A model-based adaptive rare plant sampling and monitoring design for the Lower Athabasca Region of Alberta

Report to the *Ecological Monitoring Committee for the Lower Athabasca (EMCLA)*

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Executive Summary

In 2011 the Ecological Monitoring Committee for the Lower Athabasca (EMCLA) initiated three major projects for rare and threatened species monitoring in northeast Alberta. One of the three projects was on rare plants with the goals of: (1) identifying the current state of rare plants in the Lower Athabasca area including the development of a single, user-friendly database for rare plants; (2) predicting rare plant distributions (habitat) to assist with future sampling efforts and to better understand species-habitats; and (3) recommend a coordinated regional inventory, assessment and monitoring program. Below we summarize the results for each objective.

The Alberta Conservation Information Management System (ACIMS) is the most extensive rare plant database in Alberta containing approximately 14,000 rare plant observations. Although extensive, ACIMS is not exhaustive. An additional 1,178 rare plant records for 22 species were compiled using other sources of data. All future rare plant surveys should, by policy, report their results to ACIMS. Using updated information, we selected 66 rare plant species for species distribution modeling based on a regional frequency of at least 20% of species observations in Alberta occurring within the Lower Athabasca region south of Lake Athabasca. This emphasized rare plants that were the most regionally important to the Lower Athabasca relative to Alberta.

Species distribution models were fit for each selected species at a 1 hectare resolution using the maximum entropy (Maxent) machine learning algorithm and a suite of 46 different climate, lithology, vegetation, and terrain GIS predictors. To increase efficiency in inventory of rare plants and to better understand their habitat associations, we suggest that an adaptive, model-based rare plant sampling design be employed where species habitat models are used to allocate sampling effort and the field results from those inventories used for model validation and model refinement (i.e., an iterative process of modeling and field sampling). Given the large number of species being considered, a multi-objective optimization analysis should be considered to allocate 100 new rare plant survey sites per year. Prior to implementing the optimization analysis, improvements can be made to species distribution models by introducing stand-level habitat predictors. To compliment model-based sampling efforts, an additional 50 sites per year should be surveyed for rare plants using landscape-habitat elements that make no *a priori* assumption of species occurrence. All rare plant surveys should follow *The Alberta Native Plant Council* guidelines with species absences always noted.

In addition to these inventory-based assessments, we recommend that annual trend monitoring of occupancy-abundance be used for a selected subset of rare (S1 & S2 status) and vulnerable (species associated with active developments) plant species to evaluate the effects of endogenous (e.g., local disturbances) versus exogenous (e.g. climate, fire, etc.) stressors on rare plant populations. Monitoring sites should be selected from known rare plant locations and stratified into two groups using local measures of human disturbance: (1) a ‘control’ group where the landscape is least disturbed; and (2) an ‘impacted’ group where the landscape is the most disturbed. A minimum of 3 replicates per stratum over 36 strata (3 species per taxon x 3 taxon x 2 status ranks x 2 treatments [control or impacted]) for a total of 108 sites should be annually monitored. Over time, trends in occupancy-abundance should be compared between control and impacted groups to assess changes in occupancy-abundance and where possible to determine the cause (endogenous versus exogenous) of any observed declines.

1. Introduction

In 2011 the Ecological Monitoring Committee for the Lower Athabasca (EMCLA) initiated three major projects for rare and threatened species monitoring in northeast Alberta. One of the three projects was on rare plants with the goals of: (1) identifying the current state of rare plants in the Lower Athabasca area including the development of a single, user-friendly database for rare plants; (2) predicting rare plant distributions to help prioritize future sampling efforts and to better understand species-habitat associations; and (3) recommend a coordinated regional inventory, assessment and monitoring program.

Sampling of rare plants is difficult due to the uncommon nature of rare plant habitats and/or diffuse nature of rare plant populations. Model-based sampling designs – using information on species-habitat associations – has been proposed as an alternative to the commonly employed random or systematic sampling designs for common attributes (Guisan et al. 2006). A major advantage of model-based sampling designs over random or systematic is the potential for substantial cost savings (up to 70% over that of random sampling) (Guisan et al. 2006).

In addition to creating efficiencies in sampling for assessments of general status, species location data can also be used to develop species distribution models to predict habitats in un-surveyed locations and these models subsequently used for regional land use planning. Currently, however, there is a general lack of spatially contiguous predictions of rare plant distributions in Alberta, despite similar products being available for vertebrates like caribou (James & Stuart-Smith 2000, Dyer et al. 2002, Schneider et al. 2010), grizzly bears (Nielsen et al. 2006, 2009), and sage-grouse (Aldridge et al. 2007). Similar tools are needed for rare plants to be fully represented in the planning process.

Here we outline an approach for using a model-based, adaptive sampling design for the Lower Athabasca region of northeast Alberta. Although rare plant surveys, mapping (rare plant locations), and literature reviews have been completed for energy developments in the Lower Athabasca region (e.g. Bush et al. 2004), no formalized sampling and monitoring design for rare plants has been implemented at the regional scale. Our intent here is to predict species distribution across the region and based on those results develop a formalized sampling and monitoring design that improves sampling efficiency for rare plant surveys (and thus survey cost) in order to update the status of rare plants and to identify trends for the rarest and most vulnerable species. By using an adaptive sampling design we allow for an integrative and iterative feed-back between survey effort and knowledge of species habitat where survey locations are informed by species distribution models and species distribution models are validated (tested) and refined using information (presence/absence or abundance) collected at fields surveys. Below we describe the methods and results for: (1) updating our knowledge of rare plant locations and status in Alberta with a focus on species that are most represented in the Lower Athabasca region; (2) species distribution modeling; and (3) suggested allocation of future rare plant inventories using model-based, adaptive sampling and trend monitoring for selected taxa.

2. Current status of rare plants and updated rare plant database

2.1. Existing knowledge of rare plant distribution in the Lower Athabasca region

The Alberta Conservation Information Management System (ACIMS) is a centrally deposited database of rare plant (including plant communities as well as invertebrates) managed by the Alberta Tourism, Parks and Recreation. This database – now openly available to the public – records the location, accuracy, date, and population size of rare plant observations in Alberta. It is the most extensive dataset available for rare plant locations in Alberta with approximately 14,000 observations on rare plants (Figure 1). Although these records are not without their limitations (see section 2.3 below), they do represent the best current source of information on rare plant occurrences in Alberta.

2.2. Updating known rare plant locations into a single database

While ACIMS is extensive, it does not have access to all industry-sponsored rare plant records (submissions are highly encouraged, but not required) and is not necessarily updated with all currently submitted records. To establish and update rare plant locations into a single database, Bayne (2011) compiled rare plant occurrences from other potential sources including consultants, academia (in particular Dr. Rene Belland's bryophyte database), and the Alberta Biodiversity Monitoring Institute (ABMI). For the purpose of this report, an additional 1,178 new records for 22 different rare plant species (Figure 1) were added to the ACIMS dataset bringing the total number of known rare plant records in Alberta to 15,034.

2.3. Known limitations of existing rare plant databases

Besides ABMI records that were based on a systematic sampling design (Stadt et al. 2006), the majority of rare plant records compiled were based on opportunistic observations (no formal sampling/survey design) of rare plants and as such contained inherent 'sampling' or 'effort' bias (Kadmon et al. 2004). For instance, in Alberta, sample effort for rare plants is known to be inversely related to distance from roads and major cities, particularly those cities with University herbariums and major government offices where taxonomic expertise exists, and to major energy developments that have received numerous environmental assessments like the oil sands (Stolar & Nielsen, in prep).

Not only are rare plant records biased in space (environment) with different locational accuracy, but also potentially biased in time with a number of rare plant records from ACIMS being more than 20 years old (some >100 years since last observed). When using historical records, we assume species occurrence to be constant, or that at minimum the environments being used to assess the habitat relationships of a species to be static. Clearly for the older records environmental habitat measures representing, among others, land cover, stand age (regenerating forest, old growth, etc.), or recent anthropogenic disturbances, are unlikely to be accurate. However, in other cases, such as measures of lithology and terrain, environmental measures may be considered 'static'. Regardless, care should be given when interpreting results of studies based on observations that are potentially biased in space and time. Model validation in such cases is especially important.

Another limitation of using rare plant records, such as those described here, is that they lack information defining species absences (i.e., an asymmetric knowledge of presence and absence). Because of this asymmetry in species records, they are often referred to as presence-only data

(Zaniewski et al. 2002, Pearce & Boyce 2006). Without knowledge of species absences, it is difficult to estimate environmental limitations for species presence (i.e., predict absences) unless we assume available environments or un-sampled environments represent pseudo-absences. For rare species (as opposed to common species) such an assumption may in fact only be a minor problem, since pseudo-absences are unlikely to be misclassified (i.e., assigned an absence although being present since the species is by nature absent across a vast majority of environmental space). Johnson et al. (2006) refers to this error as "sample contamination" and shows that contamination rates < 20% result in robust presence-only model estimates (Johnson et al. 2006). This is also consistent with prior research by Lancaster & Imbens (1996) who examined the effects of a contaminated sampling scheme (unknown states for 'control' comparisons) using a binary choice model. In species occupancy modeling, sample contamination is referred to as "detectability" and reflects the situation common for many rare species where observations of presence are assumed correct, but not necessarily observations of absences (MacKenzie et al. 2002), since it can be a challenge to detect the presence of cryptic species.

Despite these limitations, rare plant records from the databases collected here represent the richest source of known information on the distribution and potential habitat requirements of rare plants in Alberta. In this report we make use of these data to suggest future sampling designs for inventory and monitoring of rare plants in the Lower Athabasca region of Alberta that will improve our knowledge of rare plant status and habitat relationships.

3. Predicting rare plant distributions in the Lower Athabasca region of Alberta

3.1. Species distribution modeling approach

Species distribution models were fit for all rare (sub-national status of S1, S2, and S3) plants in Alberta having at least 8 known occurrences in the province with at least 20% of those locations occurring within the Lower Athabasca region south of Lake Athabasca. The 20% rule emphasized rare plants having greater representativeness (emphasis) in the Lower Athabasca region relative to the rest of Alberta, while the minimum observation rule was simply due to an absolute minimum sample size necessary for species distribution modeling. Using these rules, we considered a total of 66 rare plants that consisted of 28 vascular plants, 23 bryophytes, and 15 lichen species (Tables 1-3). We refer to these selected species as focal rare plants or simply focal species. In total, 2,670 location records across Alberta were used to represent species presences for our 66 focal species. Species prevalence (number of occurrences in Alberta) ranged from a minimum of 8 observations to a maximum of 133 observations (median of 28 observations).

For each focal species, we fit a presence-only model using environmental GIS predictors, a sample of presence locations and pseudo-absence samples, and the Maximum Entropy (Maxent, Phillips et al. 2006, Phillips & Dudik 2008) machine learning algorithm. Environmental predictors included 46 different GIS variables representing climate, lithology, habitat, and terrain factors (Table 4). Habitat variables included the EOSD land cover (circa 2000) classification for Canada (Wulder & Nelson 2003) and the peatland inventory of Alberta from Vitt et al. (1996). Lithology represented bedrock geology (index of geological age), surficial geology deposits, and areas identified as having sand/gravel aggregates or eolian dunes which are often important in predicting disturbance-evolved xeric-specialist species. Climate variables were composed of typical bioclimate variables describing precipitation, temperature, and growing season

conditions. Terrain-derived (from a 100m DEM) variables included a landform classification, a terrain wetness model, topographic position ruggedness indices, and solar radiation estimates. All environmental predictors and thus species distribution models were spatially represented across Alberta in a 1 hectare grid. We modeled species across Alberta to maximize sample presences and environmental gradients. Only the linear, quadratic, and product responses in Maxent were considered. For these models we did not consider landscape measures (e.g., patch size, diversity, etc.), different spatial scales of influence (e.g., moving windows), or consider biases associated with time since observation or locational accuracy.

Rather than using the Maxent default of randomly querying pseudo-absences from the entire 'background' of Alberta (our environmental study extent), we constrained pseudo-absences to be all other rare plant records known in Alberta (15,034 records – number of target species observations). By using this constraint, we controlled – to the best of our ability – survey effort. We also assumed that if an observer recorded the presence of a rare plant at a specific location, they would have also noted the presence of any of our 66 focal species being modeled. Most certainly some misclassification error of pseudo-absences (assuming it to be absent when in fact it wasn't) is likely, although presumably less so than using the default option of all environments of Alberta. Because we defined 'background' (pseudo-absence) observations, model predictions were based on the 'Projection' option in Maxent where 'current' environmental predictor variables (ASCII grids) were used to describe 'projected' species distributions (baseline conditions). All species predictions were 'clipped' to the Lower Athabasca region, since that was our area of focus.

Model accuracy (with-in sample model accuracy) for each species distribution model was assessed using the Receiver Operating Characteristic (ROC) Area Under the Curve (AUC) metric. Although not without its controversy (see Lobo et al. 2008), AUC is the most widely reported measure of model predictive accuracy for species distribution modeling (Fielding & Bell 1997). AUC values <0.7 are considered poor model accuracy, between 0.7–0.9 good model accuracy, and >0.9 high model accuracy (Swets, 1988, Manel et al. 2001). Because we did not use an independent (out-of-sample) or with-held sample of species locations for predictive accuracy assessment, nor did we have known locations of species absences, ROC AUC estimates are likely overestimated and thus caution should be used in their interpretation. Relative differences between species AUC values do, however, provide a gauge between differences in model fit (within-sample predictive accuracy) given the set of environmental predictors used.

Due to the lack of patch-level descriptions of vegetation for our analyses, caution should be given in interpreting model results. Future efforts should be given to the development of digital vegetation descriptions using products such as the Alberta Vegetation Inventory (AVI) for terrestrial sites and the Ducks Unlimited wetland classification for aquatic and semi-aquatic habitats.

3.2. Predictions of rare plant distributions

Predictions from species distribution models were mapped for each species within the Lower Athabasca region, along with locations of known occurrences for that species. Predictions of relative probability of occurrence (simply referred to as habitat suitability in species' maps) were scaled from grey representing no predicted occurrence for that species at a site, to a blue colour

representing a very low probability of occurrence, and finally yellow and orange colours were representing the highest probability of species occurrence (Figure 2). Maps for each species are published in the rare plant factsheets as Appendix 1 and also provided as a digital supplemental file.

Model accuracy of species distribution models – based on province-wide assessments between species presences and pseudo-absences at other rare plant locations – ranged from an AUC of 0.883 (*Splachnum sphaericum*) to 0.999 (*Stellaria arenicola*, sand dune chickweed). In general, AUC was inversely related to species prevalence suggesting that the rarest species were also the most site specific (habitat-specialists). On average AUC was lower for bryophytes (0.940 ±0.024 SD) compared with either vascular plants (0.963 ±0.018) or lichens (0.972 ±0.024) (see Tables 1-3). Differences between these groups may reflect site-specific habitat requirements for bryophytes that are not well-represented in current environmental predictors, more generalized patterns of occurrence that may not be limited as much by environmental conditions, but rather biotic factors (competition, dispersal, etc.), and/or the possibility that some of the bryophyte species are more common than currently considered (surveyed). A recent analysis of rare bryophytes at ABMI plots by Huggard (2011) supports in part this last possibility. Out of 486 ABMI plots (1-ha size) with bryophyte data available, there are 570 records for listed ACIMS species (~1.2 rare bryophyte species per plot). Assuming that 1 ha ABMI plots could be considered equivalent to a mapped element occurrence in ACIMS and that the existing 486 ABMI plots are representative of habitats in the province, a total of 79.5 million rare bryophyte records would be encountered if the entire province were sampled (Huggard 2011). Despite the crude nature of this extrapolation, clearly rarity for some species is likely a function of sample effort (available expertise and location effort) more than actual rarity. Further surveys are therefore required to separate rare from uncommon species and thus help prioritize conservation efforts for those species at most risk.

3.3. Predicting patterns of taxon-specific regional diversity of potential rare plants

An optimal cut-off (threshold) probability for predicting species presence was estimated using the 'equal sensitivity and specificity' threshold (Lui et al. 2005) in Maxent. This threshold balanced errors of omission and commission and was used to convert model predictions to a binary presence/absence (0 or 1) form for estimation of taxa-specific (vascular plants, bryophytes, and lichens) diversity indices using the ArcGIS 'reclassify' tool. To illustrate spatial patterns in rare plants where detecting multiple rare species from an individual taxonomic group is more or less likely, we used the 'map algebra' function to sum richness of potential species habitats within taxonomic groups (i.e., vascular plants, bryophytes, and lichens). Areas of high richness were visually compared among taxonomic groups to identify regionally important areas recognizing that maps reflect only the 66 focal species selected for the region south of Lake Athabasca and the known current limitations of species distribution models.

Focal rare vascular plant diversity (out of 28 species examined) was predicted to be highest on the Athabasca sand plain south of Lake Athabasca and northeast of Fort MacKay (Figure 3a). Rare vascular plants most representative of the Athabasca sand plain included Herriot's sagewort (*Artemisia tilesii*), cyperus-like sedge (*Carex pseudocyperus*), pink lady's-slipper (*Cypripedium acaule*), spotted Joe-pyed weed (*Eupatorium maculatum*), larger Canadian St. John's-wort (*Hypericum majus*), branched cinquefoil (*Potentilla multifida*), pitcher plant (*Sarracenia*

purpurea), sand dune chickweed (*Stellaria arenicola*), and larger Canadian St. John's-wort (*Tanacetum bipinnatum huronense*) (see Appendix 1 for individual species distribution maps). Other areas of high potential rare vascular plant diversity include small patches of habitat between Cold Lake and the Fort MacKay area (Figure 3a).

In comparison to vascular plants, focal rare bryophyte diversity (out of 23 species examined) was predicted to be highest in the central part of the study area between Lac La Biche and Fort MacKay (Figure 3b). The only bryophyte not well-represented or predicted for this region was *Neckera pennata* which was predicted to be more common on the Canadian Shield north of Lake Athabasca, on the Athabasca sand plain south of Lake Athabasca and to a lesser extent the area just north of McClelland Lake (see Appendix 1 for species distribution map).

Finally, focal rare lichen diversity was predicted to be highest in the area north of Fort MacKay around the McClelland Lake and on the northeast slopes of the Birch Mountains, as well as forested areas along the Athabasca River west of Fort McMurry, and to a lesser extent the moraines between Lac La Biche and Cold Lake (Figure 3c). Rare lichens representative of these areas include old man's beard (*Bryoria simplicior*), rim lichen (*Lecanora subintricata*), disk lichen (*Lecidella elaeochroma*), camouflage lichen (*Melanelia trabeculata*), naked kidney lichen (*Nephroma bellum*), pepper-spore lichen (*Rinodina metaboliza*), and beard lichen (*Usnea scabiosa*) (see Appendix 1 for species distribution maps).

4. Recommendations for future survey design and trend monitoring

4.1. Optimizing locations of future rare plant survey for inventory and model refinement

We suggest that the Lower Athabasca region be 'netted down' into a 1 hectare to 1-km^2 grid and predictions by species summed for each grid cell. Locations of known observations by species should also be summarized for each grid cell and targets for future allocation of survey efforts outside of known locations determined using a multi-objective (species in this case) optimization analysis, such as the simulated annealing algorithm in the software Marxan (Ball et al. 2009). A cost function could also be implemented for each grid cell, where cost would represent the relative cost in surveying a particular site based on accessibility (i.e., vehicle vs. helicopter). The resulting analysis would identify those grid cells that would meet the objective (targets) for the least possible cost. This would include locating survey sites in areas where potential species habitats are most likely to overlap, but not exclude rare habitat elements that only contain an individual rare species. We recommend that 66% of survey effort for inventory and habitat association needs be allocated using this approach. We suggest a target of 100 field sites for 2012.

For the remaining 33% of inventory surveys (e.g., 50 sites recommended for 2012), allocation of survey (sampling) effort should be based on landscape element mapping (Figure 4) and vegetation stratifications for unmodified (undisturbed) sites. Mapped landscape elements represent unique environmental conditions. This approach has previously been used as a coarse-filter measure of biodiversity for conservation planning by The Nature Conservancy. Here we suggest using the same concepts for allocating future survey effort. Using this approach we make no *a priori* assumption about species distributions. Information on presences, as well as absences, would be gathered for each site helping to refine our understanding of habitat associations and factors limiting species occurrences. Although we currently have a draft model

of landscape elements, more digital information is needed on vegetation conditions (forest stand attributes [AVI] and wetland types) before pursuing this avenue of survey design and stratification. We therefore recommend that a landscape-habitat element mapping be completed in early 2012 to enable its use in site stratification. Because the number of strata may be large relative to the number of sites that can be visited, effort for sampling these strata should be split among years.

Regardless of how new surveys are allocated, information collected on presence and absence of rare plants in 2012 can be used to iteratively update status of species, to test and better understand species-habitat relationships (requirements), and to refine and improve species distribution models. An adaptive (iterative) process of field sampling and modeling following Guisan et al. (2006) is recommended (Figure 5), given that it is the most efficient in time and cost of sampling rare species.

4.2. Recommendations for future trend monitoring of rare plants

In addition to optimizing sampling for new detections of rare plants (inventory goals), we also recommend a targeted monitoring program to evaluate trends in occupancy-abundance for a random selection of rare plants. This would be used to help identify potential causes of decline or factors affecting species persistence. Species should be randomly selected among species statuses for the rarest plants (S1 & S2 ranking) and taxon (vascular plants, bryophytes, and lichens) and for those most vulnerable to human disturbances, since it would not be possible to monitor all focal species. An initial target of three random species per stratum should be considered (18 status-taxon-species combinations), although vascular plants may need to be sub-divided into terrestrial vs. aquatic and graminoid vs. forb. Monitoring would be done at known rare plant locations and would focus on evaluating occupancy and abundance (population size) and where possible reproductive success (presence of flower and seed production for flowering plants) and survival of marked individuals for perennial species (where determining individual identity is possible). Sites should be stratified into an 'undisturbed' and 'disturbed' strata based on localized anthropogenic footprints with 3 replicates for each stratum for a total of 108 trend monitoring sites. Monitoring at these sites would be focused on evaluating/testing whether anthropogenic disturbances and/or exogenous factors (normal meta-population processes, climate change, fires, etc.), affect trends in rare plant populations. Because rare plant populations often respond to natural environmental variation (Menges 1990), annual re-monitoring for these species is essential. Information on demographic and environmental variability would then be used to assess population viability of target species under different management and climate scenarios to determine future risk. Over longer-periods, trends in plant populations could also be evaluated.

4.3. Rare plant survey field protocols – the Alberta Native Plant Council guidelines

All new rare plant surveys conducted should follow the existing and widely-accepted field protocols/guidelines from the Alberta Native Plant Council (Lancaster 2000). This includes preparation of a list of potential rare species (ideally a complete provincial tracking list) and the mapping of habitats with aerial photographs prior to the field visit, although in this case site selection will be based on models. At a site, either meander searches focusing on different micro-habitats should be employed or if necessary, patterned searches, such as walking parallel 'transects' should be used (Lancaster 2000). The type of search pattern and intensity, including

the amount of time searching a site, should always be recorded along with the observer's name. In all cases, the presence, as well as assumed absence (assuming perfect detectability), should be recorded for each species. If species are highly cryptic where detectability would be problematic (MacKenzie et al. 2002), multiple survey sessions should be employed as well as timing the surveys to the period of maximum detectability (i.e., flowering for vascular plants). Because multiple survey sessions allocated on different dates within a summer would likely be cost prohibitive, multiple survey sessions on the same date using different observers (switching observers) should be considered. Population sizes should be determined (censuses) for very small populations where individual units are obvious (vs. ramets/genets) and estimated for larger populations.

5. A summary of key recommendations for rare plant inventory and monitoring

Below we describe, in bullet format, our key recommendations for rare plant inventory and monitoring in the Lower Athabasca region of Alberta:

- ***Use the Alberta Native Plant Council guidelines*** for rare plant surveys and ensure that both presences *and absences* (non-detections) are recorded at each site.
- ***All rare plant data collected should, by policy, be reported to ACIMS***
- ***Use a multi-objective optimization model*** to identify future rare plant sampling/inventory work with 66% of future sampling effort based on these results. For the remaining 33% of future surveys, use a simple landscape classification scheme to stratify environments and randomly sample within stratum. Here we recommend a total sample size for 2012 surveys of 150 sites.
- ***Monitor trends*** in occupancy-abundance and where possible identify demographic responses for a sample of existing rare plant locations. Given the large number of species available for monitoring, a sub-sample of species should be selected for monitoring based on status, taxon, and vulnerability. Monitoring sites should be visited annually and locations for monitoring stratified into 'disturbed' and 'undisturbed' conditions. We recommend a sample size of 108 monitoring sites for 2012.
- ***Compile digital vegetation datasets*** for Alberta based on existing products such as the Alberta Vegetation Inventory (AVI) for terrestrial sites and the current classification of aquatic and semi-aquatic habitats by Ducks Unlimited. ***Update species distribution models*** using these products as this is critical to predicting species occurrences and habitat associations at the patch-scale and better understanding local species-habitat relationships.

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Table 1. Rare (S1-S3) bryophyte species (n = 23 mosses and liverworts) selected for species distribution modeling and initial targeted monitoring in the southern Lower Athabasca Regional Planning area (south of Lake Athabasca). Species were selected for the list if at least 20% of ACIMS occurrences in Alberta were in the Lower Athabasca region south of Lake Athabasca and at least 8 occurrences were mapped in Alberta.

				ACIMS records			Model	ROC	cut-off
Genus	**species**	**Common name**	**S-Rank**[1]	**Alberta**	**L. Athab.**	**%**[2]	**Obs**	**AUC**	**prob.**[3]
Anastrophylium	*helleranum*	Heller's anastrophyllum	S2	35	27	77.1	92	0.938	0.296
Brachythecium	*rutabulum*	Rough-stalked feather moss	S2?	42			42	0.911	0.424
Calypogeia	*sphagnicola*	Bog pouchwort	S3	21	10	47.6	113	0.953	0.268
Campylium	*polygamum*	Campylium moss	S3	71	18	25.4	105	0.896	0.295
Campylium	*radicale*	Campylium moss	S2	23			46	0.920	0.380
Chiloscyphus	*pallescens*		S1	41	26	63.4	133	0.930	0.328
Conocephalum	*conicum*	Snakeskin liverwort	S2	33	12	36.4	76	0.903	0.317
Entodon	*schleicheri*	Schleicher's silk moss	S1	12	6	50	24	0.952	0.463
Herzogiella	*turfacea*		S3	24	6	25	74	0.953	0.203
Hypnum	*pallescens*	Hypnum moss	S2	39	17	43.6	93	0.941	0.320
Lophozia	*heterocolpos*		S2	13	4	30.8	96	0.947	0.268
Neckera	*pennata*		S2S3	15	5	33.3	29	0.949	0.204
Pohlia	*sphagnicola*		S3	16	11	68.8	20	0.963	0.230
Pseudobryum	*cinclidioides*	River thyme-moss	S2	13	9	69.2	40	0.971	0.250
Riccardia	*latifrons*		S2	15	10	66.7	62	0.957	0.344
Scapania	*glaucocephala*		S2	28	22	78.6	88	0.941	0.272
Scapania	*paludicola*		S2	22	6	27.3	59	0.955	0.305
Sphagnum	*fallax*	Flat-top bogmoss	S2	34	28	82.4	90	0.964	0.212
Sphagnum	*fimbriatum*	Fringed bog moss	S2	20	10	50	54	0.977	0.254
Splachnum	*ampullaceum*	Flagon-fruited splachnum	S2	25	9	36	56	0.929	0.366
Splachnum	*luteum*	Yellow collar moss	S3	31	12	38.7	79	0.936	0.291
Splachnum	*rubrum*	Red collar moss	S3	40	16	40	105	0.948	0.330
Splachnum	*sphaericum*	Pinkstick dung moss	S2	37			112	0.883	0.372

[1]Status from ACIMS database; [2]Percentage representing number of ACIMS occurrences within the Lower Athabasca Regional Planning area south of Lake Athabasca; [3]Cut-off probability represents the optimal threshold classifying presence/absence of predicted species distributions (equal sensitivity / specificity).

