TOS SITE CHARACTERIZATION REPORT: DOMAIN 19

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CHANGE RECORD

REVISION	DATE	ECO#	DESCRIPTION OF CHANGE
A	04/04/2018	ECO-05512	Initial Release
B	11/20/2018	ECO-05657	• Added soil pit information table to DEJU • Added percent cover of bryophyte to the plant diversity table

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1 DESCRIPTION

1.1 Purpose

Domain and site-specific information collected and described here is used to inform the execution of protocols for the NEON Terrestrial Observation System (TOS), and complements the official NEON TOS data products generated from each site. In addition, the TOS spatial layout and plot allocation is described for each site within the domain.

1.2 Scope

This document includes any site specific characterization methods and the results of characterization efforts for each of the three sites in the Taiga domain. For more information about the sampling methods, reference the TOS Site Characterization Methods Document (RD[06]). The geographic coordinates for all TOS sampling locations can be found in the Reference Documents area of the NEON Data Portal and are provided with TOS data product downloads.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD[01]	NEON.DOC.004300	EHSS Policy, Program, and Management Plan
AD[02]	NEON.DOC.050005	Field Operations Job Instruction Training Plan
AD[03]	NEON.DOC.000909	TOS Science Design for Ground Beetle Abundance and Diversity
AD[04]	NEON.DOC.000910	TOS Science Design for Mosquito Abundance, Diversity and Phenology
AD[05]	NEON.DOC.000912	TOS Science Design for Plant Diversity
AD[06]	NEON.DOC.000915	TOS Science Design for Small Mammal Abundance and Diversity
AD[07]	NEON.DOC.000914	TOS Science Design for Plant Biomass and Productivity
AD[08]	NEON.DOC.000001	NEON Observatory Design

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD[01]	NEON.DOC.000008	NEON Acronym List
RD[02]	NEON.DOC.000243	NEON Glossary of Terms
RD[03]	NEON.DOC.000913	TOS Science Design for Spatial Sampling
RD[04]	NEON.DOC.011052	TIS Site Characterization Report
RD[05]	NEON.DOC.001373	AIS Site Characterization Report
RD[06]	NEON.DOC.003885	TOS Site Characterization Methods
RD[07]	NEON.DOC.000481	TOS Protocol and Procedure: Small Mammal Sampling
RD[08]	NEON.DOC.014041	TOS Protocol and Procedure: Breeding Landbird Abundance and Diversity
RD[09]	NEON.DOC.014042	TOS Protocol and Procedure: Plant Diversity Sampling
RD[10]	NEON.DOC.000987	TOS Protocol and Procedure: Measurement of Vegetation Structure
RD[11]	NEON.DOC.014040	TOS Protocol and Procedure: Plant Phenology
RD[12]	NEON.DOC.001709	TOS Protocol and Procedure: Bryophyte Productivity

2.3 Acronyms

Acronym	Definition
BOLD	Barcode of Life Datasystems
NLCD	National Land Cover Database

3 DOMAIN 19 OVERVIEW: TAIGA DOMAIN

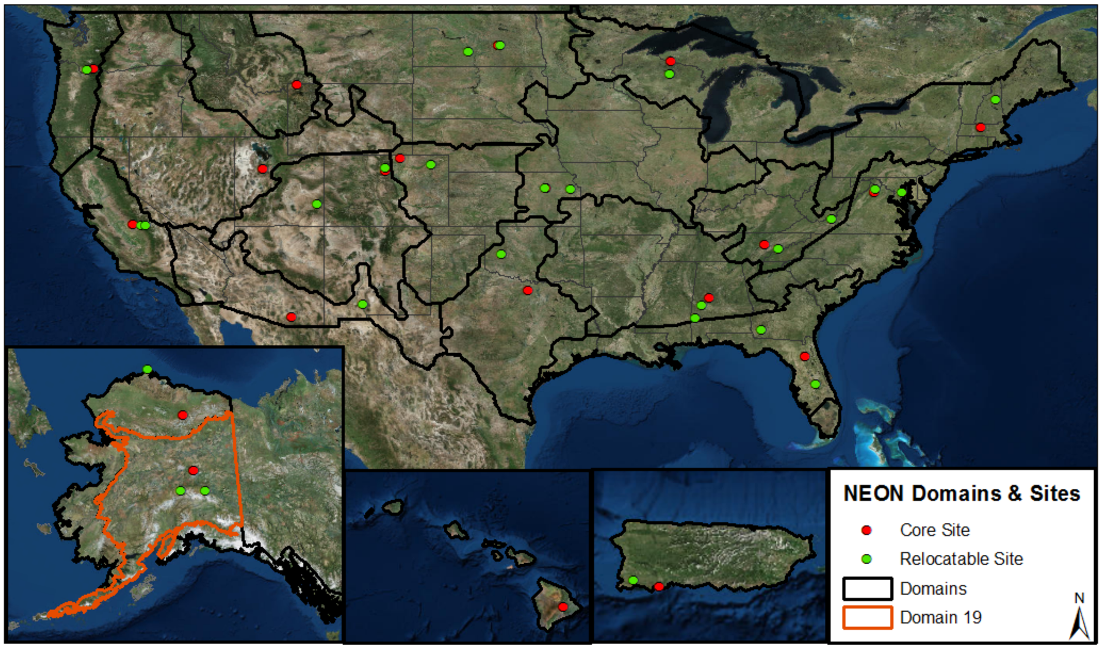

Figure 1: NEON project map with Domain 19 highlighted in red.

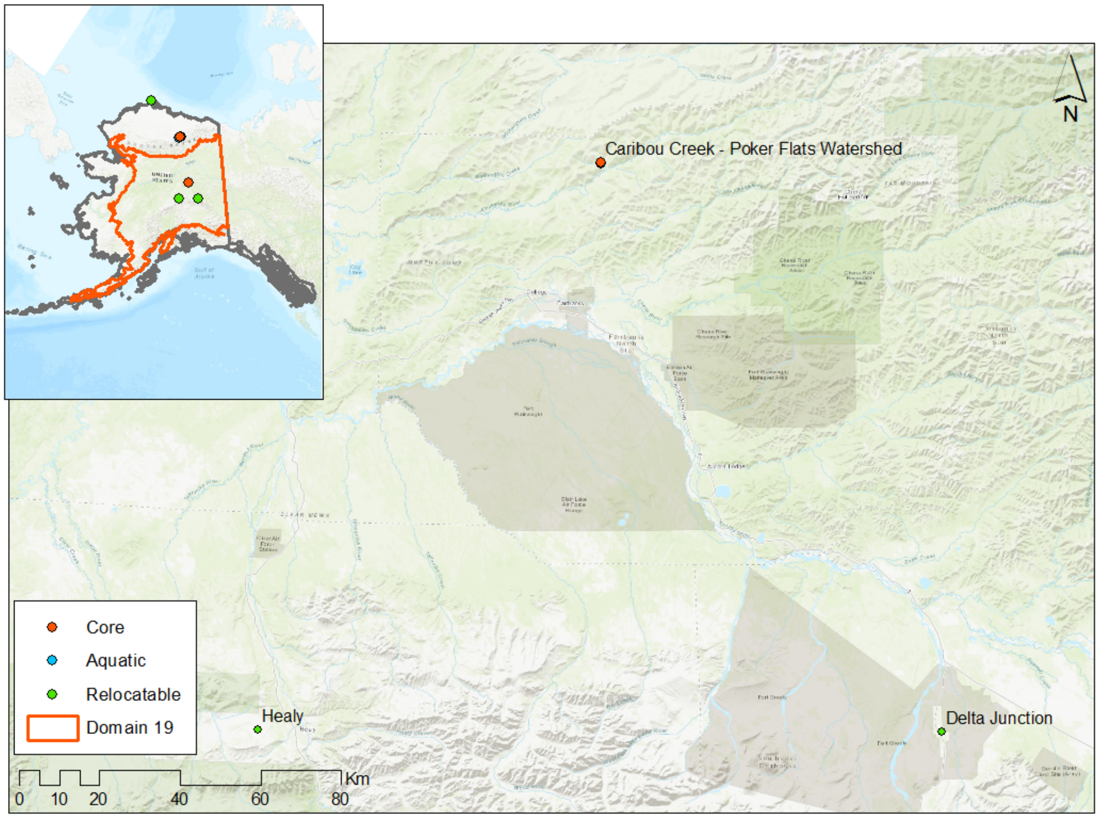

Figure 2: Site boundaries within Domain 19.

Domain 19 is characterized by relatively low precipitation, low humidity, and a large daily and annual temperature range (Alaska Climatology, 2017). Over the next several decades, the spatial distribution of permafrost in the taiga is likely to change due to shifts in temperature, precipitation, and fire intensity (Osterkamp, 2009).

- States included in the domain: Alaska
- Core site: Caribou-Poker Creeks Research Watershed
- Relocatable 1: Delta Junction
- Relocatable 2: Healy
- Science themes: Ecohydrology, Climate Impacts

4 CORE SITE- CARIBOU-POKER CREEKS RESEARCH WATERSHED (BONA)

Fifty kilometers north of Fairbanks, Caribou-Poker Creeks Research Watershed is part of the Bonanza Creek LTER research areas. The area is the only research watershed in the United States that includes areas of discontinuous permafrost and is representative of upland headwater stream basins in Alaska (Jones, 2017).

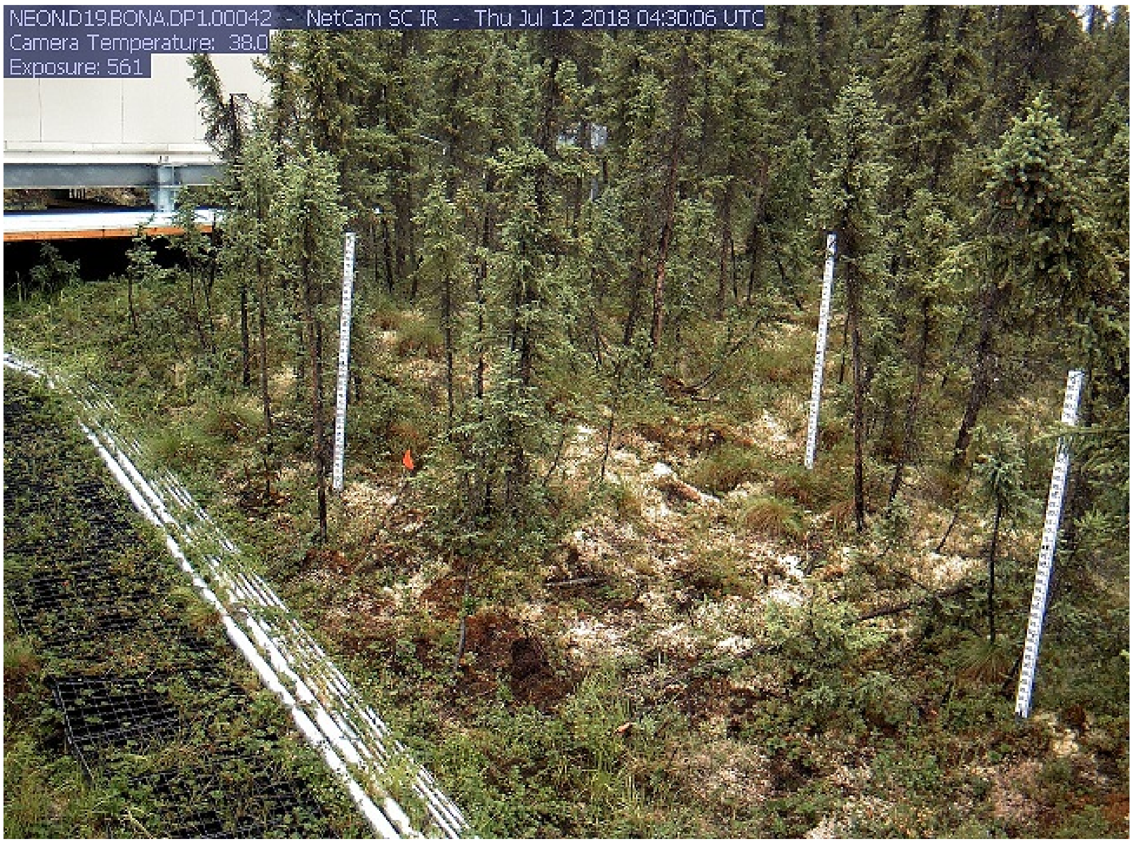

Figure 3: Phenocamera image for BONA. The image is from the mid-tower camera of the NEON tower and faces north. Phenocamera images are available at https://phenocam.sr.unh.edu/webcam/network/table/.

