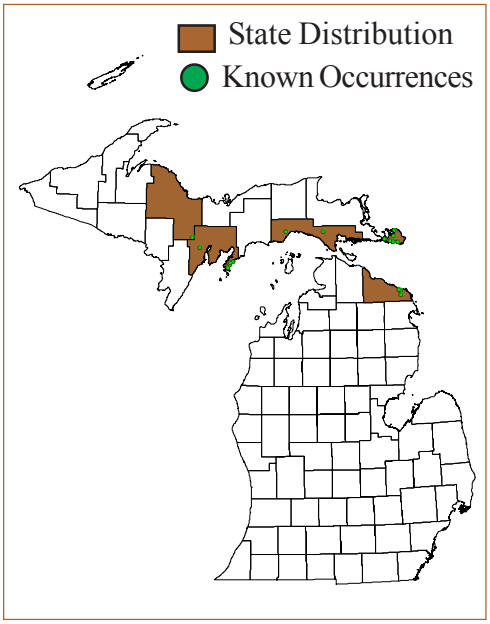
Alvar Community Abstract

Photo by Patrick Comer



Overview: Alvar (alvar grassland) is a grass- and sedge-dominated community, with scattered shrubs and sometimes trees. Alvar occurs on broad, flat expanses of calcareous limestone or dolomite (dolostone) bedrock covered by a thin veneer of mineral soil, often less than 25 cm deep. Alvars are only known from three areas of the world: the Basaltic region of northern Europe, County Clare of northwest Ireland, and the Great Lakes region south of the Canadian shield.

Global and State Rank: G2?/S1

Range: Alvar is a biologically distinct geological feature associated with Silurian, Ordovician, and Devonian limestone and dolomite bedrock occurring along the Niagaran escarpment and cuestra of the Laurentian Great Lakes and other large inland lakes, as well as in Scandinavia and Estonia (Krahulec et al. 1986, Bengtsson et al. 1988), and Ireland (D'Arcy and Hayward 1997). Alvars along the Laurentian Great Lakes are distinguished from other alvars by a distinctive Great Lakes flora and fauna (Catling and Brownell 1995, 1999). Great Lakes alvars occur in Michigan (Lee et al. 1998), New York (Reschke 1990), Ohio, Wisconsin (Judziewicz 2001), and the Canadian province of Ontario (Brownell and Riley 2000). In Michigan, alvar occurs in the Upper Peninsula near the shorelines of Lake Huron and Lake Michigan, in a band from Drummond Island to Cedarville, west to Seul Choix Point on the Garden Peninsula. Alvar also occurs further west and inland along the Escanaba River. In the Lower Peninsula, alvars occur on Thunder Bay Island and along the Lake Huron shoreline near Rogers City, Alpena, and Thompson's Harbor.

Rank Justification: The international alvar project documented approximately 11,200 hectares (27,675 acres) of alvar habitat of reasonable quality across the Great Lakes basin (Reschke et al. 1999). Much of this habitat has been substantially degraded by agriculture and other forms of human land use. There are approximately 760 hectares (1,880 acres) of alvar at five sites near Michigan's Great Lakes shoreline, including areas on Lakes Michigan and Huron (Lee et al. 1998). There are over 70 alvar sites in Ontario on Manitoulin Island and the Bruce Peninsula of Lake Huron and Georgian Bay and the Lake Erie Islands of Lake Erie (Brownell and Riley 2000). In addition, there are four Ohio alvar sites, ten New York sites, and one Wisconsin site (Reschke et al. 1999). A similar plant community in Illinois is excluded because of greater affinity to tall-grass prairie.

Physiographic Context: In Michigan, alvars are commonly found near northern Great Lakes shores where flat bedrock pavement associated with the Niagaran Escarpment is exposed (Albert et al. 1997a, 1997b). The bedrock of the Niagaran Series is Silurian-age limestone and dolostone formed from marine reefs that were common in shallow portions of the Michigan Basin (Ehlers 1973); all sites on the northern shore of Lake Michigan, including the Escanaba River and Garden Peninsula alvars, are of Silurian age. This formation typically dips gently (average 1% slope)