Table 2. Rare (S1-S3) lichen species (n = 15) selected for species distribution modeling and initial targeted monitoring in the southern Lower Athabasca Regional Planning area (south of Lake Athabasca). Species were selected for the list if at least 20% of ACIMS occurrences in Alberta were in the Lower Athabasca region south of Lake Athabasca and at least 8 occurrences mapped in the Alberta.

				ACIMS records			Model	ROC	cut-off
Genus	**species**	**Common name**	**S-Rank**[1]	**Alberta**	**L. Athab.**	**%**[2]	**Obs**	**AUC**	**prob.**[3]
Bryoria	*simplicior*	Old man's beard	S3	28	12	42.9	28	0.919	0.342
Cladonia	*stygia*	Reindeer lichen	S2	14	5	35.7	14	0.953	0.274
Imshaugia	*placorodia*	American starburst lichen	S2S3	21	13	61.9	21	0.990	0.232
Lecanora	*subintricata*	Rim lichen	S1	19	7	36.8	19	0.981	0.314
Lecidella	*elaeochroma*	Disk lichen	S1	9	7	77.8	9	0.968	0.165
Melanelixia	*fuliginosa*	Camouflage lichen	S1S2	12	4	33.3	12	0.983	0.444
Melanohalea	*trabeculata*	Camouflage lichen	S1?	15	8	53.3	15	0.993	0.261
Nephroma	*bellum*	Naked kidney lichen	S2S3	15	5	33.3	15	0.979	0.349
Ochrolechia	*gowardia*		S1	13	5	38.5	13	0.996	0.400
Peltigera	*horizontalis*		S1S2	13			13	0.981	0.377
Peltigera	*polydactylon*	Alternating dog-lichen	S1S2	14			14	0.957	0.513
Physcia	*tenella*		S2	10	3	30	10	0.925	0.518
Placynthiella	*uliginosa*	Peat tarspot lichen	S2S3	18	9	50	18	0.979	0.281
Rinodina	*metaboliza*	Pepper-spore lichen	S2	20	9	45	20	0.988	0.448
Usnea	*scabiosa*	Beard lichen	S1S2	21	19	90.5	21	0.991	0.094

[1]Status from ACIMS database; [2]Percentage representing number of ACIMS occurrences within the Lower Athabasca Regional Planning area south of Lake Athabasca; [3]Cut-off probability represents the optimal threshold classifying presence/absence of predicted species distributions (equal sensitivity / specificity).

Table 3. Candidate rare (S1-S3) vascular plant species (n=28) selected for future species distribution modeling and initial targeted monitoring for the southern Lower Athabasca Planning Region (area south of Lake Athabasca). Species were selected for the list if at least 20% of ACIMS occurrences in Alberta were in the Lower Athabasca region south of Lake Athabasca and at least 8 occurrences mapped in the Alberta.

				ACIMS records			Model	ROC	cut-off
Genus	**species**	**Common name**	**S-Rank**[1]	**Alberta**	**L. Athab.**	**%**[2]	**Obs**	**AUC**	**prob.**[3]
Artemisia	*tilesii*	Herriot's sagewort	S3	20	6	30	20	0.987	0.198
Cardamine	*pratensis*	Meadow bitter cress	S3	28	16	57.1	28	0.961	0.352
Carex	*backii*	Back's sedge	S3	30	8	26.7	30	0.961	0.355
Carex	*capitata*	Capitate sedge	S3	34	10	29.4	34	0.946	0.244
Carex	*houghtoniana*	Sand sedge	S3S4	29	11	37.9	29	0.972	0.199
Carex	*oligosperma*	Few-fruited sedge	S3?	40	39	97.5	40	0.994	0.072
Carex	*pseudocyperus*	Cyperus-like sedge	S3	34	9	26.5	34	0.974	0.297
Carex	*retrorsa*	Turned sedge	S3	36	10	27.8	36	0.940	0.377
Chrysosplenium	*iowense*	Golden saxifrage	S3?	90	43	47.8	90	0.948	0.274
Chrysosplenium	*tetrandrum*	Green saxifrage	S3S4	39	15	38.5	39	0.962	0.353
Cypripedium	*acaule*	Stemless lady's slipper	S3	32	30	93.8	32	0.990	0.168
Drosera	*linearis*	Slenderleaf sundew	S3	28			28	0.980	0.191
Eupatorium	*maculatum*	Spotted Joe-pye weed	S1S2	11	4	36.4	11	0.991	0.194
Hypericum	*majus*	Large Canada St. John's-wort	S2	23	9	39.1	23	0.982	0.135
Isoetes	*echinospora*	Northern quillwort	S2	8	3	37.5	8	0.994	0.626
Juncus	*brevicaudatus*	Short-tail rush	S2	19	6	31.6	19	0.970	0.127
Malaxis	*paludosa*	Bog adder's-mouth	S1	15	5	33.3	15	0.964	0.269
Najas	*flexilis*	Slender naiad	S2	16	5	31.3	16	0.986	0.176
Nymphaea	*leibergii*	Pygmy water-lily	S1S2	12	9	75	12	0.990	0.213
Nymphaea	*tetragona*	White water-lily	S1	9	6	66.7	9	0.997	0.317
Polygala	*paucifolia*	Fringed milkwort	S1	8	6	75	8	0.998	0.407
Potamogeton	*natans*	Floating-leaf pondweed	S3	36	16	44.4	36	0.941	0.299
Potentilla	*multifida*	Branched cinquefoil	S1	12	4	33.3	12	0.990	0.278
Sagittaria	*latifolia*	Broad-leaved arrowhead	S2	17	11	64.7	17	0.964	0.153
Sarracenia	*purpurea*	Pitcher-plant	S3	75	70	93.3	75	0.986	0.136
Spiranthes	*lacera*	Northern slender ladies'-tresses	S1	8	7	87.5	8	0.986	0.494

Stellaria	*arenicola*	Sand-dune chickweed	S1	9	9	100	9	0.999	0.403
Tanacetum	*bipinnatum (Huronens)*	Indian tansy	S2	23	9	39.1	22	0.996	0.179

[1]Status from ACIMS database; [2]Percentage representing number of ACIMS occurrences within the Lower Athabasca Regional Planning area south of Lake Athabasca; [3]Cut-off probability represents the optimal threshold classifying presence/absence of predicted species distributions (equal sensitivity / specificity).

Table 4. List of environmental GIS variables considered for species distribution modeling for focal rare plants across Alberta using the Maximum Entropy (Maxent) machine learning algorithm.

Model predictors	Variable group	Source
Aggregates (gravel & sand; category)	Lithology	Alberta Geological Survey
Active or stabilized dune (category)	Lithology	Alberta Geological Survey
Bedrock geology (approximate age)	Lithology	Alberta Geological Survey
Surficial geology (categories)	Lithology	Surficial materials of Canada, Map 1880A (Fulton, R J. 1995)
Annual moisture index	Climate	Alberta climate model (Anonymous)
Degree days (base 0° C)	Climate	Alberta climate model (Anonymous)
Degree days (base 5° C)	Climate	Alberta climate model (Anonymous)
Day of first fall (Julian day)	Climate	Alberta climate model (Anonymous)
Frost free period (days)	Climate	Alberta climate model (Anonymous)
Growing season precipitation (mm)	Climate	Alberta climate model (Anonymous)
Mean annual precipitation (mm)	Climate	Alberta climate model (Anonymous)
Mean annual temperature (°C)	Climate	Alberta climate model (Anonymous)
Mean maximum temperature (°C)	Climate	Alberta climate model (Anonymous)
Mean minimum temperature (°C)	Climate	Alberta climate model (Anonymous)
Mean temperature in the coldest month (°C)	Climate	Alberta climate model (Anonymous)
Mean temperature in the warmest month (°C)	Climate	Alberta climate model (Anonymous)
Day of first spring (Julian day)	Climate	Alberta climate model (Anonymous)
Summer moisture index	Climate	Alberta climate model (Anonymous)
Continentiality (index b/w warmest & coldest month)	Climate	Alberta climate model (Anonymous)
Landcover (categories)	Habitat	EOSD; http://www.pfc.cfs.nrcan.gc.ca/EOSD/cover/index_e.html
Bogs- open veneer w/ collapse scars (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Bogs- wooded w/ internal lawns (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Bogs- wooded w/o internal lawns (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Bogs- wooded w/ forested permafrost bog and internal lawns (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Bogs - wooded to forested permafrost (peat plateaus) w/ or w/o collapse scars (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Fens- non-patterned, open, graminoid-dominated (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Fens- non-patterned, open, shrub-dominated (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)

Fens- Patterned (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Fens- non-patterned, wooded w/ islands of internal lawns (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Fens- non-patterned, wooded w/ no internal lawns (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Fens- non-patterned, wooded w/ islands of forested peat plateau & internal lawns (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Non-wetland (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Marshes (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Swamps- deciduous (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Swamps- open (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Swamps- coniferous (%)	Habitat	Peatland inventory of Alberta (Vitt et al. 1996)
Compound topographic index (terrain wetness)	Terrain	CDED (Canadian digital elevation data) & terrain modeling
Landforms (categories)	Terrain	CDED (Canadian digital elevation data) & terrain modeling
Slope (degrees)	Terrain	CDED (Canadian digital elevation data) & terrain modeling
Slope-aspect index	Terrain	CDED (Canadian digital elevation data) & terrain modeling
Annual solar radiation ($MJ/cm^2/yr$)	Terrain	CDED (Canadian digital elevation data) & terrain modeling
Topographic position index at 2km	Terrain	CDED (Canadian digital elevation data) & terrain modeling
Topographic position index at 300m	Terrain	CDED (Canadian digital elevation data) & terrain modeling
Topographic ruggedness index	Terrain	CDED (Canadian digital elevation data) & terrain modeling
Vector ruggedness at 11x11	Terrain	CDED (Canadian digital elevation data) & terrain modeling
Vector ruggedness at 5x5 scale	Terrain	CDED (Canadian digital elevation data) & terrain modeling

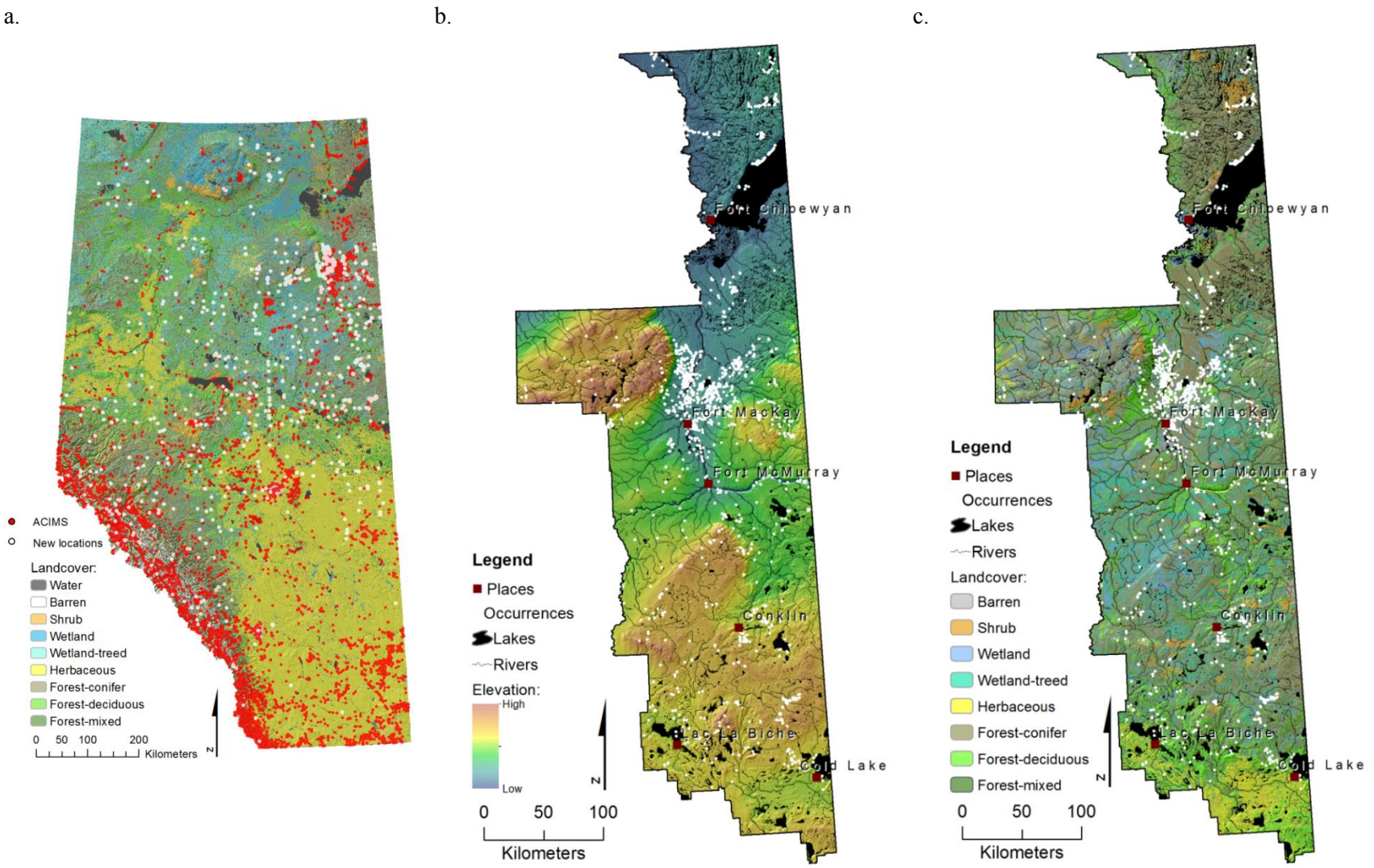
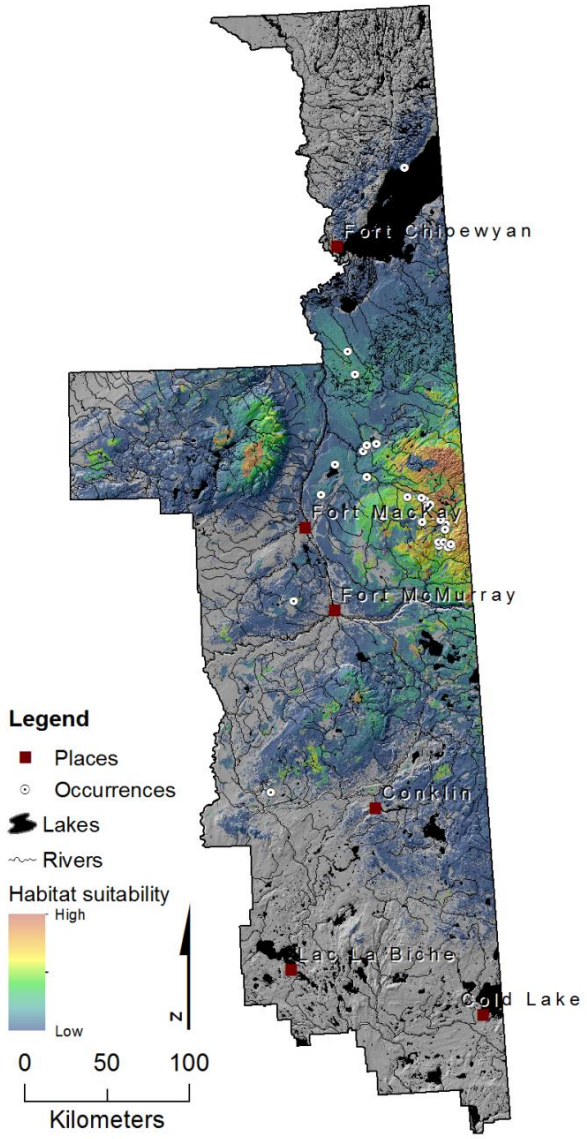


Figure 1. Locations of known rare plant observations in Alberta (a.) based on previously existing mapped occurrences (ACIMS) and updated locations from this report. Locations are shown relative to a general land cover base map. Topography (b.), land cover (c.), and all known occurrences of rare plants for the Lower Athabasca Region in northeast Alberta.

a.



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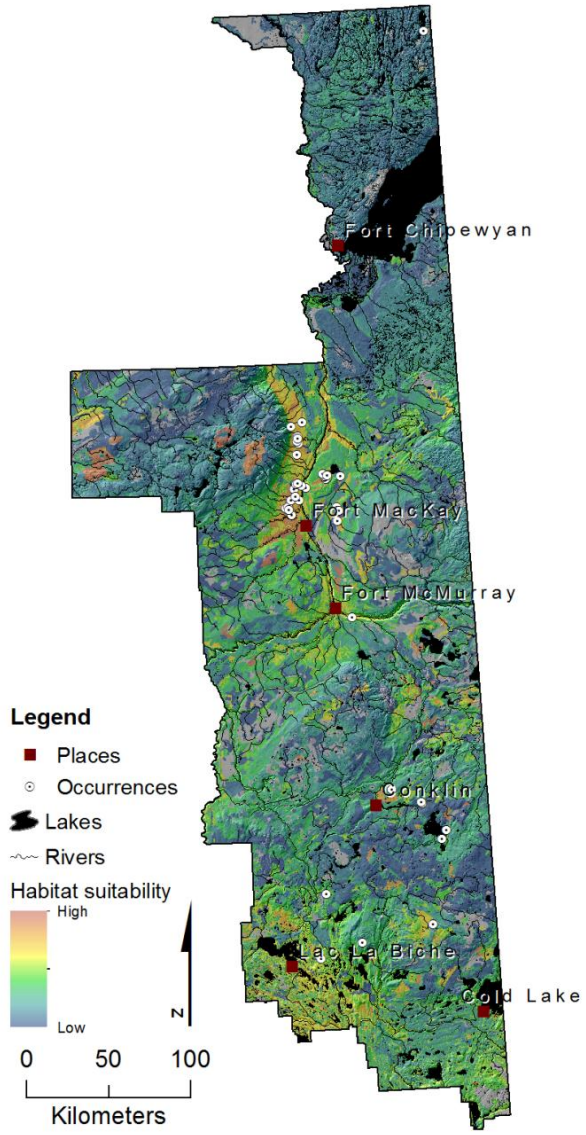


Figure 2. Example habitat models predicting potential distribution of: a. few-seeded (few-fruited) sedge (*Carex oligosperma*), an S3-ranked vascular plant found in wet meadows and bogs; and b. the Campylium moss (*Campylium polygamum*), an S3-ranked epiphytic (grows on trees) moss. See Appendix 1 for maps for all 66 focal rare plant species.

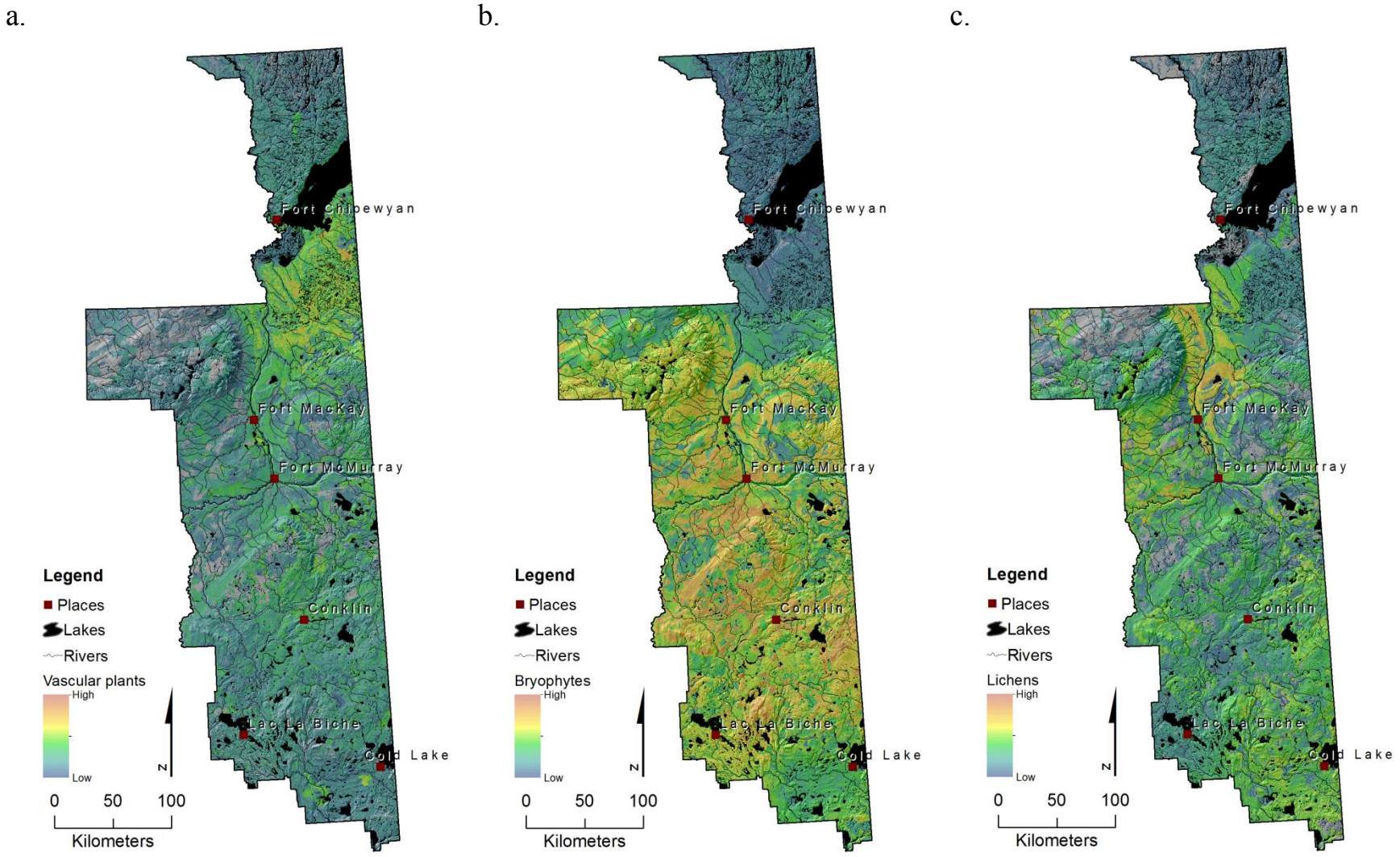


Figure 3. Patterns in the predicted distribution (potential habitat) of 66 selected S1, S2, and S3-ranked plants by taxonomic group for the Lower Athabasca region of northeast Alberta. Species-specific habitat models were based on Maximum Entropy (Maxent), which were reclassified to presence/absence and summed for potential richness (a. vascular plants, b. bryophytes, and c. lichens).

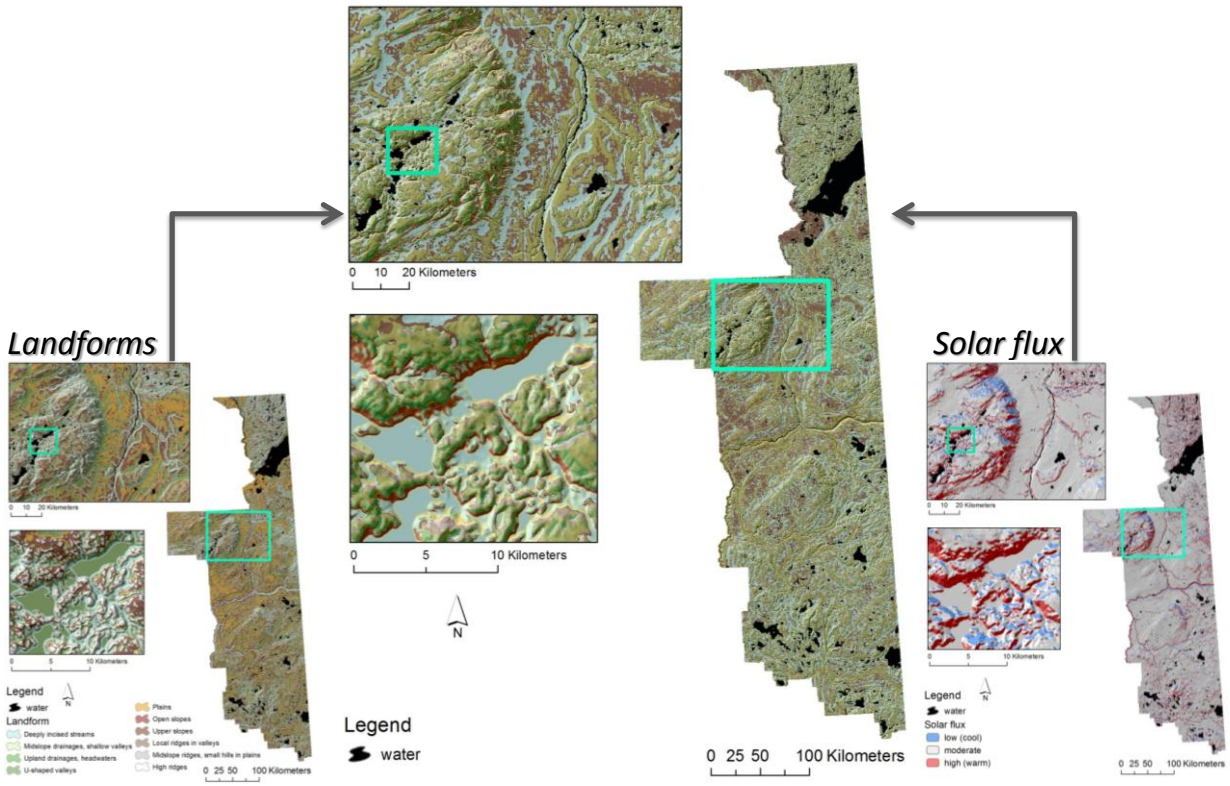


Figure 4. An example abiotic landscape classification for the Lower Athabasca region based on unique combinations of landforms (n = 10) and solar radiation/flux (cool, moderate, and high flux) (Nielsen, unpublished).

