jack Pine Type
578	234	Shrubland - Prairie Type
242	98	Shrubland - Prairie Type Savannah - Oak Type
724	293	Shrubland - Prairie Type Savannah - White Spruce Type
519	210	Shrubland - Prairie/Boreal Intermediate Type
1386	561	Shrubland - Prairie/Boreal Intermediate Type Shrubland - Boulder/Exposed Ridge Type
59	24	Wetland Shrubland - Boreal/ Prairie Type
57	23	Wetland; Shrubland - Boreal/ Prairie Type Shrubland Boulder/Exposed Ridge Type
32	13	Unknown/unclassified

Table 2. Approximate area of alvar by types

APPENDIX B: Plant, Bryophyte and Lichen Species Observed in Alvars in 2012

Note: GRanks and SRanks refer to Gloabal and Subnational Conservation Status Ranks taken from NatureServe

Grassland Alvar			
Scientific Name	**Common Name**	**Grank**	**Srank**
Vascular Plants			
Achillea millefolium	Common Yarrow	G5	S5
Allium stellatum	Glade Onion	G5	S5
Ambrosia spp.	Ragweed species		
Antennaria sp.	Pussytoes species		
Symphyotrichum sp.	Aster species		
Bromus porteri	Porter's Chess	G5	S3?
Campanula rotundifolia	American Harebell	G5	S5
Carex spp.	Sedge species		
Danthonia spicata	Poverty Oat Grass	G5	S5
Dasiphora fruticosa ssp. floribunda	Shrubby Cinquefoil	G5T5	S5
Deschampsia caespitosa	Tufted Hairgrass	G5	S5
Eleocharis sp.	Spikerush species		
Elymus trachycaulus	Slender Wild Rye	G5	S5
Elymus trachycaulus ssp. trachycaulus	Slender Wild Rye	G5T5	S5
Galium boreale	Northern Bedstraw	G5	S5
Geum triflorum	Prairie-smoke	G5	S4
Grindelia squarrosa	Broadleaf Gumweed	G5	S5
Juncus dudleyi	Dudley's Rush	G5	S5
Juniperus horizontalis	Creeping Juniper	G5	S5
Koeleria macrantha	Prairie Junegrass	G5	S5
Lepidium sp.	Pepper-grass species		
Lithospermum canescens	Hoary Puccoon	G5	S5
Phleum pratense	Meadow Timothy	GNR	SNA
Poa annua	Annual Bluegrass	GNR	SNA
Poa pratensis	Kentucky Bluegrass	G5	S5
Potentilla bipinnatifida	Tansy Cinquefoil	G5	S5
Potentilla gracilis	Fanleaf Cinquefoil	G5	S4?
Potentilla pensylvanica	Pennsylvania Cinquefoil	G5	SU
Potentilla sp.	Cinquefoil species		
Rosa acicularis	Prickly Rose	G5	S5
Symphyotrichum ericoides	White Heath Aster	G5	S4
Vicia sp.	Vetch species		
Mosses			
Abietinella abietina	Abietinella Moss	G4G5	S4S5
Barbula convoluta		G5	SU
Bryum pseudotriquetrum	Common Green Bryum Moss	G5	S4S5
Bryum sp.			
Campylium polygamum	Campylium Moss	G5	S4S5
Didymodon rigidulus		G5	S4S5
Tortella fragilis		G5	S4S5
Tortula ruralis	Tortula Moss	G5	SNR

