14660

Great Lakes Wooded Dune and Swale

BpS Model/Description Version: Aug. 2020

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| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
| Dennis Albert | albertd@michigan.gov | Dave Cleland | dcleland@fs.fed.us |
| Becky Schillo | schillor@michigan.gov | None | None |
| None | None | None | None |

Vegetation Type

Mixed Upland and Wetland

Map Zones

50, 51

Geographic Range

Great Lakes Wooded Dune and Swale complexes are found along the Great Lakes in Ontario, MI, WI, IL, IN, OH and PA. Of the 90 to 95 wooded dune and swale complexes that occurred in the Great Lakes Region, 70 were located in MI along the shores of Huron, MI, and Superior (Comer and Albert 1993). In MI wooded dune and swales are be found in subsections 212 S (all subsections; Cleland et al. 2007), 212 R (all subsections), 212 Hl, 212 Hf, 212 Hb, 212 Hj, 212 Hg, 222 Ue and 222 Ud.

For MN, this BpS occurred in Subsection 212Lb.

Biophysical Site Description

This complex of wetland swales and upland beach ridges (dunes) is found in embayments and on large sand spits along the shoreline of the Great Lakes. Many complexes began forming when the Great Lakes were at glacial Lake Algonquin levels, approximately 12,000yrs ago (Comer and Albert 1993, Dorr and Eschman 1970), but in the southern Great Lakes, some of the large complexes are younger, approximately 6,000yrs old (Chrzastowski and Thompson 1992, Thompson 1992). Receding lake levels deposited a series of sandy beach ridges ranging from 0.5-40.0m high. From the air, these ridges appear as a series of arcs generally parallel to the shoreline, and often extending up to two miles inland. The dune ridges can be quite numerous, with 150 ridges forming over 6,000yrs near Gary, Indiana (Thompson 1992) and 108 ridges forming over 3,500yrs in northern lower MI (Lichter 1998). [Text from Albert, D.A. and P.J. Comer 1999.]

Vegetation Description

Because they contain a unique assemblage of physiographic, soil and vegetative components and provide a high quality habitat for numerous shoreline animal species, the Wooded Dune and Swale Complex is considered a distinct natural community in MI (MNFI 1990). Classic ecological studies have identified distinctive successional zones within the sand dune portion of the complexes, determined on the basis of several factors, including distance from the lake, amount of soil development and available light (Olson 1958, Cowles 1899).

The foredunes of most dune and swale complexes are commonly 1-2m high, with beach grass (*Ammophila breviligulata*), dune grass (*Calamovilfa longifolia*), autumn willow (*Salix serissima*), dune willow (*S. cordata*), and balsam poplar (*Populus balsamifera*) most common. Within their ranges, federally-threatened Pitcher's thistle (*Cirsium pitcheri*) and state-threatened Lake Huron tansy (*Tanacetum huronense*) are also found on the foredunes.

Immediately behind the foredune, where lake-influenced, calcareous sands are most common, a shallow swale often contains twig-rush (*Cladium mariscoides*), sweet gale (*Myrica gale*), shrubby cinquefoil (*Potentilla fruticosa*), blue joint grass (*Calamagrostis canadensis*), Kalm's lobelia (*Lobelia kalmii*), false asphodel (*Tofieldia glutinosa*), and grass-of-Parnassus (*Parnassia glauca*). Less commonly, in the Straits of Mackinac area, federally threatened Houghton's goldenrod (*Solidago houghtonii*) is found in the swales behind the foredune.

The swale immediately behind the foredune is influenced by short-term variation in lake levels and can be partially or occasionally completely filled by dune sands following major storm events. Species common to this first swale include the rushes (*Juncus balticus*, *J. pelocarpus*, J*. Nodosus*), spike rush, (*Eleocharis acicularis*), and threesquare (*Scirpus americanus*).

A low dune field with more advanced plant succession often follows the first open dunes and swales. Jack pine (*Pinus banksiana*), white pine (*P. strobus*), and red pine (*P. Resinosa*) often form a scattered overstory canopy, while ground juniper (*Juniperus communis*), creeping juniper (*J. Horizontalis*), bearberry (*Arctostaphylos uva-ursi*), beach grass and June grass (*Koeleria macrantha*) form a scattered ground layer.

