USDA Natural Resources Conservation Service

Ecological site R097XA001MI
Beach And Foredune

Last updated: 1/16/2024
Accessed: 05/06/2024

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 097X–Southwestern Michigan Fruit and Vegetable Crop Belt

Physiography consists of sandy lake plains and dunes along the western side adjacent to Lake Michigan, and moderately sloping fine-loamy moraine from the Lake Michigan lobe of the Wisconsin Ice Sheet.

Vegetation is mostly mesophytic forests of central and northern hardwood and conifer species with prairie and oak savanna to the south. Compared to inland locations, cold sensitive hardwood species extend further north due to milder winters, and conifers extend further south due to cooler summers, heavier snowfall, and sandier soils. Lake effect snow and delayed spring warm up dampen the fire frequency relative to similar inland sites, except along the south side of Lake Michigan. The northern extent is defined by a major floristic boundary where several central hardwoods species drop out. The southern boundary is defined by fine-loamy moraines with predominantly prairie vegetation.

The ecological site inference area for MLRA 97 is subdivided along a floristic/climatic break roughly from New Buffalo, Michigan to Portage, Indiana. This corresponds to the heaviest lake effect snow belt (>160 cm) south and east of this line and is associated lower historic fire frequencies. The snow belt portion “A”, has more frequent conifer and beech, while the less snowy portion “B” has more prairie and savanna elements. Although differing in precise boundary location, both USFS and EPA ecoregions support a climatic/floristic break at the next higher rank in their respective hierarchies.

Classification relationships

Among the USFS ecoregional framework (Cleland et al., 2007), most of MLRA 97 is represented by the Humid Temperate Domain (200), Hot Continental Division (220), Midwest Broadleaf Forest Province (222), South Central Great Lakes Section (222J), subsections 222Ja and 222Jb. MLRA 97 was recently extended northward to be more consistent with the limits of the USFS ecoregions subsections 222Ja and 222Jb, because it is more consistent with vegetation patterns and species distributions. A former portion of MLRA 97 that extended westward from the southern end of Lake Michigan (including most of the city of Chicago) was recently removed from the MLRA due to its predominantly non-sandy deposits and reduced lake effect climate, and would have overlapped USFS ecoregion 222K.

Among the EPA ecoregional framework (Omernik and Griffith, 2014), most of MLRA 97 falls within Eastern Temperate Forests (Level I: 8), Mixed Wood Plains (Level II: 8.1), Southern Michigan/Northern Indiana Drift Plains (Level III: 56), and Level IV: 56d and 56f. Ecoregion 56f continues north beyond MLRA 97. Former portions of MLRA 97 that encompassed the city of Chicago included Level III ecoregion 54, Central Corn Belt Plains, before the last revision of MRLA boundaries.

Ecological site concept

The central concept of the Beach and Foredune is unstable wind and wave worked sands adjacent to Lake Michigan. The site is spatially differentiated based on proximity to the lake, but these are also successionally related based on climatically induced decadal variations in lake levels. Beaches are normally barren closest to the shoreline due to daily wave action, but can be colonized by the annual sea rocket on the upper (storm) beach, which is normally affected only by the storms waves in fall and winter seasons. The foredunes are either actively moving from windblown sand, or are partially stabilized by beach grass (*Ammophila breviligulata*). Various other species may colonize the dunes are either common to sandy disturbed sites inland or are specialists that are endemic to the Great Lakes or other lake and sea coasts. Further inland, dunes may become stabilized by vegetation for long enough for forest vegetation to develop, but in many cases these are on larger dunes that have formed thousands of years before during higher lake stages.

Associated sites

F097XA002MI	**Backdune**
F097XB003IN	**Chicago Backdune**

Similar sites

F097XA002MI	**Backdune**
F097XB003IN	**Chicago Backdune**

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Ammophila breviligulata* (2) *Cakile edentula*

Physiographic features

Beaches and and active dunes along a Great Lake.