Prairie Shrubland Alvar; Oak Savannah Alvar and White Spruce Savannah Alvar			
Scientific Name	**Common Name**	**Grank**	**Srank**
Vascular Plants			
Achillea millefolium	Common Yarrow	G5	S5
Agoseris glauca	Pale Goat-chicory	G5	S5
Allium stellatum	Glade Onion	G5	S5
Allium textile	Wild White Onion	G5	S3?
Amelanchier alnifolia	Saskatoon Serviceberry	G5	S5
Andropogon gerardii	Big Bluestem	G5	S5
Anemone canadensis	Canada Anemone	G5	S5
Anemone cylindrica	Long-fruit Anemone	G5	S5
Anemone multifida	Hudson's Bay Anemone	G5	S5
Antennaria sp.	Pussytoes species		
Apocynum androsaemifolium	Spreading Dogbane	G5	S5
Arabis hirsuta	Western Hairy Rockcress	G5	S5
Arabis sp.	Rockcress species		
Arctostaphylos uva-ursi	Bearberry	G5	S5
Artemisia campestris	Pacific Wormwood	G5	S5
Artemisia ludoviciana	White Sagebrush	G5	S5
Betula occidentalis	Spring Birch	G5	S4S5
Betula pumila var glandulifera	Bog Birch	G5T5	S5
Bromus porteri	Porter's Chess	G5	S3?
Campanula rotundifolia	American Harebell	G5	S5
Carex sp.	Sedge species		
Cerastium arvense	Field Chickweed	G5	S5
Cirsium drummondii	Drummond's Thistle	G5	S4
Cirsium sp.	Thistle species		
Comandra umbellata	Umbellate Bastard Toad-flax	G5	S5
Corylus americana	American Hazelnut	G5	S4
Cypripedium sp.	Lady's Slipper		
Dalea purpurea	Purple Prairie-clover	G5	S4
Danthonia spicata	Poverty Oatgrass	G5	S5
Dasiphora fruticosa ssp. Floribunda	Shrubby cinquefoil	G5T5	S5
Deschampsia caespitosa	Tufted Hairgrass	G5	S5
Elymus trachycaulus	Slender Wild Rye	G5	S5
Erigeron philadelphicus	Philadelphia Fleabane	G5	S5
Festuca altaica	Rough Fescue	G4	S3
Fragaria virginiana	Virginia Strawberry	G5	S5
Gaillardia aristata	Great Blanket-flower	G5	S4
Galium boreale	Northern Bedstraw	G5	S5
Geum triflorum	Prairie-smoke	G5	S4
Helianthus sp.	Sunflower species		
Heuchera richardsonii	Richardson's Alumroot	G5	S5
Hieracium umbellatum	Umbellate Hawkweed	G5	S5
Juniperus communis	Common Juniper	G5	S5
Juniperus horizontalis	Creeping Juniper	G5	S5
Koeleria macrantha	Prairie Junegrass	G5	S5
Lathyrus sp.	Vetch species		
Liatris ligulistylis	Strap-style Gayfeather	G5?	S4
Lilium philadelphicum	Wood Lily	G5	S4

Linum lewisii	Prairie Flax	G5	S4
Lithospermum canescens	Hoary Puccoon	G5	S5
Lonicera dioica	Mountain Honeysuckle		
Maianthemum stellatum	Starflower Solomon's-plume	G5	S5
Monarda fistulosa	Wild Bergamot	G5	S5
Oligoneuron album (Solidago ptarmicoides)	Prairie Goldenrod	G5	S4
Oligoneuron rigidum (Solidago rigida)	Prairie Goldenrod	G5	S5
Orthocarpus luteus	Yellow Owl's-clover	G5	S4
Oryzopsis asperifolia	White-grained Mountain-ricegrass	G5	S5
Pediomelum esculenta	Large Indian Breadroot	G5	S4
Phlox hoodii	Hood's Phlox	G5	S3
Picea glauca	White Spruce	G5	S4
Poa sp.	Bluegrass species		
Polygala senega	Seneca Snakeroot	G4G5	S4
Populus tremuloides	Quaking Aspen	G5	S5
Potentilla arguta	Tall Cinquefoil	G5	S5
Prunus pensylvanica	Fire Cherry	G5	S5
Prunus virginiana	Choke Cherry	G5	S5
Quercus macropcarpa	Bur Oak	G5	S5
Rosa acicularis	Prickly Rose	G5	S5
Rudbeckia hirta	Bleack-eyed-Susan	G5	S5
Salix sp.	Willow Species		
Sanicula marilandica	Maryland Black-snakeroot	G5	S5
Shepherdia canadensis	Canada Buffaloberry	G5	S5
Sisyrinchium montanum	Strict Blue-eyed-grass	G5	S5
Solidago hispida	Hairy Goldenrod	G5	S5
Solidago missouriensis	Missouri Goldenrod	G5	S5
Solidago nemoralis	Field Goldenrod	G5	S5
Symphoricarpos sp.	Snowberry species		
Symphyotrichum laeve	Smooth Blue Aster	G5	S5
Taraxacum officinale	Common Dandelion	G5	SNR
Thalictrum venulosum	Veined Meadowrue	G5	S5
Toxicodendron rydbergii	Northern Poison-oak	G5	S5
Vicia sp.	Vetch species		
Zigadenus elegans	White Camas	G5	S5
Zizia aptera	Heartleaf Alexanders	G5	S5
Zizia aurea	Golden Alexanders	G5	S5
Mosses			
Abietinella abietina	Abietinella Moss	G4G5	S4S5
Aulacomnium palustre	Aulacomnium moss	G5	S4S5
Barbula convoluta		G5	SU
Brachythecium campestre		G4G5Q	S4S5
Brachythecium salebrosum	Brachythecium Moss	G5	S4S5
Campylium polygamum	Campylium Moss	G5	S4S5
Ceratodon purpureus		G5	S4S5
Dicranum polysetum	Waxyleaf Moss	G5	S4S5
Eurhynchium pulchellum	Elegant Beaked Moss	G5	S4S5
Pleurozium schreberi	Feathermoss	G5	S4S5
Tortella fragilis		G5	S4S5
Tortella tortuosa	Twisted Moss	G5	S4S5