Key Characteristics:

- Site host: University of Alaska and Alaska Department of Natural Resources
- Located in: Fairbanks North Star Borough, Alaska
- Sampling Area: 49.6 km^2
- Plot Elevation: 210-730m
- Dominant vegetation type: Throughout the patchy distribution of permafrost is a mosaic of plant communities typical to areas of interior Alaska. Well-drained hardwood forests are dominated by Alaska paper birch (*Betula neoalaskana*), Quaking Aspen (*Populus tremuloides*), and black spruce (*Picea mariana*). Wet valley bottoms typically include mosses (*Sphagnum* spp.) and dwarf shrubs (*Betula nana, Salix* spp). Patchy cover of alder (*Alnus*) occurs in both areas (Jones, 2017).

- General Management: Land owned by the University of Alaska is reserved for scientific study and has continuous data from the 1970s. Major areas of study include the influence of discontinuous permafrost and fire to fresh water ecology and hydrology (Jones, 2017). The western part of the NEON sampling boundary on Department of Natural Resources land is open to the public. A large fire swept through the eastern part of the watershed in 2004.
- Caribou-Poker Creeks Research Watershed is located within the LTER. See the AIS site characterization report for more details (RD[05]).
- Plot Selection: NEON TOS Plots were allocated across the site following NEON standard criteria and avoiding existing research. Due to increased hiking times at this site, plot allocation was constrained to areas near roads and ATV trails.

4.1 TOS Spatial Sampling Design

TOS Distributed Plots were allocated at BONA according to a spatially balanced and stratified-random design (RD[3]). The 2011 National Land Cover Database (NLCD) was selected for stratification because of the consistent and comparable data availability across the United States. TOS Tower Plots were allocated according to a spatially balanced design in and around the NEON tower airshed (RD[03]). The maps below depict the plot locations for the first year of NEON sampling. Some plot locations may change over time due to logistics, safety, and science requirements. Please visit the NEON website (http://www.neonscience.org) for updated plot locations at each site.

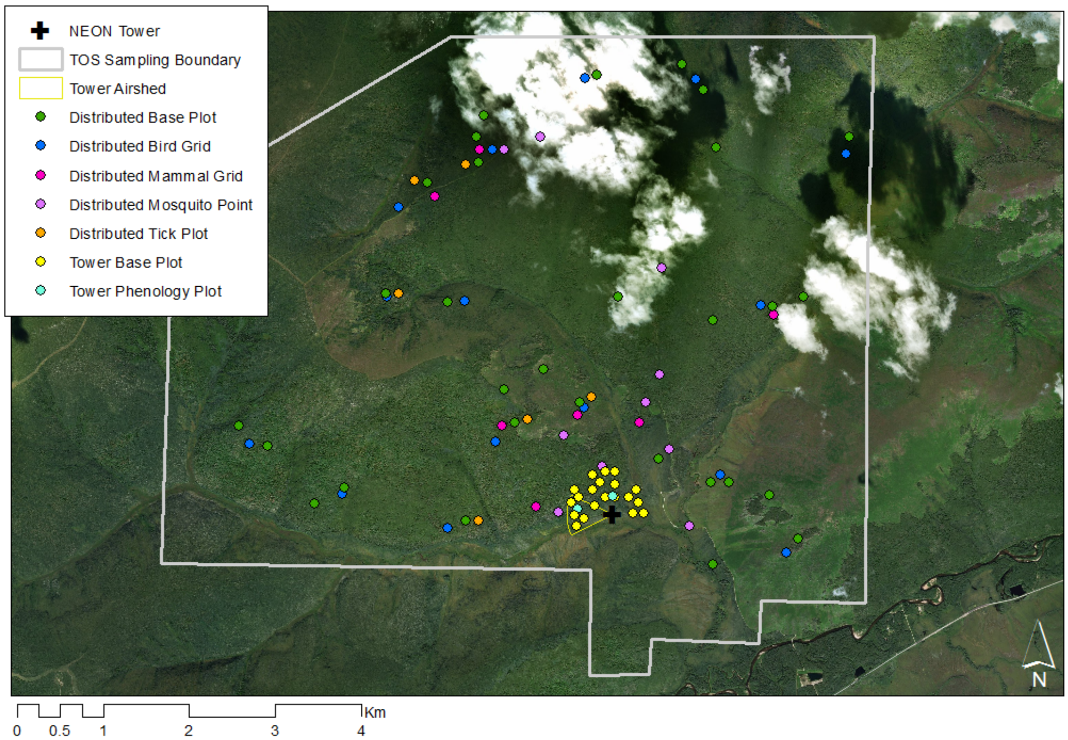

Figure 4: Map of TOS plot centroids within the NEON TOS sampling boundary at BONA.

For a list of protocols associated with each plot see tables below; for additional spatial design information see RD[03].

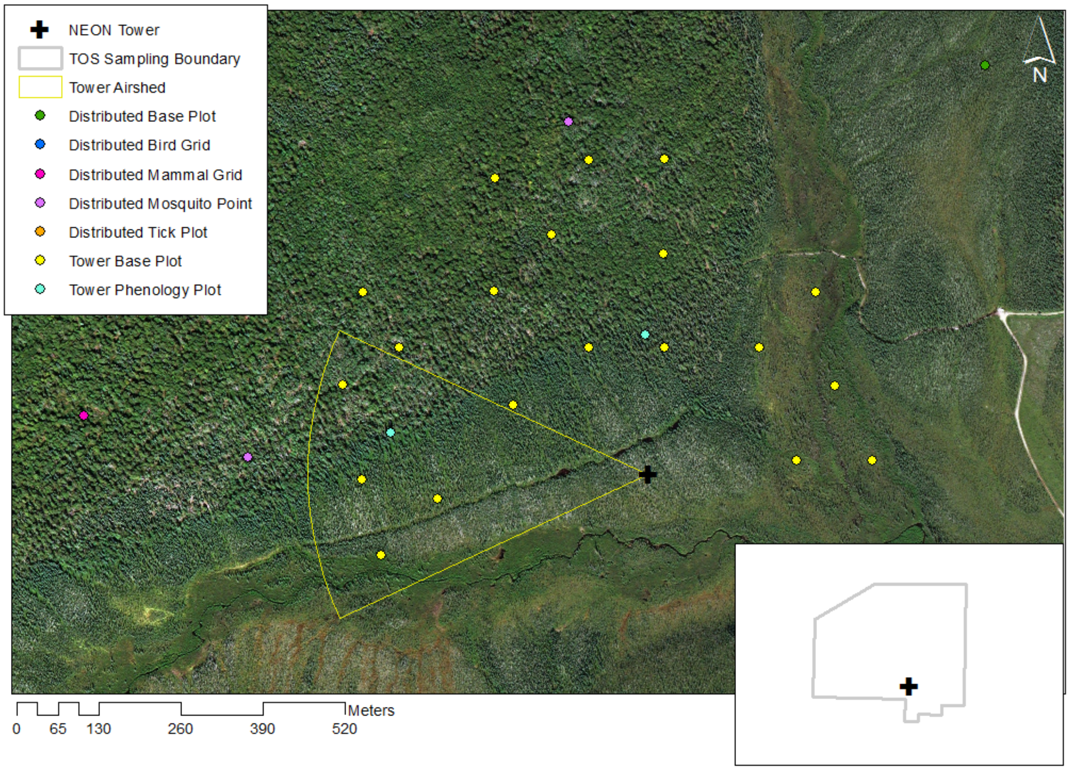

Figure 5: Map of the tower airshed and TOS plot centroids at BONA.

More information about the tower airshed can be found in the FIU site characterization report (RD[04]).

Table 1: NLCD land cover classes and area within the TOS site boundary at BONA.

NLCD Class	Site Area (km^2)	Percent (%)
Deciduous Forest	18.71	37.56
Evergreen Forest	14.92	29.95
Shrub Scrub	6.5	13.04
Mixed Forest	5.1	10.23
Woody Wetlands	4.24	8.52
Barren Land	0.23	0.46
Dwarf Scrub	0.1	0.2
Open Water	0.01	0.01
Grassland Herbaceous	0.01	0.01

Note: Any NLCD land cover classes less than 5% will not be sampled. Additionally, no sampling will take place in Water, Developed, or Barren Land NLCD classes.

Table 2: NLCD land cover classes and TOS plot numbers at BONA.

Plot Type	Plot Subtype	NLCD Class	Number of Plots Established
Distributed	Base Plot	Deciduous Forest	9
Distributed	Base Plot	Evergreen Forest	8
Distributed	Base Plot	Mixed Forest	4
Distributed	Base Plot	Shrub Scrub	5
Distributed	Base Plot	Woody Wetlands	4
Distributed	Bird Grid	Deciduous Forest	4
Distributed	Bird Grid	Evergreen Forest	3
Distributed	Bird Grid	Mixed Forest	1
Distributed	Bird Grid	Shrub Scrub	1
Distributed	Bird Grid	Woody Wetlands	1
Distributed	Mammal Grid	Deciduous Forest	3
Distributed	Mammal Grid	Evergreen Forest	2
Distributed	Mammal Grid	Mixed Forest	1
Distributed	Mammal Grid	Shrub Scrub	1
Distributed	Mosquito Point	Deciduous Forest	4
Distributed	Mosquito Point	Evergreen Forest	3
Distributed	Mosquito Point	Mixed Forest	1
Distributed	Mosquito Point	Shrub Scrub	1
Distributed	Mosquito Point	Woody Wetlands	1
Distributed	Tick Plot	Deciduous Forest	2
Distributed	Tick Plot	Evergreen Forest	2
Distributed	Tick Plot	Mixed Forest	1
Distributed	Tick Plot	Shrub Scrub	1
Tower	Base Plot	NA	20
Tower	Phenology Plot	NA	2

Note: NLCD land cover classes are not used to stratify Tower Plots which are located in and around the NEON tower airshed. The dominant NLCD land cover types within the airshed include: deciduous forest, shrub scrub, and evergreen forest.

Table 3: Number of Distributed Base Plots per NLCD land cover class per protocol at BONA.

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Deciduous Forest	Beetles	4
Distributed	Base Plot	Evergreen Forest	Beetles	3
Distributed	Base Plot	Mixed Forest	Beetles	1
Distributed	Base Plot	Shrub Scrub	Beetles	1
Distributed	Base Plot	Woody Wetlands	Beetles	1
Distributed	Base Plot	Deciduous Forest	Canopy Foliage Chemistry	4
Distributed	Base Plot	Evergreen Forest	Canopy Foliage Chemistry	3
Distributed	Base Plot	Mixed Forest	Canopy Foliage Chemistry	1
Distributed	Base Plot	Shrub Scrub	Canopy Foliage Chemistry	1
Distributed	Base Plot	Woody Wetlands	Canopy Foliage Chemistry	1
Distributed	Base Plot	Deciduous Forest	Coarse Downed Wood	7
Distributed	Base Plot	Evergreen Forest	Coarse Downed Wood	6
Distributed	Base Plot	Mixed Forest	Coarse Downed Wood	2
Distributed	Base Plot	Shrub Scrub	Coarse Downed Wood	3
Distributed	Base Plot	Woody Wetlands	Coarse Downed Wood	2
Distributed	Base Plot	Deciduous Forest	Digital Hemispherical Photos for Leaf Area Index	7
Distributed	Base Plot	Evergreen Forest	Digital Hemispherical Photos for Leaf Area Index	6
Distributed	Base Plot	Mixed Forest	Digital Hemispherical Photos for Leaf Area Index	2
Distributed	Base Plot	Shrub Scrub	Digital Hemispherical Photos for Leaf Area Index	3
Distributed	Base Plot	Woody Wetlands	Digital Hemispherical Photos for Leaf Area Index	2
Distributed	Base Plot	Deciduous Forest	Herbaceous Biomass	7
Distributed	Base Plot	Evergreen Forest	Herbaceous Biomass	6
Distributed	Base Plot	Mixed Forest	Herbaceous Biomass	2
Distributed	Base Plot	Shrub Scrub	Herbaceous Biomass	3
Distributed	Base Plot	Woody Wetlands	Herbaceous Biomass	2
Distributed	Base Plot	Deciduous Forest	Plant Diversity	9
Distributed	Base Plot	Evergreen Forest	Plant Diversity	8
Distributed	Base Plot	Mixed Forest	Plant Diversity	4
Distributed	Base Plot	Shrub Scrub	Plant Diversity	5

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Woody Wetlands	Plant Diversity	4
Distributed	Base Plot	Deciduous Forest	Soil Biogeochemistry	2
Distributed	Base Plot	Evergreen Forest	Soil Biogeochemistry	2
Distributed	Base Plot	Mixed Forest	Soil Biogeochemistry	1
Distributed	Base Plot	Shrub Scrub	Soil Biogeochemistry	1
Distributed	Base Plot	Deciduous Forest	Soil Microbes	2
Distributed	Base Plot	Evergreen Forest	Soil Microbes	2
Distributed	Base Plot	Mixed Forest	Soil Microbes	1
Distributed	Base Plot	Shrub Scrub	Soil Microbes	1
Distributed	Base Plot	Deciduous Forest	Vegetation Structure	7
Distributed	Base Plot	Evergreen Forest	Vegetation Structure	6
Distributed	Base Plot	Mixed Forest	Vegetation Structure	2
Distributed	Base Plot	Shrub Scrub	Vegetation Structure	3
Distributed	Base Plot	Woody Wetlands	Vegetation Structure	2

Note: Distributed Base Plots typically support more than one TOS protocol; 'Number of Plots' cannot be added to get total TOS Distributed Base Plot number.