Table 2. Representative physiographic features

Landforms	(1) Beach (2) Dune

Runoff class	Negligible to medium
Flooding duration	Extremely brief (0.1 to 4 hours) to very long (more than 30 days)
Flooding frequency	None to very frequent
Elevation	176–226 m
Slope	0–100%
Water table depth	0 cm
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The southeastern Lake Michigan lake plain and adjacent lake influenced moraines have a humid warm continental climate with cold winters and warm summers. About half to two thirds of the precipitation is distributed during the warmer half of the year with a significant portion of the precipitation occurring as heavy downpours during thunderstorms. Thunderstorm activity is enhanced inland by lake breeze fronts, while it is diminished near the lakeshore by the stabilizing effect of the cooler lake waters. Occasionally, thunderstorm microbursts cause localized high winds which open single tree gaps in forest canopies, or more rarely, tornados and derechos (severe straight-line winds) open larger gaps. Fall storms bring more frequent strong winds, but with impacts moderated by the lack of leaves (wind resistance) in the canopy. During July, average precipitation lags potential evapotranspiration, resulting in droughty conditions in the upper soil horizons of upland sites. During dry years, this droughty period is extended into August and September, resulting in dry fuels and potential for wildfire over oak and pine dominated areas.

Winter precipitation is enhanced by lake effect snows, with 1.6 to 2.4 m (40-95 inches) falling annually within the snow belt. Peak snowfall occurs at intermediate distances from the lake where topography enhances uplift. The combination of heavier winter snowfall, lake-delayed spring warm up, and frequent wetlands all contribute to relatively lower fire frequencies relative to inland locations with similarly droughty soils.

The area falls within USDA Hardiness zones 6a and 6b and has delayed spring warm up until after the last killing frosts, allowing for a wide range of fruit crops to be grown. There are 140-175 frost free (0°C) days and 165-200 freeze free (-2°C) days in the growing season.

Table 3. Representative climatic features

Frost-free period (characteristic range)	123-149 days
Freeze-free period (characteristic range)	156-197 days
Precipitation total (characteristic range)	864-965 mm
Frost-free period (actual range)	118-177 days
Freeze-free period (actual range)	151-202 days
Precipitation total (actual range)	838-991 mm
Frost-free period (average)	142 days
Freeze-free period (average)	177 days
Precipitation total (average)	914 mm

Climate stations used

- (1) CHICAGO UNIV [USW00014892], Chicago, IL
- (2) BENTON HARBOR AP [USW00094871], Benton Harbor, MI
- (3) HOLLAND WTP [USC00203858], Holland, MI
- (4) MUSKEGON CO AP [USW00014840], Muskegon, MI
- (5) INDIANA DUNES NATL LKS [USC00124244], Chesterton, IN
- (6) GRAND HAVEN FIRE DEPT [USC00203290], Grand Haven, MI

Influencing water features

Adjacent to large freshwater lake, sometime subject to storm wave flooding. Water table is tied to lake level and is near the surface in protected swale phases.

Soil features

Soils are excessively drained to poorly drained actively moving sands. They are commonly classified as Typic Udipsamments, and commonly mapped as Lake beaches, Beaches, and Dune land series.

Table 4. Representative soil features

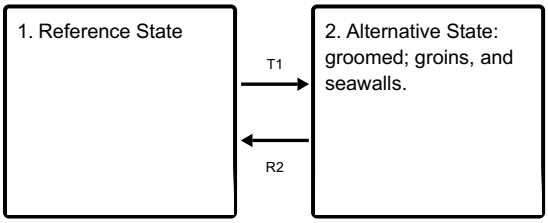
Parent material	(1) Beach sand (2) Eolian sands
Surface texture	(1) Sand
Drainage class	Subaqueous to excessively drained
Permeability class	Moderately rapid to rapid
Soil depth	201 cm
Surface fragment cover <=3"	0–1%
Surface fragment cover >3"	0%
Available water capacity (0-100.1cm)	3.99–10.01 cm
Soil reaction (1:1 water) (0-50cm)	4.5–6
Subsurface fragment volume <=3" (0-150.1cm)	0–1%
Subsurface fragment volume >3" (0-150.1cm)	0–1%