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toward the south into the Michigan Basin. Ordovician-age limestone and dolomite also support these plant communities on northern Drummond Island, while Devonian-age limestone occurs in Presque Isle and Alpena counties in Lower Michigan. Being formed from marine organisms, these rocks are rich in calcium carbonates. Resistance to erosion is variable; limestone and dolostone are readily dissolved by rain water, producing solution cracks or grykes that often connect to the underlying groundwater system. In contrast, argillaceous limestone rich in sand, silt, or clay from terrestrial sources is more resistant to solution and typically contains few broad cracks. Alvars are located within sub-subsections VII.6.3, VIII.1.1, and VIII.1.3 of the Regional Landscape Ecosystems as delineated by Albert (1995), where proximity to the Great Lakes results in moderated climate and high precipitation.

Photo by Ted Cline

Alvar within Sub-subsection VIII.1.3 occurs along the Escanaba River. In this aerial photograph, the joint patterns of the limestone can be easily seen. Vegetation establishes first in the joints and then spreads gradually across the bedrock.

Alvar is characterized by shallow soil over bedrock, with soil depth usually less than 25 cm. Soil texture is primarily loamy sand or sandy loam. Soil is saturated, or locally inundated in the spring, but it becomes droughty later in the summer. Thin layers of organic soil may develop in shallow depressions that remain wet for longer periods. The soils and substrate are neutral to slightly alkaline (pH 6.7-8.0) (Kost et al. 2007).

Low ridges of limestone or dolomite cobble, typically 1-2 m high, commonly occur on the alvar. These ridges are remnants from an earlier post-glacial period, when the inland alvar sites were inundated by higher Great Lakes lake levels. At that time, cobble ridges were deposited by ice scour and major storm events.

Photo by Patrick Comer

On alvar with better drainage conditions and thicker soils, shrubs and dwarfed trees become more common, grading into limestone bedrock glade (alvar glade).

Surrounding the alvar, where deeper soils developed upon the limestone, there are forests or alvar glades (also known as limestone bedrock glades) of *Thuja occidentalis* (northern white-cedar), *Picea glauca* (white spruce), *Abies balsamea* (balsam fir), and *Betula papyrifera* (paper birch). Lower portions of the landscape can be flooded by beaver dams, creating wetlands dominated by *Fraxinus nigra* (black ash) and many other wetland shrubs and herbs. More seasonally flooded wetlands adjacent to alvar grassland are typically dominated by northern white-cedar.

Natural Processes: The presence of bedrock at or near the surface results in seasonal flooding from fall through spring, often followed by summer drought in July and August, when seasonal pools dry up and vegetation is under drought stress (Stephenson and Herendeen 1986, Rosen 1995, Reschke et al. 1999). Surface temperatures can reach 43 to 53 degrees C (109 to 127 degrees F) (Gilman 1995, Schaefer and Larson 1997). Glacial scour has created small, shallow depressions in the bedrock, which can flood either seasonally or year round, creating herb-, shrub-, or tree-dominated wetlands within the alvar landscape. Flooding is less prevalent where there are abundant enlarged cracks (grykes) in the rock, which provide improved internal drainage. Grykes form along naturally occurring rock joints as water rich in carbon dioxide forms carbonic acid, which causes high rates of limestone dissolution. The concentration of decomposing vegetation and respiring roots in the rock joints also contributes high levels of carbon dioxide in the rock joints, accelerating the rate of limestone dissolution. Sites with many of these cracks that enhance internal

drainage are more prone to early desiccation and drought. Many of the widest grykes occur under forest cover, probably because of denser rooting and large accumulations of decomposing vegetation.

