15 GREAT LAKES ALVAR , NORTH AMERICA

contributed by Don Faber-Langendoen (NatureServe, Conservation Science Division, Arlington, VA). and Wasyl Bakowsky (Natural Heritage Information Centre, Ontario Ministry of Natural Resources, Peterborough, ON).

CLASSIFICATION

International Vegetation Classification :

Eastern North American Grassland, Meadow & Shrubland Division (D024 2.B.2.Nc)
Northern Alkaline Scrub - Herb & Outcrop Vegetation MacroGroup (M507)
Great Lakes Alvar Group (G061).

IUCN Habitats Classification Scheme (Version 3.0): 4. Grassland / 4.4 Temperate Grassland

Key References: Reschke et al. (1999), Catling and Brownell (1999).

ECOSYSTEM DESCRIPTION

Characteristic native biota

This type is characterized by a variable physiognomy, from open perennial (rarely annual) grassland or shrubland and nonvascular pavement (5-25% herb and or shrub cover) to dense grassland or shrubland (> 25%) with scattered evergreen needleleaf (more rarely broadleaf deciduous) trees < 10%, but variable) (Figure 1). Species composition contains a mix of tallgrass prairie graminoids and forbs and sub-boreal to boreal shrubs and trees. Sites are on thin-soil, limestone pavement, with a xero-hydric moisture regime. Key dominants and differentials include the perennials *Schizachyrium scoparium, Sporobolus heterolepis*, *Danthonia spicata* and *Deschampsia caespitosa*; less commonly with *Sporobolus neglectus, Sporobolus vaginiflorus*, and *Panicum philadelphicum.* Key shrubs, when present, are *Juniperus communis* ,*J. horizontalis, Dasiphora fruticosa* ssp. *floribunda and Rhus aromatica*. Trees, when present, include *Thuja occidentalis, Picea glauca, Pinus banksiana*, and *Abies balsamea* (in more northern sites) and *Juniperus virginiana, Quercus macrocarpa* or *Quercus muehlenbergii* (more southern sites).

Abiotic environment

Climate: Alvars are found in humid and subhumid climates.
Soil/substrate/hydrology: Alvars are centered on areas of glaciated horizontal limestone/dolomite (dolostone) bedrock pavement with a discontinuous thin soil mantle. Most hydrologic studies of alvars in the Great Lakes region have concentrated on Chaumont Barrens in New York State (Feeney 1996, 1997, Reschke et al. 1999). Reschke (1995) found strong correlations between soil moisture conditions and vegetation types, with "alvar grasslands" (equivalent to tufted hairgrass wet alvar grassland) located in the wettest, seasonally flooded areas, and "calcareous pavement barrens" (equivalent to juniper alvar shrubland) in the drier, never-flooded areas. At the Limerick Cedars alvar, also in New York State, Gilman (1995) observed that alvar community structure was influenced by rapidly changing environmental conditions and differential tolerances of plants, especially to periodic drought.

Figure S15. 1. Typical examples of alvar in Ontario, Canada, showing clockwise from top right: little bluestem – shrubby cinquefoil (*Schizachyrium scoparium, Dasiphora fruticosa* ssp. *floribunda*) dwarf-shrub grassland, in Carden Township; prairie dropseed (*Sporobolus heterolepis*) grassland, with white cedar (*Thuja occidentalis*) limestone woodland in background, on Manitoulin Island; alvar grassland with *Deschampsia cespitosa* in Carden Township; alvar nonvascular pavement on Manitoulin Island. All photos by Wasyl Bakowsky.

Distribution

Almost all of North America's alvars occur within the Great Lakes basin, primarily in an arc along the Niagaran Escarpment from northern Lake Michigan across northern Lake Huron and eastern Ontario and northern New York State (Figure 2).