Table 4: Number of Tower Plots per protocol at BONA.

Plot Type	Plot Subtype	Protocols	Number of Plots
Tower	Base Plot	Canopy Foliage Chemistry	4
Tower	Base Plot	Coarse Downed Wood	20
Tower	Base Plot	Digital Hemispherical Photos for Leaf Area Index	3
Tower	Base Plot	Herbaceous Biomass	20
Tower	Base Plot	Litterfall and Fine Woody Debris	20
Tower	Base Plot	Mat-Forming Bryophyte Production	20
Tower	Base Plot	Plant Belowground Biomass	20
Tower	Base Plot	Plant Diversity	3
Tower	Base Plot	Soil Biogeochemistry	4
Tower	Base Plot	Soil Microbes	4
Tower	Base Plot	Vegetation Structure	20
Tower	Phenology	Plant Phenology	2

Note: Tower Base Plots typically support more than one TOS protocol; 'Number of Plots' cannot be added to get the total TOS Tower Base Plot number.

4.2 Sampling Season Characterization: BONA

For numerous TOS protocols, the length of the sampling season, the number of bouts, and when those bouts occur is dictated by the seasonal status of the plant community. By monitoring 'greenness' on a 16 day interval, the MODIS/Terra EVI phenology product provides consistent, reliable insight into plant community phenology and intensity at the continental scale. For those protocols for which timing is standardized by greenness transitions and/or peak green status, NEON has utilized these data as the primary means of guiding temporal aspects of TOS sampling at each site.

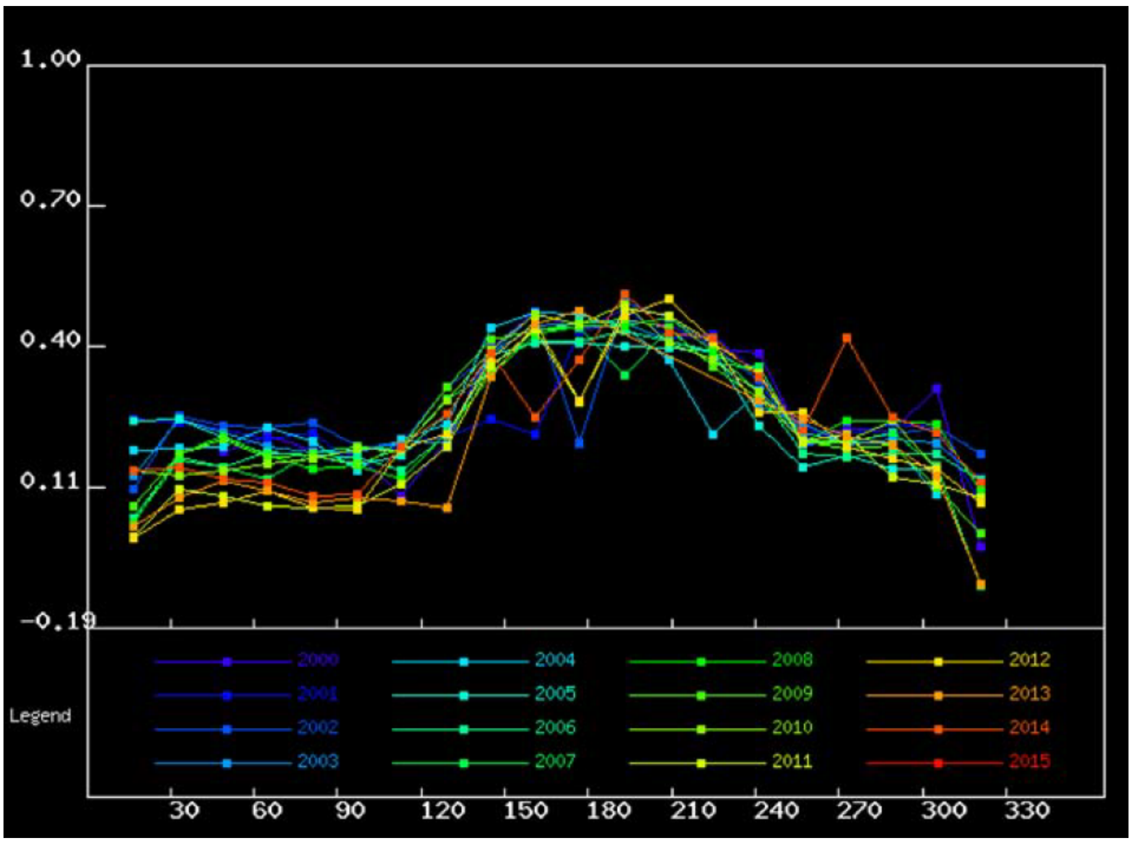

Figure 6: MODIS-EVI greenness (y-axis = EVI ratio) as a function of time (x-axis = DOY) for the years 2000-2015 at the NEON BONA site.

Table 5: Average MODIS-EVI greenness dates for the NEON BONA site, based on data from 2000-2015 (DOY, with MM/DD in parentheses).

Average Increase	Average Maximum	Average Decrease	Average Minimum
135 (05/16)	180 (06/30)	210 (07/30)	250 (09/08)

MODIS Product Details

- Product: MODIS-EVI phenology product, 16 day interval, 250 m grid, data included from all pixels with acceptable quality within user-defined square that roughly overlaps the TOS site boundary.
- Date range: 2000-2015
- User selected area: 2.25 km x 2.25 km box, centroid lat: 65.15401, centroid long: -147.50258 (WGS84 datum)

4.3 Belowground Biomass

4.3.1 Site-Specific Methods

Belowground biomass characterization data were collected down to an average depth of 166 cm by NEON staff in March 2017. Since the NEON protocol for long-term, operational sampling of belowground biomass only collects data to a depth of 30 cm, the belowground biomass site characterization data are critical for scaling belowground biomass measurements to greater depths; see the TOS Science Design for Plant Biomass, Productivity, and Leaf Area Index (AD[7]) for more information. Samples were collected following the standard methods outlined in TOS Site Characterization Methods (RD[6]). Roots were sorted to two diameter size categories ($\leq$ 2 mm and 2-30 mm) and by root status (live or dead). The tables below summarize all the belowground biomass less than or equal to 30 mm diameter; size class data and more information can be found by searching the NEON data portal for the data product numbers in Appendix A.

Belowground biomass sampling in the permafrost presented a unique set of challenges, and deviations from the standard sampling workflow are outlined below.

Field: In order to decrease disturbance, soil cores were collected during the winter when frozen conditions allowed equipment to be transported. A coring machine was used to ensure that soil was not mixed while extracted. Three cores were taken to a maximum depth of 168cm. The cores were kept frozen until they could be processed. BONA cores were taken at Latitude 65.15333, Longitude -147.50194.

Processing Cores: Cores were split while frozen into 10cm depth increments using a handsaw and chisel. After the samples were thawed it was discovered that 0-10 depth layer also included above ground plant matter and litter. To maintain consistency with the other soil pits, the depth increments were shifted for the entire core so that “0” indicates where the soil started and not the upper limit of the soil core. For example, for BONA core 13-1 what was initially called the “0-10” layer was in fact 0-5cm above ground plant material and 5-10cm soil. Subsequent depth increments were shifted so 10-20 cm became 5-15cm, 20-30 cm became 15-25 cm, etc.

Due to the extremely high density of fine roots, core samples were divided length-wise into quarters for per depth increment, and a random subsample was selected for sieving and sorting. Because the majority of the samples were dense with fine roots and roots were relatively homogeneously distributed, we are confident that subsampling did not affect final root dry mass values.

Sieving: We had low confidence in out ability to distinguish live vs. dead roots isolated from boreal taiga soils. To maintain consistency with the standard sampling workflow, roots that could not be confidently parsed were assumed to be ‘live.’

4.3.2 Results

Table 6: Fine root mass per depth increment (cm) at BONA.

Upper Depth	Lower Depth	Mean (mg per cm^3)	Std Dev
0	5-7	2.95	1.79
5-7	15-17	2.34	0.74
15-17	25-27	2.24	1.31
25-27	35-37	0.72	0.57
35-37	45-47	0.46	0.3
45-47	55-57	0.18	0.15
55-57	65-67	0.19	0.05
65-67	75-77	0.07	0.01
75-77	85-87	0.19	0.17
85-87	95-97	0.08	0.07
95-97	115-117	0.09	0.04
115-117	135-137	0.04	0.06
135-137	155-157	0.05	0.05
155-157	159-164	0.11	0.13

Note: The upper and lower depth values reflect the ranges between the three cores. See the "Processing Cores" section above for more information.

Table 7: Cumulative fine root mass as a function of depth (cm) at BONA.

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
0	5-7	177.47	115.32
5-7	15-17	411.25	98.42
15-17	25-27	635.32	226.81
25-27	35-37	707.3	282.06
35-37	45-47	752.94	304.43
45-47	55-57	771.13	296.45
55-57	65-67	789.67	301.34
65-67	75-77	796.94	300.65
75-77	85-87	816.09	317.15
85-87	95-97	824.49	324.05
95-97	115-117	842.85	330.9

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
115-117	135-137	850.56	342.44
135-137	155-157	860.43	352.62
155-157	159-164	868.36	360.67

Note: The upper and lower depth values reflect the ranges between the three cores. See the "Processing Cores" section above for more information.