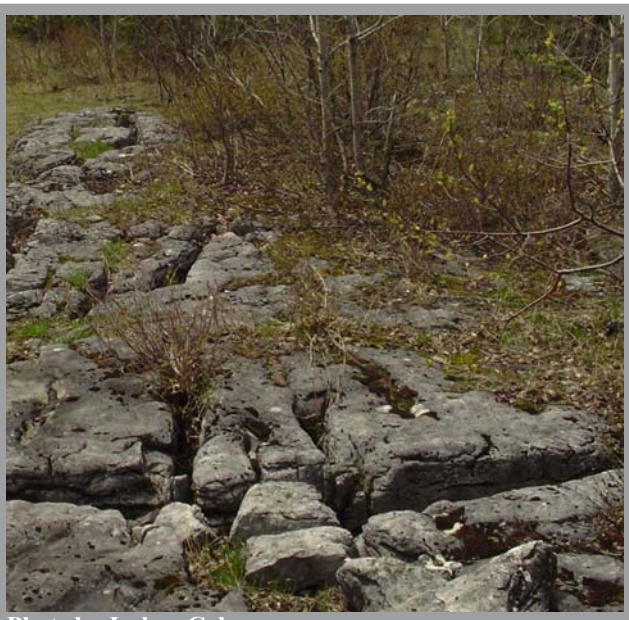

Photo by Joshua Cohen

Carbonic and organic acids from decomposing vegetation and plant respiration accelerate the rate of dissolution in the structural joints of the limestone bedrock, creating broad joints called grykes.

Fire, both natural and human-induced, has been documented for Great Lakes alvars in both the United States and Canada (Catling and Brownell 1998, Jones and Reschke 2005), but the fire regime is believed to be quite variable and fire is not considered important for maintaining biologically diverse alvar (Schaefer and Larson 1997, Reschke et al. 1999). Controlled burns can increase plant diversity (Catlin and Brownell 1998), while wildfires sometimes greatly reduce diversity (Gilman 1997). Grazing by either native or introduced ungulates is important for reducing woody encroachment (Bengtsson et al. 1988, Titlyanova et al. 1988, Rosen 1992, 1995), while lack of grazing can result in cool-season Eurasian grasses replacing native alvar dominants (Reschke et al. 1999). Overgrazing by cattle can result in increased levels of invasive plants, reduced levels of native grasses, and increased amounts of species selectively avoided by cattle, such as *Eleocharis compressa* (flattened spike-rush) and some rosette forming native perennials, including *Ranunculus fascicularis* (early buttercup), *Aster* spp. (asters) and *Solidago* spp. (goldenrods) (Brownell 1998).

Windthrown trees occur on or adjacent to the alvar because of shallow soil, poor drainage, and resultant shallow rooting of plants.

Vegetation Description: Alvars are dominated primarily by grasses and sedges, with mosses and lichens dominant in the driest areas, and scattered shrubs and occasionally trees in areas where the soil depth is greatest or where cracks or grykes provide additional moisture needed by woody vegetation (Reschke et al. 1999). Several different alvar communities are described on the basis of drainage differences, ranging from "tufted hairgrass wet alvar grassland" on the wettest sites to "juniper alvar shrubland" on the driest sites, which never flood (Reschke et al. 1999). Dominant grasses and sedges include *Schizachyrium scoparium* (little bluestem), *Sporobolus heterolepis* (prairie dropseed), and *Carex scirpoidea* (bulrush sedge). Where soil-water availability is greater, *Eleocharis compressa* (flattened spike-rush), *Andropogon gerardii* (big bluestem), *Muhlenbergia richardsonis* (mat muhly), and *Spartina pectinata* (cordgrass) are often dominant.

Photo by Dennis Albert

Shallow water often covers flat, wet alvar into the early growing season, and in some years throughout the entire growing season. This seasonal flooding restricts the growth of trees and shrubs.

Characteristic plants: The following species were present in over 50% of 5 diverse alvar sites from Michigan across Canada to New York. Characteristic grasses included *Agrostis hyemale* (ticklegrass), *Bromus kalmii* (Kalm's brome), *Danthonia spicata* (poverty grass), and *Deschampsia caespitosa* (tufted hairgrass). Sedges include *Carex crawei* (Crawe's sedge), *C. richardsonii* (Richardson's sedge), *C. scirpoidea* (bulrush sedge), and *Eleocharis elliptica* (golden-seeded spike-rush). Herbs included *Antennaria neglecta* (small-leaved pussytoes), *Aquilegia canadensis* (wild columbine), *Arabis hirsuta* (hairy rock