Tortula ruralis	Tortula Moss	G5	SNR
Liverworts			
Cephaloziella rubella		G5	SNR
Lichen			
Cladina spp.	Reindeer Lichen species		
Cladonia spp.	Cup Lichen species		

Boreal Shrubland Alvar; Jack Pine Savannah Alvar and Exposed Ridge/Boulder Shrubland Alvar			
Scientific Name	**Common Name**	**Grank**	**Srank**
Vascular Plants			
Achillea millefollium	Common Yarrow	G5	S5
Agrostis scabra	Rough Bentgrass	G5	S5
Agrostis stolonifera	Creeping Bentgrass	G5	SNA
Allium stellatum	Glade Onion	G5	S5
Amaelanchier alnifolia	Saskatoon Serviceberry	G5	S5
Ambrosia spp.	Ragweed species		
Andropogon gerardii	Big Bluestem	G5	S5
Anemone cylindrical	Long-fruit Anemone	G5	S5
Anemone multifida	Hudson's Bay Anemone	G5	S5
Antennaria sp.	Pussytoes species		
Apocynum androsaemifolium	Spreading Dogbane	G5	S5
Arctostaphylos uva-ursi	Bearberry	G5	S5
Artemisia campestris	Pacific Wormwood	G5	S5
Asclepias sp	Milkweed species		
Symphyothrichum spp.	Aster species		
Betula occidentalis	Spring Birch	G5	S4S5
Betula papyrifera	Paper Birch	G5	S5
Betula pumila	Bog Birch	G5T5	S5
Bromus porter	Porter's Chess	G5	S3?
Campanula rotundifolia	American Harebell	G5	S5
Carex spp.	Sedge species		
Cerastium arvense	Field Chickweed	G5	S5
Comandra umbellata	Umbellate Bastard Toad-flax	G5	S5
Corylus americana	American Hazelnut	G5	S4
Danthonia spicata	Poverty Oatgrass	G5	S5
Dasiphora fruticosa ssp. floribunda	Shrubby cinquefoil	G5T5	S5
Elymus trachycaulus	Slender Wild Rye	G5	S5
Erigeron philadelphicus	Philadelphia Fleabane	G5	S5
Erigeron spp.	Fleabane Species		
Festuca hallii	Rough Fescue	G4	S3
Fragaria virginiana	Virginia Strawberry	G5	S5
Gaillardia aristata	Great Blanket-flower	G5	S4
Galium boreale	Northern Bedstraw	G5	S5
Geum triflorum	Prairie-smoke	G5	S4
Heuchera richardsonii	Richardson's Alumroot	G5	S5
Juniperus communis	Common Juniper	G5	S5
Juniperus horizontalis	Creeping Juniper	G5	S5
Koeleria macrantha	Prairie Junegrass	G5	S5
Lepidium sp.	Peppergrass species		

