USDA Natural Resources Conservation Service

Ecological site R096XY001MI
Coastal Dune Complex

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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): 096X–Northwestern Michigan Fruit Belt

This area is dominated by outwash plains and moraines. Lake plains, till plains, drumlins, and sand dunes are found locally across the area. The terrain is steep on stream carved moraines, ice contact ridges, and sand dunes, and flat on outwash plains and lake plains. Elevation ranges from 177 to 369 m (580 to 1210 ft). Local topographic relief averages 11 m (35 ft) in the south to 20 m (65 ft) in the north and ranges up to a maximum of 158 m (520 ft) at Empire Bluff (Sleeping Bear Dunes). Much of the area rises sharply from the lakeshore to the adjoining hilltops. The Manistee River is the longest river in this area. Its trout fishery is maintained by constant inflow of cool ground water from the porous sand dominated landscape. The Pine and Pere Marquette Rivers also occur in this MLRA. Surficial topography are formed of glacial deposits except for local areas with dune building near Lake Michigan. Most of the bedrock surface is at or below the elevation of Lake Michigan, and is exposed in only in limited extents near Charlevoix. The bedrock, all Paleozoic in age, is the Traverse Group and the Dundee Limestone. These Silurian-Devonian rocks are mostly limestone and dolomite with some interbedded shale, chert, and anhydrite stringers. The drumlin belts in the northern portion of the area is the most affected by the limestone nearer to the surface in terms of carbonates in the till.

About two-thirds of this area is in small, privately owned holdings, and one-third consists mostly of State forests. The forests are used mainly for timber production and recreation. The growth of orchard crops and other crops and dairy and beef operations are important enterprises in the area. Forage and feed grains for dairy and other livestock

are the principal crops. Asparagus, wheat, oats, corn, and hay are commonly grown in the area. Orchard products include sweet and tart cherries, apples, plums, and peaches. The Manistee National Forest and Sleeping Bear Dunes National Lakeshore are among the more notable conservation lands in the area. Nordhouse Dunes Wilderness Area is within the Manistee National Forest. Sections of the Pere Marquette, Pine, and Manistee Rivers, and Bear Creek have been designated as National Wild and Scenic Rivers.

Summary of existing land use:
Upland Forest (52%)
Hardwood (38%)
Conifer (11%)
Agricultural (15%)
Swamps and Marshes (13%)
Developed (13%)

Classification relationships

According to the USFS (Bailey) system of ecoregions, the site is located mostly within 212Ha (Oceana Sandy Lake Plains and Dunes), 212Hb (Manistee Sandy Outwash Plain), 212Hd (Grand Traverse Ground Moraine), and 212Hf (Grand Traverse Drumlin Fields) subsections. According to the EPA (Omernik) system of ecoregions, the site is located in 50ag (Newaygo Barrens) and northern 56d (Michigan Lake Plain) level IV ecoregions. This site concept is outside the range of the USFS Ecological Land Type classification and the Kotar system.

Ecological site concept

The central concept of Coastal Dune Complex is sand dunes and beaches adjacent to open Great Lakes (large fetches) subject to frequent strong winds and large surf. Vegetation is usually sparse, consisting of species tolerant of drought and sand abrasion.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Prunus pumila*
Herbaceous	(1) *Ammophila breviligulata* (2) *Cirsium pitcheri*

Physiographic features

Site is formed of sand eroded and re-deposited by shoreline processes (waves and littoral currents) and wind.

Table 2. Representative physiographic features

Landforms	(1) Beach (2) Dune (3) Interdune

Climatic features

Mean annual temperatures are 7.1 to 8.5 °C (45 to 47 °F). The warmest six months average 15.5 to 16.5 °C (60 to 62 °F). Mean July temperatures range from 20.0 to 21.1 °C (68 to 70 °F). Mean January temperatures range from -6.7 to -3.9 °C (20 to 25 °F). The maximum monthly average daily highs are 25.5 to 28.1 °C (78 to 83 °F). The minimum monthly average daily lows are -11.2 to -7.3 °C (12 to 19 °F). Mean annual precipitation ranges from 850 to 920 mm (33 to 36 in). Prevailing winds pick up moisture from the Great Lakes in the form of lake effect rain and snow showers during fall and winter seasons, and in the form of fog during spring and summer. Thunderstorm intensity is reduced by temperature inversions over the lake during the spring and early summer when lake water is cools the air flowing over it. Average 0 °C (32 °F) frost-free season ranges from 108 to 161 days. Average -2 °C (28 °F) freeze-free season is 141 to 194 days increasing in length from north to south and decreasing in length from the lakeshore inward. Mean annual snowfall ranges from 1.6 to 2.5 m (60 to 100 in). Mean annual extreme minimum

temperatures range from -29 to -18.9 °C (-20 to -2 °F), or hardiness zones 4b to 6b.