cress), *Arenaria stricta* (rock sandwort), *Campanula rotundifolia* (harebell), *Castilleja coccinea* (Indian paintbrush), *Cerastium arvense* (field chickweed), *Comandra umbellata* (bastard-toadflax), *Lepidium virginicum* (common peppergrass), *Monarda fistulosa* (wild bergamot), *Potentilla arguta* (prairie cinquefoil), *Ranunculus fascicularis* (early buttercup), *Calamintha arkansana* (low calamint), *Senecio pauperculus* (balsam ragwort), and *Solidago nemoralis* (old-field goldenrod). Characteristic shrubs include *Juniperus communis* (common juniper), *Potentilla fruticosa* (shrubby cinquefoil), *Rhus aromatica* (fragrant sumac), *Prunus virginiana* (choke cherry), and *Symphoricarpos albus* (snowberry). Characteristic trees include *Thuja occidentalis* (northern white-cedar), *Picea glauca* (white spruce), *Pinus strobus* (white pine), and *Populus tremuloides* (trembling aspen). Cryptogram diversity (mosses, lichens, and liverworts) is also high on alvar (Marr 1997), but additional comprehensive surveys are needed.

Photo by Dennis Albert

Solution depressions form as rain water gradually dissolves the surface of alvar. Nostoc, an algae, grows in the larger depressions when moisture is available.

Associated Species: Alvar supports many of the same species found on limestone bedrock lakeshores, with additional species, including *Geum triflorum* (prairie smoke) and flattened spike-rush found only at inland sites. Although prairie-like in appearance, alvars are located far northeast of the Prairie Peninsula. About half of the species with constancy above 50% are of northern distribution. Among other high constancy species, about 20% have southeastern distributions, and some species typical of upland prairies are present.

Invasive Plants: Invasive plant species are common at many alvar sites. The frequency of invasives was studied at U.S. and Canadian sites (Reschke et al. 1999), with the following results: *Poa compressa* (Canada bluegrass) at 62% of observation points, *Hypericum perforatum* (St. John's-wort) at 49%, *Potentilla recta* (rough-fruited cinquefoil) at 25%, *Verbascum thapsus* (common mullein) at 24%, *Phleum pratense* (common timothy) at 22%, *Chrysanthemum leucanthemum* (ox-eye daisy) at 17%, *Hieracium piloselloides* (glaucous king devil) at 17%, *Rumex crispus* (curly-leaf dock) at 14%, *Hieracium* spp. (hawkweeds) at 13%, *Daucus carota* (wild carrot) at 11%, *Echium vulgare* (blueweed) at 11%, *Melilotus alba* (white sweet-clover) at 10%, *Poa pratensis* (Kentucky bluegrass) at 9%, and *Rhamnus cathartica* (buckthorn) at 9%. St. John's-wort and common mullein appear to most significantly alter the composition and structure of the alvar because of their density or size.

Michigan Indicator Species: *Schizachyrium scoparium* (little bluestem), *Eleocharis compressa* (flattened spike-rush), *Danthonia spicata* (poverty grass), *Deschampsia caespitosa* (hair grass), *Carex crawei* (Crawe's sedge), *Eleocharis elliptica* (golden-seeded spike-rush), *Campanula rotundifolia* (harebell), *Castilleja coccinea* (Indian paintbrush), *Calamintha arkansana* (low calamint), *Senecio pauperculus* (balsam ragwort), *Solidago nemoralis* (old-field goldenrod), *Juniperus communis* (common juniper), *Juniperus horizontalis* (creeping juniper), *Potentilla fruticosa* (shrubby cinquefoil), *Symphoricarpos albus* (snowberry), *Thuja occidentalis* (northern white-cedar), *Picea glauca* (white spruce), and *Populus tremuloides* (trembling aspen).

Other Noteworthy Species: Rare animals associated with alvar in Michigan include *Lanius ludovicianus migrans* (loggerhead shrike, state special concern), *Sistrurus catenatus catenatus* (eastern massasauga rattlesnake, state special concern), and several land snails (*Vertigo elatior*, *V. ventricosa*, *V. morsei*, *V. hubrichtii*, and *Catinella exile*, all state special concern species). Rare prairie insects include an undescribed species of *Aceratagallia*, *Prosapia ignipectus* (red-legged spittlebug, state special concern) and *Flexamia delongi* (leafhopper, state special concern). A number of rare butterflies have been recorded, including *Phyciodes batesii* (tawny crescent,

state special concern) and *Pyrgus wyandot* (grizzled skipper, state special concern).