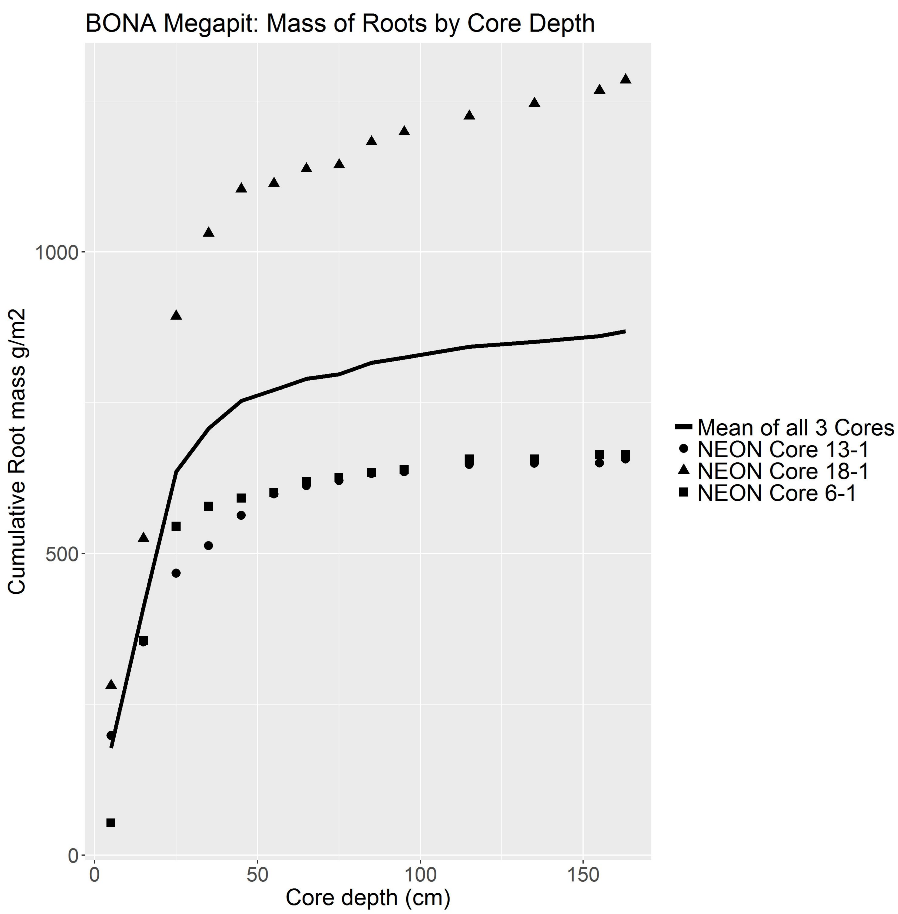

Figure 7: Cumulative root mass by core depth at BONA.

Table 8: Fine root biomass sampling summary data at BONA.

Total Average Core Depth (cm)	162
Total Mean Cumulative Mass at 30cm (g per m^2)	635.32
Total Mean Cumulative Mass at 100cm (g per m^2)	824.49
Total Mean Cumulative Mass (g per m^2)	868.36

4.4 Plant Characterization and Phenology Species Selection

4.4.1 Site-Specific Methods

Plant characterization data were collected by NEON staff during October of 2016. Plant characterization data inform sampling procedures for plant phenology and plant productivity protocols.

The overall ranking ("Rank" in the table below) was calculated based on three separate measurements. Overall ranking weights are influenced by the number of species within each grouping.

1. Mean percent cover values were calculated based on species specific cover estimation for all plant species under 3m tall in eight 1m by 1m subplots per plot; see the TOS Protocol and Procedure: Plant Diversity Sampling (RD[09]) for more information.
2. Mean canopy area values were calculated based on all species specific shrub canopy diameter measurements within the entire plot or subplot; see the TOS Protocol and Procedure: Measurement of Vegetation Structure (RD[10]) for more information.
3. Mean ABH (area at breast height) measurements were calculated based on diameter at breast height measurements for all woody vegetation with a diameter greater than 1cm at 130cm height within the entire plot or subplot; see the TOS Protocol and Procedure: Measurement of Vegetation Structure (RD[10]) for more information.

The standard field methods and ranking calculations are further outlined in TOS Site Characterization Methods (RD[6]). For more information on this protocol and data product numbers see Appendix A.

4.4.2 Results

Table 9: Site plant characterization and phenology species summary at BONA.

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
PIMA	*Picea mariana* (Mill.) Britton, Sterns & Poggenb.	1	6	<1	5.02
POTR5	*Populus tremuloides* Michx.	2	<1	<1	2.54

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
ALVI5	*Alnus viridis* (Chaix) DC.	3	<1	0.05	0.01
BENE4	*Betula neoalaskana* Sarg.	4	<1	<1	3.03
VAVI	*Vaccinium vitis-idaea* L.	5	5	<1	<1
LEGR	*Ledum groenlandicum* Oeder	6	4	<1	<1
VAUL	*Vaccinium uliginosum* L.	7	3	<1	<1
PIGL	*Picea glauca* (Moench) Voss	8	<1	<1	0.32
BENA/BEGL	*Betula glandulosa* or *nana*	9	2	0.01	<1
LALA	*Larix laricina* (Du Roi) K. Koch	10	<1	<1	0.08
SASC	*Salix scouleriana* Barratt ex Hook.	11	<1	0.01	<1
RUCH	*Rubus chamaemorus* L.	12	<1	<1	<1
SABE2	*Salix bebbiana* Sarg.	13	<1	<1	<1
COCA13	*Cornus canadensis* L.	14	<1	<1	<1
ROAC	*Rosa acicularis* Lindl.	15	<1	<1	<1
EQSY	*Equisetum sylvaticum* L.	16	<1	<1	<1
SAPU15	*Salix pulchra* Cham.	17	<1	<1	<1
SAHA	*Salix hastata* L.	18	<1	<1	<1
LYCO3	*Lycopodium complanatum* L.	19	<1	<1	<1
DAFR6	*Dasiphora fruticosa* (L.) Rydb.	20	<1	<1	<1
ALIN2	*Alnus incana* (L.) Moench	21	<1	<1	<1
LYAN2	*Lycopodium annotinum* L.	22	<1	<1	<1
COPA28	*Comarum palustre* L.	23	<1	<1	<1
CALA6	*Calamagrostis lapponica* (Wahlenb.) Hartm.	24	<1	<1	<1
EQSC	*Equisetum scirpoides* Michx.	24	<1	<1	<1
LEPA11	*Ledum palustre* L.	26	<1	<1	<1
GELI2	*Geocaulon lividum* (Richardson) Fernald	27	<1	<1	<1

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
ERVA4	*Eriophorum vaginatum* L.	28	<1	<1	<1
EQAR	*Equisetum arvense* L.	29	<1	<1	<1
VAOX	*Vaccinium oxycoccos* L.	29	<1	<1	<1
ARLA2	*Arctagrostis latifolia* (R. Br.) Griseb.	31	<1	<1	<1
RALA	*Ranunculus lapponicus* L.	32	<1	<1	<1
CAAQ	*Carex aquatilis* Wahlenb.	33	<1	<1	<1
PEFR5	*Petasites frigidus* (L.) Fr.	34	<1	<1	<1
CACA4	*Calamagrostis canadensis* (Michx.) P. Beauv.	35	<1	<1	<1
ALINT	*Alnus incana* (L.) Moench ssp. *tenuifolia* (Nutt.) Breitung	36	<1	<1	<1
CHAN9	*Chamerion angustifolium* (L.) Holub	37	<1	<1	<1
SPST3	*Spiraea stevenii* (C.K. Schneid.) Rydb.	38	<1	<1	<1
POBA2	*Populus balsamifera* L.	39	<1	<1	0.03
RUAR	*Rubus arcticus* L.	40	<1	<1	<1
ORSE	*Orthilia secunda* (L.) House	41	<1	<1	<1
CALAM	*Calamagrostis* sp.	42	<1	<1	<1
POACEA	Poaceae sp.	42	<1	<1	<1
EQFL	*Equisetum fluviatile* L.	44	<1	<1	<1
EMNI	*Empetrum nigrum* L.	45	<1	<1	<1
LIBO3	*Linnaea borealis* L.	45	<1	<1	<1
ARLA2	*Arctagrostis latifolia* (R. Br.) Griseb.	47	<1	<1	<1
ARCTA	*Arctagrostis* sp.	47	<1	<1	<1
ANRI	*Anemone richardsonii* Hook.	49	<1	<1	<1
ARRU	*Arctostaphylos rubra* (Rehder & Wilson) Fernald	49	<1	<1	<1
SALIX	*Salix* sp.	49	<1	<1	<1

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
CHCA2	*Chamaedaphne calyculata* (L.) Moench	52	<1	<1	<1
CALAMSPP	*Calamagrostis* sp.	54	<1	<1	<1
MOLA6	*Moehringia lateriflora* (L.) Fenzl	54	<1	<1	<1
SAAR3	*Salix arbusculoides* Andersson	56	<1	<1	<1
CANOI	*Carex norvegica* Retz. ssp. *inferalpina* (Wahlenb.) Hultén	57	<1	<1	<1
PAPA8	*Parnassia palustris* L.	57	<1	<1	<1
PYCH	*Pyrola chlorantha* Sw.	57	<1	<1	<1
ALVI	*Allium vineale* L.	60	<1	<1	<1
CASTI3	*Calamagrostis stricta* (Timm) Koeler ssp. *inexpansa* (A. Gray) C.W. Greene	60	<1	<1	<1
CAREXSPP	*Carex* sp.	60	<1	<1	<1
COTR18	*Corallorhiza trifida* Chatelain	60	<1	<1	<1
SPRO	*Spiranthes romanzoffiana* Cham.	60	<1	<1	<1
CALA15	*Carex lapponica* O.F. Lang	65	<1	<1	<1
CALEL3	*Carex lenticularis* Michx. var. *lipocarpa* (T. Holm) L.A. Standl.	65	<1	<1	<1
CAREX	*Carex* sp.	65	<1	<1	<1
GATR2	*Galium trifidum* L.	65	<1	<1	<1
GYDR	*Gymnocarpium dryopteris* (L.) Newman	65	<1	<1	<1
PELA	*Pedicularis labradorica* Wirsing	65	<1	<1	<1
PICEA	*Picea* sp.	65	<1	<1	<1
PIVI	*Pinguicula villosa* L.	65	<1	<1	<1
PYROLSPP	*Pyrola* sp.	65	<1	<1	<1

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
STELL	*Stellaria* sp.	65	<1	<1	<1
VIEP	*Viola epipsila* Ledeb.	65	<1	<1	<1
VIOLA	*Viola* sp.	65	<1	<1	<1

Note:Taxon IDs and scientific names are based on the USDA Plants database (plants.usda.gov).

Table 10: Per plot breakdown of species richness, diversity, and herbaceous cover at BONA.

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover	Bryophyte Percent Cover
BONA_070	15	2.12	46	79.62
BONA_071	17	2.37	40	95.57
BONA_072	18	2.47	41	13.88
BONA_073	21	2.42	46	87.67
BONA_074	22	2.45	49	83.75
BONA_075	12	1.93	50	0.44
BONA_076	14	2.02	62	45.93
BONA_077	22	2.38	59	87
BONA_078	14	2.04	32	8.81
BONA_079	18	1.8	135	2.19
BONA_080	13	2.15	32	69
BONA_081	27	2.85	61	53.88
BONA_082	11	1.34	66	2.19
BONA_083	25	2.63	48	86.33
BONA_084	18	2.1	79	1.56
BONA_085	22	2.32	82	48
BONA_086	25	2.73	78	29.75
BONA_087	17	1.93	76	0.75
BONA_088	14	1.6	54	15.83
BONA_089	16	1.5	62	1.94
Bryophyte Mean				40.7

Note: Percent herbaceous cover was measured by species and then added together to calculate the percent total herbaceous cover for each plot.

According to AD[07], sites qualify for bryophyte productivity sampling when average bryophyte cover is $\geq$ 20% across all Tower plots. However, bryophyte productivity sampling was discontinued in 2018 and NEON no longer implements this protocol.

4.5 Beetles

4.5.1 Site-Specific Methods

Beetle site characterization was conducted in September of 2013 by NEON staff following the standard methods outlined in TOS Site Characterization Methods (RD[6]). Beetle site characterization data were collected to start site level teaching collections. All samples were pooled before identification. For more information on this protocol and data product numbers see Appendix A.

4.5.2 Results

Table 11: Beetle identification results at BONA.

Sample ID	Scientific Name	Sex
NEON8193	*Agonum quinquepunctatum*	M
NEON8190	*Bembidion mutatum*	F
NEON8191	*Pterostichus adstrictus*	M
NEON8192	*Pterostichus adstrictus*	M
NEON8194	*Pterostichus adstrictus*	F

4.6 Mosquitoes

4.6.1 Site-Specific Methods

Mosquito site characterization was conducted in September of 2013 by NEON staff following the standard methods outlined in TOS Site Characterization Methods (RD[6]) to test protocol methods and start site level species lists. No pathogen testing was performed. All samples were pooled before identification. For more information on this protocol and data product numbers see Appendix A.

4.6.2 Results

Table 12: Mosquito identification results at BONA.