Ecological dynamics

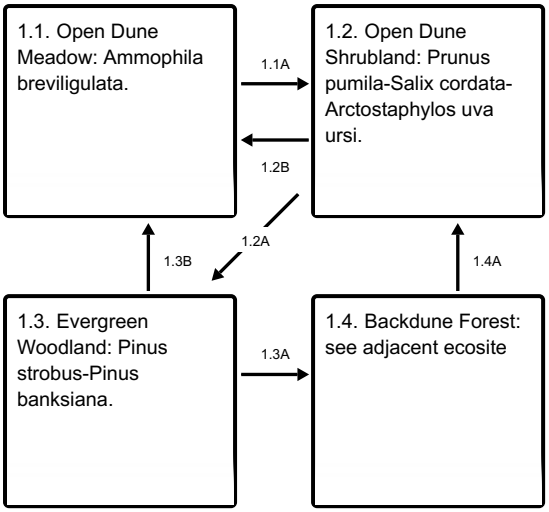
Fire was infrequent, allowing succession to fire sensitive species. Beach erosion and shifting sand limits the time a given vegetation can persist and precludes forest development. Beach grass is an important dune stabilizer. Sand abrasion and exposure to hot sand are important stressors affecting species composition.

State and transition model

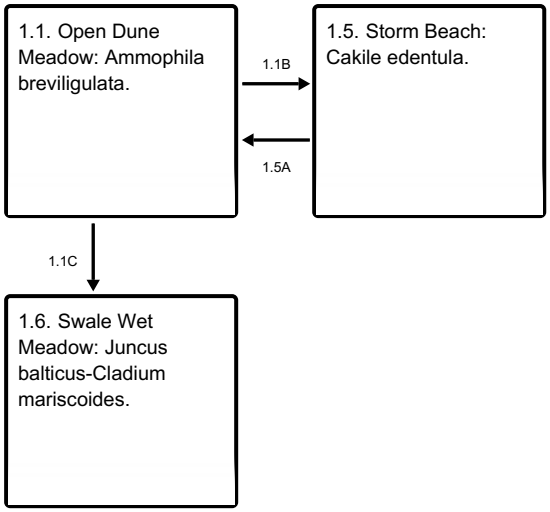
Ecosystem states

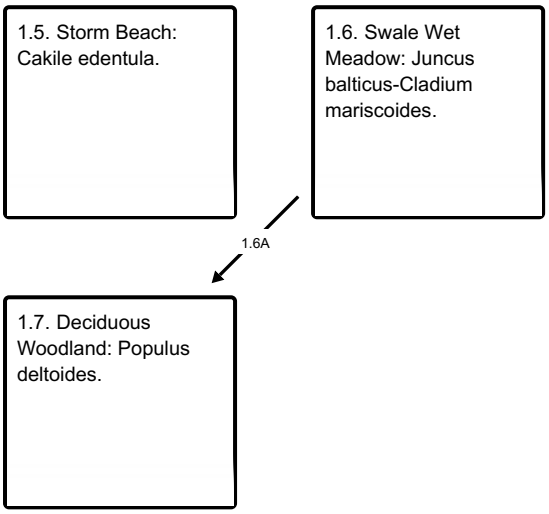


State 1 submodel, plant communities

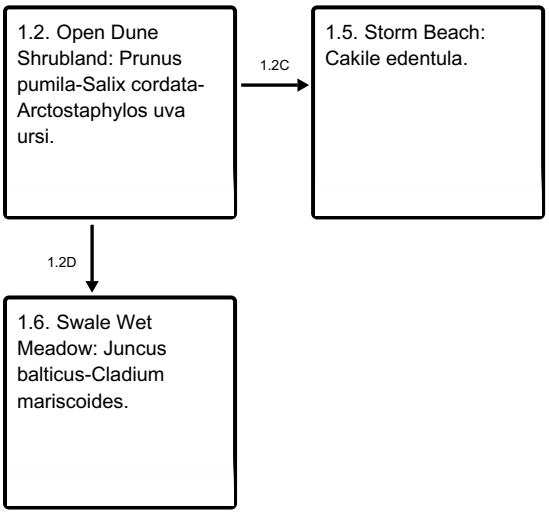


Communities 1, 5 and 6 (additional pathways)