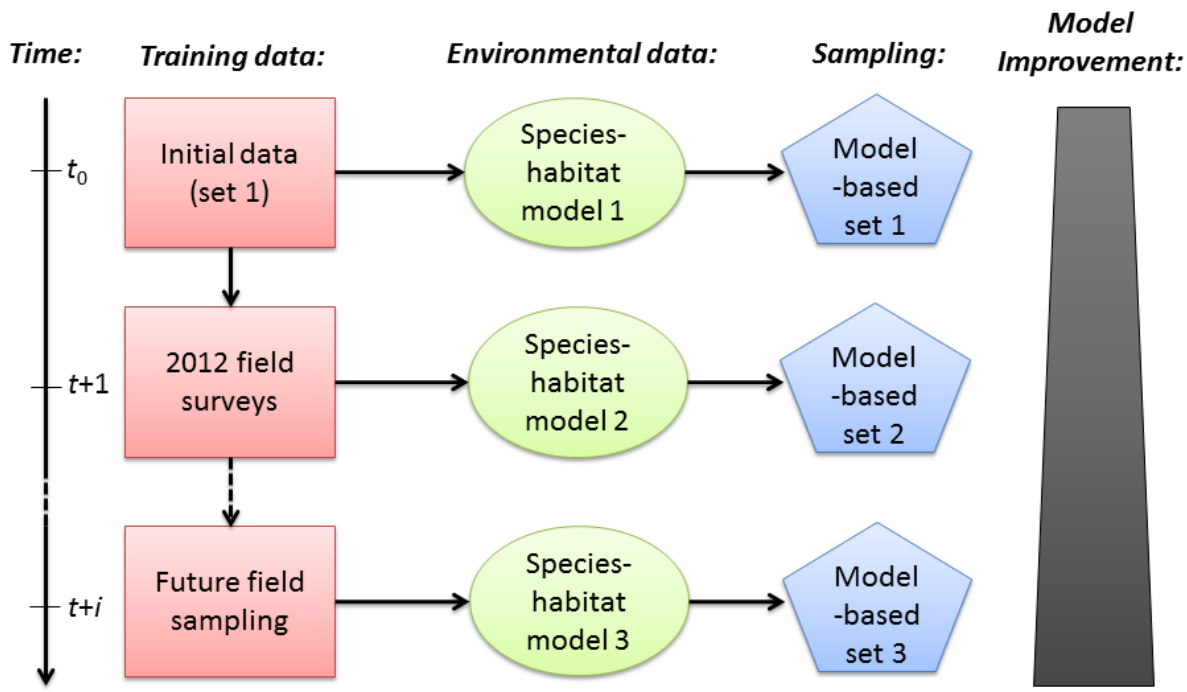


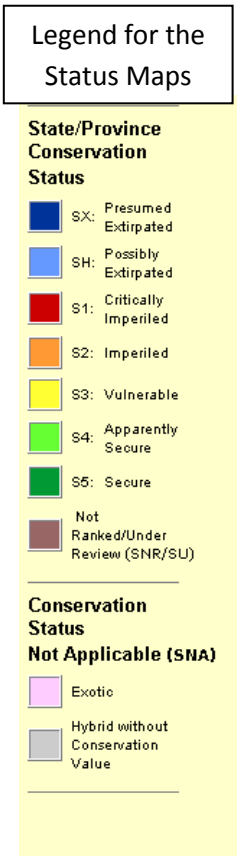
Figure 5. Model-based iterative sampling design for rare plant surveys (adapted from Guisan et al. 2006).

Appendix 1. Fact sheets for rare vascular plant, bryophyte and lichens in the Lower Athabasca Regional Planning area of northeast Alberta, Canada. Fact sheets by James Glasier and Sonya Odsen (species distribution models/maps by Scott Nielsen).

Table of Contents

Overview:

The following species pages provide a brief description, status map, photo, ICUN status, local status and an occurrence map and potential habitat model (map) for rare (S1 to S3 status according ACIMS) vascular plant, bryophyte, or lichen species that contain at least 20% of their provincial observations in the Lower Athabasca region south of Lake Athabasca. For some species, photographs and/or status maps were unavailable and are stated as such. Maps of North America status were from NatureServe (www.natureserve.org) from October 2011. A status legend for these maps are provided below.



NatureServe
A Network Connecting Science With Conservation

Vascular Plants

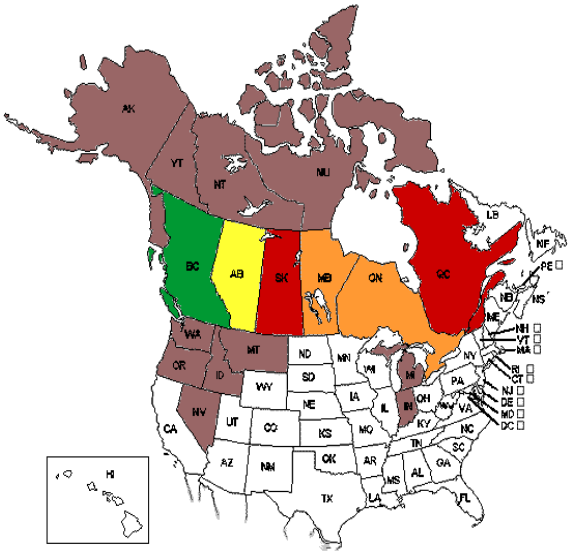
Artemisia tilesii flowering. Photo by Barbara J. Collins

Artemisia tilesii (spp. *elatior*)
Common Name: Herriot's sagewort, Tilesius wormwood, mountain sagewort
Alberta Status: S3
Canada Status: NNR
World Status: G5
Habitat Requirements: Found in woodlands, river flats, and alpine slopes.
Life History: A perennial with woody root crowns and strong underground rhizomes.
Flowering Time: July to September. Fruits late summer early fall.
Time of Highest Detectability: Summer
Literature:

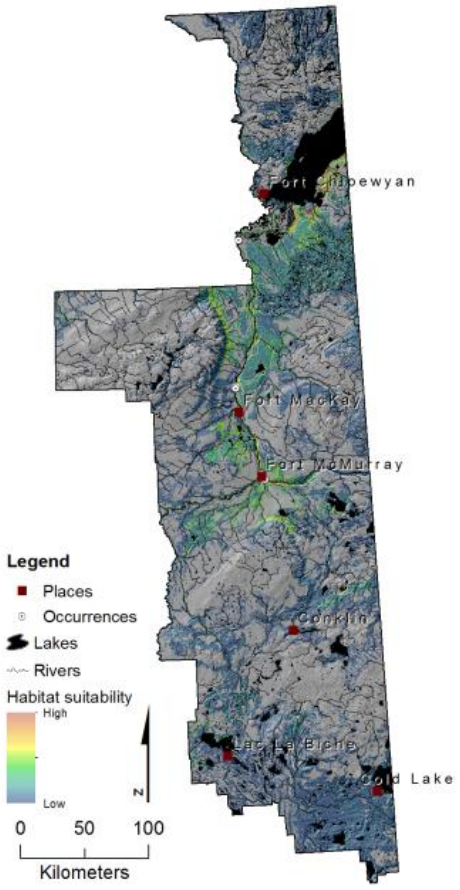
Shultz, L.M., 2006. Artemisia. In: Flora of North America Editorial Committee, eds 1993. Flora of North America North of Mexico. New York et Oxford 19:503-534.

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 241.

North American Status



Occurrences and Potential Habitat



Cardamine pratensis

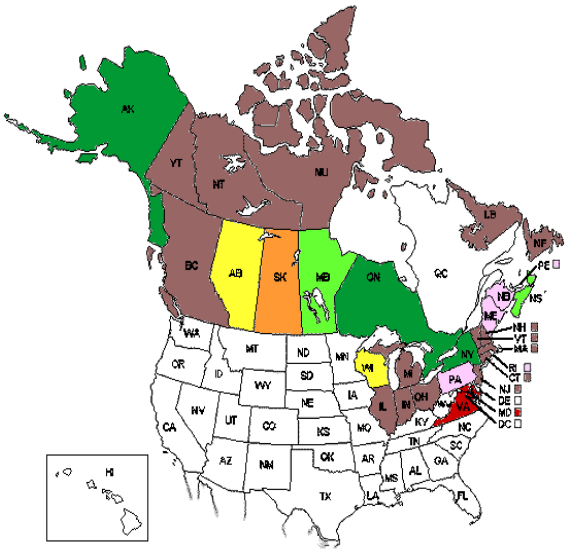
Common Name: cuckoo flower, meadow bitter cress
Alberta Status: S3
Canada Status: N5
World Status: G5
Habitat Requirements: Found in calcareous sites, with a high water table in swamps and along creeks.
Life History: A perennial with short rhizomes that often grow plantlets at the base of older plants.
Flowering Time: May-June.
Time of Highest Detectability: Summer
Literature:

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

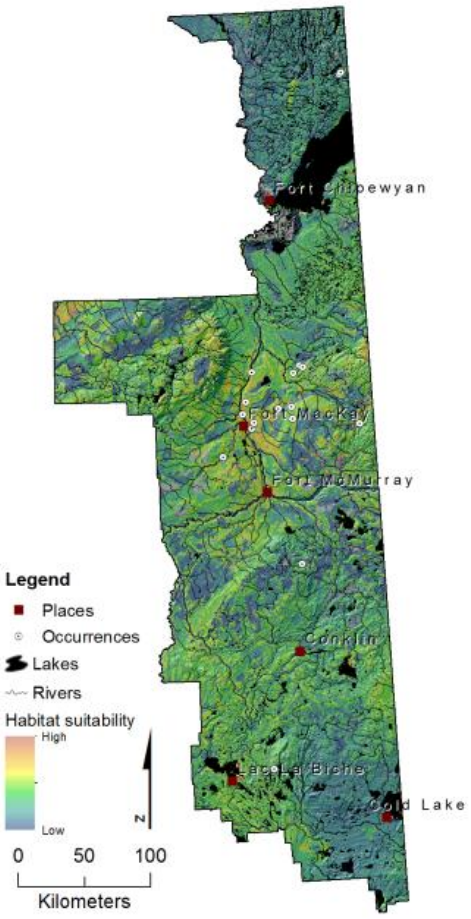
Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 110.

Cardamine pratensis with flower. Photo by Henk Wallays © 2007

North American Status



Occurrences and Potential Habitat



Carex backii

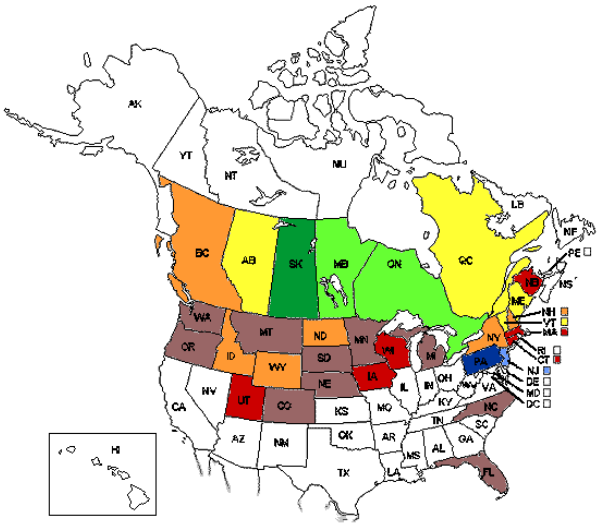
Common Name: Back's sedge
Alberta Status: S3
Canada Status: NNR
World Status: G5
Habitat Requirements: Found in shady wooded areas
Life History: A perennial.
Flowering Time: May to July
Time of Highest Detectability: Early Summer
Literature:

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, N.C.

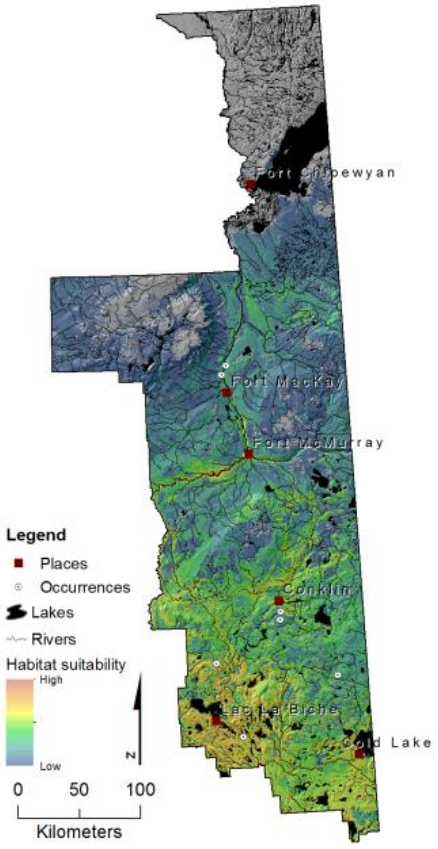
Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 292.

Carex backii. Photo by A. A. Reznicek.

North American Status



Occurrences and Potential Habitat



Carex capitata

Common Name: Capitate Sedge
Alberta Status: S3
Canada Status: NNR
World Status: G5
Habitat Requirements: Found in wet areas, as well as calcareous fens.
Life History: A perennial with ascending rhizomes; often found in more open areas.
Flowering Time: June to August
Time of Highest Detectability: Summer

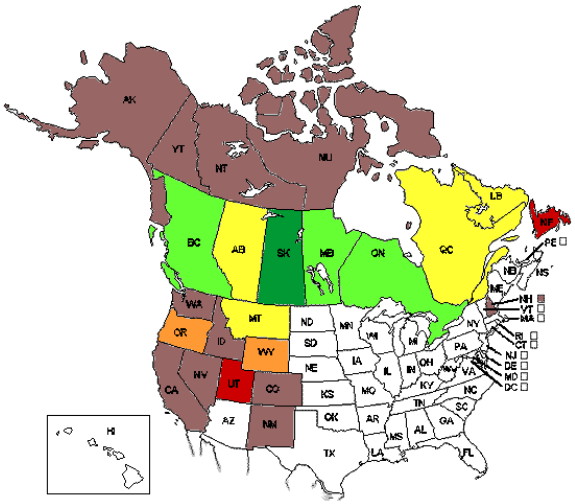
Carex capitata with fruiting body. Photo by Josef Hlasek..

Literature:

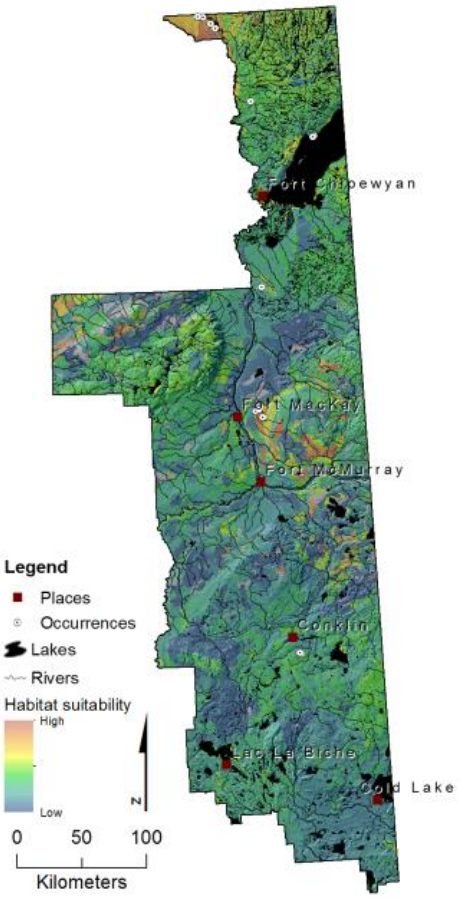
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 276.

North American Status



Occurrences and Potential Habitat



Carex houghtoniana

Common Name: Sand Sedge
Alberta Status: S3
Canada Status: NNR
World Status: G5
Habitat Requirements: Found in dry acidic sandy soils, often associated with pine.
Life History: A perennial with underground rhizomes that multiply in the presence of disturbance, implying that fire is beneficial to the survival of this plant.
Flowering Time: June to July
Time of Highest Detectability: June to July

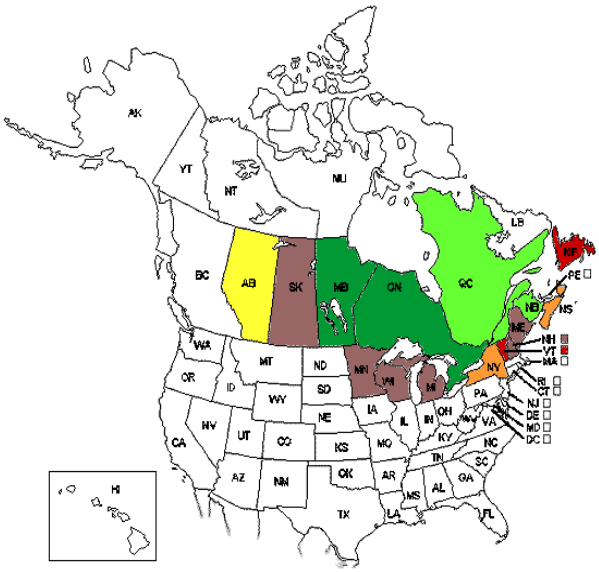
Carex houghtoniana fruiting body. Photo by J. Sulman.

Literature:

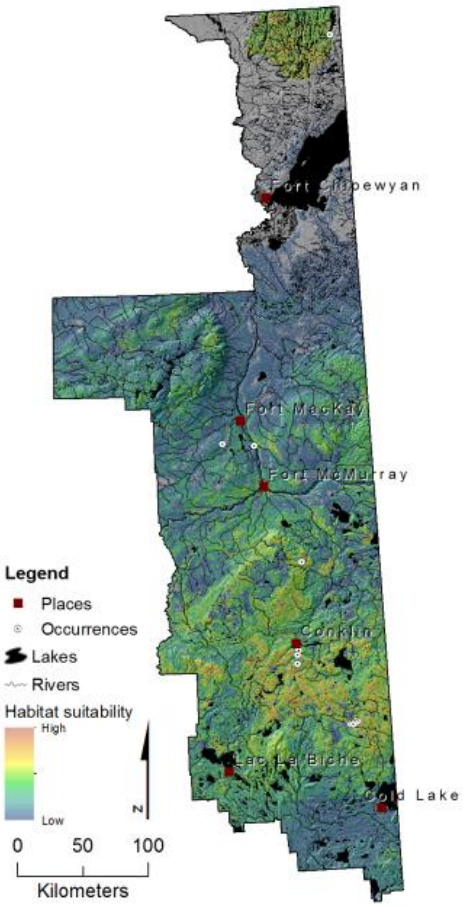
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 303.

North American Status



Occurrences and Potential Habitat



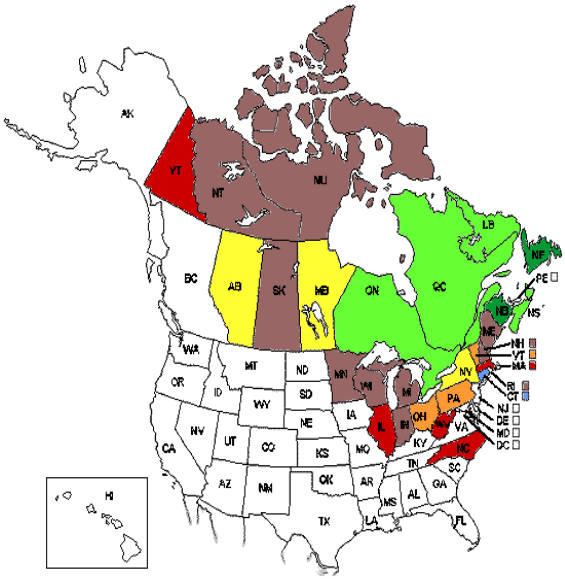
Carex oligosperma

Common Name: few-seeded sedge, few-fruited sedge
Alberta Status: S3
Canada Status: N5
World Status: G5
Habitat Requirements: Found in wet meadows and bogs.
Life History: Perennial.
Flowering Time: Late June and July
Time of Highest Detectability: Summer
Literature:

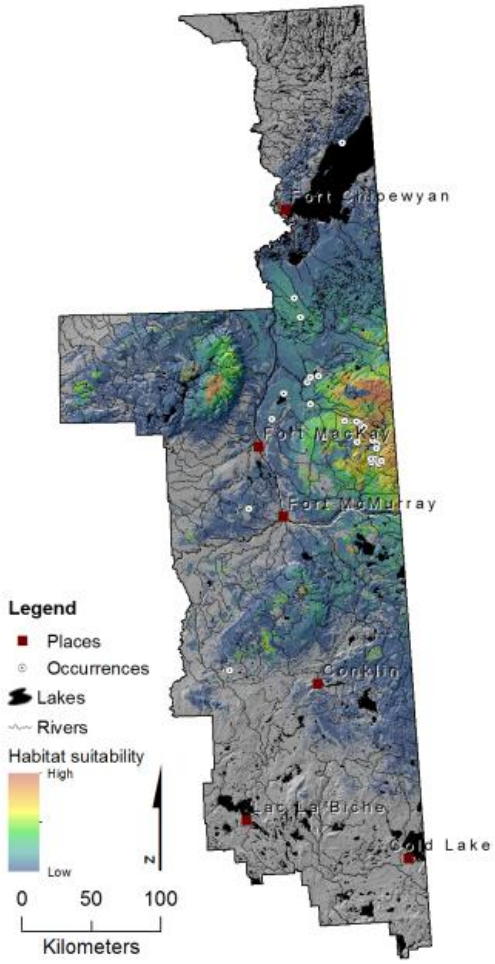
Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 306.

Carex oligosperma fruiting body Photo by Gary Fewless

North American Status



Occurrences and Potential Habitat



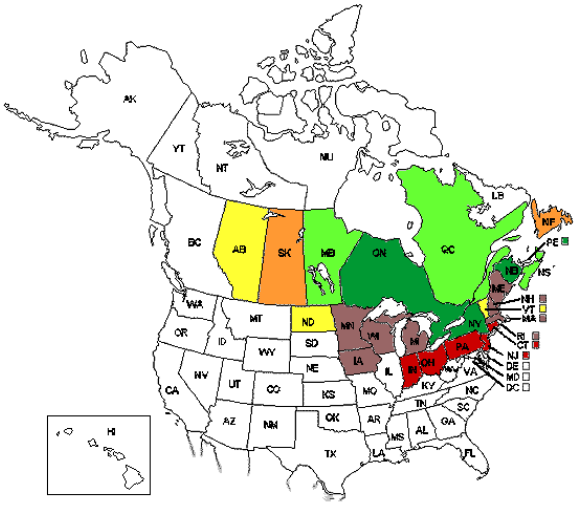
Carex pseudocyperus
Common Name: Cyperus-like sedge
Alberta Status: S3
Canada Status: N5
World Status: G5
Habitat Requirements: Found in marshes and swamps.
Life History: A perennial that forms dense clumps.
Flowering Time: August
Time of Highest Detectability: Late Summer
Literature:

Carex pseudocyperus with fruting body. Photo by Lorna Allen.

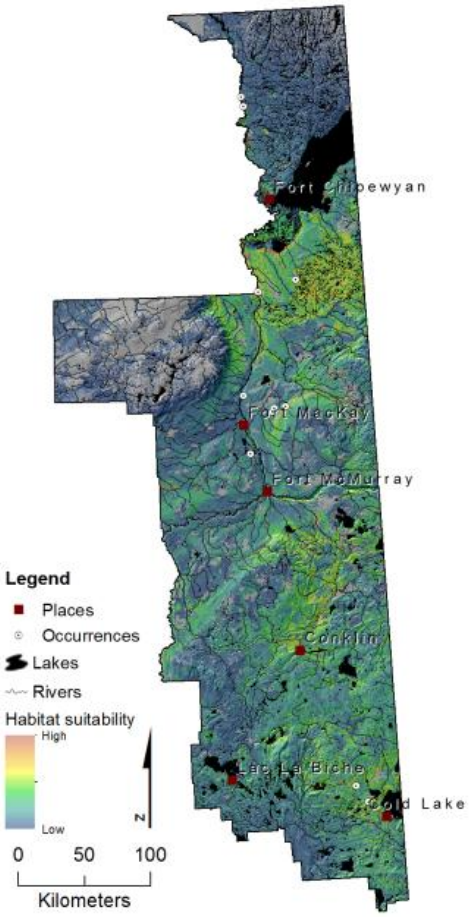
Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 305.

North American Status



Occurrences and Potential Habitat



Carex retrorsa

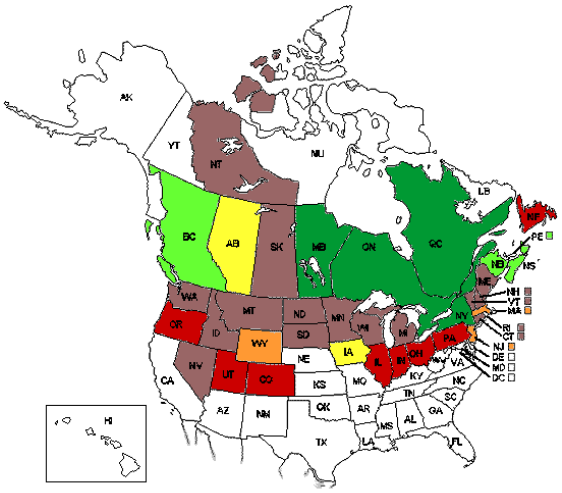
Common Name: retrorse sedge
Alberta Status: S3
Canada Status: N5
World Status: G5
Habitat Requirements: Found in swamps and wet meadows.
Life History: A perennial.
Flowering Time: May to September
Time of Highest Detectability: Late spring to early fall.
Literature:

Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

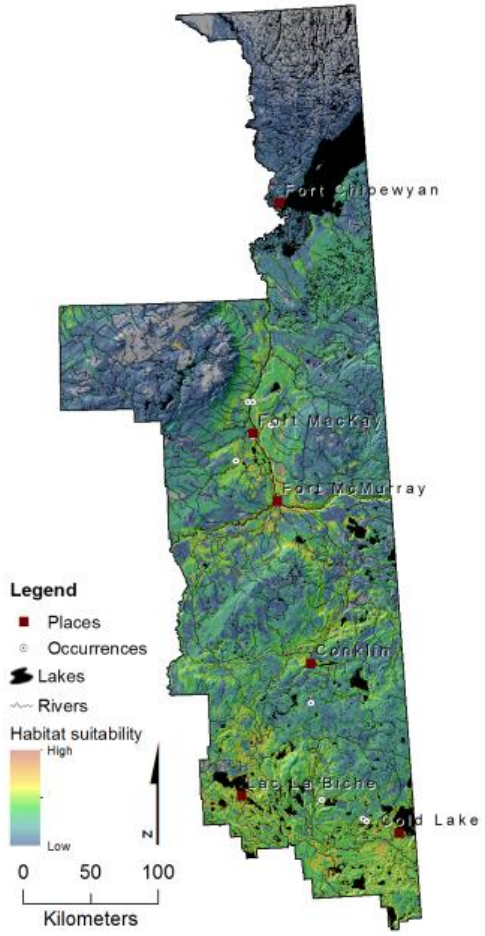
Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 309.