Sample ID	Scientific Name	Count
BONA.September2013.SC.1	*Aedes communis*	9

Sample ID	Scientific Name	Count
BONA.September2013.SC.1	*Aedes diantaeus*	16
BONA.September2013.SC.1	*Aedes excrucians*	1
BONA.September2013.SC.1	*Aedes pullatus*	6
BONA.September2013.SC.1	*Aedes* spp.	9
BONA.September2013.SC.1	*Culiseta* spp.	2

4.7 Ticks

4.7.1 Site-Specific Methods

Tick site characterization was conducted in September of 2013 by NEON staff following the standard methods outlined in TOS Site Characterization Methods (RD[6]) to test protocol methods and start site level species lists. No ticks were collected. For more information on this protocol and data product numbers see Appendix A.

4.8 Species Reference Lists

A review of the literature for taxonomic lists of interest for each site was conducted prior to field work. In the case of vertebrates that NEON may capture (e.g., reptiles, amphibians, small mammals), these lists were often required to secure permits. Key references identified in this effort are listed below. Species lists and associated references for small mammals and breeding landbirds can be found in the appendices of the respective protocols (RD[07], RD[08]).

Bousquet, Y. 2012. Catalogue of Geadephaga (Coleoptera, Adephaga) of America, north of Mexico. ZooKeys, (245), 1-1722.

Centers for Disease Control and Prevention. (2015). *Geographic distribution of ticks that bite humans.* Retrieved from http://www.cdc.gov/ticks/geographic_distribution.html

Darsie Jr., R. F., and R. A. Ward. 2005. Identification and geographical distribution of the mosquitoes of North America, North of Mexico. University Press of Florida, Gainesville.

Dingman, S.L. and Koutz, F.R., 1974. Relations among vegetation, permafrost, and potential insolation in central Alaska. Arctic and Alpine Research, pp.37-47.

Jones, Jeremy. 2017. Study Sites & Design: Caribou-Poker Creeks Research Watershed. Retrieved from http://www.lter.uaf.edu/research/study-sites-cpcrw.

Klaar, M., C. Kidd, E. Malone, R. Bartlett, G. Piney, F.S. Chapin, III, A.M. Milner. 2015. Vegetation succession in deglaciated landscapes: Implications for sediment and landscape stability. Earth Surface Processes and Landforms 40(8). pp. 1088-1100. doi: 10.1002/esp.3691

Reptiles and Amphibians, 2017. Alaska Department of Fish and Game. Retrieved from: http://www.adfg.alaska.gov/index.cfm?adfg=animals.listreptiles

Werner, R.A. and T. Ward. 1976. Biomass and density of arthropods inhabitation the black spruce ecosystem. In proceedings of Proceedings: 27th Alaska science conference, Fairbanks, AK, August 4-7, 1976. (University of Alaska, Agricultural and Forestry Experiment Station, Fairbanks, Alaska, USA). pp. 220.

5 RELOCATABLE SITE 1- DELTA JUNCTION (DEJU)

Delta Junction is located 150 kilometers southeast of Fairbanks along the Alaska Highway. The site sits within the Tanana River Valley; the White Mountains are located to the north, the Granite Mountains to the southeast, and the Alaska Range to the southwest.

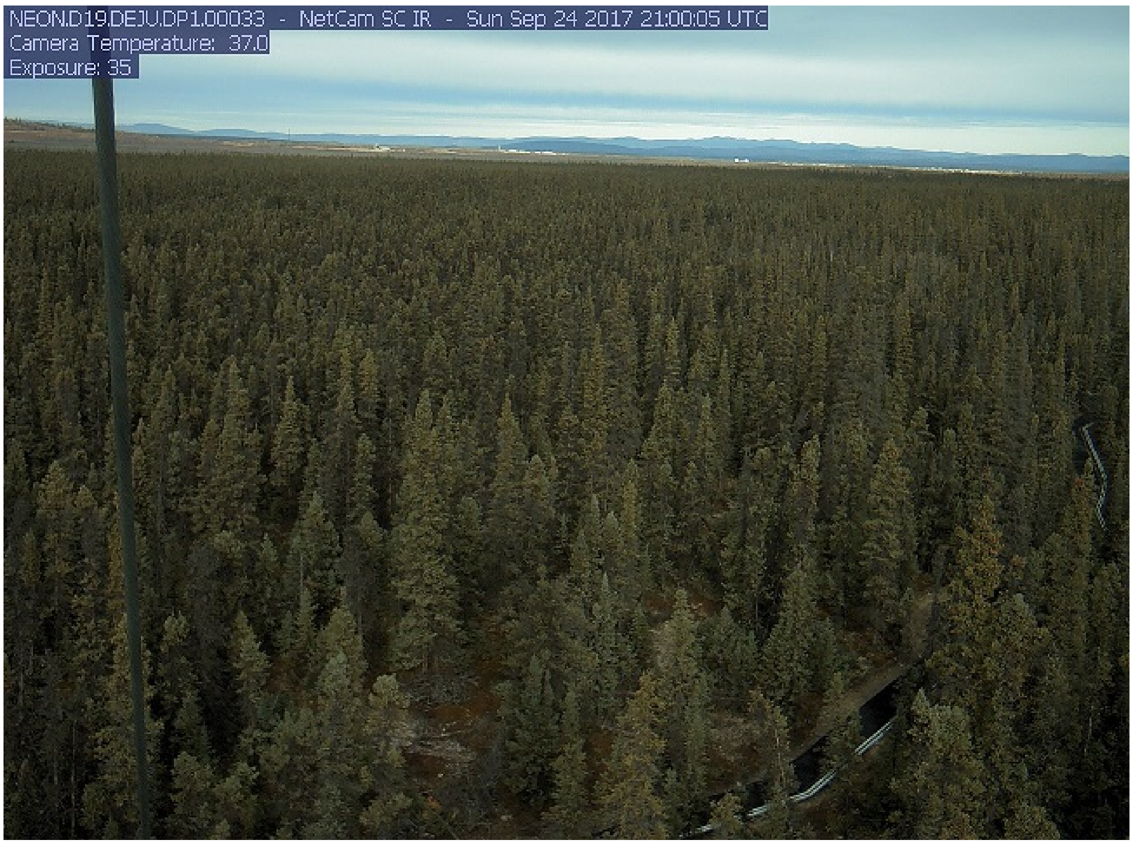

Figure 8: Phenocamera image for DEJU. The phenocamera is located at the top of the NEON tower and faces north. Phenocamera images are available at https://phenocam.sr.unh.edu/webcam/network/table/.

Key Characteristics:

- Site host: Bureau of Land Management
- Located in: Southeast Fairbanks Census Area, Alaska
- Sampling Area: 29.9 km^2
- Plot Elevation: 440-485m
- Dominant vegetation type: The Greater Delta Area is underlain by discontinuous permafrost. Generally less than 75 cm in depth, the permafrost is preserved by a thick surface layer of moss or other vegetation and is vulnerable to disturbance. Stands of aspen (*Populus tremuloides*), Alaska paper birch (*Betula neoalaskana*), and white spruce (*Picea glauca*) grow on the upland sites. Dense stands of black spruce (*Picea mariana*) generally grow on sites where the drainage is impeded. Mosses, sedges, and low-growing shrubs dominate

in areas having the poorest drainage (Pink, 2008).

- General management: The NEON TOS sampling boundary is within public land south of the town of Delta Junction. The area is surrounded by Fort Greely. A fire burned through the northern half of the site in 1999.
- Plot Selection: NEON TOS Plots were allocated across the site following NEON standard criteria and avoiding existing research.

5.1 TOS Spatial Sampling Design

TOS Distributed Plots were allocated at DEJU according to a spatially balanced and stratified-random design (RD[3]). The 2001 National Land Cover Database (NLCD) was selected for stratification because of the consistent and comparable data availability across the United States. TOS Tower Plots were allocated according to a spatially balanced design in and around the NEON tower airshed (RD[03]). The maps below depict the plot locations for the first year of NEON sampling. Some plot locations may change over time due to logistics, safety, and science requirements. Please visit the NEON website (http://www.neonscience.org) for updated plot locations at each site.

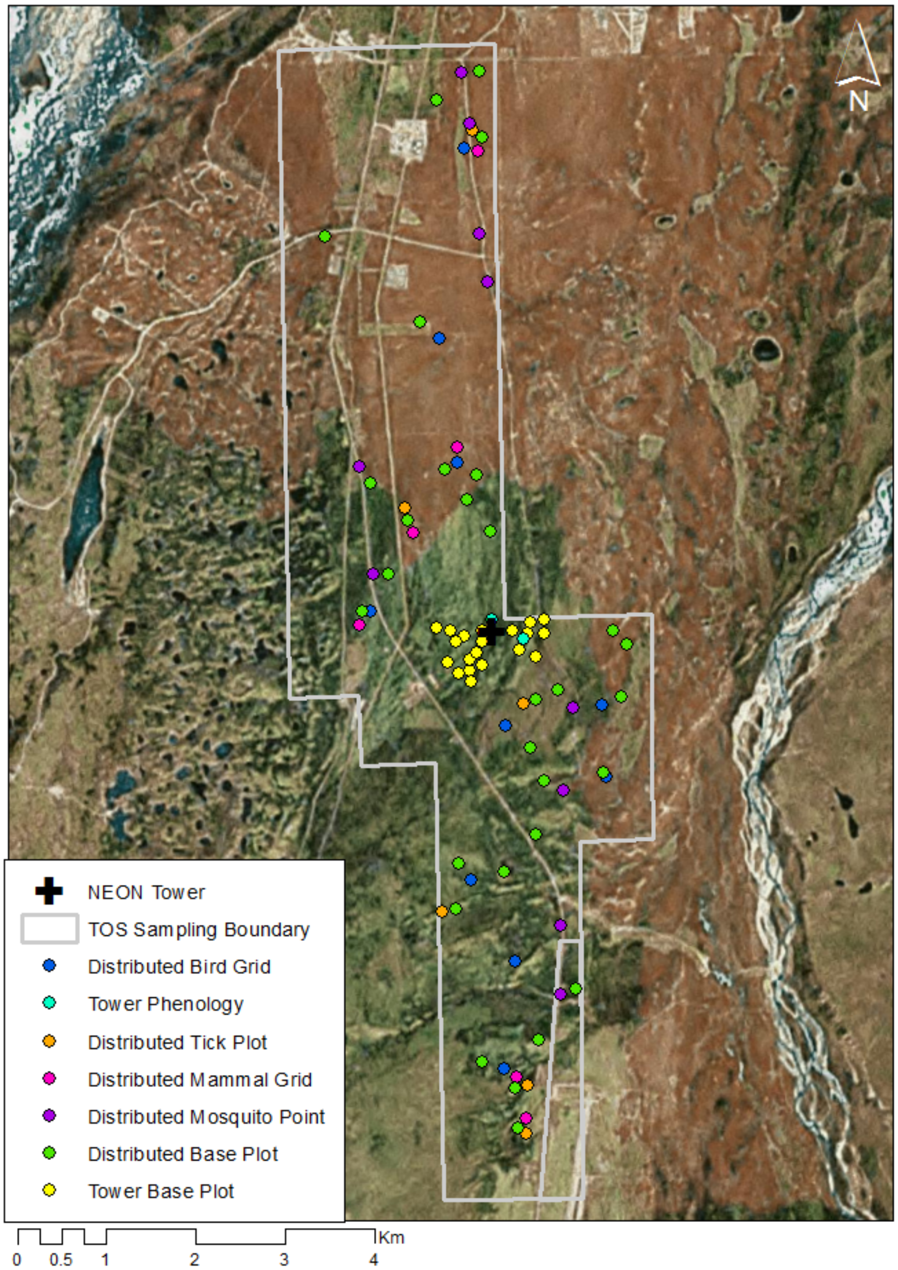

Figure 9: Map of TOS plot centroids within the NEON TOS sampling boundary at DEJU.

For a list of protocols associated with each plot see tables below; for additional spatial design information see

RD[03].