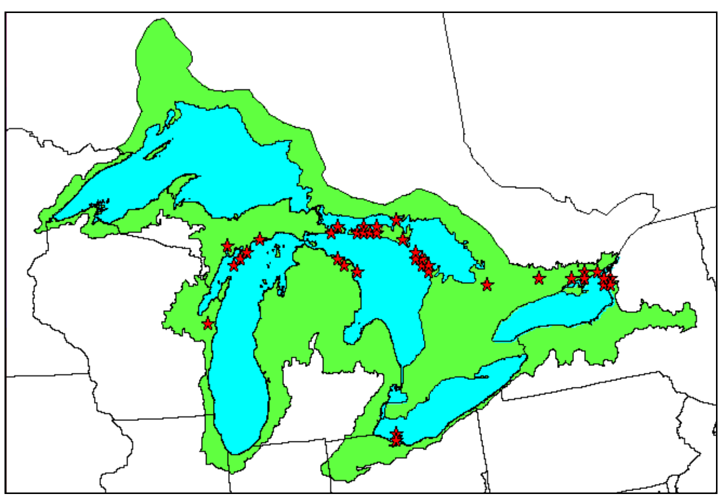

Figure S15. 2. Distribution of Great Lakes Alvar sites within the Great Lakes basin (green area). A few Great Lakes alvar sites occur near, but outside, the basin.

Key processes and interactions

Hydrology: The extreme range in hydrologic conditions on a relatively flat, fractured limestone with thin soils habitat appears to be a principal factor in limiting the establishment of woody tree species and maintaining grassland and other open alvar communities (Figure 3; Stephenson and Herendeen 1986, Reschke 1995). The shallow soils limit rooting depth, making them prone to summer drought. Hard summer droughts can result in a die-back of woody plants that do not have their roots in moist bedrock cracks, along with an increased diversity of annual alvar plants the following year (Stephenson and Herendeen 1986).

Fires: Natural fires appear always to have been at least an incidental part of alvar history, and probably instrumental in maintaining some alvar types, such as juniper alvar shrubland. It is estimated that fire return intervals range from 200-500 years in the Great Lakes basin (Jones and Reschke 2005). From the alvars with old trees and no burn evidence, it is clear that not all alvars require fire to remain in an open state, although it may be beneficial for some sites such as Stone Road Alvar on Pelee Island (Reschke et al. 1999). A post-fire successional alvar shrubland that replaced semi-open white cedar woodland adjacent to open alvar near Ottawa had twice as many species present, including many that were regionally rare (Catling 2009). Persistence of invertebrate fauna may depend on local patchiness of burnt areas.

Grazing: Alvars in the Great Lakes basin and elsewhere have long been influenced by grazing livestock. While this influence has been little studied in North America, the effects of grazing have been documented on alvar habitats of the Swedish island of Oland, where grazing by domestic animals has occurred since the first centuries A.D. (Titlyanova et al. 1988). The intensity of grazing appears to be a critical factor in maintaining open conditions. A comparison of ungrazed, moderately grazed, and overgrazed sites showed decreased biomass and floristic changes in the overgrazed area, with perennial and annual ruderal (quick-germinating, disturbed soil specialists) species replacing the dominant alvar grassland species (Brownell (1998). The Alvar Working Group suggested that cattle grazing is generally detrimental to alvar communities, but some light grazing may help to keep alvar areas open. Also, as the intensity of grazing increases, diversity of native species decreases and the number of exotics increases (Reschke et al. 1999).

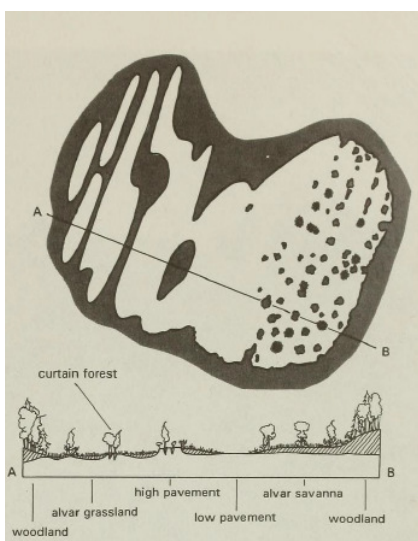

Figure S15. 3. Key hydrological and substrate processes shape the alvar found on the relatively flat, fractured limestone with thin soils, as shown from the diagrammatic cross-section of an alvar complex. Types include alvar grassland, alvar pavements, and alvar savanna, and adjacent limestone woodland (from Catling and Brownell 1995). Used with permission from Canadian Field Naturalist and the authors.