Liatris ligulistylis	Strap-style Gayfeather	G5?	S4
Linnaea borealis	Twinflower	G5	S5
Lithospermum canescens	Hoary Puccoon	G5	S5
Lonicera dioica var. glaucescens	Mountain Honeysuckle	G5	S5
Maianthemum canadense	Wild Lily-of-the-Valley	G5	S5
Medicago lupulina	Black Medic	GNR	SNA
Melampyrum lineare	American Cow-wheat	G5	S5
Monarda fistulosa	Wild Bergamot	G5	S5
Oligoneuron album	Prairie Goldenrod	G5	S4
Oligoneuron rigidum	Prairie Goldenrod	G5	S5
Orthocarpus luteus	Yellow Owl's-clover	G5	S4
Oryzopsis asperifolia	White-grained Mountain-ricegrass	G5	S5
Phleum pretense	Meadow Timothy	GNR	SNA
Picea glauca	White Spruce	G5	S4
Pinus banksiana	Jack Pine	G5	S5
Poa annua	Annual Bluegrass	GNR	SNA
Poa pratensis	Kentucky Bluegrass	G5	S5
Polygala senega	Seneca Snakeroot	G4G5	S4
Populus tremuloides	Quaking Aspen	G5	S5
Potentilla anserina	Silverweed	G5	S5
Prunus virginiana	Choke Cherry	G5	S5
Quercus macropcarpa	Bur Oak	G5	S5
Rhus glabra	Smooth Sumac	G5	S4
Ribes oxyacanthoides	Canadian Gooseberry	G5	S5
Rosa acicularis	Prickly Rose	G5	S5
Rubus idaeus	Common Red Raspberry	G5	S5
Salix spp.	Willow Species		
Shepherdia canadensis	Canada Buffaloberry	G5	S5
Smilax herbacea	Smooth Herbaceous Greenbrier	G5	
Solidago hispida	Hairy Goldenrod	G5	S5
Solidago nemoralis	Field Goldenrod	G5	S5
Solidago spp.	Goldenrod Species		
Symphoricarpos spp.	Snowberry species		
Taraxacum officinale	Common Dandelion	G5	SNR
Thalictrum venulosum	Veined Meadowrue	G5	S5
Toxicodendron rydbergii	Northern Poison-oak	G5	S5
Viburnum rafinquesianum	Downy Arrow-wood	G5	S4
Vicia americana	American Purple Vetch	G5	S5
Zigadenus elegans	White Camas	G5	S5
Zizia aptera	Heartleaf Alexanders	G5	S5
Mosses			
Abietinella abietina	Abietinella Moss	G4G5	S4S5
Barbula convoluta		G5	SU
Brachythecium sp.			
Bryum sp.			
Campylium polygamum	Campylium Moss	G5	S4S5
Didymodon rigidulus		G5	S4S5
Encalypta procera	Extinguisher Moss	G4G5	S4S5
Eurhynchium pulchellum	Elegant Beaked Moss	G5	S4S5
Grimmia teretinervis		G3G5	

Hedwigia ciliata	Hedwig's Fringeleaf Moss	G5	SU
Hylocomium splendens	Stairstep Moss	G5	S4S5
Sanionia uncinata	Sanionia Moss	G5	S4S5
Tortella fragilis		G5	S4S5
Tortella tortuosa	Twisted Moss	G5	S4S5
Tortula norvegica		G5	SU
Tortula ruralis	Tortula Moss	G5	SNR
Lichen			
Cladina spp.	Reindeer Lichen species		
Cladonia spp.	Cup Lichen species		

Prairie/Boreal Intermediate Shrubland Alvar and Exposed Ridge/ Boulder Shrubland			
Scientific Name	**Common Name**	**Grank**	**Srank**
Vascular Plants			
Achillea millefolium	Common Yarrow	G5	S5
Allium stellatum	Glade Onion	G5	S5
Ambrosia spp.	Ragweed Species		
Amelanchier alnifolia	Saskatoon Serviceberry	G5	S5
Andropogon gerardii	Big Bluestem	G5	S5
Anemone cylindrica	Long-fruit Anemone	G5	S5
Anemone multifida	Hudson's Bay Anemone	G5	S5
Apocynum androsaemifolium	Spreading Dogbane	G5	S5
Arabis sp.	Rockcress species		
Arctostaphylos uva-ursi	Bearberry	G5	S5
Symphyotrichum spp.	Aster species		
Bromis inermis	Awnless Brome	G5	SNA
Campanula rotundifolia	American Harebell	G5	S5
Carex spp.	Sedge species		
Cerastium arvense	Field Chickweed	G5	S5
Chenopodium spp.	Goosefoot Species		
Comandra umbellate	Umbellate Bastard Toad-flax	G5	S5
Dalea purpurea	Purple Prairie-clover	G5	S4
Danthonia spicata	Poverty Oatgrass	G5	S5
Dasiphora fruticosa ssp. floribunda	Shrubby cinquefoil	G5T5	S5
Elymus trachycaulus	Slender Wild Rye	G5	S5
Erigeron philadelphicus	Philadelphia Fleabane	G5	S5
Erigeron spp.	Fleabane Species		
Gaillardia aristata	Great Blanket-flower	G5	S4
Galium boreale	Northern Bedstraw	G5	S5
Geum triflorum	Prairie-smoke	G5	S4
Helichtotrichon hookeri	Spike-oat	G5	S4
Heuchera richardsonii	Richardson's Alumroot	G5	S5
Juniperus communis	Common Juniper	G5	S5
Juniperus horizontalis	Creeping Juniper	G5	S5
Koeleria macrantha	Prairie Junegrass	G5	S5
Lepidium sp.	Peppergrass species		