Following the dune-field zone, both dunes and swales are typically forested. Moist swales are often forested and soil organic material has often begun to accumulate. Northern white cedar (*Thuja occidentalis*), speckled alder (*Alnus rugosa*), willows (*Salix* spp.) and red maple (*Acer rubrum*) dominate the partial overstory canopy and understory. In northern Lake Michigan and Lake Huron, where these swales are better drained and northern white cedar forms the overstory, federally-threatened dwarf lake iris (*Iris lacustris*) may be found in large non-flowering populations. In contrast to the dry or moist swales, in those swales where standing water is present through most of the year, sedges (*Carex aquatilis*) and (*C. stricta*), twigrush, marsh marigold (*Caltha palustris*), swamp candles (*Lysimachia terrestris*), and swamp cinquefoil (*Potentilla palustris*) commonly dominate the ground layer.

Forested beach ridges, with soils of medium to course sand, tend to be dominated by species common to dry-mesic and mesic northern forest (MNFI 1990). Soil moisture conditions appear to change dramatically with slight elevational changes and are reflected in the development of soil organic material and changing plant species. On higher, drier ridges, soils often have less than three cm of organic material. Red pine, white pine and red oak (*Quercus rubra*) are often co-dominant, while paper birch (*Betula papyrifera*), bigtooth aspen (*Populus grandidentata*), balsam fir (*Abies balsamea*), and red maple are sub-dominant or understory species. Bracken fern (*Pteridium aquilinum*), black huckleberry (*Gaylussacia baccata*), blueberry (*Vaccinium myrtilloides*), bunchberry (*Cornus canadensis*), and wintergreen (*Gaultheria procumbens*) occur in the shrub and ground layers.

On lower ridges, where soils are moister, soil organic material accumulation is greater. White pine may still dominate the overstory, but often white spruce, black spruce, red maple, balsam fir, northern white cedar and occasionally tamarack (*Larix laricina*) are co-dominant. Canada honeysuckle (*Lonicera canadensis*), mountain holly (*Nemopanthus mucronatus*), twinflower (*Linnaea borealis*), dwarf blackberry (*Rubus pubescens*), Canada mayflower (*Maianthemum canadensis*) and starflower (*Trientalis borealis*) are common in the shrub and ground layers.

Complexes located in embayments protected from prevailing winds tend to be formed entirely of low, water-lain beach ridges. As a result, even the beach ridges within these complexes support wetland vegetation. An example is Ogontz Bay, in the eastern Upper Peninsula of MI. Here swales ranged from 1-30m wide and 0.5-30.0m deep.

Narrow, shallow swales are forested with northern white cedar, black spruce and red maple, with speckled alder and willows in the understory and shrub layers and sedges (*Carex disperma*), (C*. trisperma*), (*C. leptalea*), (*C. interior*), (*C. cryptolepis*), (*C. flava*), (*C. intumescens*), blue joint grass, fowl manna grass (*Glyceria striata*), water horehound (*Lycopus uniflorus*), and sphagnum mosses (*Sphagnum* spp.) in the ground layer.

Wider, deeper swales are more often unforested, with chokeberry (*Aronia prunifolia*), red osier dogwood (*Cornus stolonifera*), bog birch (*Betula pumila*), and speckled alder forming a shrubby ecotone, while sedges (*Carex lasiocarpa*), (*C. oligosperma*), (*C. aquatilis*), (*C. stricta*), and woolgrass (*Scirpus cyperinus*) form a mat within which marsh fern (*Thelypteris palustris*) and horned bladderwort (*Utricularia cornuta*) also occur. Where a sedge mat is not well developed, bur-reed (*Sparganium minimum*), pond-lily (*Nuphar variegata*), and pondweeds (*Potamogeton berchtoldii* and *P. natans*) are commonly found.

Organic material gradually accumulates in the swales over time; organic material in swales reaches a depth of 30-75cm within 300m of the lake's edge. Vegetation in

swales reflects the more acid conditions of the older thickets as peat accumulations. Leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), Labrador tea (*Ledum groenlandicum*), bog laurel (*Kalmia polifolia*), large cranberry (*Vaccinium macrocarpon*), cottongrass (*Eriophorum virginicum*), pitcher-plant (*Sarracenia purpurea*), Sphagnum mosses (*Sphagnum centrale*, *S. wulfianum*, *S. warnstorfii*, *S. Magellanicum*, and *S. squarrosum*) are commonly found in the thick peat soils of the swale behind the shoreline. An even stronger pattern of increased organic matter accumulation occurs farther north along Lake Superior. For example, at Grand Traverse Bay in Keweenaw County, very low beach ridges and swales have thick accumulation of acid organic matter, with bog-like vegetation in the first swale of the shoreline. [Text from Albert, D.A. and P.J. Comer 1999.]