Rare plants found in alvar include *Allium schoenoprasum* var. *sibiricum* (wild chives, state threatened), *Asplenium trichomanes-ramosum* (green spleenwort, state threatened), *Astragalus neglectus* (Cooper's milk vetch, state special concern), *Calypso bulbosa* (calypso, state threatened), *Carex concinna* (beauty sedge, state special concern), *C. richardsonii* (Richardson's sedge, state special concern), *C. scirpoidea* (bulrush sedge, state threatened), *Cirsium hillii* (Hill's thistle, state special concern), *Cypripedium arietinum* (ram's head lady's-slipper, state special concern), *Danthonia intermedia* (oatgrass, state special concern), *Eleocharis compressa* (flattened spike-rush, state threatened), *Geum triflorum* (prairie smoke, state threatened), *Gymnocarpium robertianum* (limestone oak fern, state threatened), *Hymenoxys herbacea* (lakeside daisy, state endangered), *Iris lacustris* (dwarf lake iris, state threatened), *Muhlenbergia richardsonis* (mat muhly, state threatened), *Pinguicula vulgaris* (butterwort, state special concern), *Piperia unalascensis* (Alaska orchid, state special concern), *Poa alpina* (alpine bluegrass, state threatened), *Scutellaria parvula* (small skullcap, state threatened), *Solidago houghtonii* (Houghton's goldenrod, state threatened), *Sporobolus heterolepis* (prairie dropseed, state special concern), and *Viola novae-angliae* (New England violet, state threatened).

Photo by Dennis Albert

Many alvars are dominated by the state-threatened grass, *Sporobolus heterolepis* (prairie dropseed). In addition, groves of stunted trembling aspen are common within alvar grassland.

Beaver flood long, narrow depressions in the bedrock plain, providing the conditions for the establishment of *Fraxinus nigra* (black ash) swamps. Many species of ant are found living in diverse niches in the bedrock landscape. Black bears are attracted to feed on the ants and other insects.

Conservation and Biodiversity Management: Principal threats to alvar are over-grazing, alteration of hydrology with road construction and off-road vehicle use, construction of summer residences within the open grassland, and quarry development (Reschke et al. 1999). All of these result in the introduction or spread of invasive, non-native plant species. Private and commercial off-road vehicle use has become a major threat to the alvars on Drummond Island in recent years. Control of invasive species by herbicide or mechanical removal will probably be successful only in combination with correction of hydrologic alterations to the site. Either prescribed burning or forest harvest may become necessary where hydrologic alterations have resulted in increased tree growth, but these should be evaluated with carefully designed monitoring of faunal and floristic response. Dumping of waste materials and recreational construction of stone cairns are other forms of alvar degradation.

1978 Infra-red Aerial Photograph of Maxton Plains

Patches of alvar grasslands (light green) are surrounded by upland or swamp forests (reddish brown), which have thicker soils. Roads (white) connect the patches of alvar, altering the hydrology and introducing many weedy plant species. Conservation of alvars depends on limiting further road development and off-road vehicle impacts, restoring hydrologic regimes, and controlling non-native invasives.

Research Needs: Additional characterization of non-vascular plants and insects is needed as well as further research into the effects of residential and road development, forest management, ungulate herbivory (domestic and wild), and fire (natural and prescribed) on the function of alvar.

Similar Communities: In Michigan: limestone bedrock lakeshore (Comer et al. 1997), limestone bedrock glade (formerly alvar glade), limestone cliff, limestone lakeshore cliff, limestone cobble shore, boreal forest, rich conifer swamp. Limestone bedrock lakeshore differs from alvar due to its location along the Great Lakes shoreline, where its vegetation is strongly influenced by storm waves and ice scour. Limestone bedrock glade supports scattered, stunted trees, as well as a well-developed shrub layer. Elsewhere in U.S.: Ozark dolomite glade, Southeastern U.S. cedar glade (Baskin and Baskin 1985, 1999; Quarterman et al. 1993), Central limestone glade, common juniper alvar woodland. Additional plant communities identified by an international alvar working group (Reschke et al. 1999) include alvar shrubland, little bluestem alvar grassland, tuft hairgrass wet alvar grassland, poverty grass dry alvar grassland, river edge limestone pavement, and alvar nonvascular pavement.