Carex retrorsa with fruiting body. Photo by Josef Hlasek..

North American Status



Occurrences and Potential Habitat



Chrysosplenium iowense

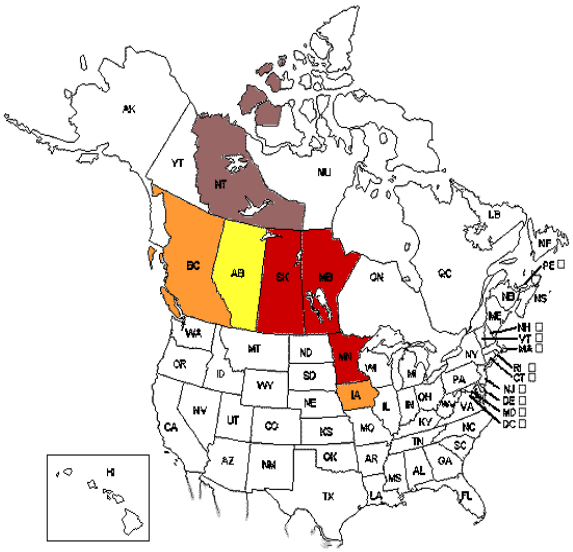
Common Name: golden saxifrage
Alberta Status: S3
Canada Status: N3
World Status: G3?
Habitat Requirements: Found in shady moist to wet stream banks and marshes in montane areas.
Life History: A perennial that usually flowers after maturing for a year. Seed production is highly dependent on insect presence.
Flowering Time: May-July.
Time of Highest Detectability: May-July.
Literature:

Douglas, G.W., D. Meidinger, and J. Penny. 2002. Rare Native Vascular Plants of British Columbia, 2nd ed. B.C. Conserv. Data Centre, Terrestrial Inf. Branch, Victoria. 358

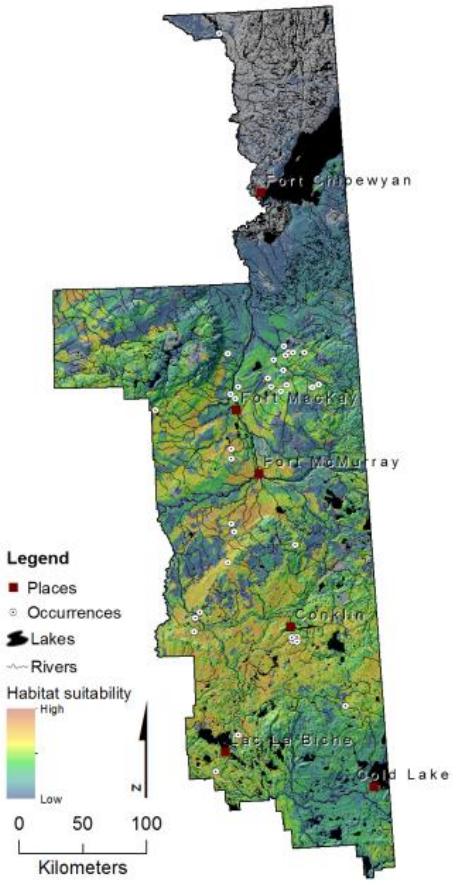
Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

Chrysosplenium iowense with flower. Photo by Jason Jollinger

North American Status



Occurrences and Potential Habitat



Chrysosplenium tetrandrum

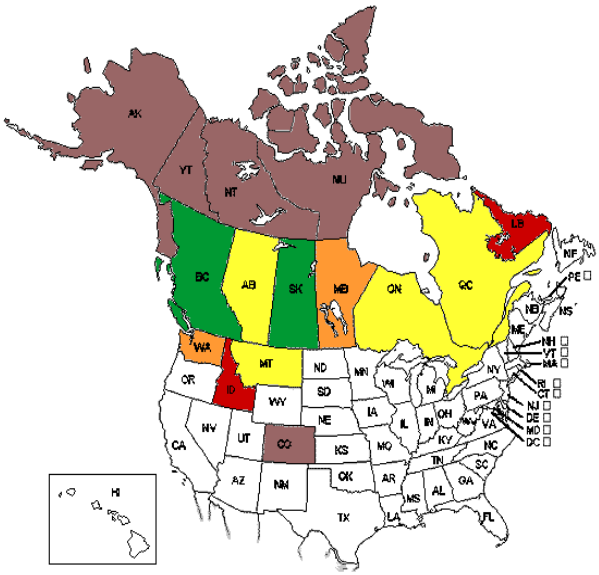
Common Name: green saxifrage, North golden-carpet
Alberta Status: S3
Canada Status: NNR
World Status: G5
Habitat Requirements: Found in rock crevices, wetter conifer forests.
Life History: A creeping perennial that roots at the nodes.
Flowering Time: May to July
Time of Highest Detectability: May to July
Literature:

Chrysosplenium tetrandrum flowers. Photo Author Unknown.

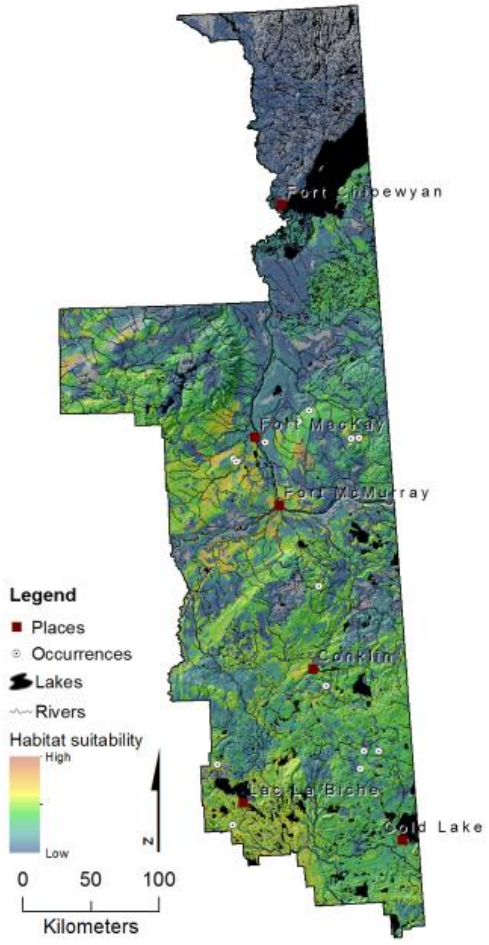
Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1964. Vascular Plants of the Pacific Northwest, Part 3: Saxifragaceae to Ericaceae. University of Washington Press, Seattle. 614

Washington Natural Heritage Program. 1981. An Illustrated Guide to the Endangered, Threatened and Sensitive Vascular Plants of Washington. Washington State Department of Natural Resources: 328

North American Status



Occurrences and Potential Habitat



Cypripedium acaule

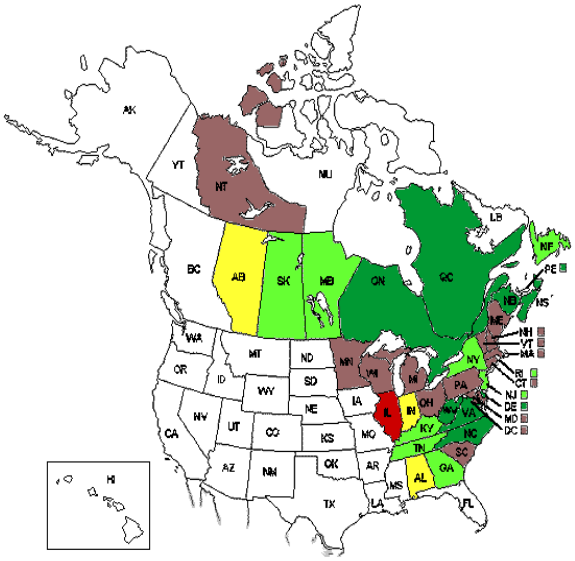
Common Name: pink lady's-slipper
Alberta Status: S3
Canada Status: N5
World Status: G5
Habitat Requirements: Wetlands, woods and overgrown sand dunes with acidic soil.
Life History: Perennial. As they are a "deceptive orchid" pollination is poor as pollinators gain no reward for visiting the flower.
Flowering Time: Late June and July
Time of Highest Detectability: June and July
Literature:

Cypripedium acaule flowering. Photo by Octillo, Nova Scotia Wild flora Society, 20/09/2011

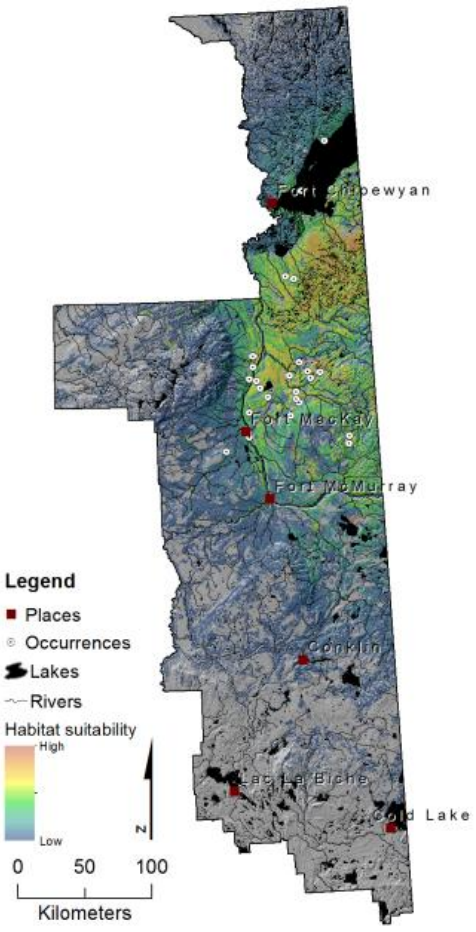
Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 51.

Luer, C.A., 1975. The native orchids of the United States and Canada excluding Florida. New York Botanical Garden: 361.

North American Status



Occurrences and Potential Habitat



Drosera linearis

Common Name: Slenderleaf sundew, narrow sundew
Alberta Status: S3
Canada Status: N4
World Status: G4
Habitat Requirements: Grows in marl fens, either in shallow water or on soil hummocks.
Life History: A carnivorous plant that obtains supplementary nutrients by digesting arthropods.
Flowering Time: mid-June to early July
Time of Highest Detectability: Summer

Drosera linearis. Photo by John Egbert.

Literature:

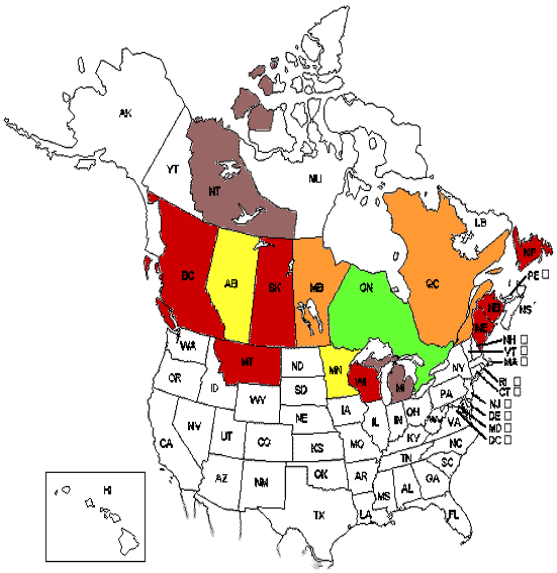
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

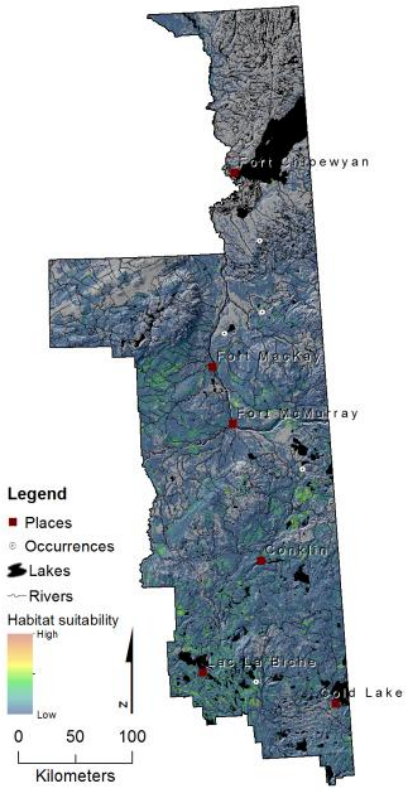
Schnell, D.E. 1982. Notes on *Drosera linearis* Goldie in Northeastern Lower Michigan. Castanea 47:313-328.

Williston, P. and P. Bartemucci. 2007. Notes on Drosera in British Columbia. In BEN (Botanical Electronic Newsletter) #317: January 30, 2007. Available: http://www.ou.edu/cas/botany-micro/ben/ben371.html

North American Status



Occurrences and Potential Habitat



Eupatorium maculatum

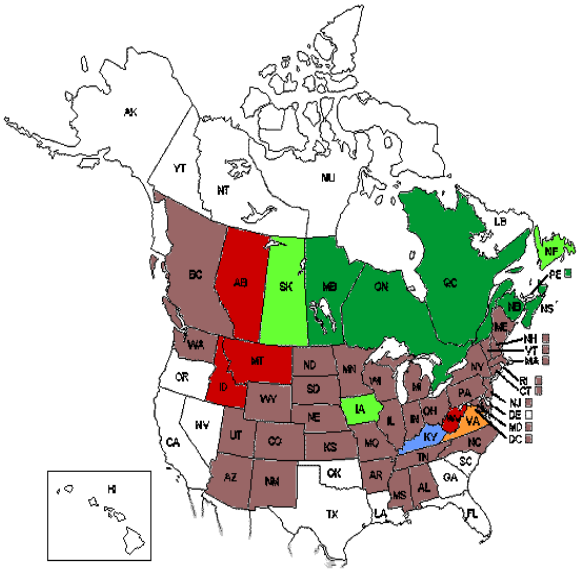
Common Name: spotted Joe-pyed weed
Alberta Status: S1
Canada Status: N5
World Status: G5
Habitat Requirements: Found wet to moist meadows and open woods.
Life History: A perennial
Flowering Time: Late July to early September
Time of Highest Detectability: Summer
Literature:

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

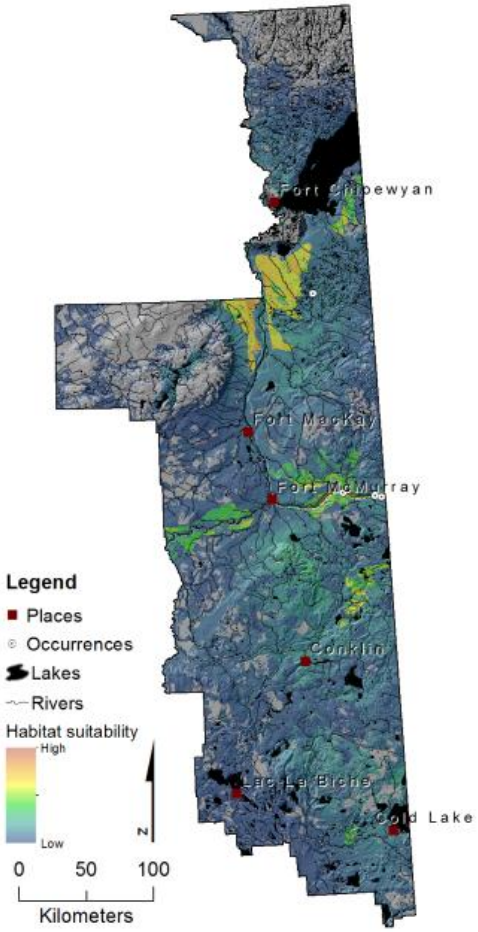
Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 352.

Eupatorium maculatum
Photographer unknown.

North American Status



Occurrences and Potential Habitat



Hypericum majus

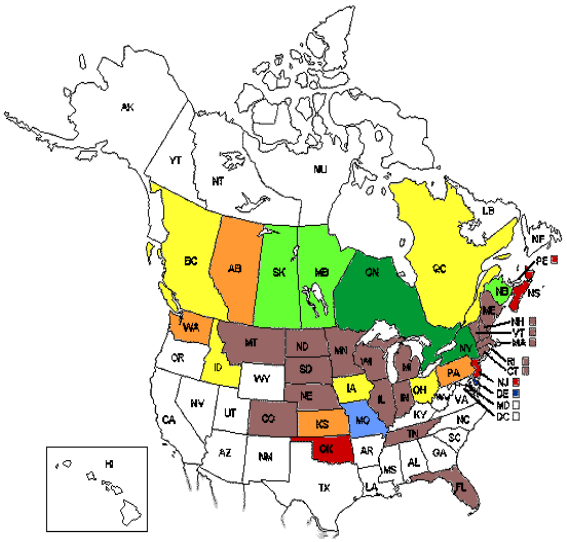
Common Name: larger Canadian St. John's-wort
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Found in wet sits in the boreal forest.
Life History: An annual species.
Flowering Time: Late June to September
Time of Highest Detectability: Summer.
Literature:

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

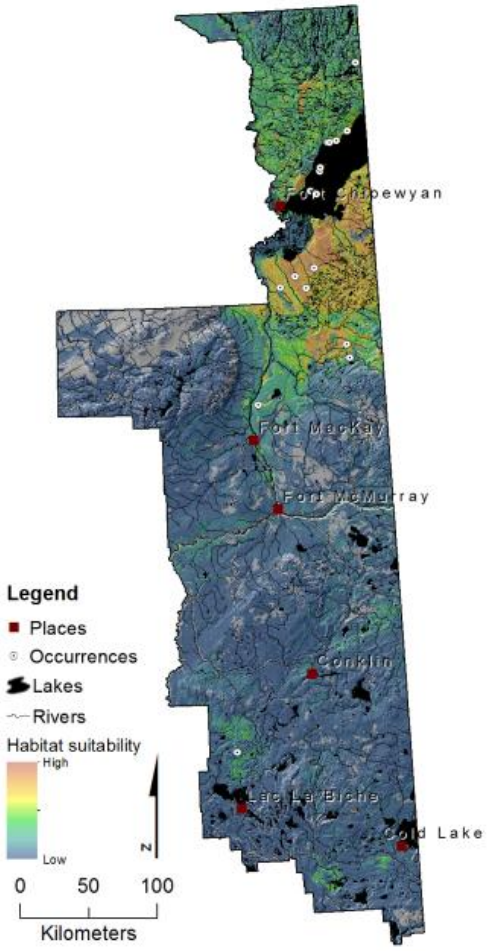
Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 145.

Hypericum majus flowers. Photo by Robert H. Read

North American Status



Occurrences and Potential Habitat



Isoetes echinospora

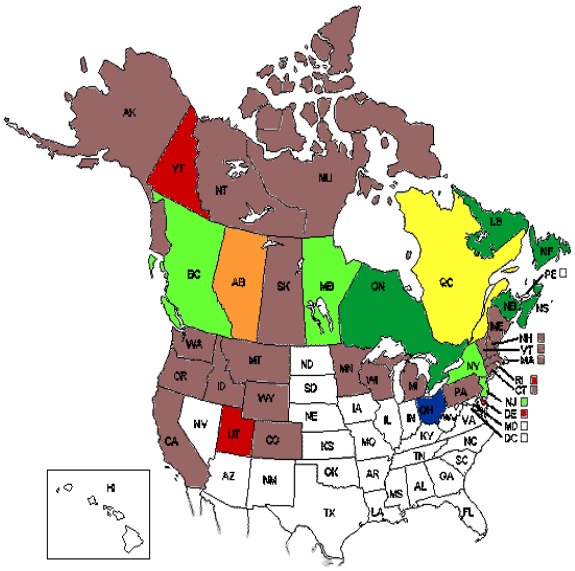
Common Name: northern quillwort
Alberta Status: S2
Canada Status: N5
World Status: G5
Habitat Requirements: Found permanent lakes and ponds that are non-calcareous, nutrient poor and clear.
Life History: An aquatic perennial that require clean clear water.
Flowering Time: Late August it produces spore clusters
Time of Highest Detectability: Summer
Literature:

Isoetes echinospora. Photo by Gary Fewless.

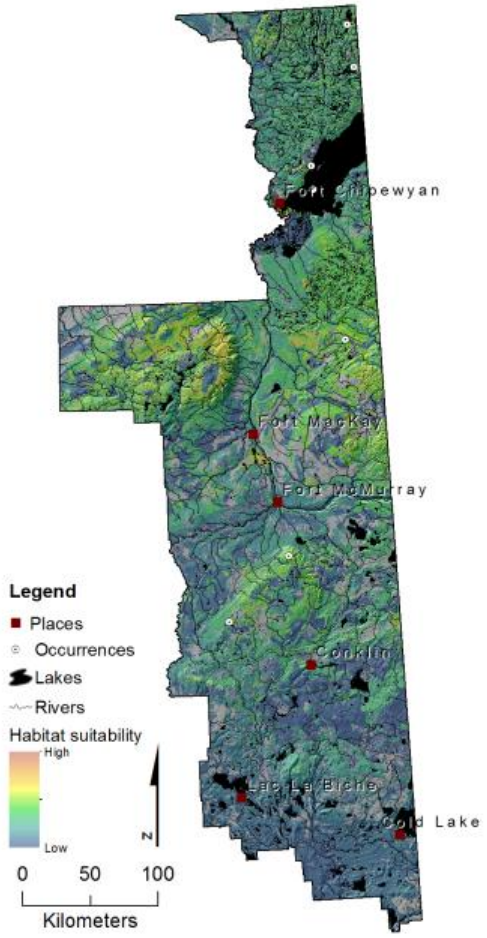
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 352.

North American Status



Occurrences and Potential Habitat



Juncus brevicaudatus

Common Name: Narrow-panicle Rush
Alberta Status: S2
Canada Status: N5
World Status: G5
Habitat Requirements: Found along shores of lakes, and in marshes.
Life History: A perennial with woody rhizomes that requires very moist to wet substrate..
Flowering Time: Fruits July to August.
Time of Highest Detectability: Summer

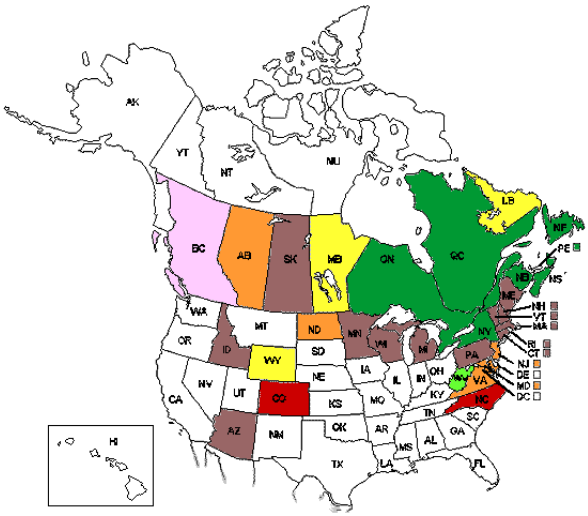
Juncus brevicaudatus. Photo by Louis-M. Landry.

Literature:

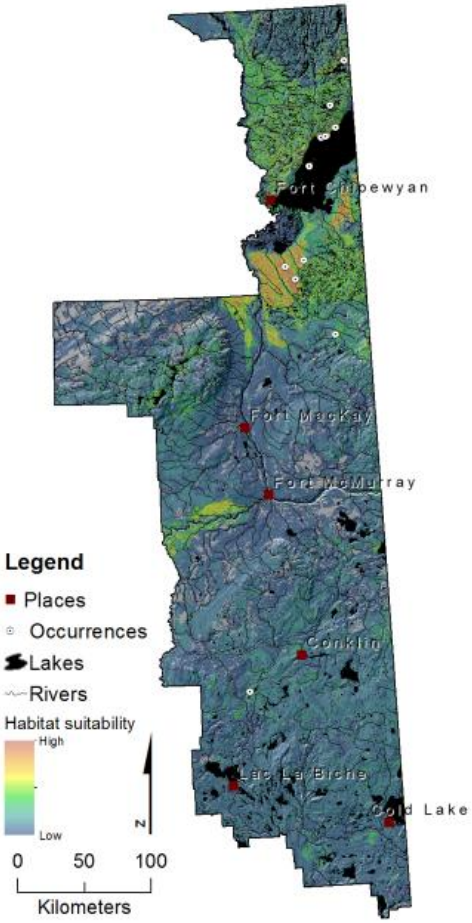
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 263.

North American Status



Occurrences and Potential Habitat



Najas flexilis

Common Name: slender naiad, slender water -nymph
Alberta Status: S2
Canada Status: N5
World Status: G5
Habitat Requirements: Found in ponds and streams
Life History: An annual that is a true aquatic plant, flowering and being pollinated underwater. Pieces of the plant can sometimes survive over the winter, but most new plants sprout from seeds.
Flowering Time: July to August
Time of Highest Detectability: Summer

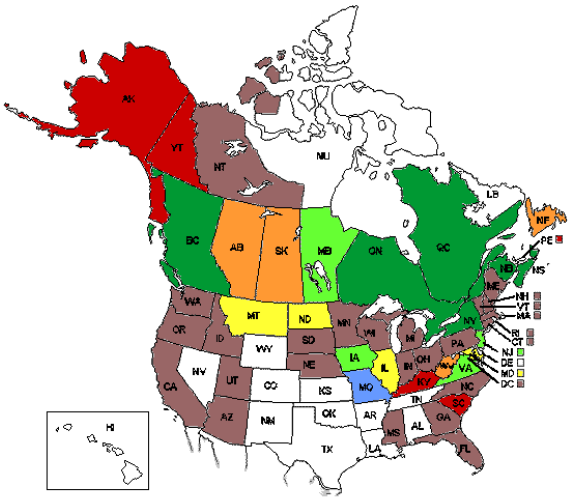
Najas flexilis. Photo by Sue Scott.

Literature:

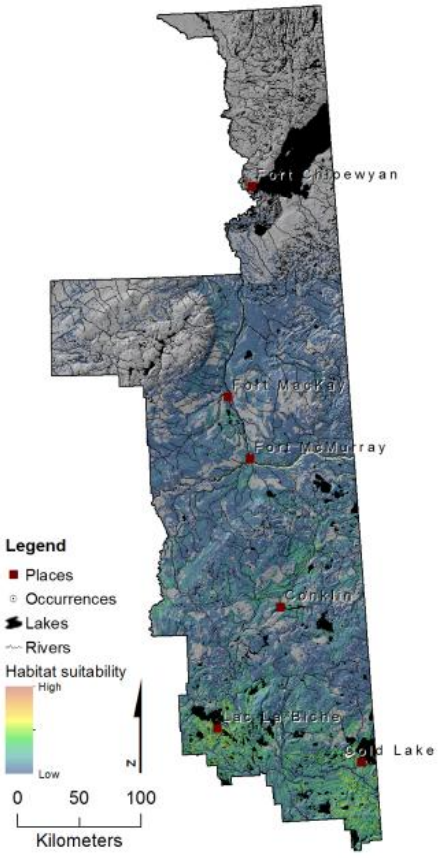
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 31.