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| AMBR | *Ammophila breviligulata* | American beachgrass |
| CALO | *Calamovilfa longifolia* | Prairie sandreed |
| JUNCU | *Juncus* | Rush |
| PIBA2 | *Pinus banksiana* | Jack pine |
| PIRE | *Pinus resinosa* | Red pine |
| PIST | *Pinus strobus* | Eastern white pine |
| THOC2 | *Thuja occidentalis* | Arborvitae |
| ELAC | *Eleocharis acicularis* | Needle spikerush |

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

Natural processes: These complexes are best developed where streams provide a dependable sand source. The combination of along-shore currents, waves, and wind form foredunes along the shoreline. With gradual long-term drops in water level, combined with post-glacial uplifting of the earth's crust, these low dunes gradually rise above the direct influence of the lakes, and new foredunes replace them. Over several thousand years (far beyond the scope of this model), a series of ridges and swales is created. For most complexes, the flow of surface streams and groundwater maintain the wet conditions in the swales. Along the Lake Superior shoreline, where post-glacial uplift is greatest, many of the complexes consist primarily of dry, forested swales. The number and size of the dune ridges and swales differs depending on fetch and the amount of sediment available. (Comer and Albert 1993)

Lichter's (1998) recent study of dune and swale complexes at Wilderness State Park in northern Lower Michigan has identified similar successional trends. He found that, at the Lake Michigan shoreline, young dunes had 1) stronger winds, 2) more sand burial and erosion, 3) higher levels of sunlight, 4) higher rates of evaporation and 5) lower available nitrogen and phosphorus than older beach ridges farther inland, resulting in an open herbaceous-dominated plant community along the shore. Farther inland, with greater protection from sun and wind and with greater soil development, there was succession from open dune, first to grassland, then to shrubs, and finally to forests, with mesic northern hardwoods increasing in dominance on beach ridges farther from the shoreline.

Both swales and upland dune ridges were studied by MNFI (Comer and Albert 1991, 1993). Of the 17 sites where elevations were measured from the shoreline inland, only three sites contained swales where the sandy bottoms of all or most of the swales lay below the current Great Lakes water levels. This suggests that, except for a few examples, the influence of Great Lakes water-level fluctuations is probably limited to the first few swales inland from the shoreline. For most of the complexes, the water occupying the swales comes from streams flowing from the adjacent uplands or from groundwater seepage. [Text from Albert, D.A. and P.J. Comer 1999.]

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 3655 | 13 |  |  |
| Moderate (Mixed) | 531 | 87 |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 463 | 100 |  |  |

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

This system is truly a complex of natural communities that occur in a repeated pattern on landscapes influences by the Great Lakes. The complex is a large-patch system comprised of linear arc-shaped communities that parallel the Great Lakes shoreline.

Adjacency or Identification Concerns

Many wooded dune and swale complexes have been destroyed, degraded and fragmented by anthropogenic disturbances. Protecting hydrology is important in the maintenance of vegetative structure in wooded dune and swale complexes. Road development across the swales, even with culverts, typically modifies the hydrology. Marinas, typically requiring dredging and other major modification of the wetlands, have been constructed in some complexes. Golf courses have also been built on complexes and unsuccessfully proposed for others. Intensive use as deer yards has greatly altered the wetlands in the Upper Peninsula, where regeneration of northern white cedar has been eliminated or greatly reduced. In some deer yarding areas, conversion of the ridges to aspen has also been proposed. Residential development has resulted in major alteration of several dune and swale complexes, due to several factors, including road and driveway construction, wetland filling and septic leakage. Nutrient addition from leaking septic tanks and drain fields is suspected of contributing to the dominance of invasives such as *Typha angustifolia* (narrowleaved cat-tail), giant bulrush and purple loosestrife. [Text from Albert, D.A. and P.J. Comer 1999.]

Issues or Problems

This model represents a complex of spatially explicit natural communities that occur in a repeatable pattern along the Great Lakes. Although some natural processes such as hydrology, plant succession and wind action influence the entire complex, each community is also controlled by processes such as insects, disease and possibly fire. These internal dynamics may set a community back to an earlier seral stage of specific community but not send it to a different class of the model. For example a drought or fire may kill a percentage of pine or oak trees on an inland dune ridge, setting the dry forest to a mid-seral stage, but given the topography of the complex it would not convert the dry dune ridge into a swale.

