USDA

United States Department of Agriculture

NEON Site-Level Plot Summary
Barrow Environmental Observatory (BARR)

Document Information

Date
March 2019

Author
Dennis Mulligan, Soil Scientist, Wasilla AK

Site Background

The Barrow (BARR) NEON site is near Barrow, Alaska on the Barrow Environmental Observatory. The site is in MLRA 246 -Arctic Coastal Plains and consists of 12,374 acres on the Arctic Coastal Plains with fairly uniform geology. Elevations range from 0 to 12 meters (0 to 40 feet).

Site Information

The Barrow (BARR) site exists on a nearly level coastal plain along the Arctic Ocean with many lakes and wetlands throughout. Most lakes are elongated 'thaw lakes', oriented from north to northwest. Narrow, nearly level flood plains and stream terraces occur along the rivers.
This area was never glaciated, and the current surface is mantled with Quaternary deposits of alluvial, eolian, or glaciofluvial origin.

This site is in the zone of continuous permafrost. Permafrost occurs in all soils. However, very localized taliks, small unfrozen areas in the permafrost, may occur along rivers or near lakes. Periglacial features, such as high and low center ice wedge polygons and frost boils, occur throughout the BARR site.

The vegetation on the site represents a continuum of tundra communities influenced by moisture. On wetter sites, wet sedge, sedge-grass, and sedge-moss meadows are common. On drier sites, dwarf scrub and ericaceous communities are common, including willow sp., birch sp., black crowberry, bog blueberry, and numerous lichen sp.

Analysis of Plots for Sampling

There is no soil survey for this site. No soil series, map unit components, or soil transect data have been established for this site. For this project, a preliminary soil map was created for the area utilizing SPOT5 imagery, available Interferometric Synthetic Aperture Radar (IFSAR) data, the publication "Soils of the Barrow Region, Alaska" (Bockheim et al., 1995), personal observations, and KSSL lab data. Much of this data was not on file at the local NRCS office and was therefore researched and sourced from University of Alaska, Alaska State Division of

USDA is an equal opportunity provider, employer, and lender.

Geologic and Geophysical Surveys and the KSSL data base. For mapping, major soil areas were delineated based on landform and parent material. Soils were further refined based on geomorphic shape, vegetation, and readily identifiable surface features. Some components were assigned primarily on personal experience, soils observed and/or collected from other projects, KSSL sample points, and the Alaska STATSGO. This array of points, however, was not described or collected with the major intent of soil map unit development.

The plots selected for sampling should adequately represent the broad soil mapunits or map unit components established for the Barrow site. Preliminary analysis resulted in 19 plots being selected for sampling, with seven additional plots selected as alternate sampling locations. The 24 plots not chosen for sampling either occurred in non-typical settings or were adequately represented in one of the 19 chosen plots.

Sampled soil map units represent approximately 94 percent of the BARR site:

Map unit symbol	Map Unit Name	% Total site area
ALL	Alluvial landform	7
H&L	Areas with even amounts of high center and low center polygons	8
HCP	Areas dominated by high center polygons	32
LCP	Areas dominated by low center polygons	25
VPD	Very poorly drained soils associated with drained lake beds	22
	Total	**94**

Two miscellaneous map units make up the remaining 6 percent of the BARR site. These map units are of minor extent and do not contain any NEON distributed plots. These map units are:

Map unit symbol	Map Unit Name	% Total site area
W	Water, lakes and ponds	5.9
pits	Gravel pits	0.1
	Total	**6**

Plot Findings

20 pedons were sampled, composed of 19 primary plots and an alternate plot BARR_011. These points represent the six proposed soil map units. The only map units not represented are non-soil, miscellaneous areas. The soil components sampled are Orthels, Turbels and Histels.

Landforms— The Barrow (BARR) site is located on a level coastal plain dotted with lakes and ponds. The lakes tend to be oriented slightly west of north on their long axes. These lakes go through a cycle of formation, migration and drainage. These processes are evidenced by the large number of lake scars with varying degrees of ice wedge formation. Plots BARR_018, 021, 026 and 027 are in recently drained lake beds.

USDA is an equal opportunity provider, employer, and lender.

Ice wedge polygons are caused from contraction and expansion processes in the frozen active layer and near-surface permafrost. Cracks form from the surface through the frozen active layer into the underlying permafrost in winter. Before summer, expansion can close the cracks, melt water migrates into them and freezes. The cycle repeats annually, causing the ice wedges to expand. These expanding, nearly vertical ice wedges form the troughs around the polygons and are joined together in a honeycomb-like pattern. Low center polygons are caused by the displacement of soil material by growing ice wedges, resulting in a raised-edge that encloses the polygon that will typically have a ponded center. Plots BARR_001, 011, 014, 022, 024 and 028 occur in areas dominated by low center polygons.

Water movement along these troughs and warming can cause melting of the ice wedges. This degradation causes subsidence and erosion along troughs and polygon edges, destroying the raised outer rim and resulting in high-center polygons. High-center polygons are driest in the center and wetter around the margins. Plots BARR_004, 005, 012, 037 and 084 occur in areas dominated by high center polygons.