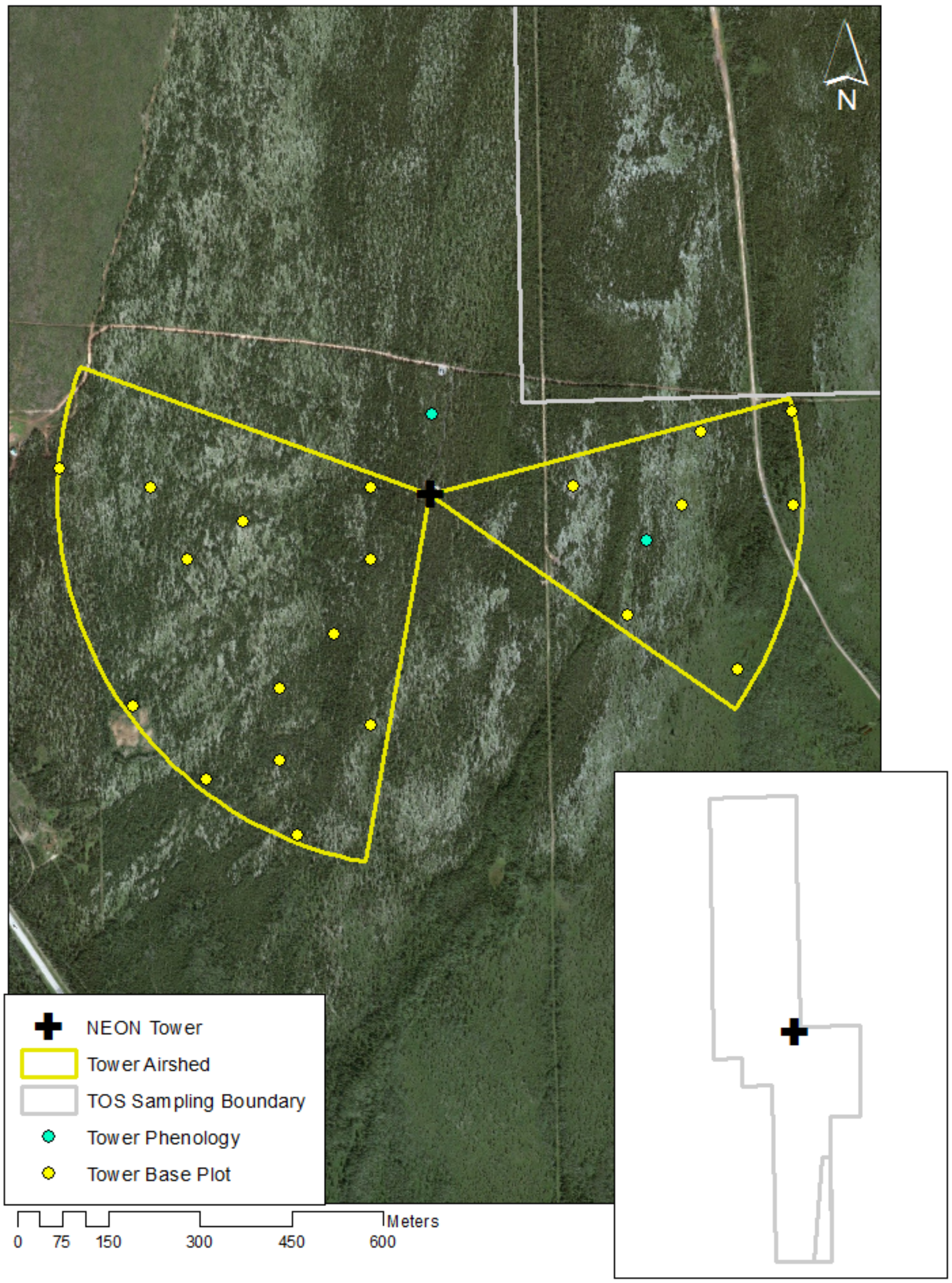

Figure 10: Map of the tower airshed and TOS plot centroids at DEJU.

More information about the tower airshed can be found in the FIU site characterization report (RD[04]).

Table 13: NLCD land cover classes and area within the TOS site boundary at DEJU.

NLCD Class	Site Area (km^2)	Percent (%)
Evergreen Forest	12.53	41.9
Shrub Scrub	9.95	33.26
Woody Wetlands	3.34	11.17
Deciduous Forest	1.26	4.21
Developed Low Intensity	1.2	4.02
Mixed Forest	0.93	3.12
Barren Land	0.24	0.79
Developed Open Space	0.15	0.49
Dwarf Scrub	0.09	0.29
Sedge Herbaceous	0.09	0.29
Developed Medium Intensity	0.07	0.25
Open Water	0.04	0.14
Developed High Intensity	0.02	0.06

Note: Any NLCD land cover classes less than 5% will not be sampled. Additionally, no sampling will take place in Water, Developed, or Barren Land NLCD classes.

Table 14: NLCD land cover classes and TOS plot numbers at DEJU.

Plot Type	Plot Subtype	NLCD Class	Number of Plots Established
Distributed	Base Plot	Evergreen Forest	12
Distributed	Base Plot	Shrub Scrub	11
Distributed	Base Plot	Woody Wetlands	7
Distributed	Bird Grid	Evergreen Forest	4
Distributed	Bird Grid	Shrub Scrub	4
Distributed	Bird Grid	Woody Wetlands	1
Distributed	Mammal Grid	Evergreen Forest	3
Distributed	Mammal Grid	Shrub Scrub	3
Distributed	Mosquito Point	Evergreen Forest	5
Distributed	Mosquito Point	Shrub Scrub	4
Distributed	Mosquito Point	Woody Wetlands	1
Distributed	Tick Plot	Evergreen Forest	3
Distributed	Tick Plot	Shrub Scrub	2

Plot Type	Plot Subtype	NLCD Class	Number of Plots Established
Distributed	Tick Plot	Woody Wetlands	1
Tower	Base Plot	NA	20
Tower	Phenology Plot	NA	2

Note: NLCD land cover classes are not used to stratify Tower Plots which are located in and around the NEON tower airshed. The dominant NLCD land cover type within the airshed is evergreen forest.

Table 15: Number of Distributed Base plots per NLCD land cover class per protocol at DEJU.

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Evergreen Forest	Beetles	5
Distributed	Base Plot	Shrub Scrub	Beetles	4
Distributed	Base Plot	Woody Wetlands	Beetles	1
Distributed	Base Plot	Evergreen Forest	Canopy Foliage Chemistry	5
Distributed	Base Plot	Shrub Scrub	Canopy Foliage Chemistry	4
Distributed	Base Plot	Woody Wetlands	Canopy Foliage Chemistry	1
Distributed	Base Plot	Evergreen Forest	Coarse Downed Wood	10
Distributed	Base Plot	Shrub Scrub	Coarse Downed Wood	8
Distributed	Base Plot	Woody Wetlands	Coarse Downed Wood	2
Distributed	Base Plot	Evergreen Forest	Digital Hemispherical Photos for Leaf Area Index	10
Distributed	Base Plot	Shrub Scrub	Digital Hemispherical Photos for Leaf Area Index	8
Distributed	Base Plot	Woody Wetlands	Digital Hemispherical Photos for Leaf Area Index	2
Distributed	Base Plot	Evergreen Forest	Herbaceous Biomass	10
Distributed	Base Plot	Shrub Scrub	Herbaceous Biomass	8
Distributed	Base Plot	Woody Wetlands	Herbaceous Biomass	2
Distributed	Base Plot	Evergreen Forest	Plant Diversity	12
Distributed	Base Plot	Shrub Scrub	Plant Diversity	11
Distributed	Base Plot	Woody Wetlands	Plant Diversity	7
Distributed	Base Plot	Evergreen Forest	Soil Biogeochemistry	3
Distributed	Base Plot	Shrub Scrub	Soil Biogeochemistry	2
Distributed	Base Plot	Woody Wetlands	Soil Biogeochemistry	1
Distributed	Base Plot	Evergreen Forest	Soil Microbes	3
Distributed	Base Plot	Shrub Scrub	Soil Microbes	2

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Woody Wetlands	Soil Microbes	1
Distributed	Base Plot	Evergreen Forest	Vegetation Structure	10
Distributed	Base Plot	Shrub Scrub	Vegetation Structure	8
Distributed	Base Plot	Woody Wetlands	Vegetation Structure	2

Note: Distributed Base Plots typically support more than one TOS protocol; 'Number of Plots' cannot be added to get total TOS Distributed Base Plot number.

Table 16: Number of Tower Plots per protocol at DEJU.

Plot Type	Plot Subtype	Protocols	Number of Plots
Tower	Base Plot	Canopy Foliage Chemistry	4
Tower	Base Plot	Coarse Downed Wood	20
Tower	Base Plot	Digital Hemispherical Photos for Leaf Area Index	3
Tower	Base Plot	Herbaceous Biomass	20
Tower	Base Plot	Litterfall and Fine Woody Debris	20
Tower	Base Plot	Mat-Forming Bryophyte Production	20
Tower	Base Plot	Plant Belowground Biomass	20
Tower	Base Plot	Plant Diversity	3
Tower	Base Plot	Soil Biogeochemistry	4
Tower	Base Plot	Soil Microbes	4
Tower	Base Plot	Vegetation Structure	20
Tower	Phenology	Plant Phenology	2

Note: Tower Base Plots typically support more than one TOS protocol; 'Number of Plots' cannot be added to get total TOS Tower Base Plot number.

5.2 Sampling Season Characterization: DEJU

For numerous TOS protocols, the length of the sampling season, the number of bouts, and when those bouts occur is dictated by the seasonal status of the plant community. By monitoring 'greenness' on a 16 day interval, the MODIS/Terra EVI phenology product provides consistent, reliable insight into plant community phenology and intensity at the continental scale. For those protocols for which timing is standardized by greenness transitions and/or peak green status, NEON has utilized these data as the primary means of guiding temporal aspects of TOS sampling at each site.

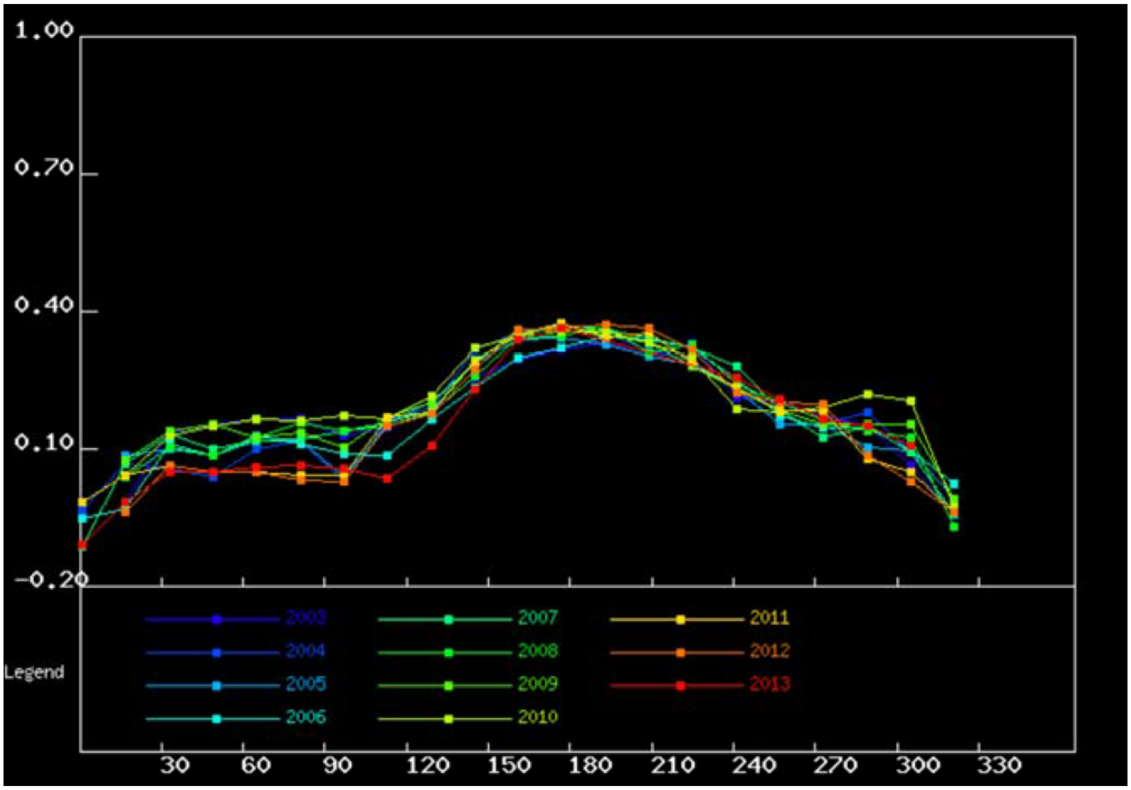

Figure 11: MODIS-EVI greenness (y-axis = EVI ratio) as a function of time (x-axis = DOY) for the years 2003-2013 at the NEON DEJU site.