Additionally in the time-span of the LANDFIRE model (1,000yrs) it is not possible to model the long-term processes that created these complexes, the gradual long-term decline in glacial lake water levels and post-glacial uplift. Also the fluctuation of glacial lake levels and post-glacial uplift were stochastic climatic events, making it difficult to guess when or if they may occur again.

Essentially, the classes as modeled represent two parallel pathways - one for dune and one for swale - on a time scale beyond the 1,000yr time frame of the model. Therefore each class is set to range in age between 0-999yrs.

Native Uncharacteristic Conditions

Comments

Succession Classes

**Mapping Rules**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Upper Layer Lifeform** | **Height (m)** | **Canopy Cover (%)** | | | | | | | | | |
| **0-10** | **11-20** | **21-30** | **31-40** | **41 - 50** | **51-60** | **61-70** | **71-80** | **81-90** | **91-100** |
| Herb | 0-0.5 | A | A | A | A | A | A | B | B | B | B |
| Herb | 0.5-1.0 | A | A | A | A | A | A | B | B | B | B |
| Herb | >1.0 | A | A | A | A | A | A | B | B | B | B |
| Shrub | 0-0.5 | D | D | D | D | D | D | D | D | D | D |
| Shrub | 0.5-1.0 | D | D | D | D | D | D | D | D | D | D |
| Shrub | 1.0-3.0 | D | D | D | D | D | D | D | D | D | D |
| Shrub | >3.0 | D | D | D | D | D | D | D | D | D | D |
| Tree | 0-5 | D | D | D | D | D | D | D | D | D | D |
| Tree | 5-10 | D | D | D | D | D | D | D | D | D | D |
| Tree | 10-25 | C | C | C | C | C | C | C | C | C | C |
| Tree | 25-50 | C | C | C | C | C | C | C | C | C | C |
| Tree | >50 | C | C | C | C | C | C | C | C | C | C |

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

**Description**

Class A 23 Early Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| AMBR | Ammophila breviligulata | American beachgrass | Lower |
| CALO | Calamovilfa longifolia | Prairie sandreed | Lower |
| POBA2 | Populus balsamifera | Balsam poplar | Upper |
| SALIX | Salix | Willow | Middle |

Description

Early seral dune: On the landscape, this class would be located closest to the lake but since the model is aspatial, it is characterized here by its vegetation rather than its spatial location. This class may also be referred to a an open dune/foredune. It is influenced by along-shore currents, waves, wind and fluctuating Great Lakes water levels. The dominant lifeform would be the herbaceous layer of *Calamovilfa longifolia* and *Ammophila brevilgulata*. Given that these are foredunes subject to shifting sands and blowouts large portions may non- to sparsely vegetated.

Foredunes are typically 1-2m high and dominated by beach grass (*Ammophila breviligulata*), dune grass (*Calamovilfa longifolia*), Autumn willow (*Salix serissima*), dune willow (*Salix cordata*) and balsam poplar (*Populus balsamifera*). Rare plants such as Lake Huron tansy (*Tanacetum huronense*) and Pitcher's thistle (*Cirsium pitcheri*).

*Maximum Tree Size Class*  
None

Class B 23 Early Development 2 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| JUNCU | Juncus | Rush | Lower |
| ELAC | Eleocharis acicularis | Needle spikerush | Lower |
| SCAM6 | Schoenoplectus americanus | Chairmaker's bulrush | Lower |
| CLMA | Cladium mariscoides | Smooth sawgrass | Lower |

Description

Early seral swale: On the landscape, this class would be located between the foredune and nearshore dunes closest to the lake but since the model is aspatial, it is characterized here by its vegetation rather than its spatial location. This class may also be referred to a an interdunal wetland, shore fen, or herbaceous wetland. This zone would be influenced by short-term fluctuations in Great Lakes water levels.

Common species include rushes (*Juncus balticus*, *J. pelocarpus*, *J. nodosus*), spike rush (*Eleocharis acicularis*), threesquare (*Scripus americanus*), twig-rush (*Cladium mariscoides*), sweet gale (*Myrica gale*), shrubby cinquefoil (*Potentilla fruticosa*), blue-joint grass (*Calamagrostis canadensis*), and Kalm's lobelia (*Lobelia kalmii*).