North American Status



Occurrences and Potential Habitat



Nymphaea leibergii

Common Name: Dwarf Water-lily
Alberta Status: S1S2
Canada Status: N5
World Status: G5
Habitat Requirements: Found in remote ponds, lake, and slow moving streams at a about 2m depth.
Life History: An aquatic perennial.
Flowering Time: Usually flowers in August, but can flower from June to September.
Time of Highest Detectability: Summer

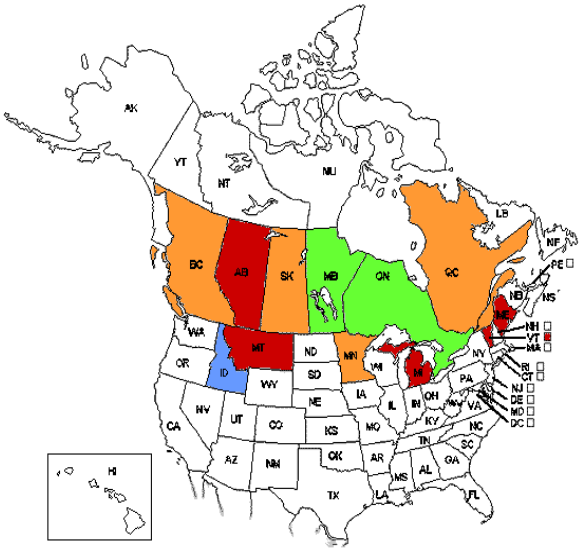
Nymphaea leibergii flower and leaf.

Literature:

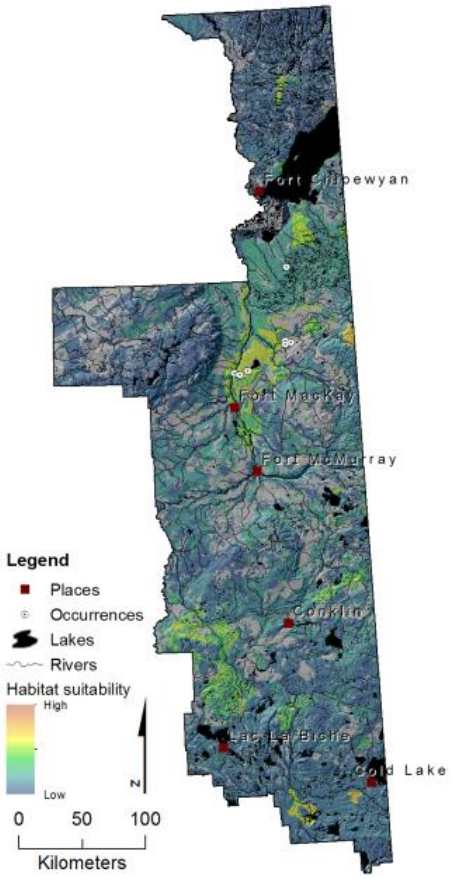
Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, N.C.

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 83.

North American Status



Occurrences and Potential Habitat



Nymphaea tetragona

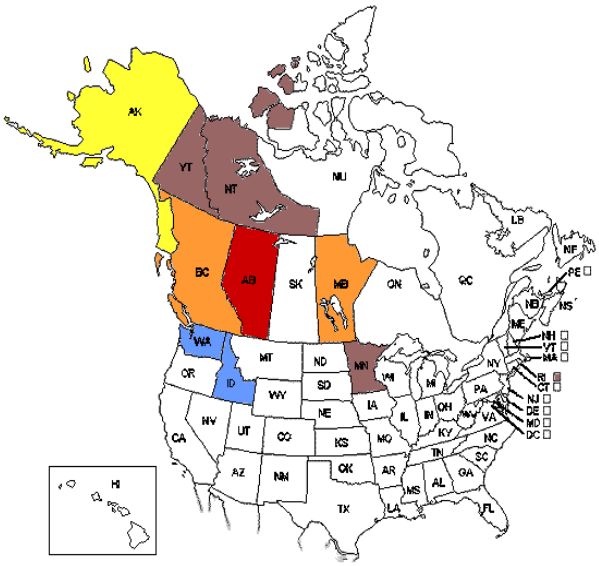
Common Name: small white water lily
Alberta Status: S1
Canada Status: N5
World Status: G5
Habitat Requirements: Found lakes, ponds and slow moving streams in the northern parts of Alberta.
Life History: An aquatic perennial that is sensitive to water quality changes caused by nearby logging or agriculture.
Flowering Time: Summer.
Time of Highest Detectability: Summer
Literature:

Nymphaea tetragona flower and lily-pads. Photo by Marinka

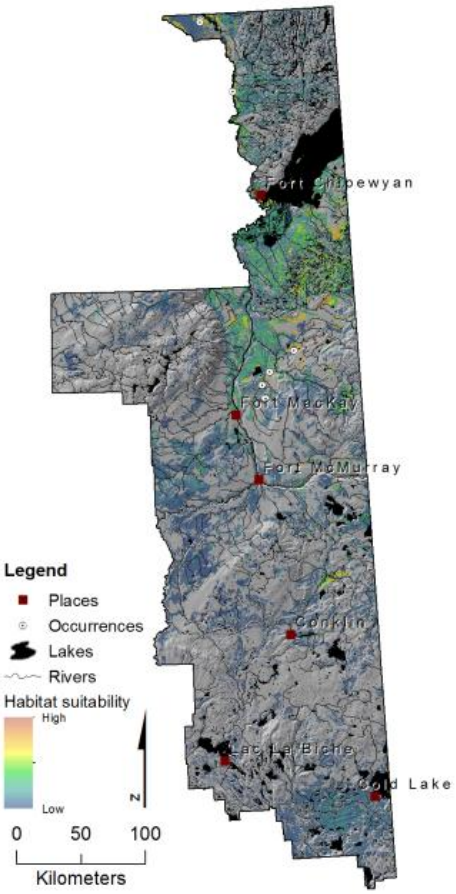
Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 83.

North American Status



Occurrences and Potential Habitat



Polygala paucifolia

Common Name: fringed milkwort, gay-wing milkwort, Snoopy flower.

Alberta Status: S1S2

Canada Status: NNR

World Status: G5

Habitat Requirements: Found in moist conifer and mixed forests.

Life History: A perennial with slender stolons. Has two types of flowers a larger chasmogamous flower, and a lower, smaller cleistogamous flower

Flowering Time: Large pink flower blooms in May while the smaller white ones bloom from June to Early July.

Time of Highest Detectability: May to June

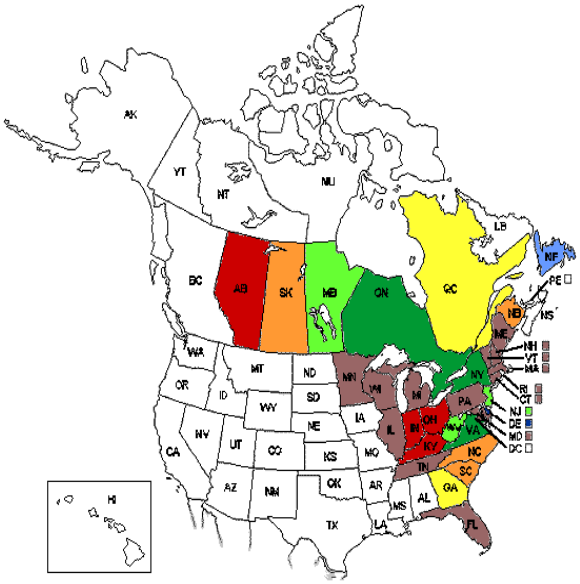
Polygala paucifolia with its chasmogamous flower. Photo by Brandee Wenzel.

Literature:

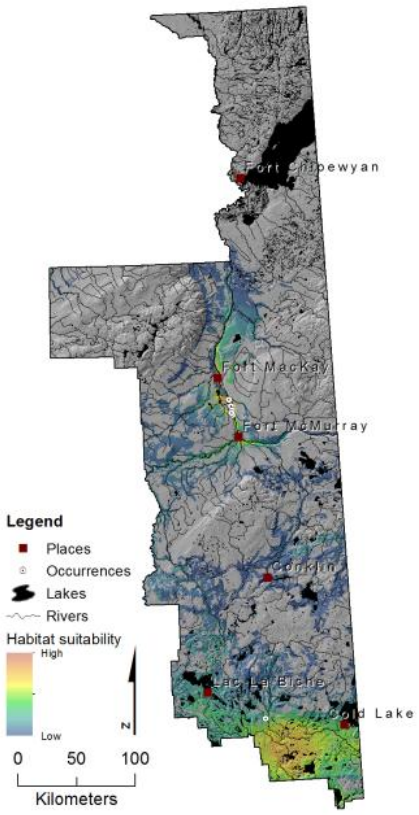
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 143.

North American Status



Occurrences and Potential Habitat



Potamogeton natans

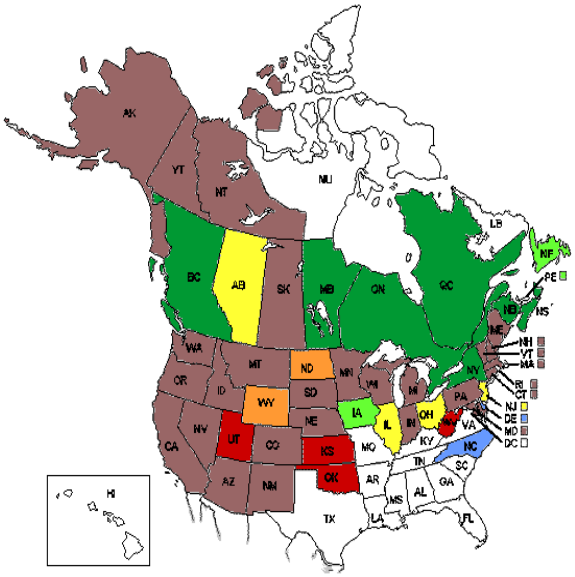
Common Name: floating pondweed
Alberta Status: S3
Canada Status: N5
World Status: G5
Habitat Requirements: Found in still or slow moving water.
Life History: An aquatic perennial lives in about 1m of water with leatherly floating leaves.
Flowering Time: June and July.
Time of Highest Detectability: Summer.
Literature:

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

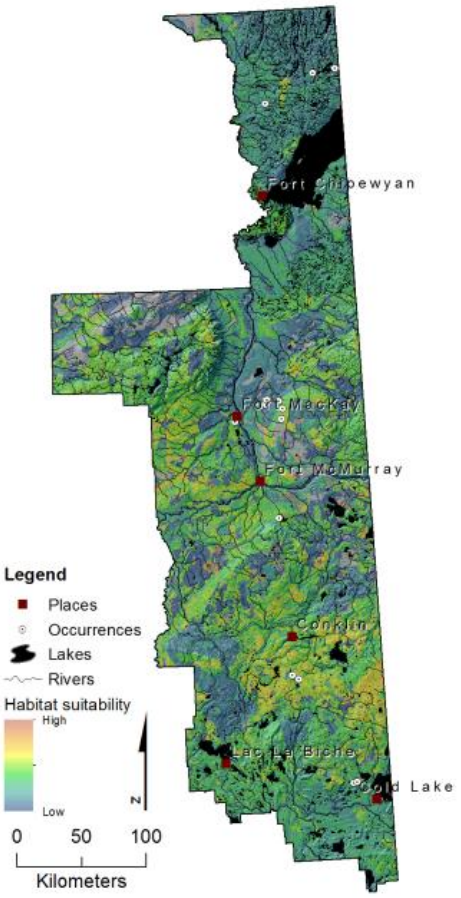
Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 32.

Potamogeton natans. © 1995 Saint Mary's College of California

North American Status



Occurrences and Potential Habitat



Potentilla multifida

Common Name: branched cinquefoil
Alberta Status: S1
Canada Status: NNR
World Status: G5
Habitat Requirements: Found grave bars, open slopes and sandy areas.
Life History: A perennial found often in slightly disturbed areas.
Flowering Time: July
Time of Highest Detectability: July

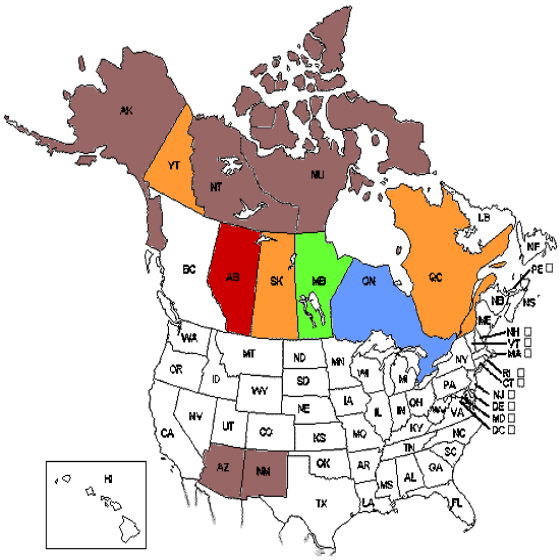
Potentilla multifida plant and flower

Literature:

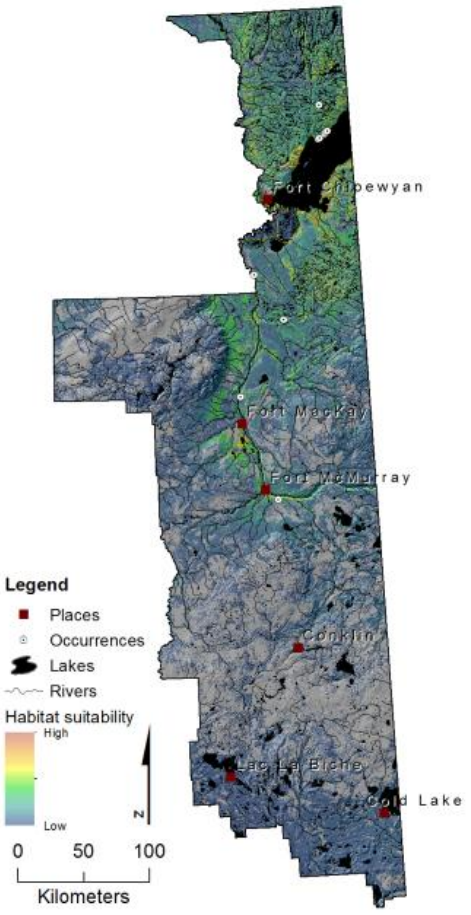
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 54.

North American Status



Occurrences and Potential Habitat



Sagittaria latifolia

Common Name: broad-leaved arrowhead
Alberta Status: S2
Canada Status: N5
World Status: G5
Habitat Requirements: Found along edges of ponds and lakes and in wet ditches.
Life History: An emergent perennial that has underground rhizomes that form tubers, which are often used by food by animals.
Flowering Time: Mid to late Summer.
Time of Highest Detectability: Summer

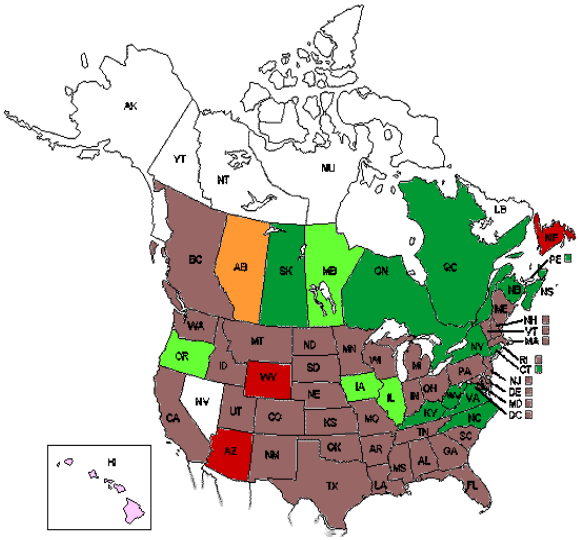
Sagittaria latifolia with flower
Photo by Mike Ryon.

Literature:

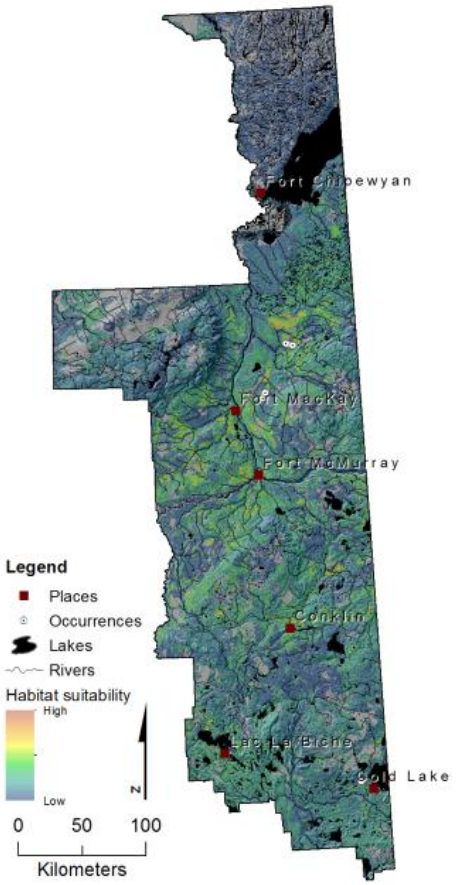
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 39.

North American Status



Occurrences and Potential Habitat



Sarracenia purpurea

Common Name: Pitcher Plant, Purple Pitcher Plant
Alberta Status: S3
Canada Status: N5
World Status: G5T5
Habitat Requirements: Found in peat bogs, fens and wet meadows. Periodic fires help viability of populations.
Life History: A perennial carnivorous plant that uses a pitcher filled with water and digestive enzymes to capture and digest prey. Prey usually consists of invertebrates, especially small Diptera species.
Flowering Time: Flowers in spring, pitcher forms late spring early summer, fruits late summer.
Time of Highest Detectability: Summer

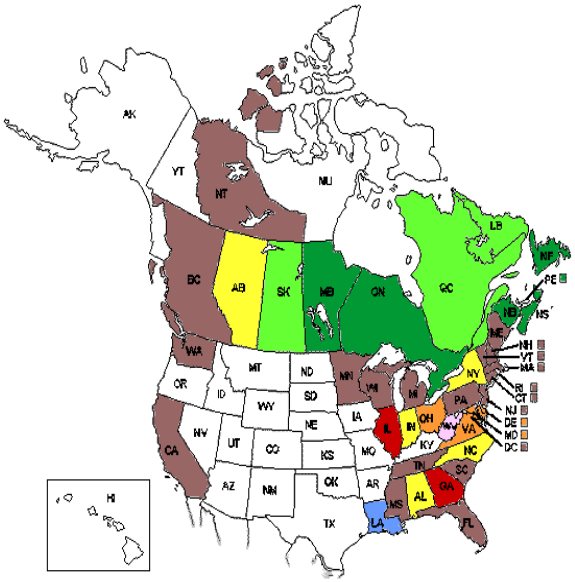
Sarracenia purpurea blooming

Literature:

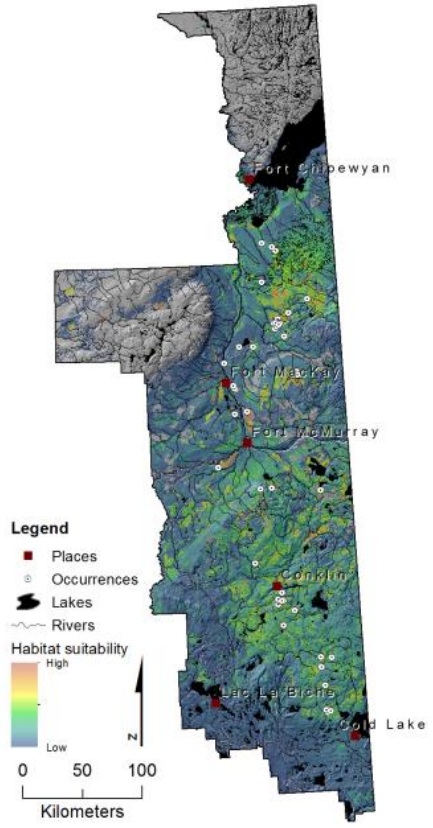
Moran, R.C., 1981. Prairie fens in northeastern Illinois: Floristic composition and disturbance. In Stuckey, R.L. and K.J. Reese, eds., Proceeds Sixth North American Prairie Conf. Ohio Biol. Survey. Columbus, Ohio 15: 164-168.

Newell, S.J., and A.J. Nastase, 1998. Efficiency of insect capture by *Sarracenia purpurea* (Sarraceniaceae) the northern pitcher plant. American Journal of Botany 85: 88-91.

North American Status



Occurrences and Potential Habitat



Spiranthes lacera

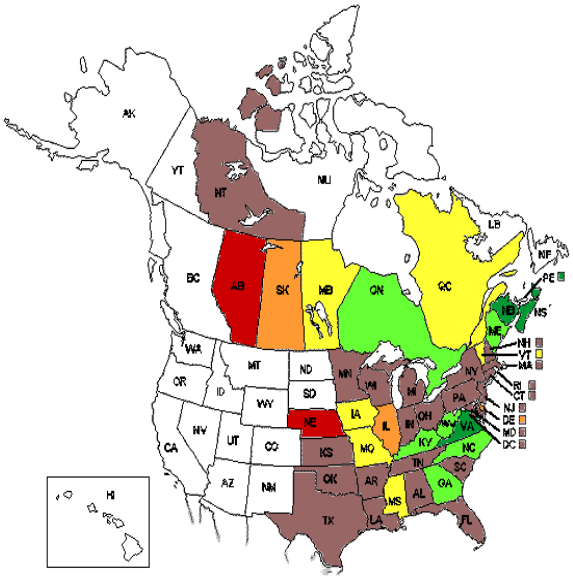
Common Name: Northern sender ladies'-tresses
Alberta Status: S1
Canada Status: N5
World Status: G5
Habitat Requirements: Dry, rocky woodland and grasslands or in jack pine lichen forests, often with *Vaccinium myrtilloides*.
Life History: Perennial. Grow for 3-5 years before flowering. Considered a companion plant that benefits from being in close association of other plants, in Alberta, *Vaccinium myrtilloides* is often it's "companion"..
Flowering Time: mid-July to August.
Time of Highest Detectability: mid-July to August.
Literature:

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

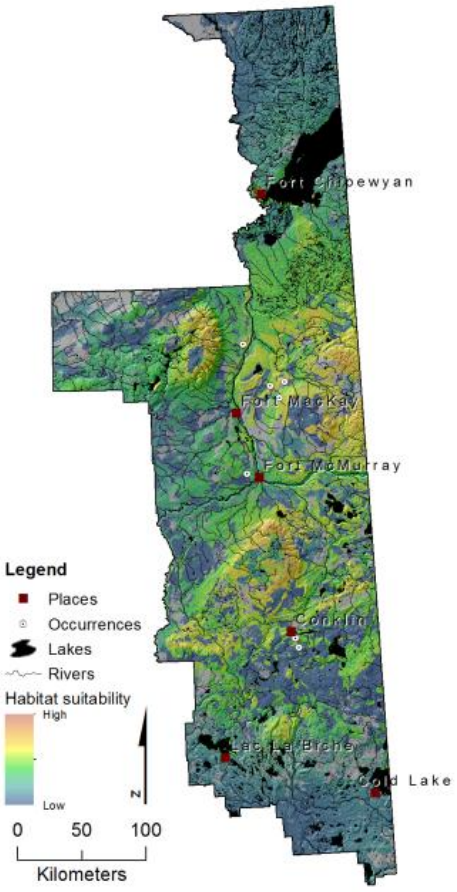
Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 56.

Spiranthes lacera flowering. Photo by Richard Reeves 2001.

North American Status



Occurrences and Potential Habitat



Stellaria arenicola

Common Name: Sand dune chickweed,
Alberta Status: S1
Canada Status: N3
World Status: T3
Habitat Requirements: Found only in sandy areas, in the Lake Athabasca Region
Life History: A perennial that has thin stalks and has adapted to life on northern sand dunes.
Flowering Time: Flowers July to August.
Time of Highest Detectability: Summer

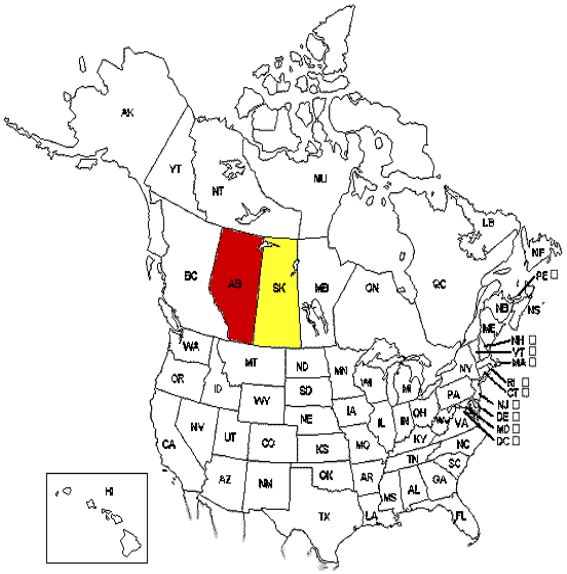
Stellaria arenicola flowering. Photo by Lorna Allen (Athabasca sand dunes).

Literature:

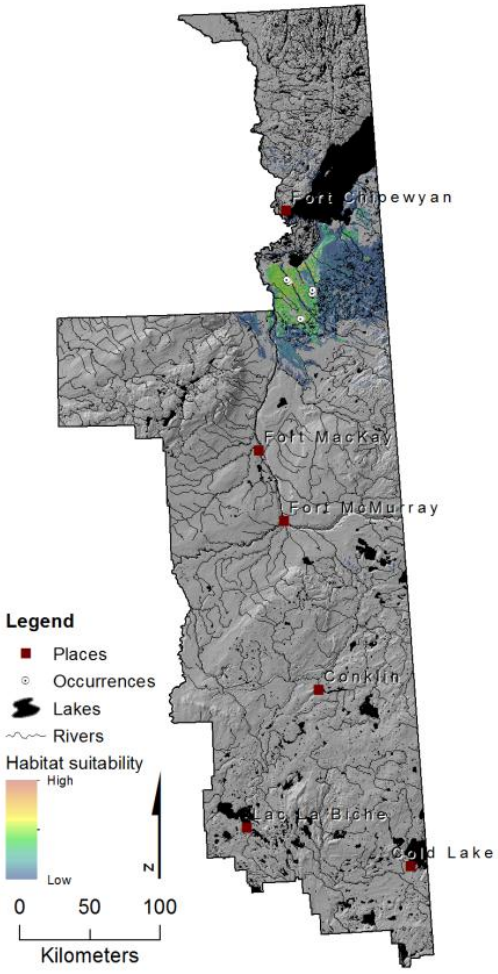
Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 82.