Table 17: Average MODIS-EVI greenness dates for the NEON DEJU site, based on data from 2003-2013 (DOY, with MM/DD in parentheses).

Average Increase	Average Maximum	Average Decrease	Average Minimum
130 (05/11)	170 (06/20)	210 (07/30)	250 (09/08)

MODIS Product Details

- Product: MODIS-EVI phenology product, 16 day interval, 250 m grid, data included from all pixels with acceptable quality within user-defined square that roughly overlaps the TOS site boundary.
- Date range: 2003-2013
- User selected area: 14.25 km x 14.25 km box, centroid lat: 63.881252, centroid long: -145.75163 (WGS84 datum)

5.3 Belowground Biomass

5.3.1 Site-Specific Methods

Belowground biomass characterization data were collected down to a depth of 200 cm by NEON staff in June 2015. Since the NEON protocol for long-term, operational sampling of belowground biomass only collects data to a depth of 30 cm, the belowground biomass site characterization data are critical for scaling belowground biomass measurements to greater depths; see the TOS Science Design for Plant Biomass, Productivity, and Leaf Area Index (AD[7]) for more information. Samples were collected following the standard methods outlined in TOS Site Characterization Methods (RD[6]). Roots were sorted to two diameter size categories ($\leq$ 4 mm and 4-30 mm) and by root status (live or dead). The tables below summarize all the belowground biomass less than or equal to 30 mm diameter; size class data and more information can be found by searching the NEON data portal for the data product numbers in Appendix A.

At DEJU, the C horizon layer started at 72cm and no roots were found after this depth.

5.3.2 Results

Table 18: Soil Pit Information at DEJU.

Latitude	Longitude	Soil Family	Soil Order
63.87983	-145.74765	Coarse-loamy - mixed - superactive Typic Haplocryepts	Inceptisol

Soil Profile was described by Natural Resource Conservation Service (NRCS).

Table 19: Fine root mass per depth increment (cm) at DEJU.

Upper Depth	Lower Depth	Mean (mg per cm^3)	Std Dev
0	10	28.48	9.16
10	20	2.72	1.14
20	30	2.74	2.2
30	40	0.29	0.4
40	50	0.01	0.01
50	60	0.02	0.02
60	70	0.01	0.01
70	80	0.01	0.01
80	90	0	0
90	100	0	0
100	120	0	0
120	140	0	0

Upper Depth	Lower Depth	Mean (mg per cm^3)	Std Dev
140	160	0	0
160	180	0	0
180	200	0	0

Note: The C horizon layer started at 72cm.

Table 20: Cumulative fine root mass as a function of depth (cm) at DEJU.

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
0	10	2848.46	916.47
10	20	3120.46	1012.46
20	30	3394.37	867.35
30	40	3422.88	886.1
40	50	3423.61	886.54
50	60	3425.79	888.37
60	70	3427.14	889.13
70	80	3427.74	889.58
80	90	3427.91	889.71
90	100	3427.91	889.71
100	120	3427.91	889.71
120	140	3427.91	889.71
140	160	3427.91	889.71
160	180	3427.91	889.71
180	200	3427.91	889.71

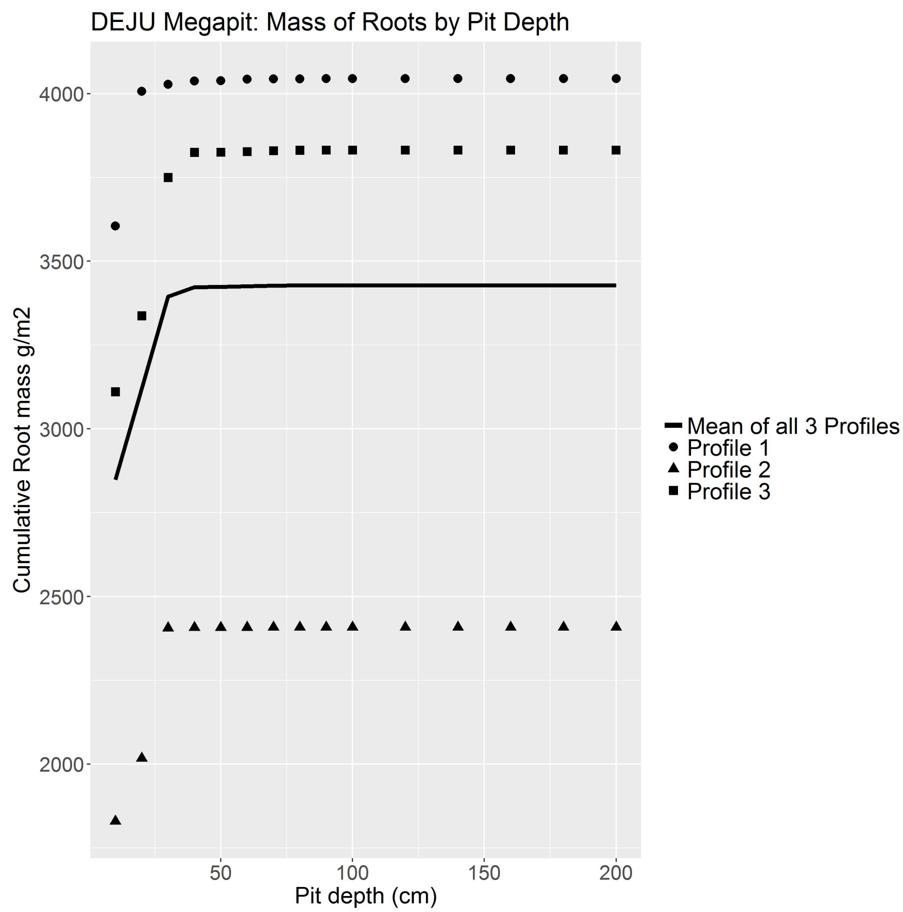

Figure 12: Cumulative root mass by pit depth at DEJU.

Table 21: Fine root biomass sampling summary data at DEJU.

Total Pit Depth (cm)	200
Total Mean Cumulative Mass at 30cm (g per m^2)	3394.37
Total Mean Cumulative Mass at 100cm (g per m^2)	3427.91
Total Mean Cumulative Mass (g per m^2)	3427.91

5.4 Plant Characterization and Phenology Species Selection

5.4.1 Site-Specific Methods

Plant characterization data were collected by NEON staff during June of 2015. Plant characterization data inform sampling procedures for plant phenology and plant productivity protocols.

The overall ranking ("Rank" in the table below) was calculated based on three separate measurements. Overall ranking weights are influenced by the number of species within each grouping.

1. Mean percent cover values were calculated based on species specific cover estimation for all plant species under 3m tall in eight 1m by 1m subplots per plot; see the TOS Protocol and Procedure: Plant Diversity Sampling (RD[09]) for more information.
2. Mean canopy area values were calculated based on all species specific shrub canopy diameter measurements within the entire plot or subplot; see the TOS Protocol and Procedure: Measurement of Vegetation Structure (RD[10]) for more information.
3. Mean ABH (area at breast height) measurements were calculated based on diameter at breast height measurements for all woody vegetation with a diameter greater than 1cm at 130cm height within the entire plot or subplot; see the TOS Protocol and Procedure: Measurement of Vegetation Structure (RD[10]) for more information.

The standard field methods and ranking calculations are further outlined in TOS Site Characterization Methods (RD[6]). For more information on this protocol and data product numbers see Appendix A. .

5.4.2 Results

Table 22: Site plant characterization and phenology species summary at DEJU.

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
PIMA	*Picea mariana* (Mill.) Britton, Sterns & Poggenb.	1	9	0.04	11.93
VAVI	*Vaccinium vitis-idaea* L.	2	26	NA	NA
BEGL/BENA	*Betula glandulosa* or *nana*	3	6	0.02	NA
EMNI	*Empetrum nigrum* L.	4	4	NA	NA
POTR5	*Populus tremuloides* Michx.	5	<1	<1	0.45
ALVI5	*Alnus viridis* (Chaix) DC.	6	<1	<1	NA
VAUL	*Vaccinium uliginosum* L.	7	3	NA	NA
LEPAD	*Ledum palustre* L. ssp. *decumbens* (Aiton) Hultén	8	2	NA	NA
GELI2	*Geocaulon lividum* (Richardson) Fernald	9	1	NA	NA
ARUV	*Arctostaphylos uva-ursi* (L.) Spreng.	10	<1	NA	NA

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
CABI5	*Carex bigelowii* Torr. ex Schwein. or *NA* Torr. ex Schwein.	11	<1	NA	NA
POAR2	*Poa arctica* R. Br.	12	<1	NA	NA
SALIX	*Salix* sp.	13	NA	<1	NA
POACEA	Poaceae sp.	14	<1	NA	NA
LEGR	*Ledum groenlandicum* Oeder	15	<1	NA	NA
VAOX	*Vaccinium oxycoccos* L.	16	<1	NA	NA
COCA13	*Cornus canadensis* L.	17	<1	NA	NA
ROAC	*Rosa acicularis* Lindl.	18	<1	NA	NA
SAAR27	*Salix arctica* Pall.	21	<1	NA	NA
SAAL	*Salix alaxensis* (Andersson) Coville	22	<1	<1	NA
PELA	*Pedicularis labradorica* Wirsing	23	<1	NA	NA
ARFR2	*Arnica frigida* C.A. Mey. ex Iljin	25	<1	NA	NA
PEFR5	*Petasites frigidus* (L.) Fr.	26	<1	NA	NA
CACA11	*Carex canescens* L.	27	<1	NA	NA
SARE2	*Salix reticulata* L.	27	<1	NA	NA
POBA2	*Populus balsamifera* L.	29	NA	NA	0.01
DAFR6	*Dasiphora fruticosa* (L.) Rydb.	30	<1	NA	NA
PELA14	*Pedicularis lanata* Cham. & Schltdl.	30	<1	NA	NA
CHAN9	*Chamerion angustifolium* (L.) Holub	32	<1	NA	NA
GABO2	*Galium boreale* L.	32	<1	NA	NA
LUAR2	*Lupinus arcticus* S. Watson	32	<1	NA	NA
ARRU	*Arctostaphylos rubra* (Rehder & Wilson) Fernald	35	<1	NA	NA
EQPR	*Equisetum pratense* Ehrh.	35	<1	NA	NA
ERIGE2	*Erigeron* sp.	35	<1	NA	NA
JUNCAC	Juncaceae sp.	35	<1	NA	NA

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
ORSE	*Orthilia secunda* (L.) House	35	<1	NA	NA
PYAS	*Pyrola asarifolia* Michx.	35	<1	NA	NA
SAOF3	*Sanguisorba officinalis* L.	35	<1	NA	NA
VIED	*Viburnum edule* (Michx.) Raf.	35	<1	NA	NA
CALA11	*Carex lasiocarpa* Ehrh.	43	<1	NA	NA
COSU4	*Cornus suecica* L.	43	<1	NA	NA
EQSC	*Equisetum scirpoides* Michx.	43	<1	NA	NA
EQSY	*Equisetum sylvaticum* L.	43	<1	NA	NA
PESU	*Pedicularis sudetica* Willd.	43	<1	NA	NA
STELL	*Stellaria* sp.	43	<1	NA	NA
STLO2	*Stellaria longipes* Goldie	43	<1	NA	NA

Note: Taxon IDs and scientific names are based on the USDA Plants database (plants.usda.gov).

Table 23: Per plot breakdown of species richness, diversity, and herbaceous cover at DEJU.