Linum lewisii	Prairie Flax	G5	S4
Medicago lupulina	Black Medic	GNR	SNA
Monarda fistulosa	Wild Bergamot	G5	S5
Oligoneuron album	Prairie Goldenrod	G5	S4
Pellaea gastonyi	Gastony's Cliffbrake	G2G3	S1
Pellaea glabella subsp. occidentalis	Western dwarf Cliffbrake	G5T4	S2
Picea glauca	White Spruce	G5	S4
Pinus banksiana	Jack Pine	G5	S5
Poa annua	Annual Bluegrass	GNR	SNA
Poa pratensis	Kentucky Bluegrass	G5	S5
Potentilla anserina	Silverweed	G5	S5
Potentilla pennsylvanica	Pennsylvania Cinquefoil	G5	SU
Prunus virginiana	Choke Cherry	G5	S5
Quercus macropcarpa	Bur Oak	G5	S5
Ribes oxyacanthoides	Canadian Gooseberry	G5	S5
Rosa acicularis	Prickly Rose	G5	S5
Rubus idaeus	Common Red Raspberry	G5	S5
Salix spp.	Willow Species		
Selaginella densa	Dense Spikemoss	G5	S3
Shepherdia canadensis	Canada Buffaloberry	G5	S5
Solidago missouriensis	Missouri Goldenrod	G5	S5
Solidago nemoralis	Field Goldenrod	G5	S5
Symphoricarpos spp.	Snowberry species		
Toxicodendron rydbergii	Northern Poison-oak	G5	S5
Viola spp.	Violet Species		
Mosses			
Abietinella abietina	Abietinella Moss	G4G5	S4S5
Tortella torturorsa	Twisted Moss	G5	S4S5
Grimmia teretinervis		G3G5	
Lichens			
Cladina spp.	Reindeer Lichen species		
Cladonia spp.	Cup Lichen species		

APPENDIX C: Detailed Site Assessment Methodology (adapted from Faber-Langendoen 2010)

This methodology was peer reviewed by Paul Catling, John Riley, Carol Reschke, Cary Hamel, and Nicole Firlotte.

- Plots to determine percent cover of vegetation are laid in what is suspected to be unique types of alvar based on plant and bryophyte composition.

- Plot locations are not random, but selected as representative of potentially unique alvar types in order to establish a classification scheme

- A multivariate statistical analysis will be run to examine patterns of similarity and difference between/amongst sampling locations. Results will be used to classify alvar types in Manitoba and determine similarity to other North American alvars.

- The vegetation plots have been adapted from the Natureserve Wetland Ecological Integrity Assessment – Level 3 Assessment Form (See below) – these forms were recommended by Don Faber – Langendoen, Senior Ecologist with NatureServe

- At each plot location information regarding, anthropogenic activity, hydrology, and other envirnonmental factors is noted, either taken from Step 1 field surveys or at time of Level 3 Assessment

-Hydrological information is based on observed flooding patterns and the species composition and distribution across the alvar (ie wetland species indicate long term wet conditions, while bare rock lacking moss or lichen suggests sustained water levels followed by harsh dry conditions)

- The plots measure 50m X 20m, with four core modules of 10 X 10m (see assessment form below)

- Percent canopy cover of plants, mosses, lichens, litter, bare soil, and bare rock is determined in each module and averaged.