North American Status



Occurrences and Potential Habitat



Tanacetum bipinnatum huronense

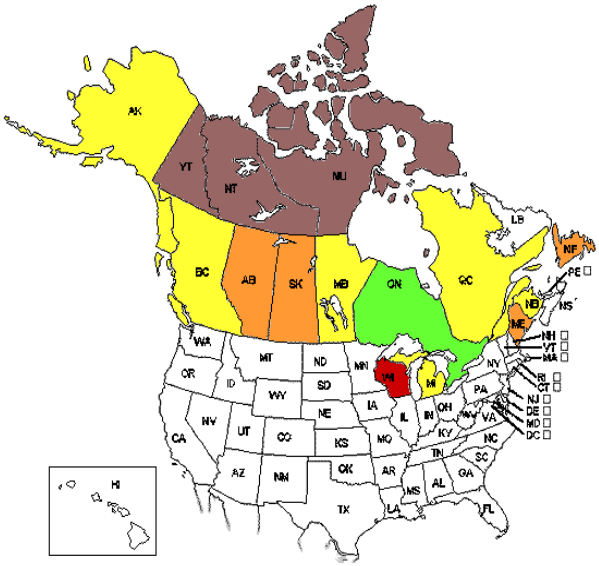
Common Name: larger Canadian St. John's-wort
Alberta Status: S2
Canada Status: N4
World Status: G5T4T5
Habitat Requirements: Found in sandy of gravelline shores, dunes and gravel bars.
Life History: A perennial that requires moderate continued disturbance.
Flowering Time: May to July
Time of Highest Detectability: Summer.
Literature:

Tanacetum bipinnatum huronense flowers. Photo by Lorna Allen.

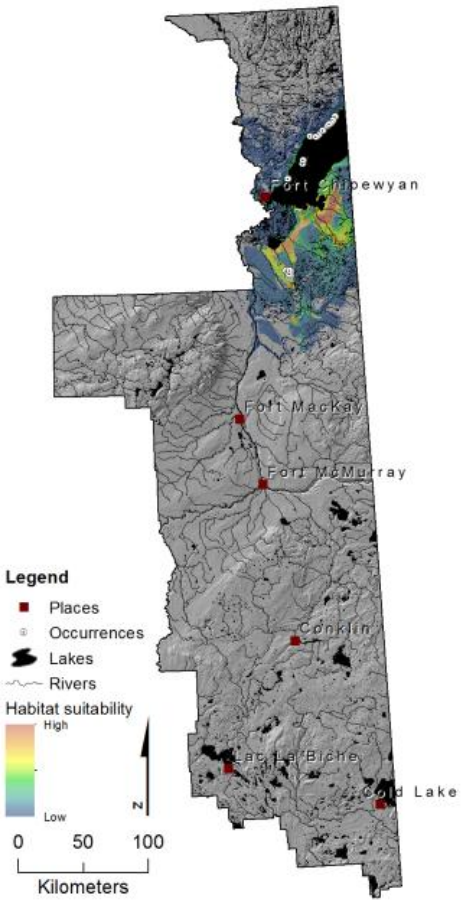
Brouillet, L., F. Coursol et M. Favreau 2006. VASCAN. La base de données des plantes vasculaires du Canada. Herbier Marie-Victorin, Institut de recherche en biologie végétale, Université de Montréal. (inédit).

Kershaw, L., J. Gould, D. Johnson, and J. Lancaster, 2001. Ra Vascular Plants. University of Alberta Press and Canadian Forest Service. Edmonton Alberta, 239.

North American Status



Occurrences and Potential Habitat

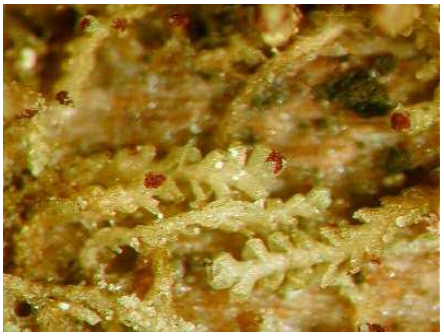


Anastrophyllum helleranum

Common Name: Heller's anastrophyllum
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Grows on decaying logs and coarse woody debris in old-growth boreal forest.
Life History: Reproduces by spores and asexual gammae.
Literature:

Pohjamo, M., S. Laaka-Lindberg, O. Ovaskainen and J. Korpelainen. 2006. Dispersal potential of spores and asexual propagules in the epixylic hepatic *Anastrophyllum hellerianum*. Evolutionary Ecology 20: 415-430.

Stotler, R. and B. Crandall-Stotler. 1977. A checklist of liverworts and hornworts of North America. The Bryologist. 76:405-428.

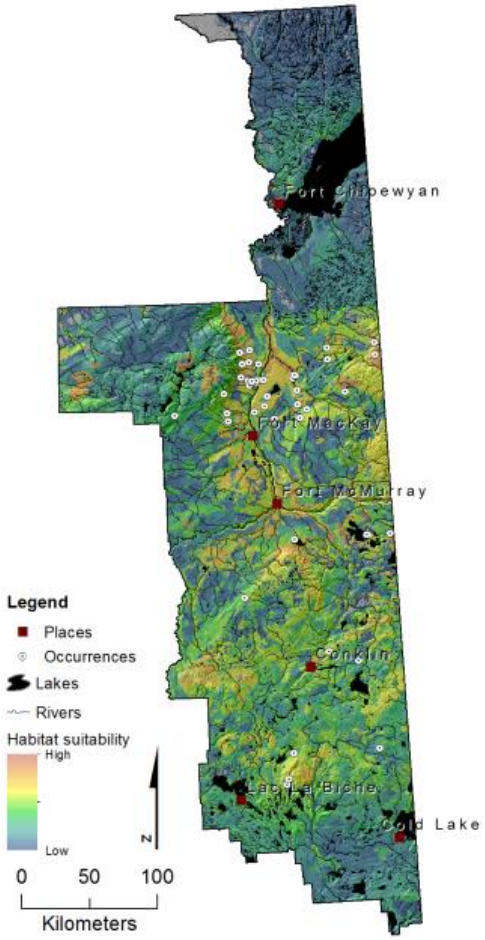


Anastrophyllum helleranum. Photo by Michael Lüth.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Brachythecium rutabulum

Brachythecium rutabulum. Photo by Sean Edwards.

Common Name: Rough-stalked feather-moss
Alberta Status: S2?
Canada Status: NNR
World Status: G5
Habitat Requirements: Most often grows on wood or stones in a broad range of habitats. Can also grow on soil or gravel, or in grasslands and marshes.
Life History: An adaptive species, which grows rapidly in response to temporarily increased nutrient availability.
Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

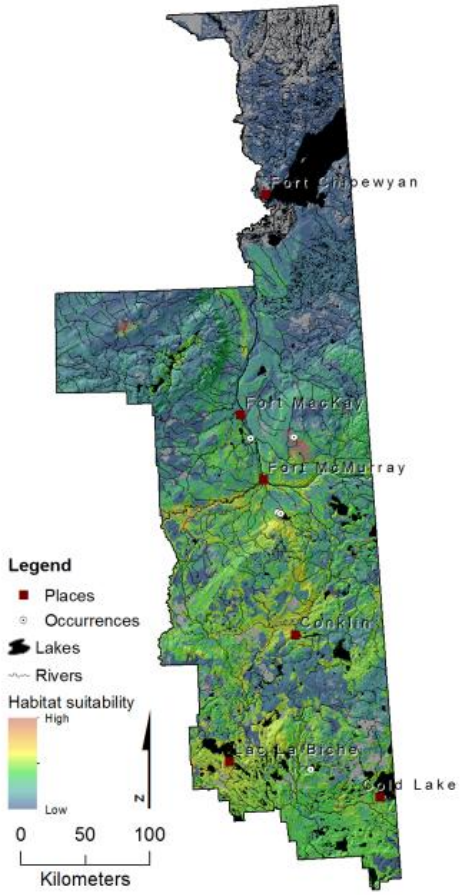
Bates, J.W. 1994. Responses of the mosses *Brachythecium rutabulum* and *Pseudoscleropodium purum* to a mineral nutrient pulse. Functional Ecology 8: 686-692.

Blockeel, T. 2010. *Brachythecium rutabulum.* In: British Bryological Society. British Mosses and Liverworts: A Field Guide. Online at http://www.bbsfieldguide.org.uk/content/brachythecium-rutabulum. Accessed Oct. 4, 2011.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Calypogeia sphagnicola

Common Name: Bog pouchwort
Alberta Status: S3
Canada Status: NNR
World Status: G4
Habitat Requirements: Occurs almost exclusively on sphagnum hummocks and in peat bog pools.
Life History: Inadvertent trampling of hummocks is a source of damage.
Literature:

Bosanquet, S. 2010. *Calypogeia sphagnicola/suecica*. In: British Bryological Society. British Mosses and Liverworts: A Field Guide. Online at http://www.bbsfieldguide.org.uk/content/calypogeia-sphagnicolasuecica. Accessed Oct. 4, 2011.

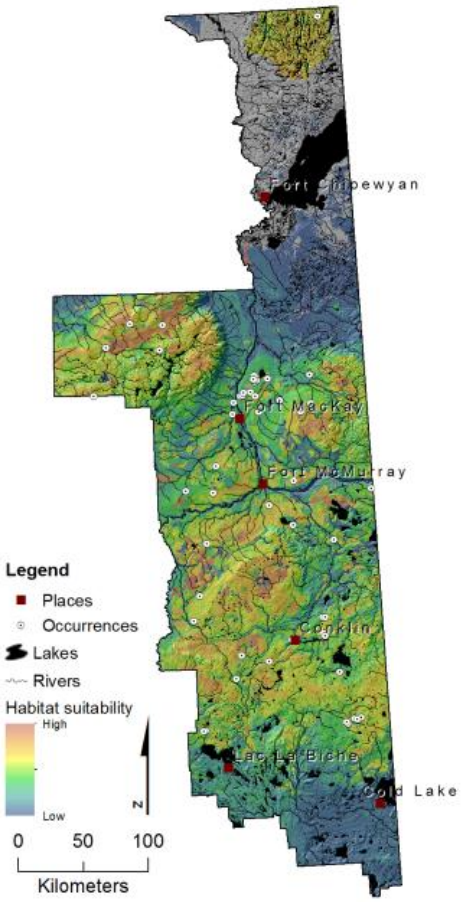
Stotler, R. and B. Crandall-Stotler. 1977. A checklist of liverworts and hornworts of North America. The Bryologist. 76:405-428.

Calypogeia sphagnicola. Photo by J-P. Frahm.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Campylium polygamum

Common Name: Campylium moss
Alberta Status: S3
Canada Status: NNR
World Status: G5
Habitat Requirements: Grows on trees (epiphytic).
Life History: A pleurocarpous moss.
Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

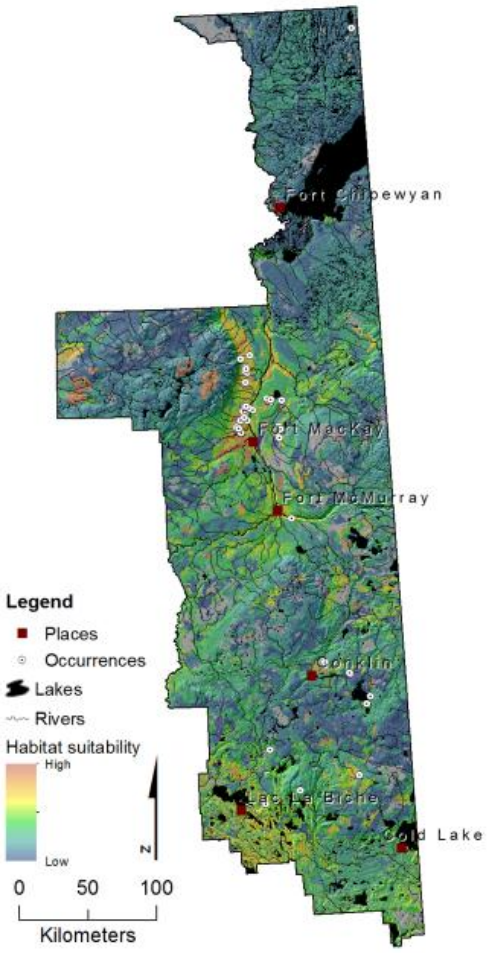
Ingerpuu, N., K. Kull and K. Vellak. 1998. Bryophyte vegetation in a wooded meadow: relationships with phanerogram diversity and responses to fertilisation. Plant Ecology 134: 163-171.

Campylium polygamum. Photo by K. Peters.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Campylium radicale

Common Name: Campylium moss
Alberta Status: S2
Canada Status: NNR
World Status: G3G5
Habitat Requirements: Grows on the ground, tree bases and logs in mixedwood forests.
Life History: Likely undercollected due to its resemblance to several other moss species.

Campylium radicale. Photo by Michael Lüth: Bildatlas der Moose Deutschlands.- www.milueth.de

Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

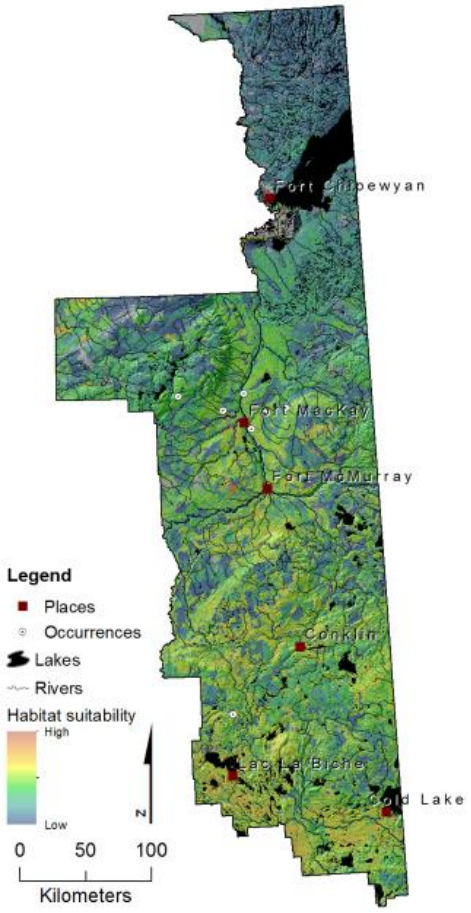
Hedenas, L. 1997. A partial generic revision of Campylium (Musci). The Bryologist 100(1):65-88.

Robinson, A. L. 2007. Miquelon Lake Provincial Park Rare Bryophyte and Lichen Survey June 29 – July 1, 2007. Report prepared for Alberta Tourism, Parks, Recreation and Culture. Edmonton, Alberta.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Chiloscyphus pallescens

Common Name: None
Alberta Status: S1
Canada Status: NNR
World Status: G5
Habitat Requirements: Occurs in fens and can grow on clay, leaf litter and wood. Often grows mixed with other moss species.
Life History: An aquatic bryophyte.
Literature:

Hodgett, Nick. 2010. *Chiloscyphus polyanthus/pallescens*. In: British Bryological Society. British Mosses and Liverworts: A Field Guide. Online at http://www.bbsfieldguide.org.uk/content/chiloscyphus-polyanthospallescens. Accessed Oct. 3, 2011.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

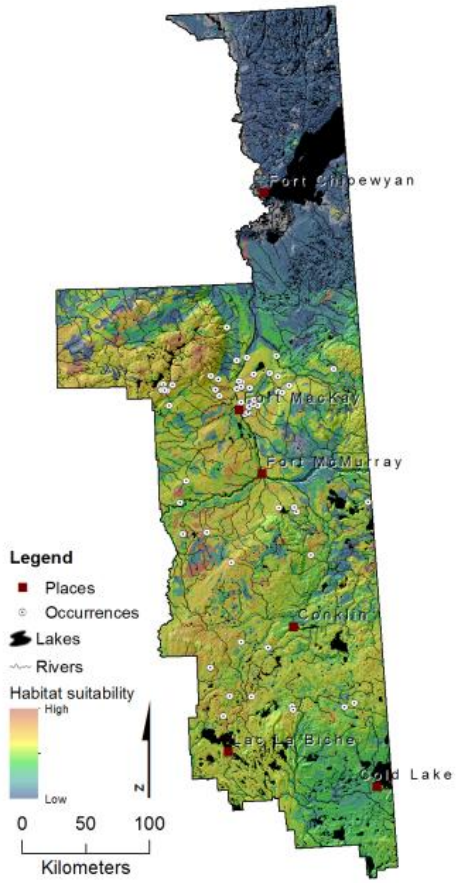
Stotler, R. and B. Crandall-Stotler. 1977. A checklist of liverworts and hornworts of North America. The Bryologist. 76:405-428.

Chiloscyphus pallescens. Photo by G. Motley.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Conocephalum conicum

Common Name: Snakeskin liverwort, scented liverwort
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Occurs on stream banks and on damp forest floors.
Life History: Unknown
Literature:

Lemke, C. 2003. Cal's Plant of the Week, *Conocephalum conicum*. University of Oklahoma Dept. of Botany & Microbiology. Online at http://www.plantoftheweek.org/week234.shtml. Accessed Oct. 4, 2011.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

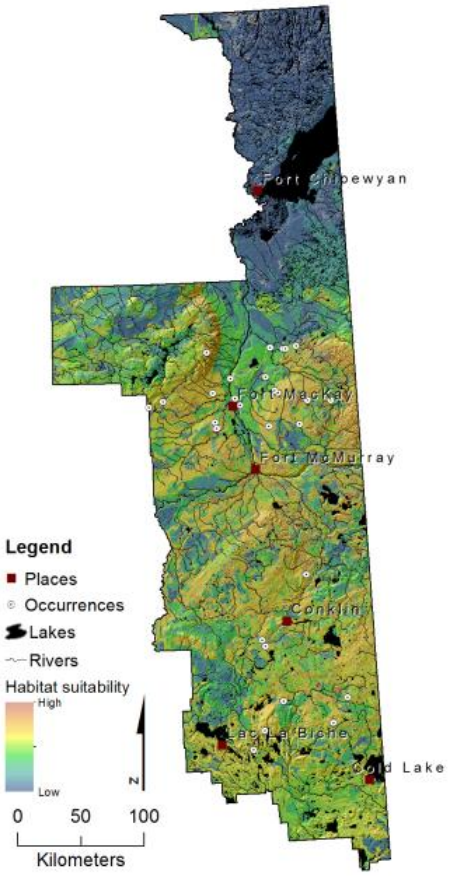
Stotler, R. and B. Crandall-Stotler. 1977. A checklist of liverworts and hornworts of North America. The Bryologist. 76:405-428.

Conocephalum conicum found in Stanley Park, Vancouver, B.C. Photographer unknown.

North American Status

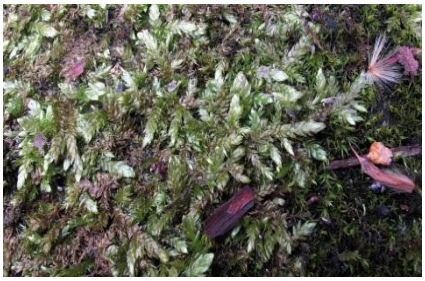
MAP UNAVAILABLE

Occurrences and Potential Habitat



Entodon schleicheri

Common Name: Schleicher's silk moss
Alberta Status: S1
Canada Status: NNR
World Status: G3G5
Habitat Requirements: Has been found on rocks, rotting logs and soil.
Life History: Unknown.
Literature:



Entodon schleicheri. Photo by Michael Lüth: Bildatlas der Moose Deutschlands.- www.milueth.de

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

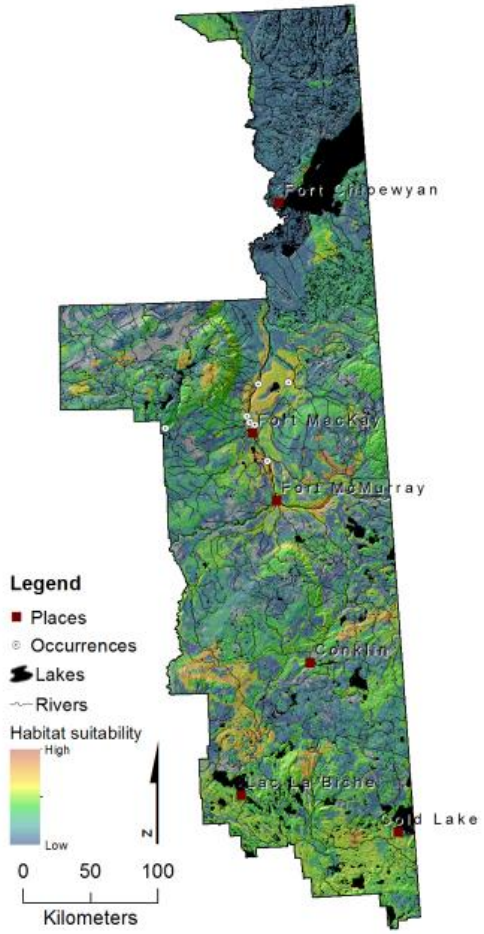
Sharp, Aaron J. et. al. 1994: The Moss Flora of Mexico. Buck, William R., Thomas Wm.Wayt, Daniel F. Thomas, editors.

Udar, R. and S. C. Srivastava. 1978. Entodon schleicheri new to North America. The Bryologist 81(3): 429-432.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Herzogiella turfacea

Common Name: None
Alberta Status: S3
Canada Status: NNR
World Status: G4G5
Habitat Requirements: Grows on coarse woody debris, primarily in coniferous forests.
Life History: A monoicous bryophyte.
Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

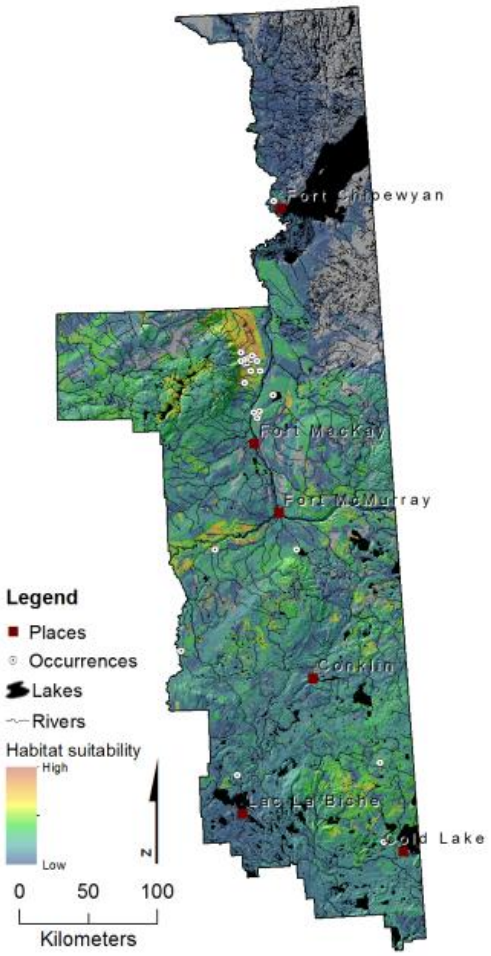
Caners, R.T., S.E. Macdonald and R.J. Belland. 2009. Recolonization potential of bryophyte diaspore banks in harvested boreal mixed-wood forest. Plant Ecology 204:55-68.

Herzogiella turfacea. Photo by Michael Lüth: Bildatlas der Moose Deutschlands.- www.milueth.de

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Hypnum pallescens

Common Name: Hypnum moss
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: An epiphyte, this species grows on trees, and has been observed growing on oak (*Quercus*) and birch (*Betula*).
Life History: Unknown.

Hypnum pallescens. Photo by Michael Lüth.

Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

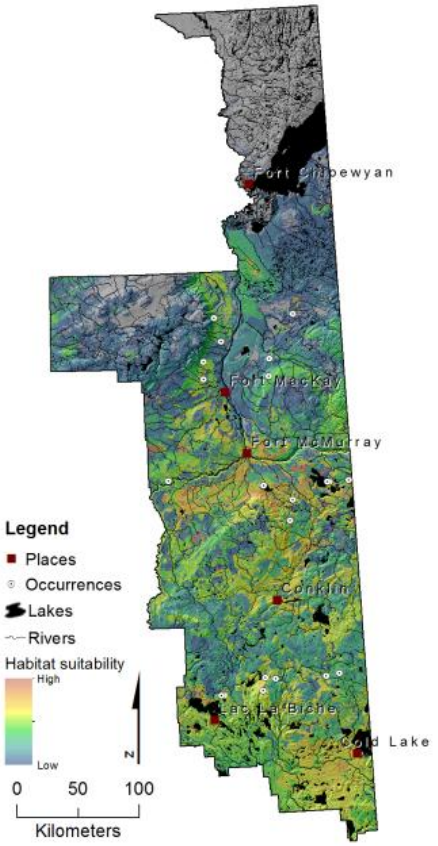
Trynoski, S.E. and J.M. Glime. 1982. Direction and height of bryophytes on four species of northern trees. The Bryologist 85: 281-300.

Weber, D.P. and G.R. Brassard. 1976. Bryophytes of Cataracts Provincial Park, Newfoundland: ecology and phytogeography. Canadian Journal of Botany 54: 1697-1708.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



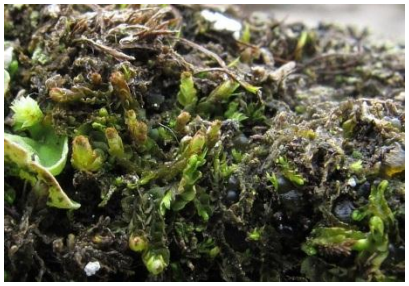
Lophozia heterocolpos

Common Name: None
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Occurs in the montane zone, growing on damp, silicaceous and moderately basic rock faces.
Life History: A liverwort.
Literature:

Belland, R.J. et W.B. Schofield. 1990. The Bryophytes of Mingan Archipelago National Park Reserve. Department of Botany, University of British Columbia.

Stotler, R. and B. Crandall-Stotler. 1977. A checklist of liverworts and hornworts of North America. The Bryologist. 76:405-428.

Werner, J., L. Reichling et R. Schumacker. 1984. *Lophozia heterocolpos* (Thed.) Howe, *Scapania aequiloba* (Schwaegr.) Dum. et *Scapania mucronata* Buch (*Hepaticae*) dans la vallée de la Pétrusse (Grand-Duché de Luxembourg). Bulletin de la Société Royale de Botanique de Belgique 117: 109-121.