Other classifications:

Michigan Natural Features Inventory (MNFI) Circa 1800 Vegetation: Exposed bedrock (74)

Michigan Department of Natural Resources (MDNR): K-rock

Michigan Resource Information Systems (MIRIS): 74 (exposed rock)

National Wetland Inventory (NWI): none.

The Nature Conservancy National Vegetation Classification (Faber-Langendoen 2001, NatureServe 2006): CODE; ALLIANCE; ASSOCIATION; COMMON NAME

III.A.3.N.a; *Juniperus communis* - (*Juniperus virginiana*) - *Rhus aromatica* - *Viburnum rafinesquianum* / *Oligoneuron album* Shrubland Alliance; Common Juniper - (Eastern Red-cedar) - Fragrant Sumac - Downy Arrow-wood / Prairie Goldenrod Shrubland; Juniper Alvar Shrubland

III.A.3.N.a; *Picea glauca* - *Thuja occidentalis* - *Juniperus communis* / *Iris lacustris* - *Carex eburnea* Shrubland; White Spruce - Northern White-cedar - Common Juniper / Dwarf Lake Iris - Bristleleaf Sedge Shrubland; Scrub Conifer / Dwarf Lake Iris Alvar Shrubland

IV.A.1.N.b; *Juniperus horizontalis* - *Dasiphora fruticosa* ssp. *floribunda* / *Schizachyrium scoparium* - *Carex richardsonii* Dwarf-shrubland; Creeping Juniper - Shrubby-cinquefoil / Little Bluestem - Richardson's Sedge Dwarf-shrubland; Creeping Juniper - Shrubby-cinquefoil Alvar Pavement

V.A.5.N.c; *Sporobolus heterolepis* - *Schizachyrium scoparium* - (*Carex scirpoidea*) / (*Juniperus horizontalis*) Herbaceous Vegetation; Prairie Dropseed - Little Bluestem - (Scirpus-like Sedge) / (Creeping Juniper) Herbaceous Vegetation; Little Bluestem Alvar Grassland

V.A.5.N.c; *Deschampsia caespitosa* - (*Sporobolus heterolepis*, *Schizachyrium scoparium*) - *Carex crawei* - *Packera paupercula* Herbaceous Vegetation; Tufted Hairgrass - (Prairie Dropseed, Little Bluestem) - Crawe's Sedge - Balsam Ragwort Herbaceous Vegetation; Tufted Hairgrass Wet Alvar Grassland

V.A.5.N.e; *Danthonia spicata* - *Poa compressa* - (*Schizachyrium scoparium*) Herbaceous Vegetation; Poverty Grass - Canada Bluegrass - (Little Bluestem) Herbaceous Vegetation; Poverty Grass Dry Alvar Grassland

VII.A.2.N.a; *Spartina pectinata* - *Muhlenbergia richardsonis* - *Sporobolus heterolepis* - *Oligoneuron album* - *Euthamia graminifolia* Herbaceous Vegetation; Prairie Cordgrass - Mat Muhly - Prairie Dropseed - Prairie Goldenrod - Flat-top Goldentop Herbaceous Vegetation; River Ledge Limestone Pavement

VII.A.2.N.a; *Tortella tortuosa* - *Cladonia pocillum* - *Placynthium* spp. Sparse Vegetation; Twisted Moss - Cup Lichen - Crustose Lichen Species Sparse Vegetation; Alvar Nonvascular Pavement

Related abstracts: wild chives, Cooper's milk vetch, calypso, pale Indian-plantain, Richardson's sedge, Hill's thistle, ram's-head lady's-slipper, prairie smoke, lakeside daisy, dwarf lake iris, Alaskan orchid, Houghton's goldenrod, northern dropseed, red-legged spittlebug, loggerhead shrike, eastern massasauga rattlesnake, limestone bedrock lakeshore, limestone bedrock glade, limestone cobble shore.

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Photo by Gary Reese

Alvar occurring as a thin band along the Escanaba River.

Abstract citation:

Albert, D.A. 2006. Natural community abstract for alvar. Michigan Natural Features Inventory, Lansing, MI. 8 pp.

Updated January 2008.

Funding for abstract provided by Michigan Department of Natural Resources' Forest, Minerals, and Fire Management Division and Wildlife Division.

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