*Maximum Tree Size Class*  
None

Class C 27 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIBA2 | Pinus banksiana | Jack pine | Upper |
| JUCO6 | Juniperus communis | Common juniper | Low-Mid |
| PTAQ | Pteridium aquilinum | Western brackenfern | Lower |
| PIRE | Pinus resinosa | Red pine | Upper |

Description

Low dune field and mid/late seral forested dune: On the landscape this class would be located inland of the first series of dunes and swales. This class is characterized by more advanced plant succession. A replacement fire could convert this forested system to an open dune. A mixed fire would maintain the system in this class.

In the low dune field common species include: Jack pine (*Pinus banksiana*), white pine (*P. strobus*), and red pine (*P. resinosa*) often forming a scattered overstory canopy, while ground juniper (*Juniperus communis*), creeping juniper (*J. horizontalis*), bear berry (*Arctostaphylos uva-ursi*), beach grass, and June grass (*Koeleria macrantha*) form a scattered ground layer. The mid/late seral forested dunes with soils of medium to course sand, tend to be dominated by species common to dry-mesic and mesic northern forest (MNFI 1990). Soil moisture conditions appear to change dramatically with slight elevational changes and are reflected in the development of soil organic material and changing plant species. On higher, drier ridges, soils often have less than three cm of organic material. Red pine, white pine and red oak (*Quercus rubra*) are often co-dominant, while paper birch (*Betula papyrifera*), bigtooth aspen (*Populus grandidentata*), balsam fir (*Abies balsamea*), and red maple are sub-dominant or understory species. Bracken fern (*Pteridium aquilinum*), black huckleberry (*Gaylussacia baccata*), blueberry (*Vaccinium myrtilloides*), bunchberry (*Cornus canadensis*), and wintergreen (*Gaultheria procumbens*) occur in the shrub and ground layers.

*Maximum Tree Size Class*  
Very Large >33" DBH

Class D 27 Late Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| THOC2 | Thuja occidentalis | Arborvitae | Upper |
| ACRU | Acer rubrum | Red maple | Lower |
| ALINR | Alnus incana ssp. rugosa | Speckled alder | Upper |
| CAREX | Carex | Sedge | Mid-Upper |

Description

Mid/late seral swale: This class may range from shrub dominated to forested swales.

A major hydrologic change, such as increased precipitation leading to higher ground water levels or flooding may kill trees and shrubs, converting this class to an open wetland swale.

Forested systems occur in dry or moist swales and are dominated by northern white cedar (*Thuja occidentalis*), speckled alder (*Alnus rugosa*), willows (*Salix* spp.), and red maple (*Acer rubrum*). In swales with standing water present through most of the year, sedges (*Carex aquatilis*) and (*C. stricta*), twigrush, marsh marigold (*Caltha palustris*), swamp candles (*Lysimachia terrestris*) and swamp cinquefoil (*Potentilla palustris*) commonly dominate the ground layer.

*Maximum Tree Size Class*  
Large 21-33" DBH

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:OPN | 0 | Late1:CLS | 200 |
| Early2:OPN | 1 | Late2:CLS | 200 |
| Late1:CLS | 201 | Late1:CLS | 999 |
| Late2:CLS | 201 | Late2:CLS | 999 |

Probabilistic Transitions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Disturbance Type** | **Disturbance occurs In** | **Moves vegetation to** | **Disturbance Probability** | **Return Interval (yrs)** | **Reset Age to New Class Start Age After Disturbance?** | **Years Since Last Disturbance** |
| Optional 1 | Early1:OPN | Early2:OPN | 0.002 | 500 | Yes | 0 |
| Wind or Weather or Stress | Early1:OPN | Early2:OPN | 0.01 | 100 | Yes | 0 |
| Optional 2 | Early2:OPN | Early1:OPN | 0.002 | 500 | Yes | 0 |
| Wind or Weather or Stress | Early2:OPN | Early1:OPN | 0.01 | 100 | Yes | 0 |
| Replacement Fire | Late1:CLS | Early1:OPN | 0.001 | 1000 | Yes | 0 |
| Mixed Fire | Late1:CLS | Late1:CLS | 0.007 | 143 | No | 0 |
| Wind or Weather or Stress | Late2:CLS | Early2:OPN | 0.001 | 1000 | Yes | 0 |

Optional Disturbances

Optional 1: short-term increase in Great Lakes water levels

Optional 2: short-term decrease in Great Lakes water levels

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