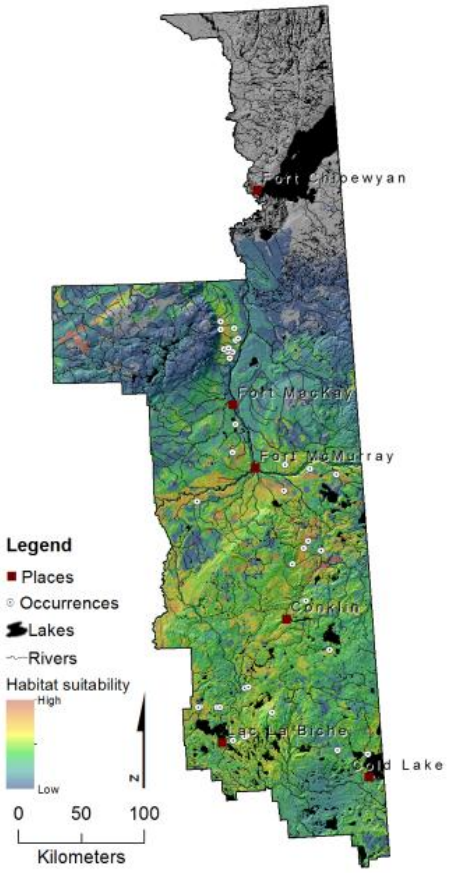


Lophozia heterocolpos. Photo by Michael Lüth: Bildatlas der Moose Deutschlands.- www.milueth.de

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Neckera pennata

Common Name: None
Alberta Status: S2S3
Canada Status: NNR
World Status: G5
Habitat Requirements: Generally grows on the basal trunks of old deciduous trees, although it has been observed on vertical rock surfaces.
Life History: Requires old-growth forest stands for habitat.
Literature:

Neckera pennata. Photo by Michael Lüth.

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

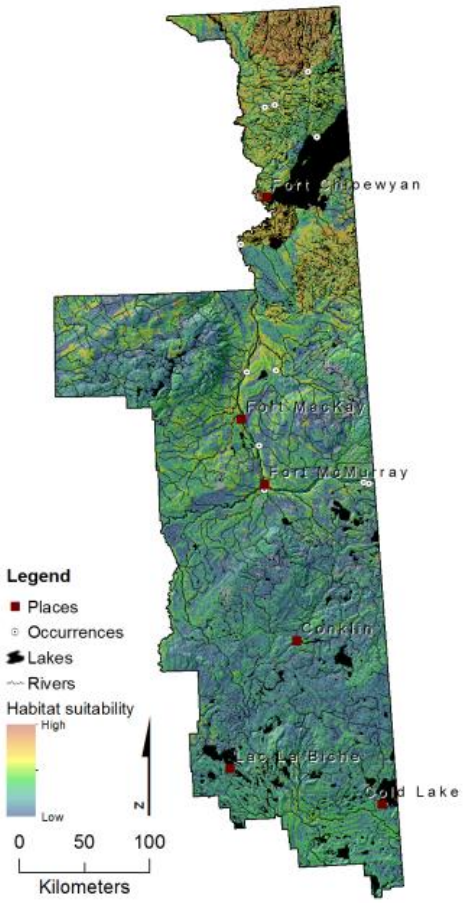
Kuusinen, M. and A. Penttinen. 1999. Spatial pattern of the threatened epiphytic bryophyte *Neckera pennata* at two scales in a fragmented boreal forest. Ecography 22: 729-735.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Pohlia sphagnicola

Common Name: None
Alberta Status: S3
Canada Status: NNR
World Status: G2G3
Habitat Requirements: Found in bogs and fens on *Sphagnum* hummocks, at sea level or montane elevations.
Life History: Possibly more common than suggested by the available data, due to confusion with its close relative, *P. nutans*, and its occurrence on *Sphagnum* hummocks, which would contribute to undercollection and misidentification.

Pohlia sphagnicola. Photo by Michael Lüth: Bildatlas der Moose Deutschlands.- www.milueth.de

Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

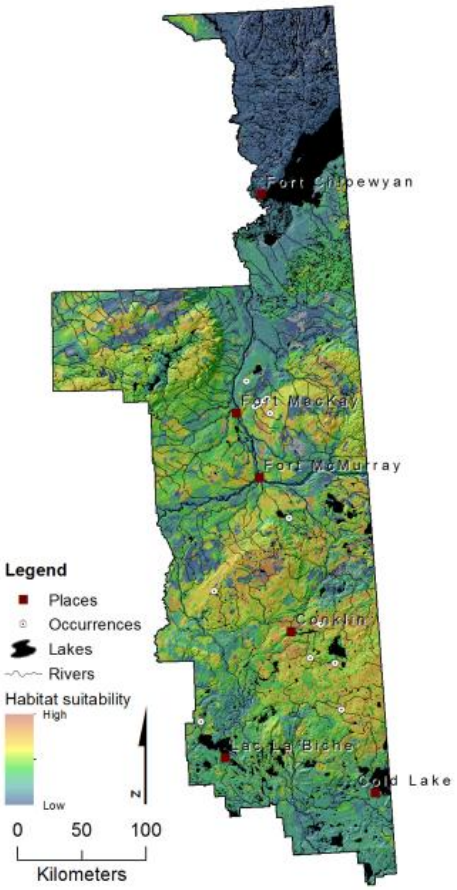
Shaw, J. 1982. Pohlia Hedw. (Musci) in North and Central America and the West Indies. Contributions from the University of Michigan Herbartium 15: 219-295.

Shaw, J. 1982. Pohlia hedw. (Musci) in North and Central America and the West Indies. Contributions from the University of Michigan Herbarium, vol. 15 : 219-295.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Pseudobryum cinclidioides

Common Name: Pseudobryum moss, River thyme-moss
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Occurs on wet soils in marshes, woodland fens and along riverbanks; primarily a montane species, but can occur in woodlands.
Life History: Vulnerable to moisture loss.
Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

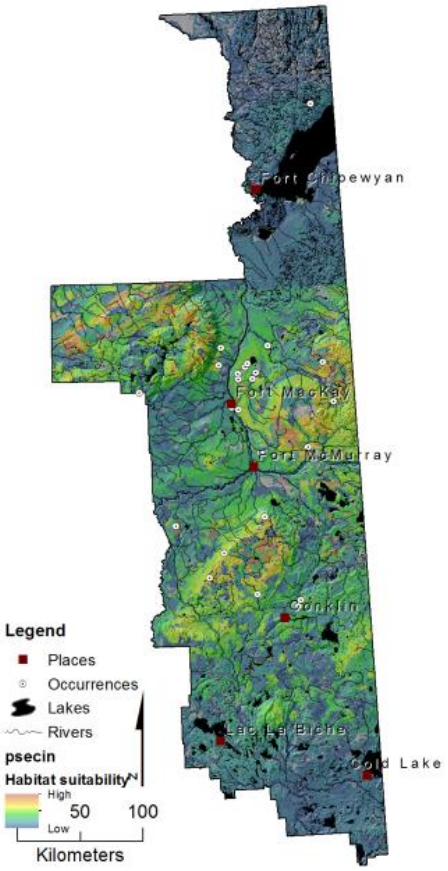
Orange, Alan. 2010. *Pseudobryum cinclidioides*. In: British Bryological Society. British Mosses and Liverworts: A Field Guide. Online at http://www.bbsfieldguide.org.uk/content/pseudobryum-cinclidioides. Accessed Oct. 3, 2011.

Pseudobryum cinclidioides. Photo by D. Callaghan.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Riccardia latifrons

Common Name: None
Alberta Status: S2
Canada Status: NNR
World Status: G4G5
Habitat Requirements: Grows on decaying logs.
Life History: A liverwort.
Literature:

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

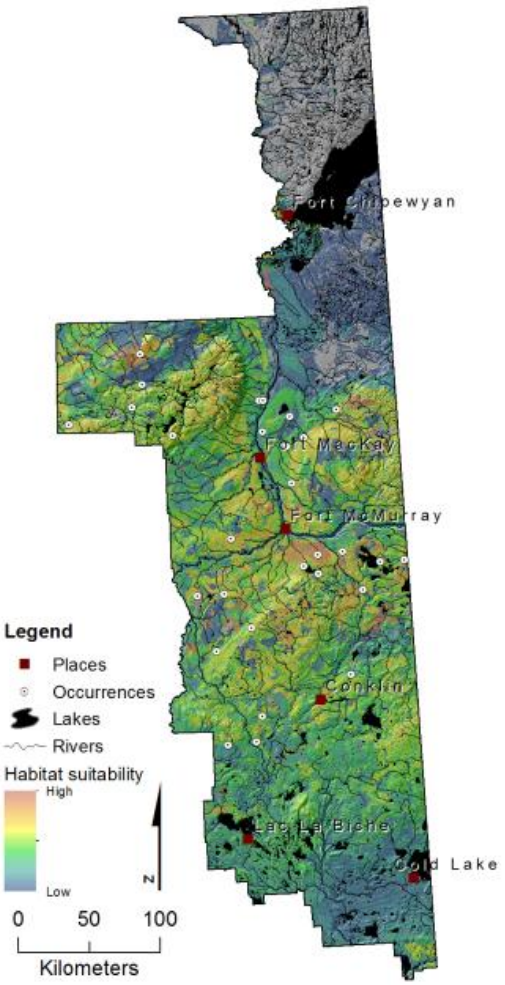
Stotler, R. and B. Crandall-Stotler. 1977. A checklist of liverworts and hornworts of North America. The Bryologist. 76:405-428.

Riccardia latifrons. Photographer unknown.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Scapania glaucocephala

Common Name: None
Alberta Status: S2
Canada Status: NNR
World Status: G4G5
Habitat Requirements: Only found on decaying logs; more specifically on cedar, fir, pine and spruce logs in western North America.
Life History: A liverwort.
Literature:

Scapania glaucocephala. Photo by Michael Lüth.

Hong, W.S. 1980. The genus *Scapania* in western North America. II. Taxonomic treatment. The Bryologist 83(1):40-59.

Muhle, H. et F. LeBlanc, s.c. 1975. Bryophyte and lichen succession on decaying logs. I. Analysis along an evaporational gradient in eastern Canada. Journ. Hattori Bot. Lab. 39 1-33.

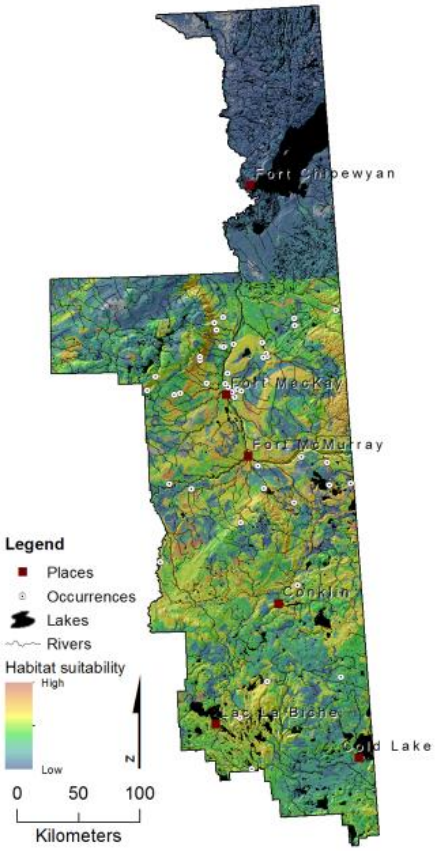
Schuster, R.M. 1974. The Hepaticae and Anthocerotae of North America East of the Hundredth Meridian. Volume III. Columbia University, New York.

Stotler, R. and B. Crandall-Stotler. 1977. A checklist of liverworts and hornworts of North America. The Bryologist. 76:405-428.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Scapania paludicola

Common Name: None
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Occurs at the edge of tundra pools and lakes, on wet peaty soil.
Life History: A liverwort.
Literature:

Hong, W.S. 1980. The genus Scapania in western North America. II. Taxonomic treatment. The Bryologist 83(1):40-59.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

Steere, W.C., and H. Inoue. 1978. The Hepaticae of Arctic Alaska. Journ. Hattori Bot. Lab. 44:251-345.

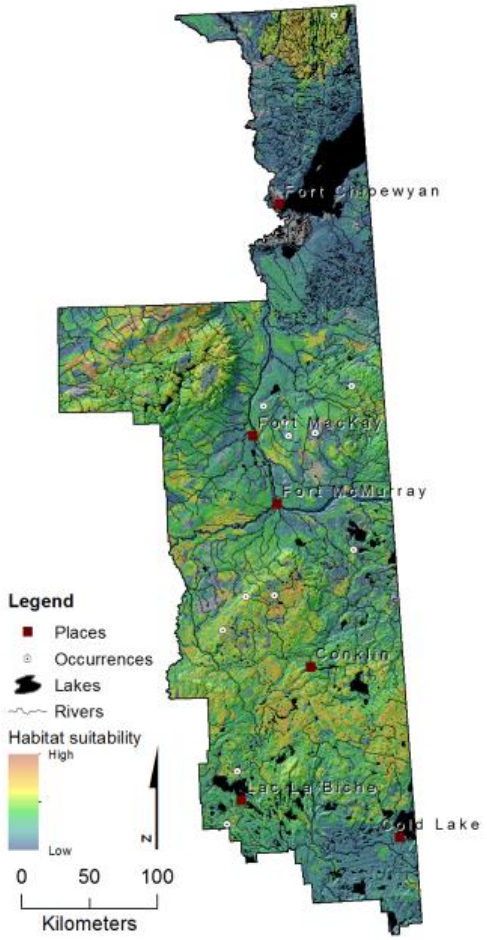
Stotler, R. and B. Crandall-Stotler. 1977. A checklist of liverworts and hornworts of North America. The Bryologist. 76:405-428.

Scapania paludicola. Photo by Michael Lüth.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Sphagnum fallax

Common Name: Flat-top bogmoss
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Found in peatlands and fens; known as a pioneer species of drained peatlands in Switzerland, and can dominate nutrient-rich fens.
Life History: Threats include land-use conversion, habitat fragmentation, forest management practices, and sedimentation.

Sphagnum fallax. Photo by Michael Lüth.

Literature:

Anderson, L.E. 1990. A checklist of Sphagnum in North America north of Mexico. The Bryologist 93(4):500-501.

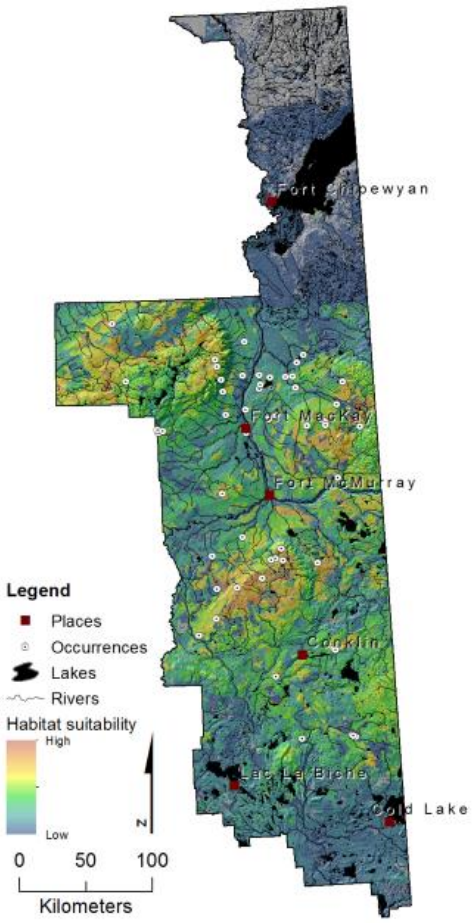
Danley, D. 2004. Annotated List of the Sphagnum of Western North Carolina. Manuscript in preparation.

Gabka, M. and M. Lamentowicz. 2008. Vegetation-Environment Relationships in Peatlands Dominated by Sphagnum fallax in Western Poland. Folia Geobot 43: 413-429.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Sphagnum fimbriatum

Common Name: Fringed bogmoss, fringed bog-moss
Alberta Status: S2
Canada Status: N5
World Status: G5
Habitat Requirements: A minerotrophic species that occurs in nutrient-moderate, damp, shady sites, often in association with birch (*Betula*) and willow (*Salix*). Also occurs in more open riparian sites and fens.
Life History: Reproduces by spores and regenerates from fragments.

Sphagnum fimbriatum. Photo by K. Peters.

Literature:

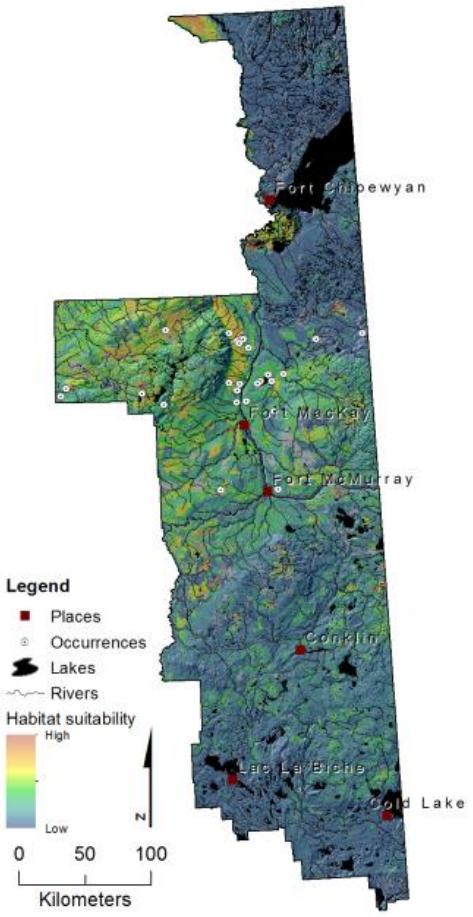
Amphlett, A. and S. Payne. 2010. *Sphagnum fimbriatum*. In: British Bryological Society. British Mosses and Liverworts: A Field Guide. Online at http://www.bbsfieldguide.org.uk/content/sphagnum-fimbriatum. Accessed Oct. 4, 2011.

Anderson, L.E. 1990. A checklist of Sphagnum in North America north of Mexico. The Bryologist 93(4):500-501.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Splachnum ampullaceum

Common Name: Flagon-fruited splachnum, cruet collar-moss
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Grows in wet areas of bogs, specifically on herbivore dung.
Life History: Threatened by trampling by uninformed visitors and elk.

Splachnum ampullaceum. Photo by F. Boas.

Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

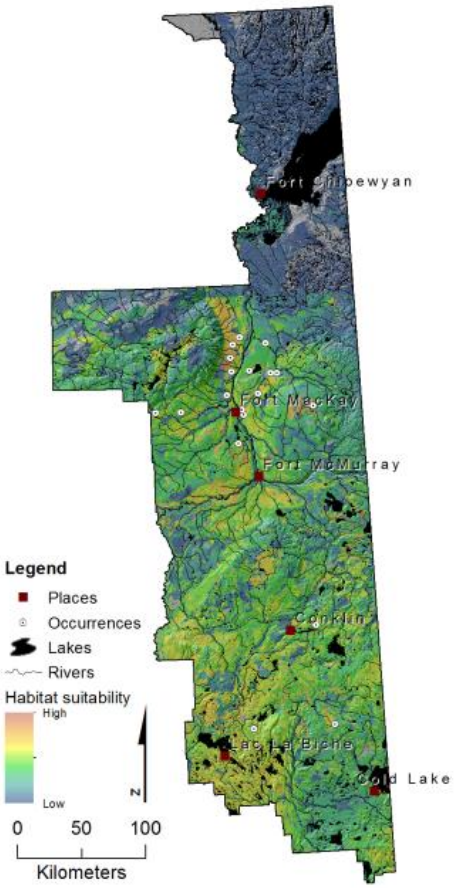
Cleavitt, N.L., S.A. Williams, and N. Slack. 2006. Updating the rare moss list for New York State: Ecological community and species-centered approaches. Final report for the Biodiversity Research Institute. New York State Museum. Albany, NY.

Hodgetts, N. 2010. *Splachnum ampullaceum.* In: British Bryological Society. British Mosses and Liverworts: A Field Guide. Online at http://www.bbsfieldguide.org.uk/content/splachnum-ampullaceum. Accessed Oct. 4, 2011.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Splachnum luteum

Common Name: Yellow collar moss
Alberta Status: S3
Canada Status: NNR
World Status: G4?
Habitat Requirements: In northern regions of North America, grows in muskeg and boggy woods on old moose dung.
Life History: Spores are dispersed by flies.
Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

Crum, H.A., and L.E. Anderson. 1981. Mosses of eastern North America. 2 Volumes. Columbia Univ. Press, New York. 1328 pp.

Ireland, R.R. and L.M. Ley. 1992. Atlas of Ontario Mosses. Syllogeus No. 70, Canadian Museum of Nature, Ottawa. 138 pp.

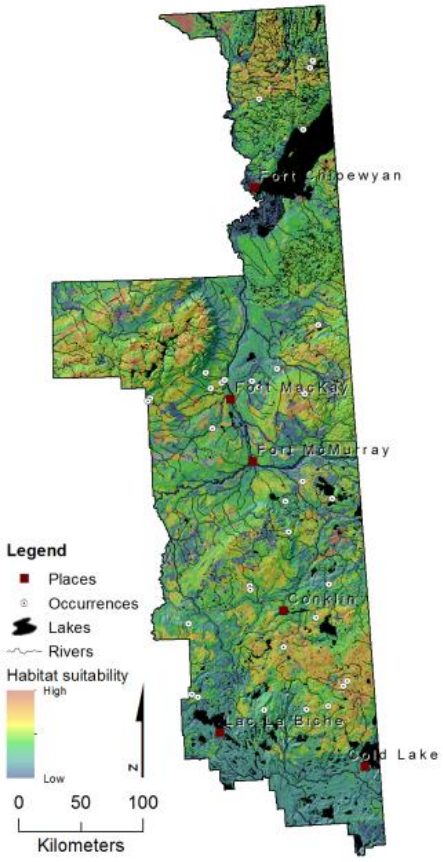
Martensson, O. 1956. Bryophytes of the Tornetrask area, northern Swedish Lappland. II. Musci. Kungl. Svensak Vetenskapsakadenmiens Avhandlinger I Narturskyddsarenden 14.

Splachnum luteum. Photo by T. Kortelainen.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Splachnum rubrum

Common Name: Red collar moss
Alberta Status: S3
Canada Status: NNR
World Status: G4?
Habitat Requirements: In North America, likely occurs only in the same range as moose (*Alces alces*). Very rare the northern regions of North America.
Life History: Spores are dispersed by flies.
Literature:

Splachnum rubrum. Photo by Michael Lüth.

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

Cleavitt, N.L., S.A. Williams, and N. Slack. 2006. Updating the rare moss list for New York State: Ecological community and species-centered approaches. Final report for the Biodiversity Research Institute. New York State Museum. Albany, NY.

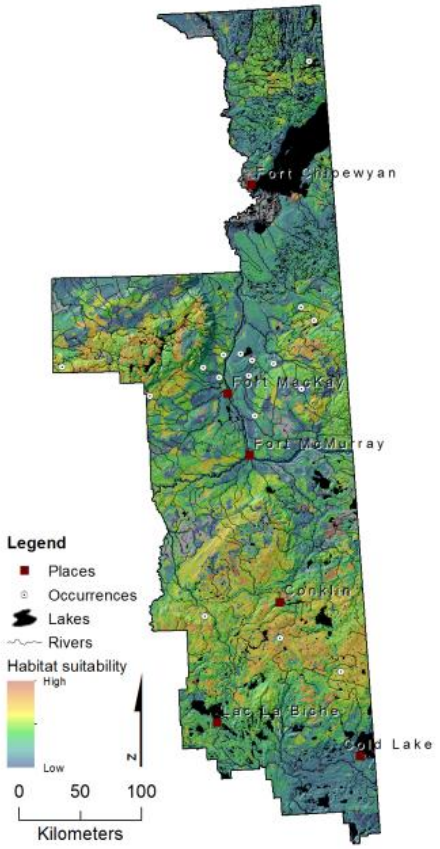
Crum, H.A., and L.E. Anderson. 1981. Mosses of eastern North America. 2 Volumes. Columbia Univ. Press, New York. 1328 pp.

Ireland, R.R. 1982. Moss flora of the Maritime Provinces. National Museums of Canada, Publications in Botany 13.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Splachnum sphaericum

Common Name: Pinkstick dung moss, round-fruited collar-moss
Alberta Status: S2
Canada Status: NNR
World Status: G3G5
Habitat Requirements: Grows exclusively on (generally herbivore) dung in bogs.
Life History: A dioecious moss.
Literature:

Anderson, L.E., H.A. Crum, and W.R. Buck. 1990. List of the mosses of North America north of Mexico. The Bryologist 93(4):448-499.

Hodgetts, Nick. 2010. *Splachnum sphaericum*. In: British Bryological Society. British Mosses and Liverworts: A Field Guide. Online at http://www.bbsfieldguide.org.uk/content/splachnum-sphaericum. Accessed Oct. 5, 2011.

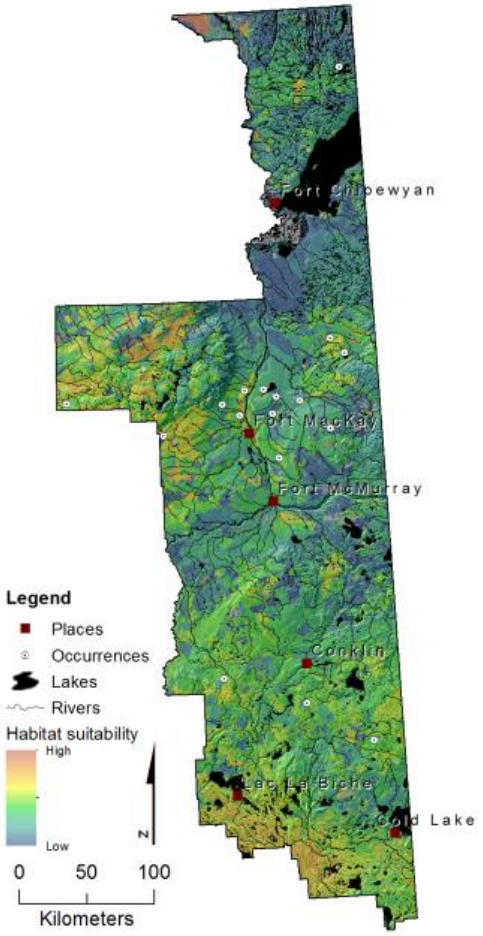
NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

Splachnum sphaericum. Photo by Michael Lüth.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Bryoria simplicior

Common Name: Old man's beard
Alberta Status: S2S3
Canada Status: NNR
World Status: G3G5
Habitat Requirements: Generally grows on well-lit twigs, small branches and lignum.
Life History: Unknown.
Literature:

Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4): 467-549.

Nash, T. H., B. D. Ryan, C. Gries, and F. Bungartz, eds. 2002. Lichen flora of the greater sonoran desert region. Volume 1. Lichens Unlimited, Department of Plant Biology, Arizona State University, Tempe, AZ. 532 pp.