Threatening processes

Across their Great Lakes range, alvar habitats face a daunting series of threats to their future survival and quality. For example, The NatureServe protection urgency rankings for multiple-value alvar sites places 56% of the sites with high or very high securement urgency, and 53% with high or very high management urgency (Reschke et al. 1999, Table 10). Although the nature and extent of these threats tend to be site-specific and constantly changing, a number of common factors emerge:

Quarrying: The loss of alvar habitats to quarries (for easily accessible limestone with no overburden) has taken place across the Great Lakes basin and continues to be a primary threat in many places.

Residential and related development: The construction of rural residences, cottages and second homes, trailer parks, and other forms of low-density rural development is an ongoing threat to many alvar habitats, especially shoreline alvars. A diverse mix of other rural developments can be located on alvar habitats.

All-terrain vehicle and off-road vehicle use: Recreational users of all-terrain vehicles, trail bikes, and off-road trucks are attracted to some alvar areas because of their flat open terrain and remoteness. The rutting caused by these vehicles disrupts local hydrological patterns, creates conditions suitable for the invasion by exotic species and visually scars the alvar surface. Snowmobiles are also used on many alvar sites, but their impact appears to be substantially less, or at least less documented.

Grazing and browsing: Many grassland alvars have been grazed by cattle for decades. The degree of threat posed by grazing to alvar quality is the subject of ongoing research. While intensive grazing appears to be associated with the loss of some alvar species and an increased presence of exotic species, light grazing helps to maintain the open character of some alvars. For some alvar-related fauna such as loggerhead shrike (*Lanius ludovicianus migrans*), grazing to maintain short grass conditions appears to be an essential habitat requirement for nesting. Deer browsing is also an important factor in most Great Lakes alvar sites. High deer densities, possibly due to loss of top predators, may be preventing successful regeneration of some alvar species, but the longer-term effects are uncertain at this stage.

Exotic species: Virtually all Great Lakes alvars include a diverse mix of exotic species in their flora and fauna, but the extent and trends of non-native species populations vary widely. Aggressive species which are problematic include buckthorn (*Rhamnus cathartica*), common St. John's wort (*Hypericum perforatum*), rough-fruited cinquefoil (*Potentilla recta*), Dog-strangling Vine (*Cynanchum rossicum*) and many others. Canada blue grass (*Poa compressa*), which is considered by most experts to be an introduced species, is also well established on many alvar sites. These exotic species compete for space and nutrients with native species and, in some cases, become dominant, significantly reducing the ecological value of alvar communities.

Plant collecting: The extent of plant collecting on alvars by hobbyists is unknown, but the removal of stunted old-growth cedars and other trees by bonsai collectors is a serious management problem on the Bruce Peninsula. Other showy wildflowers of alvars, such as dwarf lake iris (*Iris lacustris*) and several orchid species, are also at risk from collectors or from careless photographers who trample surrounding vegetation.

Logging and forestry: Logging of mature trees from alvar savannas and adjacent woodlands can disrupt the landscape integrity of alvar sites. In some instances, the flat open areas provided by alvars have been used as log assembly areas or skidways, resulting in serious damage to shallow soils and vegetation communities from rutting and accumulation of bark and other debris. A related issue is the inappropriate planting of alvar sites with trees designed to provide a future commercial crop.

Ecosystem collapse

For assessment of criteria A and B, collapse was assumed to occur when the mapped distribution of the ecosystem declines to zero, signalling the replacement of alvar by developed areas (e.g. quarries, rural-residential development and roads). For criterion C, ecosystem collapse was defined based on degree of mechanical disturbance to the soil substrate. Collapse was assumed to occur between 50 and 90% of the alvar surface was severely degraded, as basic abiotic states and processes are sufficiently damaged to make them unrestorable. Severely degraded processes include trampling, creation of berms, or removal of rocks and/or soil (Reschke et al. 1999). Under criterion D, the abundance of invasive species is the most appropriate biotic variable for assessment, as these species alter the native biotic composition. Collapse was assumed to occur when the abundance of exotic species exceeds between 50 and 90%, a sufficiently high level of exotics such that restoration of natural processes could not successfully recover a typical set of alvar species and interactions, and when > 90% of the surrounding landscape was intensive agriculture, commercial or residential development (Reschke et al. 1999).