Table 3. Representative climatic features

Frost-free period (average)	123 days
Freeze-free period (average)	157 days
Precipitation total (average)	889 mm

Climate stations used

- (1) FRANKFORT 2NE [USC00202984], Frankfort, MI
- (2) MONTAGUE 4 NW [USC00205567], Montague, MI
- (3) CHARLEVOIX [USC00201468], Charlevoix, MI
- (4) MANISTEE 3SE [USC00205065], Manistee, MI
- (5) NORTHPORT 2W [USC00206007], Northport, MI
- (6) TRAVERSE CITY CHERRY CPTL AP [USW00014850], Traverse City, MI

Influencing water features

Surface waters of the Great Lakes have the greatest influence on this site, though groundwater seeps may occur inland. See ecological dynamics for details on water level variability.

Soil features

Soils are very poorly drained to well drained sands or gravel. They are commonly classified Spodic Udipsamments, and commonly mapped as Quartzipsamments, Dune land, and Psammaquents series or components. The top 50 cm has a typical pH of 5.9 and is 95% sand and 0.2% organic matter. At depth, pH ranges up to 6, and texture averages 95% sand and 5% clay. Depth to impeded hydraulic conductivity or root restrictive layers averages >200 cm. Depth to carbonates averages >200 cm.

Ecological dynamics

Coastal Dune Complex tends to share the same ecological dynamics as Natureserve/Landfire system, Great Lakes Dune, Northern Great Lakes Interdunal Wetlands, or Great Lakes Dune or Swale. Due to discontinuous fuels, stand replacing fires rarely occurred, while light to moderate intensity fires occurred every 250-1050 years. During the calm periods, the storm beach may provide habitat by water dispersed annual sea rocket (Cakile endentula). The width of the storm beach is determined by exposure to wave action and gradient (5-10% slope) of the beach. Seas are calm for 60% of the late spring and summer along even the most exposed shoreline with waves less than 0.5 m (periods of around 3.6 s). Calm periods are regularly interrupted by storms with waves of 1-2 m (periods 5-6 s). From fall through early spring, exposed shorelines are subject to wave action for 74% of the time, with average wave heights greater than 1 m (period >5 s). Peak storm waves in fall through early spring are typically 2-3.5 m (periods 6-8 s). On top of this, storm surge may add another 0.25 m to the water level. As a result, berms of the storm beach can lie more than 0.5-2 m above lake level and 5-20 m from the waterline. During high water years, the beach becomes steeper and erodes inland. During low water years, more beach is exposed, and sand tends to accrete. Inland from the storm beach, dune grasses like *Ammophila breviligulata* may allow windblown sand to accumulate. Subsequent erosion of sand may create depressions which may reach the water table, allowing for marsh vegetation. The height of the water table is largely controlled by average lake levels. Water levels rise and fall on annual cycles of about a 30 cm, peaking in summer. Average water levels vary more than 1 m over periods of 20 years or more due to trends in basin wide precipitation and evaporation. Maximum range within the last century has been about 2 m.