Plots BARR_008, 015, 019, and 085 occur in intermediate areas not dominated by either high or low center polygons.

Narrow floodplains and alluvial terraces occur along streams in the area. Plot BARR_031 occurs on the flood plain of the Mayoeak River.

Parent Material— The arctic coastal plain is mantled by Tertiary and Quaternary age unconsolidated marine, eolian, and lacustrine, and alluvial deposits. The cold, wet environment results in thick deposits of peat. Nearly all the mineral and organic soil materials have been reworked by cryoturbation that results in broken, mixed and generally convoluted soil horizons. All but one of the BARR plots are in this cyclic, very dynamic, parent material. The materials are loamy and silty with very few coarse fragments. Probably the best way to differentiate these soils is age based on time since a lake drained through the various stages of polygon formation. Plots BARR_018, 021, 026 and 027 are in recently drained lake beds and show no or very limited polygon formation. Plots BARR_001, 011, 014, 022, 024 and 028 occur in areas dominated by low center polygons. These plots are relatively young and have active ice wedge formation. Plots BARR_004, 005, 012, 037 and 084 occur in areas dominated by high center polygons. These plots are the oldest and are in the degradation part of the ice wedge polygon cycle. Plots BARR_ 008, 015, 019, and 085 occur in areas of intermediate age and are not dominated by either high or low center polygons.

BARR_031 is formed in alluvial sediments. These sediments are generally very young and distinguished from the other parent materials by their location on a floodplain, the horizontal stratification that has not been affected by cryoturbation.

The main goal at the site was to sample plots representative of the major preliminary map units. To facilitate auger borings, BARR was sampled in the winter, which presented some limiations. One of the major problems was not being able to determine the type of polygon at a location, as

USDA is an equal opportunity provider, employer, and lender.

well as not knowing the location within the polygon; trough, edge or center. Snow-free photos were provided by NEON for 7 of the 19 plots - BARR_001, 008, 012, 015, 026, 084, and 085 - to assist with situating sample pedons on the ideal micromorphological location on the polygons. While some of this can be inferred from the soil profile, an exact comparison of the pedons will be difficult without additional photographic data.

Four plots were selected to represent the very poorly drained (VPD) or drained lake bed map unit. Plots BARR_021, 026, and 027 have been exposed long enough to develop cryoturbation. BARR_026 and 027 have also developed histic epipedons. BARR_018 was young enough to not have cryoturbation or a histic epipedon. The photo provided by NEON for plot BARR_026 shows the site to be very level and ponded with an emergent sedge community.

Six plots were selected to represent the preliminary map unit low-center polygon (LCP). Plots BARR_011 and 024 classify as Terric Hemistels, soils in which organic matter comprises 80 percent or more, by volume, from the soil surface to a depth of 50 cm. Terric indicates there is a mineral layer at least 30 cm thick within the upper 100 cm. Plots BARR_001, 014 and 022 are all Histoturbels. These are soils with a thick organic surface layer depth of 50 cm. They also have cryoturbation. Plot BARR_022 also has a Glacic horizon, which contains a layer 30 cm or more thick and contains 75 percent or more visible ice. Without further information it is difficult to know if this is an ice wedge, vertical, and located in the trough or an ice lens, horizontal, that would be in the interior of the polygon. The photo for plot BARR_001 clearly shows a low center polygon with a raised polygon edge and trough in the background.

Six plots were selected to represent the preliminary map unit dominated by high center polygons (HCP). These sites have noticeably thinner organic horizons. Plots BARR_004, 005, 012, 037 and 085 are Turbels. These are wet soils with cryoturbation. Of these only BARR_017 has a histic epipedon. Plots BARR_004, 037, 084 and 085 have Glacic horizons. For Plot_004 there is not enough information to determine if this is wedge ice or lens ice. For plot BARR_037 this is most likely a lens where the ice occurs as a distinct horizontal layer, with an organic layer above it and a mineral layer below. A photo provided by NEON for Plot BARR_084 shows the soil bore holes solidly in the middle of a high center polygon. Another photo for plot BARR_085 appears to be located on a high center polygon, but it is not clear where on the polygon.

Three plots were selected to represent the proposed map unit of areas not dominated by either high or low center polygons (H&L). As expected, the soil pedons here are quite variable. Plot BARR_015 is an Aquiturbel or wet, cryoturbated mineral soil. Plots BARR_008 and 019 are frozen organic soils. BARR_008 also has a Glacic horizon. The photo provided by NEON for plot BARR_008 shows the bore hole at the edge of the ponding in a low center polygon.

One plot was selected to represent the alluvial map unit (ALL). This pedon classified as a Fluvaquentic Aquorthel that has horizontal stratification, which does not appear to have been altered by cryoturbation.

Literature Cited

J. G. Bockheim, K. M. Hinkel & F. E. Nelson (2001) Soils of the Barrow region, Alaska, Polar Geography, 25:3, 163-181, DOI: 10.1080/10889370109377711

USDA is an equal opportunity provider, employer, and lender.