ASSESSMENT

Summary

Criterion	A	B	C	D	E	overall
subcriterion 1	DD	LC	DD	VU(NT- VU)	DD	EN(VU-EN)
subcriterion 2	DD	VU(NT-VU)	DD	DD		
subcriterion 3	EN(VU-EN)	LC	DD	DD		

Criterion A

Current decline: The Great Lakes Alvar has experienced a wide range of threats (see Threatening Processes above). Based on the combination of these threats, the distribution of the ecosystem is likely to have declined by > 30% over the past 50 years. But the data are insufficient to document this trend, so the status of the ecosystem is therefore Data Deficient under criterion A1.

Future decline: The future persistence of Great Lakes Alvar is affected by a wide range of threats (see Threatening Processes above). Based on the combination of these threats, the distribution of the ecosystem is likely to decline by > 30% over the next 50 years. But the data are insufficient to document this trend, so the status of the ecosystem is therefore Data Deficient under criterion A2

Historic decline: In 1999, alvars were estimated to cover approximately 11,200 ha (112 km^2) of reasonable quality (NatureServe integrity ranks A–C) across the entire Great Lakes Basin (Reschke et al. 1999), and, combined with more recent survey work in Ontario, that total is now closer to 130 km^2 of reasonable quality alvar, with Ontario containing almost 100 km^2, and 30 km^2 is found in Michigan, Ohio and New York. Considerable areas of alvar that have been substantially degraded by agricultural and other uses are excluded from these estimates.

There is little data to estimate changes in alvar since 1750. We have two sources. First, Catling and Brownell (1995) estimate that the extent of alvar in southern Ontario prior to settlement was 1100 to 1500 km^2, including both open alvar and limestone woodland, but they provided no clear distributional boundaries. A substantial portion of the original extent has been lost. In 1999, alvars were estimated to cover approximately 11,200 ha (112 km^2) of reasonable quality (NatureServe integrity ranks A –C) across the entire Great Lakes Basin (Reschke et al. 1999). We can develop approximate estimates for the upper bound of historic loss across Ontario as follows: we assume that the remaining areas of degraded habitat are roughly comparable to that of reasonable quality (i.e. 100 km^2 from above), giving a total of 200 km^2, and we choose the lower estimate of historic extent (1100 km^2), which gives a decline in distribution since 1750 of 82%. Second, we also estimated loss within one township (Carden) within the Carden Plains region, based on reconstruction of presettlement maps from early surveys and current extent (Bakowsky unpublished). We determined that the current extent of alvar is 1335 ha = 13.35 km^2 and the presettlement estimates total 35 km^2, giving values of 38% still remaining, or 62% loss since settlement. Assuming that changes to alvar distribution in Carden and Ontario are indicative of a range-wide decline of 62 - 82%, and given that Ontario accounts for the majority of the distribution, the status of the ecosystem is Endangered (plausible range Vulnerable to Endangered) under criterion A3.

Criterion B

In 1999, alvars were documented to cover approximately 11,200 ha (112 km^2) of reasonable quality (integrity ranks A – C) across the entire Great Lakes Basin (Reschke et al. 1999). More recent surveys suggest the total is closer to 13,000 ha (130 km^2), see “Criterion A: Historic decline” above.

Extent of occurrence: A minimum convex polygon enclosing all mapped occurrences of Great Lakes alvar (Figure 4) has an area of 153,000 km^2 based on moderately conservative criteria for its distribution and over 295,000 km^2 if outliners are included. The status of the ecosystem is therefore Least Concern under criteria B1.

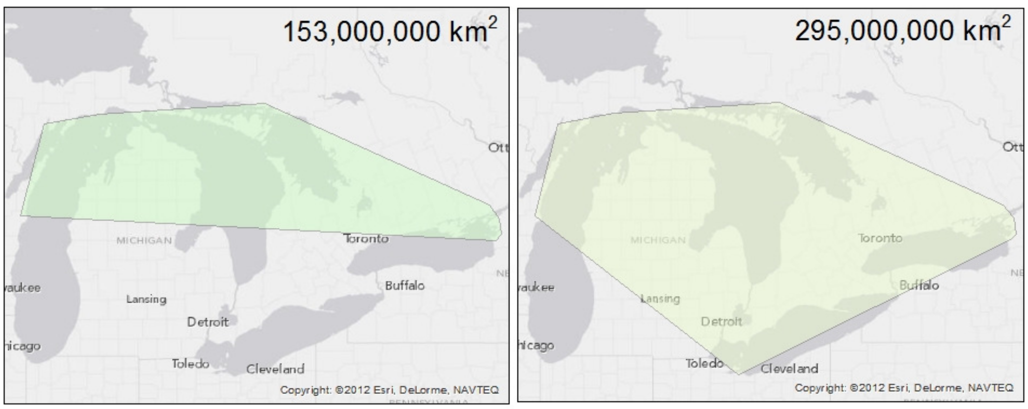

Figure S15. 4. Mapped distribution of Great Lakes Open Alvar showing minimum convex polygon enclosing all occurrences (Extent of occurrence). Compare with Figure 2 above.