- Tree species are split into mature, sapling and seedling and scored separately

- Percent cover of mosses and lichens is scored separate, but not split into species

- Specimens have been collected for later identification and are stored at the Manitoba Conservation Data Centre.

- Percent covers of rock, and bare soil only include those which have no vegetative or litter cover

- The percent cover for additional species found outside the four modules, but within the plot, is estimated to capture outliers

- Soil depth and type is measured at two locations within the plot

- GPS co-ordinates and photos are taken at the 0m and 50m marks

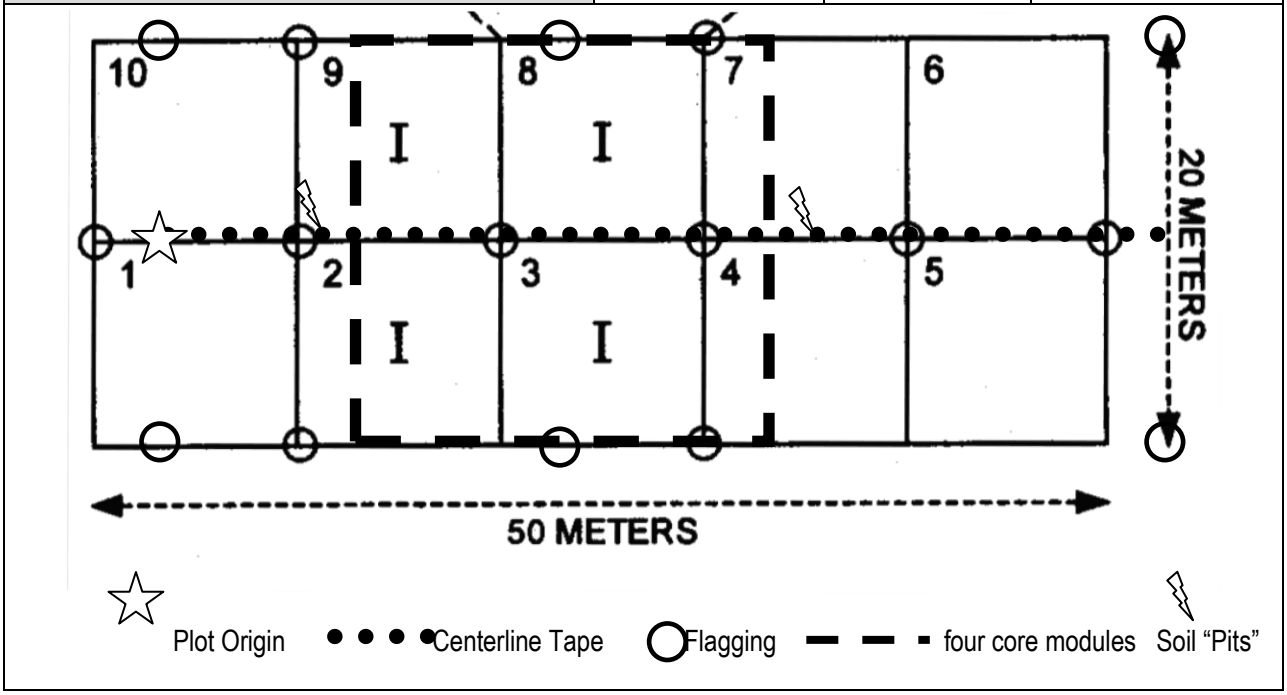
- An ecological integrity ranking is determined using the following stressors checklist(taken from the Natureserve Assessment). Stressors are activities or processes that affect the biodiversity and natural processes of the ecosystem, they primarily include human activity, or natural disturbance that is a threat only due to degradation caused by human activity.

Rating	Rating	Scope of Stressors Scoring
A	**Small**	Affects a small (1-10%) of the total occurrence or assessment area.
B	**Restricted**	Affects some (11-30%) of the total occurrence or assessment area.
C	**Large**	Affects much (31-70%) of the total occurrence or assessment area.
D	**Pervasive**	Affects all or most (71-100%) of the total occurrence or assessment area.

Rating	Rating	Severity of Stressors Scoring
A	**Slight**	Within the scope, the stressor is likely to only slightly degrade/reduce the affected occurrences or habitat.
B	**Moderate**	Within the scope, the stressor is likely to moderately degrade/reduce the affected occurrences or habitat.
C	**Serious**	Within the scope, the stressor is likely to seriously degrade/reduce the affected occurrences or habitat.
D	**Extreme**	Within the scope, the stressor is likely to destroy or eliminate the occurrence or habitat.