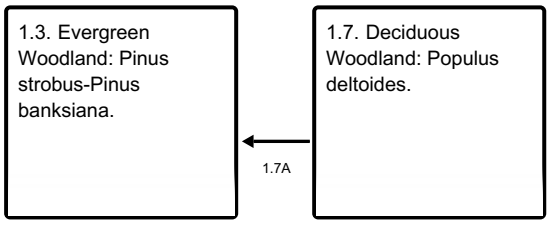




Communities 2, 5 and 6 (additional pathways)



Communities 3 and 7 (additional pathways)



State 1
Reference State

The Reference State consists of barren shoreline, drifting dunes, and patchy grassland.

Dominant plant species

- American beachgrass (*Ammophila breviligulata*), grass
- American searocket (*Cakile edentula*), other herbaceous

Community 1.1
Open Dune Meadow: Ammophila breviligulata.

Community 1.2
Open Dune Shrubland: Prunus pumila-Salix cordata-Arctostaphylos uva ursi.

Community 1.3
Evergreen Woodland: Pinus strobus-Pinus banksiana.

Community 1.4
Backdune Forest: see adjacent ecosite

Community 1.5
Storm Beach: Cakile edentula.

Community 1.6
Swale Wet Meadow: Juncus balticus-Cladium mariscoides.

Community 1.7
Deciduous Woodland: Populus deltoides.

Pathway 1.1A
Community 1.1 to 1.2

Stabilization, shrub establishment.

Pathway 1.1B
Community 1.1 to 1.5

Beach erosion.

Pathway 1.1C
Community 1.1 to 1.6

Blowout to the water table.

Pathway 1.2B
Community 1.2 to 1.1

Blowout to the water table.

Pathway 1.2A
Community 1.2 to 1.3

Succession.

Pathway 1.2C
Community 1.2 to 1.5

Beach erosion.

Pathway 1.2D
Community 1.2 to 1.6

Blowout to the water table.

Pathway 1.3B
Community 1.3 to 1.1

Blowout or burial (or fire) removing woody vegetation.

Pathway 1.3A
Community 1.3 to 1.4

Long-term lake level drop, new foredune formation, succession.

Pathway 1.4A
Community 1.4 to 1.2

Long-term lake level increase with massive beach erosion, or clearcut with subsequent dune rejuvenation.

Pathway 1.5A
Community 1.5 to 1.1

Longshore sand accumulation plus foredune development.

Pathway 1.6A
Community 1.6 to 1.7

Succession.

Pathway 1.7A
Community 1.7 to 1.3

Burial and succession.

State 2
Alternative State: groomed; groins, and seawalls.

The natural flow of sand along shore is interrupted by groins and seawalls, dunes are kept smoothed out by bulldozers, or dredged sand is used to replenish an eroding beach.

Transition T1
State 1 to 2

Dune leveling or construction of shoreline structure which stop the flow of sand.

Restoration pathway R2
State 2 to 1

Dunegrass reestablishment, plus foredune redevelopment. Invasive species may need to be treated or removed.

Conservation practices

Brush Management
Tree/Shrub Establishment
Restoration and Management of Rare and Declining Habitats
Upland Wildlife Habitat Management
Early Successional Habitat Development/Management
Herbaceous Weed Control

Additional community tables

Inventory data references

Site Development and Testing Plan
Future work is needed, as described in a future project plan, to validate the information presented in this provisional ecological site description. Future work includes field sampling, data collection and analysis by qualified vegetation ecologists and soil scientists. As warranted, annual reviews of the project plan can be conducted by the Ecological Site Technical Team. A final field review, peer review, quality control, and quality assurance reviews of the ESD are necessary to approve a final document.

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Contributors

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Approval

Nels Barrett, 1/16/2024

Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	05/06/2024
Approved by	Nels Barrett
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial**

distribution on infiltration and runoff:

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