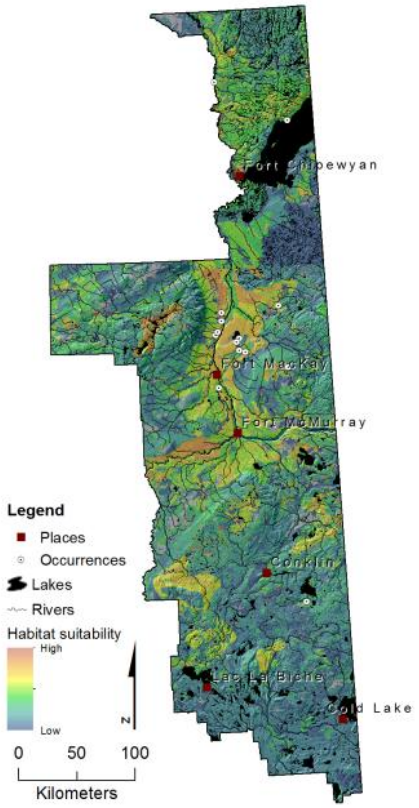
NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

Bryoria simplicior on *Abies.* Photo by Stephen Sharnoff.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat

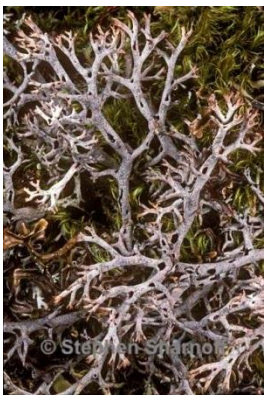


Cladina stygia (syn. *Cladonia stygia*)
Common Name: Reindeer lichen
Alberta Status: S1
Canada Status: G5
World Status: NNR
Habitat Requirements: Grows in bogs and open wetlands.
Life History: An often overlooked species, closely related to *Cladina rangifera*.
Literature:

Brodo, Irwin M., Sharnoff, Sylvia D. and Stephen Sharnoff. 2001. Lichens of North America. Yale University Press. New Haven and London. 795 pp.

Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4): 467-549.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

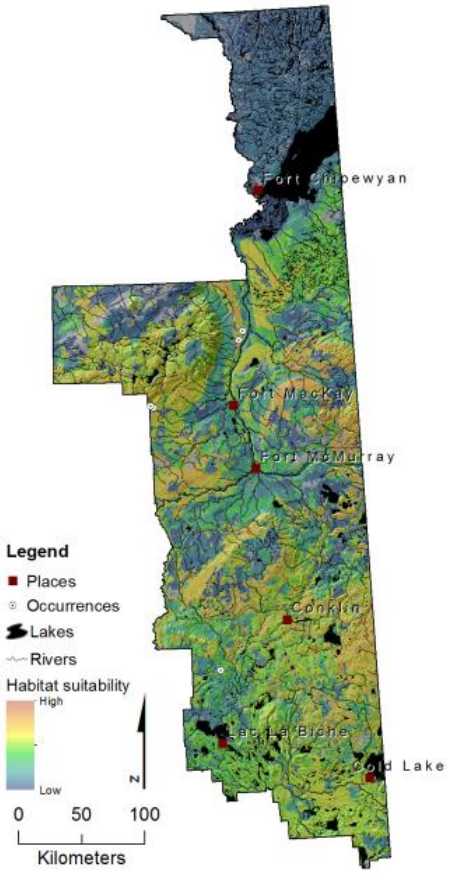


Cladina stygia growing on a tundra mat. Photo by Stephen Sharnoff.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Imshaugia placorodia

Common Name: American starburst lichen
Alberta Status: S2
Canada Status: NNR
World Status: G3G5
Habitat Requirements: Grows on dead branches, tree bark, and scrub pine along the sides of roads and open woods. Has been observed growing on jack pine.
Life History: Unknown.
Literature:

Imshaugia placorodia. Photographer unknown.

Brodo, Irwin, Sylvia Duran Sharnoff, and Stephen Sharnoff. 2001. Lichens of North America. Yale University Press. 828pp.

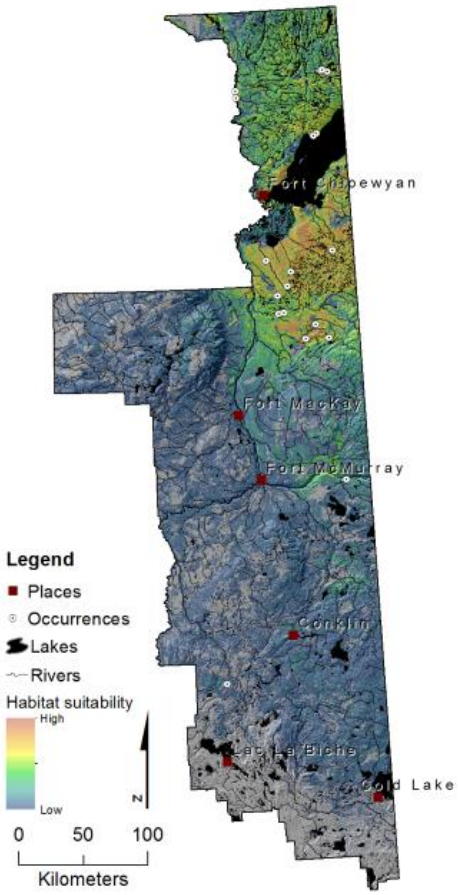
Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

Flenniken, D.G. The Macrolichens in West Virginia. Carlisle Printing, Ohio.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Lecanora subintricata

Common Name: Rim lichen
Alberta Status: S1
Canada Status: NNR
World Status: G3G5
Habitat Requirements: Grows on old wood and the bark of trees and shrubs.
Life History: Occurs at high elevations.
Literature:

Lecanora subintricata growing on a dead pine. *http://www.stridvall.se/la/galleries.php*

Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

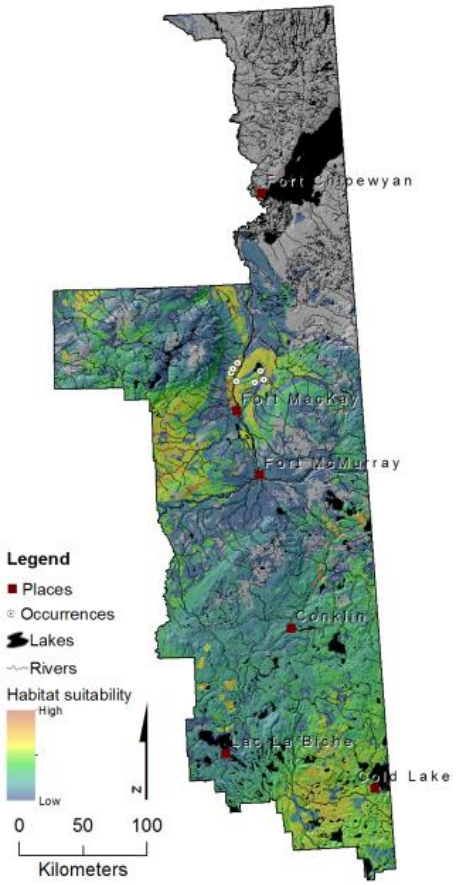
NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

Thomson, J.W. American arctic lichens 2. The microlichens. The University of Wisconsin Press, Madison, Wisconsin. 675 pp.

North American Status

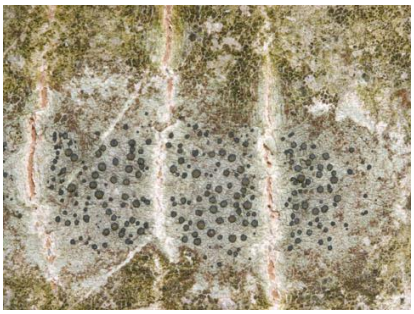
MAP UNAVAILABLE

Occurrences and Potential Habitat



Lecidella elaeochroma

Common Name: Disk lichen
Alberta Status: S1
Canada Status: NNR
World Status: G5?
Habitat Requirements: Grows on numerous tree and shrub species, on the twigs and bark.
Life History: Increases in response to increasing nitrogen levels.
Literature:



Lecidella elaeochroma. Photo © 2004 by Paul Diederich.

Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

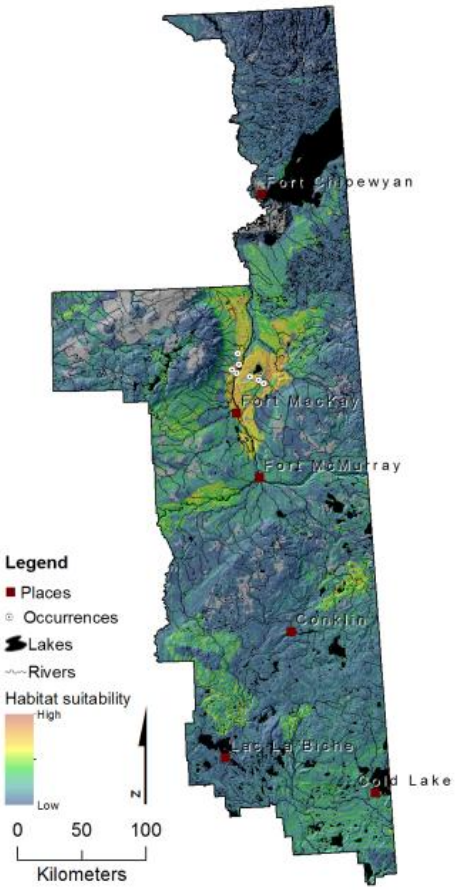
NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

Thomson, J.W. American arctic lichens 2. The microlichens. The University of Wisconsin Press, Madison, Wisconsin. 675 pp.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Melanelia fuliginosa

Common Name: Camouflage lichen
Alberta Status: S1
Canada Status: G5
World Status: NNR
Habitat Requirements: Grows on bark and rocks.
Life History: Most frequently found in coastal regions.
Literature:

Melanelia fuliginosa. Photo by Jirí Novák.

Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

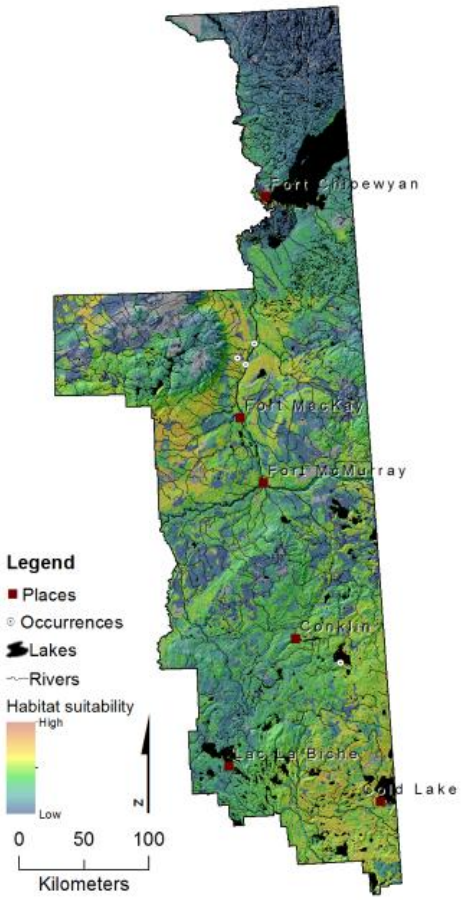
McCune, B. and L. Geiser. 1997. Macrolichens of the Pacific Northwest. Oregon State University Press, Corvallis, Oregon. A co-publication with the U.S. Department of Agriculture Forest Service. 386 pp.

Otte, V., T.L. Esslinger and B. Litterski. 2005. Global distribution of the European species of the lichen genus *Melanelia* Essl. Journal of Biogeography 32: 1221-1241.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Melanelia trabeculata

Common Name: Camouflage lichen
Alberta Status: S2?
Canada Status: NNR
World Status: GNR

PHOTO UNAVAILABLE

Habitat Requirements: Member of a genus of which most species grow on bark and wood.
Life History: Unknown.
Literature:

Blanco, O., A. Crespo, P. K. Divakar, T. L. Esslinger, D. L. Hawksworth and H. T. Lumbsch. 2004. Melanelixia and Melanohalea, two new genera segregated from Melanelia (Parmeliaceae) based on molecular and morphological data. Mycological Research 108(8): 873-884.

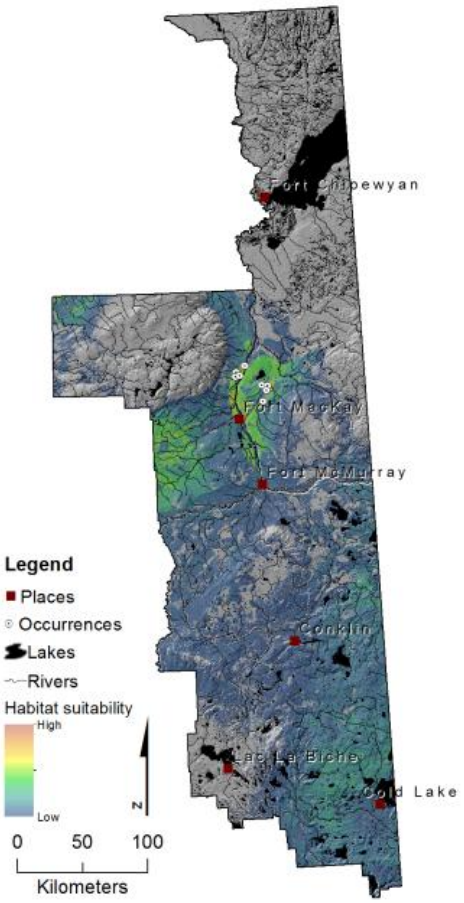
Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Nephroma bellum

Common Name: Naked kidney lichen
Alberta Status: S2
Canada Status: NNR
World Status: G3G5
Habitat Requirements: Grows on large, old, broadleaved hardwoods.
Life History: Threatened by deforestation of old-growth forests.
Literature:

Nephroma bellum. Photo by Stephen Sharnoff.

Brodo, Irwin M., Sharnoff, Sylvia D. and Stephen Sharnoff. 2001. Lichens of North America. Yale University Press. New Haven and London. 795 pp.

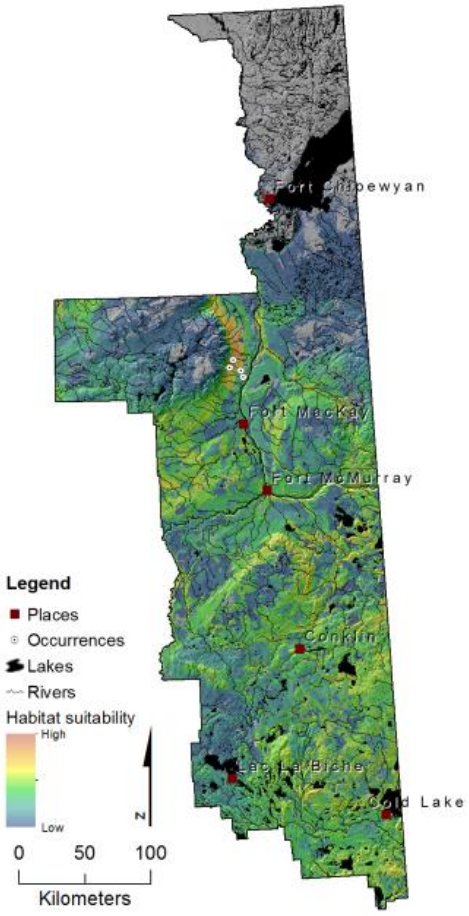
Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

Gustafsson, L., A. Fiskesjo, T. Ingelog, B. Pettersson, G. Thor. 1992. Factors of importance to some lichen species of deciduous broad-leaved woods in south Sweden. Lichenologist 24(3) pp255-266.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Ochrolechia gowardii

Common Name: None
Alberta Status: S1
Canada Status: NNR
World Status: GNR

PHOTO UNAVAILABLE

Habitat Requirements: Has been observed on black spruce bark.
Life History: Member of the tree crust lichen group.
Literature:

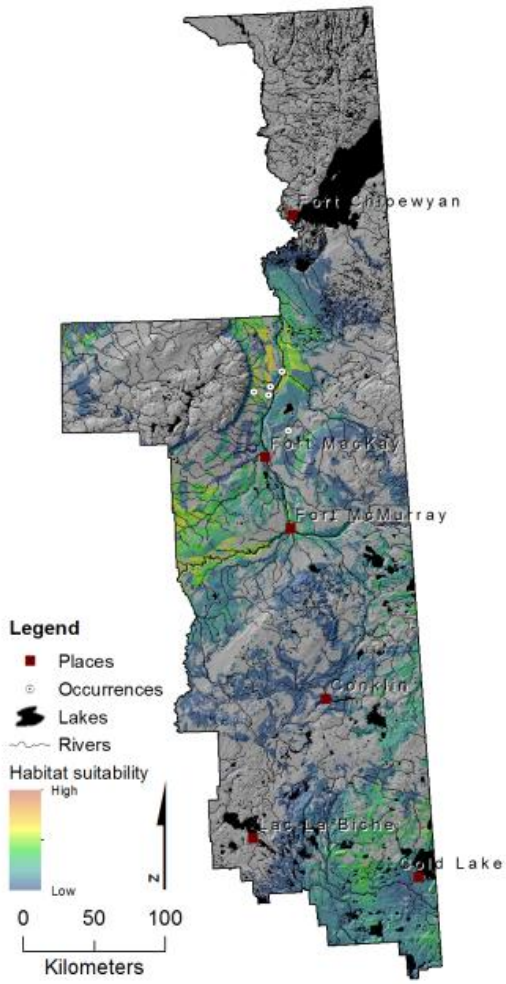
Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

Holien, H. and D. Triebel. 1996. *Spirographa Vinosa*, a new odontotremoid fungus on *Ochrolechia* and *Pertusaria*. Lichenologist 28(4): 307-313.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Peltigera horizontalis

Common Name:
Alberta Status: S1S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Grows on rock surfaces, mosses, rotting wood and soil.
Life History: Grows in small patches of individuals, distributed sparsely across the landscape.
Literature:

Peltigera horizontalis. Photo by Alan Silverside.

Brodo, Irwin M., Sharnoff, Sylvia D. and Stephen Sharnoff. 2001. Lichens of North America. Yale University Press. New Haven and London. 795 pp.

Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

North American Status

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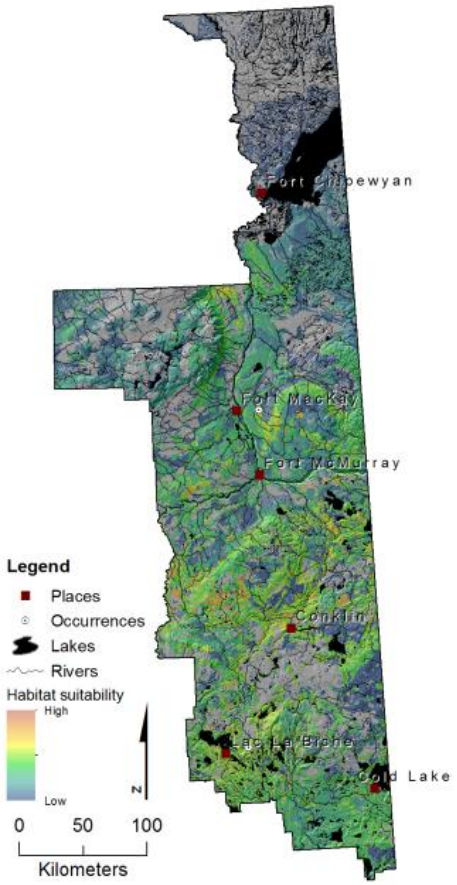
Occurrences and Potential Habitat



Peltigera polydactylon

Common Name: Alternating dog-lichen
Alberta Status: S1S2
Canada Status: NNR
World Status: G5?
Habitat Requirements: Grows on rock surfaces, moss-covered logs and soil, in open or sheltered areas.
Life History: Unknown.
Literature:

Egan, Robert S. 1987. A fifth checklist of the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. The Bryologist 90(2):77-173.

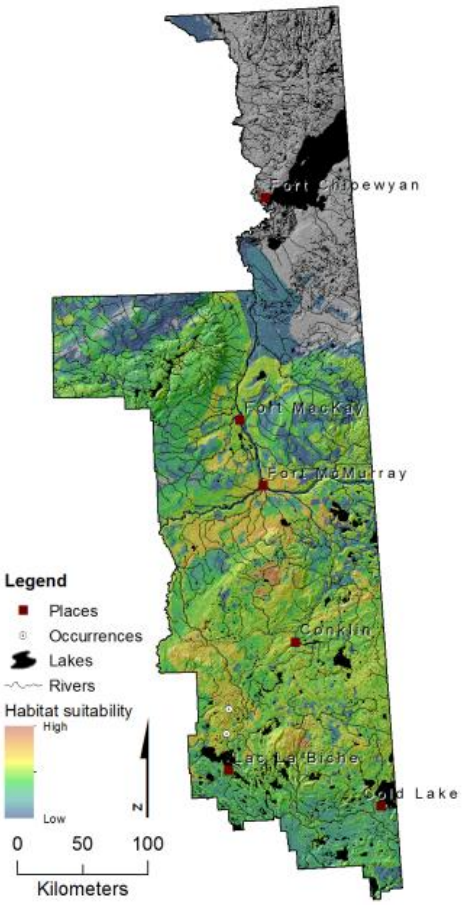
Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

Peltigera polydactylon on a montane boulder. Photo by Alan Silverside.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Physcia tenella

Common Name: None
Alberta Status: S2
Canada Status: NNR
World Status: G4
Habitat Requirements: Grows on tree bark.
Life History: An asexual lichen.
Literature:

Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4): 467-549.

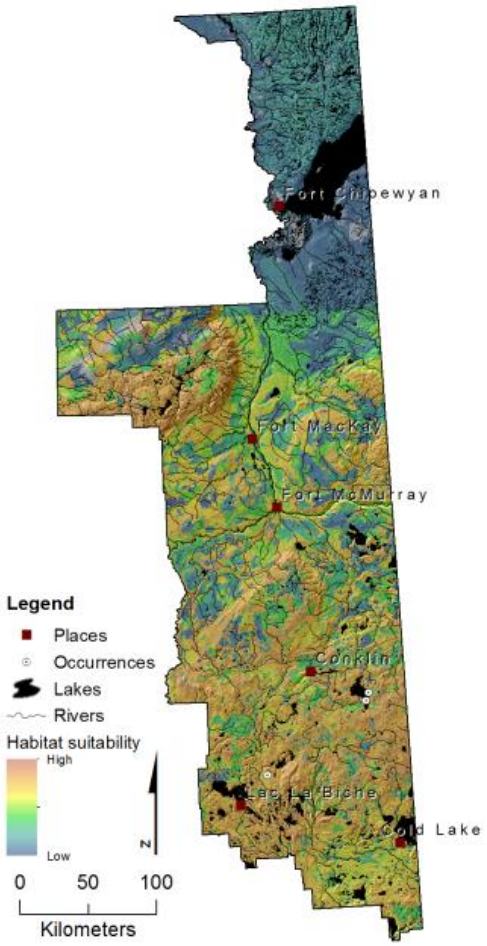
NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

Physcia tenella. Photo by Ulrich Kirschbaum.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Placynthiella uliginosa

Common Name: Peat tarspot lichen
Alberta Status: S2
Canada Status: NNR
World Status: G5
Habitat Requirements: Grows on old wood, soil and humus.
Life History: Performs well on acidic soil.
Literature:

Placynthiella uliginosa. Photo by Stephen Sharnoff.

Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

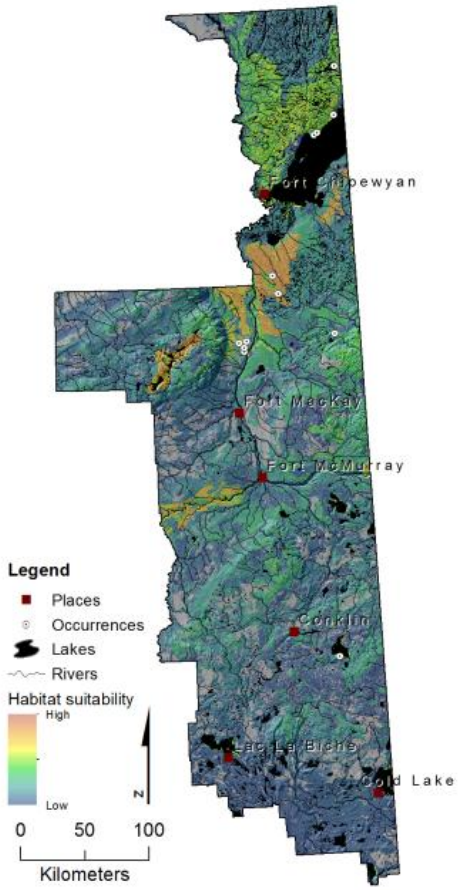
NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

Thomson, J.W. American arctic lichens 2. The microlichens. The University of Wisconsin Press, Madison, Wisconsin. 675 pp.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Rinodina metaboliza

Common Name: Pepper-spore lichen
Alberta Status: S2
Canada Status: NNR
World Status: GNR

PHOTO UNAVAILABLE

Habitat Requirements: A boreal species whose range extends south into the Rocky Mountains.
Life History: A crustose lichen.
Literature:

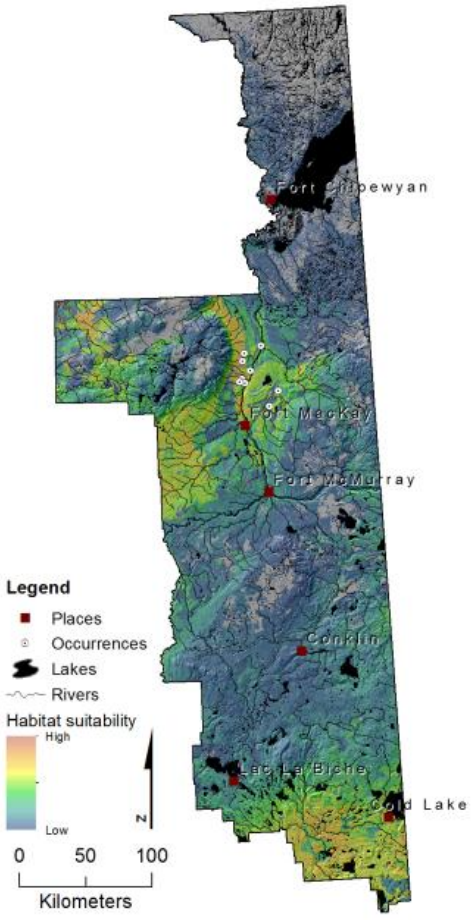
Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

Sheard, J.W. 2010. The Lichen Genus *Rinodina* (Arch.) Gray (Lecanoromycetidae, Physciaceae) in North America, North of Mexico. NRC Research Press, Ottawa, Ontario, Canada. 246 pp.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat



Usnea scabiosa

Common Name: Beard lichen
Alberta Status: SU
Canada Status: NNR
World Status: GNR
Habitat Requirements: A boreal/arctic alpine species, found more commonly in the southern, drier mountain ranges.
Life History: Elongate fruticose lichen.
Literature:

Esslinger, T.L. and R.S. Egan. 1995. A sixth checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada. The Bryologist 98(4):467-549. As supplied by USDA, NRCS from The PLANTS database. National Plant Data Center, Baton Rouge, LA. Version: November 19, 1997.

NatureServe et ses centres de données sur la conservation. 1994 -. Banque de données centrale NatureServe, active depuis 1994. Arlington, Virginie, USA.

Usnea scabiosa. Photo by Jason Hollinger.

North American Status

MAP UNAVAILABLE

Occurrences and Potential Habitat