Area of occurrence: Confirmed occurrences of Great Lakes Alvar (Fig. S15. 2) occupy at least 37 10 × 10 km grid cells, but there is some uncertainty in this estimate and there could be as many as 60 occupied cells. The Great Lakes Alvar ecosystem meets subcriterion B2b because of continued disruption by exotic plants and continued degradation from quarrying, low density rural development, such as cottages and second homes, and off-road vehicles that disrupt the natural water flow patterns and create ideal conditions for invasions by exotic species (See Threatening Processes above). With respect to criterion B2c, there are well over 10 locations. The status of the ecosystem is therefore Vulnerable (plausible range Near Threatened to Vulnerable) under criteria B2b.

Number of locations: Based on the widespread distribution of Great Lakes Alvar throughout the Great Lakes Basin, there are far more than 5 locations present, and likely at least 37 because of the localised nature of threats. The status of the ecosystem is therefore Least Concern under criteria B3.

Criterion C

The principal mechanism of environmental degradation is through continued degradation from quarrying, low density rural development, such as cottages and second homes, and off-road vehicles that disrupt the natural water flow patterns and create ideal conditions for invasions by exotic species. Above, we assumed that collapse would occur between 50 and 90% of the alvar surface was severely degraded by these processes. But current methods of evaluation typically give emphasis to the biotic response of alvars to these threats and there are insufficient data on the status of alvar soils across their range. Thus we have insufficient data to independently evaluate this criterion. The status of the ecosystem is Data Deficient under criteria C1, C2 and C3.

Criterion D

Ongoing disruption of ecosystem function is caused by continued degradation from quarrying, low density rural development, such as cottages and second homes, and off-road vehicles that disrupt the natural water flow patterns and create ideal conditions for invasions by exotic plant species. Our strongest data are for exotics, which have been obtained in surveys focussed on the high quality Alvar remnants (NatureServe integrity ranks A and B), which account for a minority of Alvar occurrences. Estimates from Reschke et al. (1999) show that the median cover of exotics by alvar type, in the higher quality stands, varied from 0.1 to 20%, and the maximum cover value varied from 5% to 75%. Based on historical development of the region, we assumed that the increase in cover of exotic plants occurred primarily during the past 50 years. Given a collapse threshold of 50-90% exotic cover, the relative severity of decline in some of the higher quality stands could be as low as 0.1% (0.1/90) or as high as 100% (75/75). The median exotic cover values for more degraded remnants of the higher quality Alvar types suggest a functional decline with relative severity of up to 40% (20/50) during the 50-year period.

As noted previously, data are unavailable for lower quality stands, which currently precludes a formal calculation of the relative severity of functional decline across the entire ecosystem. Nonetheless, we inferred that Alvars underwent a functional decline over the past 50 years with a relative severity of at least 30% over at least 80% of the ecosystem extent based on the following:

i) cover of exotics in an appreciable portion of higher quality stands had reached 20% by 1998, corresponding to functional decline with a relative severity of up to 40%;
ii) higher quality stands (ranked A or B) account for a minority of Alvar distribution;
iii) lower quality stands (ranked C or lower), which make up the majority of Alvar distribution, are likely to have suffered higher levels of invasion than high-quality stands (ranked A or B); and
iv) cover of exotic plants has continued to increase since 1998, and hence estimates based on the survey data are likely to further under-estimate the severity of functional decline.

Given the uncertainty about the severity of invasion in low-quality stands, estimates of severity and extent just below 30% and 80%, respectively, are plausible. The status of the ecosystem was therefore assessed as Vulnerable (plausible range Near Threatened - Vulnerable) under criteria D1b.

Criterion E

No quantitative analysis has been carried out to assess the risk of ecosystem collapse for Great Lakes Alvar. The status of the ecosystem is therefore Data Deficient under criterion E.

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