State and transition model

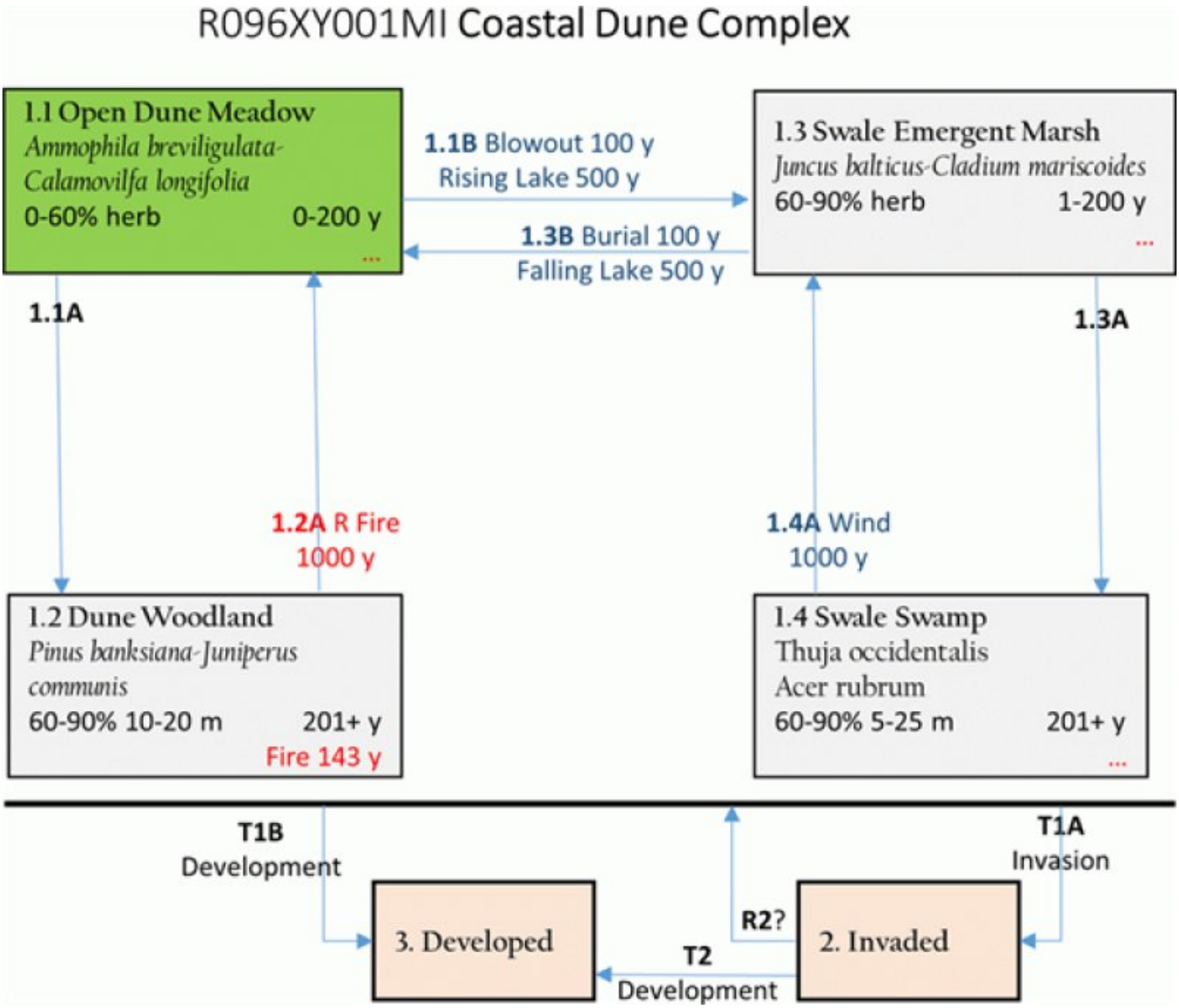
R096XY001MI Coastal Dune Complex
1.1 Open Dune Meadow
Ammophila breviligulata-Calamovilfa longifolia
0-60% herb
0-200 y
...
1.1B Blowout 100 y
Rising Lake 500 y
1.3B Burial 100 y
Falling Lake 500 y
1.3 Swale Emergent Marsh
Juncus balticus-Cladium mariscoides
60-90% herb
1-200 y
...
1.1A
1.3A
1.2A R Fire
1000 y
1.4A Wind
1000 y
1.2 Dune Woodland
Pinus banksiana-Juniperus communis
60-90% 10-20 m
201+ y
Fire 143 y
1.4 Swale Swamp
Thuja occidentalis
Acer rubrum
60-90% 5-25 m
201+ y
...
T1B
Development
T1A
Invasion
3. Developed
R2?
2. Invaded
T2
Development

Figure 6. stm

Legend

1.1A	Succession
1.1B	Wind erosion/blowout forming depression every 100 years or rising lake level or water table every 500 years
1.2A	Replacement fire every 1000 years
1.3A	Succession
1.3B	Windblown sand accumulation/burial or migrating dune every 100 years or falling lake level or water table every 500 years
1.4A	Extreme wind every 1000 years
R2	Restoration?
T1A	Invasive species introduction
T1B	Development of shoreline structures
T2	Development of shoreline structures

Figure 7. Legend

State 1
Reference State

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
Forest

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

Other references

A PROVISIONAL ECOLOGICAL SITE is a conceptual grouping of soil map unit components within a major land resource area (MLRA) based on the similarities in response to management. A provisional ecological site is a first approximation based on a cursory literature review, personal experience, and limited field reconnaissance. As more adequate literature review, expert opinion, and intensive plot data are collected, the site concept is subject to shifting, broadening, narrowing, subdivision, or re-aggregation in definition. Likewise, the community dynamics will be more elaborate in content, and may also change in structure, upon reaching approved status.

Future work, as described in a project plan, to validate the information in this provisional ecological site description is needed. This will include field activities to collect low and medium intensity sampling, soil correlations, and analysis of that data. Annual field reviews should be done by soil scientists and vegetation specialists. A final field review, peer review, quality control, and quality assurance reviews of the ESD will be needed to produce the final document. Annual reviews of the project plan are to be conducted by the Ecological Site Technical Team.

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Contributors

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Approval

Nels Barrett, 10/03/2019

Acknowledgments

The following individuals made substantive comments regarding the development of the Provisional Ecological Sites: Randy Swaty, The Nature Conservancy; Trevor Hobbs, USFS; Richard A. Corner, USFS; Andy Henriksen, NRCS; Dan Zay, NRCS.

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	
Approved by	
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:**

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

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:

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

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

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

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:**

17. **Perennial plant reproductive capability:**