LEVEL 3 ASSESSMENT FORM

General Information page 32			
Site Name	**Photographer**:_____(Y/N) Photographs taken at 0 and 50 m points, looking inward to plot.		
L3 Assessment Code (e.g. NY.DFL.L3.001) _ _ .__ __ __.L3.__ __ __	***GPS Location*** **Set GPS to :** **UTM Zone = 16 Datum = NA83, Or WGS84**		
L2 Assessment Code: _ _ .__ __ __.L2.__ __ _		**0m**	**50**
Date __ __ __ __.__ __. __ __ YEAR MO DAY	**UTM-E:**		
Team Members: Leader: Co-Leader: Assistant:	UTM-N:		
	LAT:		
Ownership [office]	LONG:		
	Accuracy:		



Plot Notes: Standard Layout__YES / NO: If NO, explain Alternative Layout. Alternative Layout should preferentially retain the overall 0.1 ha area and the four core 100 m² modules.

Plot Representativeness- Is plot typical of assessment area:

__YES __ NO, but variation part of type at site (e.g. shrubby area in prairie; sedge depressions in swamps)

__ NO, variation atypical or includes parts of other types, but less than 10% in core modules

__ NO, variation atypical or includes parts of other types, > 10% in core modules

VEGETATION SPECIES PROFILE: Level 3								
Cover Classes 1: trace 2: 0.1–<1% 3: 1–<2% 4: 2–<5% 5: 5–<10% 6: 10–<25% 7: 25–<50% 8: 50–<75% 9: 75–<95% 10: >95%								
Cover = Canopy Cover - percentage of ground covered by the vertical projection of outermost perimeter of natural spread of foliage of plants.		**Module 100m2**				**400 m2**	**1000m2**	**Asst A**
		Estimate Cover either for each of the four 100 m² modules OR for a single 400m² plot					**Estimate cover for additional spp.**	**List**
Species	**Collect Info**	%Cover	%Cover	%Cover	%Cover	%Cover	%Cover	Present
Start module list with mature trees first (≥ 10 cm), but record cover on stem profile page). Record sapling and seedling here.		2	3	8	9	Total	Rest	Nearby
Unvegetated surface (% cover) across MODULE 2,3,8,9:: ____Surface Water ____Litter, duff, small wood < 10 cm diameter ____Dead Wood > 10 cm diameter ____Rock ____Bare Surface ____Other(describe):								
TREE								
E.g. Acer rubrum (mature)		X						
Acer rubrum (seedling)		2						

VEGETATION SPECIES PROFILE: Level 3								
Cover Classes **1**: trace **2**: 0.1–<1% **3**: 1–<2% **4**: 2–<5% **5**: 5–<10% **6**: 10–<25% **7**: 25–<50% **8**: 50–<75% **9**: 75–<95% **10**: >95%								
Cover = Canopy Cover - percentage of ground covered by the vertical projection of outermost perimeter of natural spread of foliage of plants.		**Module 100m2**				**400 m2**	**1000m2**	**Asst A**
		Estimate Cover either for each of the four 100 m^2 modules OR for a single 400m^2 plot					**Estimate cover for additional spp.**	**List**
Species	**Collect Info**	%Cover	%Cover	%Cover	%Cover	%Cover	%Cover	Present
Start module list with mature trees first (≥ 10 cm), but record cover on stem profile page). Record sapling and seedling here.		2	3	8	9	Total	Rest	Nearby
SHRUB								

L. Soil Profile Level 3. A soil auger or soil core may be used instead of digging a pit.

Pit 1 and Pit 2 should be in separate modules just outside the 400 m^2 area.

Soil Characteristic	Note:	Pit 1	Pit 2
Depth to Impervious Layer (cm)	If > 50 cm, put > 50 cm		
Depth to Saturated Soils (cm)	If > 50 cm, put > 50 cm		
Depth to Water Table(cm)	If > 50 cm, put > 50 cm		
Is Soil Organic? Y or N	Type (S= sapric, H = hemic or F= fibric)		
	Thickness of Organic Layer (cm)		
If Mineral: Texture of Soil			

Comments: additional substrate characteristics (e.g. marl layers, isolated depressions, etc):