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover	Bryophyte Percent Cover
DEJU_045	13	2.03	114	1.56
DEJU_046	19	1.64	100	37.62
DEJU_047	20	2.2	117	71.25
DEJU_048	11	1.56	105	68.75
DEJU_049	21	2.14	147	62.5
DEJU_050	11	1.76	111	20.75
DEJU_051	9	1.27	92	69.12
DEJU_052	13	1.92	101	1.12
DEJU_053	5	1.14	111	61.38
DEJU_054	18	1.77	83	43.69
DEJU_055	10	1.8	77	21.69
DEJU_056	14	2.16	65	0.75
DEJU_057	20	2.17	145	40.62

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover	Bryophyte Percent Cover
DEJU_058	12	1.71	75	74.38
DEJU_059	10	1.85	83	10
DEJU_060	10	1.51	90	82.29
DEJU_061	17	2.23	104	10.31
DEJU_062	12	1.81	84	48.81
DEJU_063	10	1.35	54	61
DEJU_064	10	1.47	74	30
Bryophyte Mean				40.88

Note: Percent herbaceous cover was measured by species and then added together to calculate the percent total herbaceous cover for each plot.

According to AD[07], sites qualify for bryophyte productivity sampling when average bryophyte cover is $\geq$ 20% across all Tower plots. However, bryophyte productivity sampling was discontinued in 2018 and NEON no longer implements this protocol.

5.5 Beetles

5.5.1 Site-Specific Methods

Beetle site characterization was conducted in September of 2013 by NEON staff following the standard methods outlined in TOS Site Characterization Methods (RD[6]). Beetle site characterization data were collected to start site level teaching collections. All samples were pooled before identification. For more information on this protocol and data product numbers see Appendix A.

5.5.2 Results

Table 24: Beetle identification results at DEJU.

Sample ID	Scientific Name	Sex
NEON8168	*Calathus ingratus*	M
NEON8170	*Calathus ingratus*	F
NEON8171	*Calathus ingratus*	M
NEON8172	*Calathus ingratus*	M
NEON8173	*Calathus ingratus*	U
NEON8175	*Calathus ingratus*	F

Sample ID	Scientific Name	Sex
NEON8176	*Calathus ingratus*	F
NEON8178	*Calathus ingratus*	M
NEON8177	*Cymindis vaporariorum*	F
NEON8169	*Pterostichus adstrictus*	M
NEON8174	*Pterostichus adstrictus*	M

5.6 Mosquitoes

5.6.1 Site-Specific Methods

Mosquito site characterization was conducted in September of 2013 by NEON staff following the standard methods outlined in TOS Site Characterization Methods (RD[6]) to test protocol methods and start site level species lists. No pathogen testing was performed. All samples were pooled before identification. For more information on this protocol and data product numbers see Appendix A.

5.6.2 Results

Table 25: Mosquito identification results at DEJU.

Sample ID	Scientific Name	Count
DEJU.September2013.SC.1	*Aedes vexans*	2
DEJU.September2013.SC.1	*Aedes* spp.	1
DEJU.September2013.SC.1	*Anopheles* spp.	1
DEJU.September2013.SC.1	*Culiseta* spp.	6

5.7 Ticks

5.7.1 Site-Specific Methods

Tick site characterization was conducted in September of 2013 by NEON staff following the standard methods outlined in TOS Site Characterization Methods (RD[6]) to test protocol methods and start site level species lists. No ticks were collected. For more information on this protocol and data product numbers see Appendix A.

5.8 Species Reference Lists

A review of the literature for taxonomic lists of interest for each site was conducted prior to field work. In the case of vertebrates that NEON may capture (e.g., reptiles, amphibians, small mammals), these lists were often required to secure permits. Key references identified in this effort are listed below. Species lists and associated references for small mammals and breeding landbirds can be found in the appendices of the respective protocols (RD[07], RD[08]).

Bousquet, Y. 2012. Catalogue of Geadephaga (Coleoptera, Adephaga) of America, north of Mexico. ZooKeys, (245), 1-1722.

Centers for Disease Control and Prevention. (2015). *Geographic distribution of ticks that bite humans.* Retrieved from http://www.cdc.gov/ticks/geographic_distribution.html

Chapin, F.S., III, T. Hollingsworth, D.F. Murray, L.A. Viereck, and M.D. Walker. 2006. Floristic diversity and vegetation distribution in the Alaskan boreal forest. p. 81-99. In F.S. Chapin III et al. (ed.) Alaska's changing boreal forest. Oxford Univ. Press, New York.

Darsie Jr., R. F., and R. A. Ward. 2005. Identification and geographical distribution of the mosquitoes of North America, North of Mexico. University Press of Florida, Gainesville.

Pink, T. 2008. Soil survey of the Greater Delta area, Alaska. U.S. Gov. Print. Office, Washington, DC

Viereck, L.A., C.T. Dyrness, K. Van Cleve, and M.J. Foote. 1983. Vegetation, soils, and forest productivity in selected forest types in interior Alaska. Can. J. For. Res. 13:703-720

Weber, N.A., 1950. A survey of the insects and related arthropods of Arctic Alaska. Part I. Transactions of the American Entomological Society (1890-), 76(3), pp.147-206.

6 RELOCATABLE SITE 2- HEALY (HEAL)

HEAL is located 120 kilometers southwest of Fairbanks and north of Denali National Park. Unlike BONA or DEJU, the HEAL site is not forested and mostly consists of dwarf shrubs. This upland area features widespread permafrost thawing and can serve as an important study site for the near-future fate of other permafrost systems of Alaska (Osterkamp, 2009).

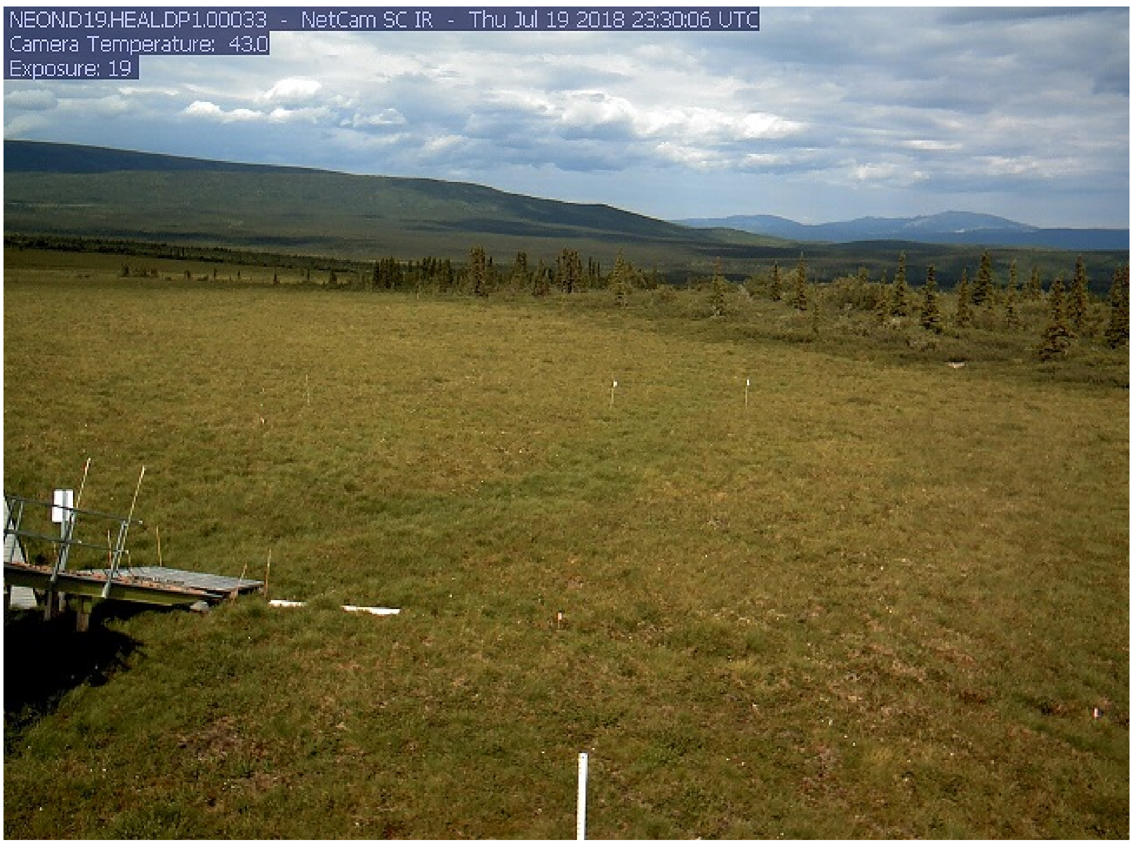

Figure 13: Phenocamera image for HEAL. The phenocamera is located at the top of the NEON tower and faces north. Phenocamera images are available at https://phenocam.sr.unh.edu/webcam/network/table/.

Key Characteristics:

- Site host: Alaska Department of Natural Resources
- Located in: Denali Borough, Alaska
- Sampling Area: 45.6 km^2
- Plot Elevation: 580-720m
- Dominant vegetation type: The TOS sampling boundary at HEAL includes wide areas or dwarf shrub dominated by birch (*Betula nana* or *glandulosa*) and *Vaccinium*. Stands of black spruce (*Picea mariana*) dot the landscape and bands of willow (*Salix pulchra*) and alder (*Alnus* sp.) increase with elevation changes.
- General management: HEAL is open to the public and is a popular destination for hunting, berry picking,

snowmobiling, and dog sledding.

- Plot Selection: NEON TOS Plots were allocated across the site following NEON standard criteria and avoiding existing research.

6.1 TOS Spatial Sampling Design

TOS Distributed Plots were allocated at HEAL according to a spatially balanced and stratified-random design (RD[3]). The 2001 National Land Cover Database (NLCD) was selected for stratification because of the consistent and comparable data availability across the United States. TOS Tower Plots were allocated according to a spatially balanced design in and around the NEON tower airshed (RD[03]). The maps below depict the plot locations for the first year of NEON sampling. Some plot locations may change over time due to logistics, safety, and science requirements. Please visit the NEON website (http://www.neonscience.org) for updated plot locations at each site.

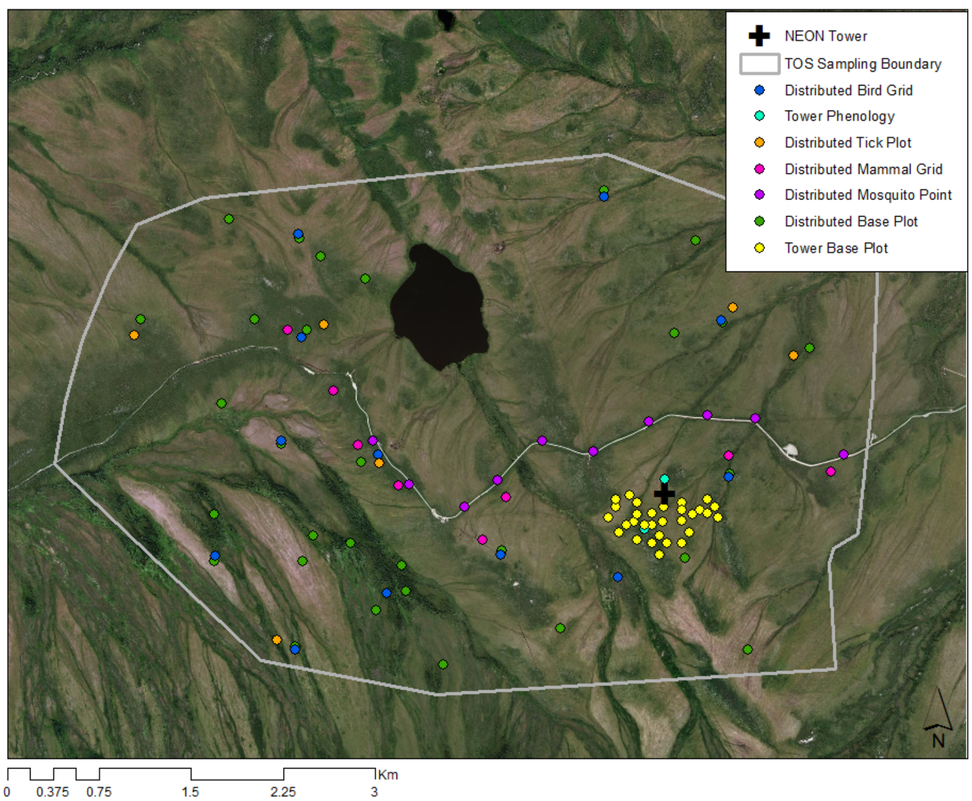

Figure 14: Map of TOS plot centroids within the NEON TOS sampling boundary at HEAL.

For a list of protocols associated with each plot see tables below; for additional spatial design information see RD[03].

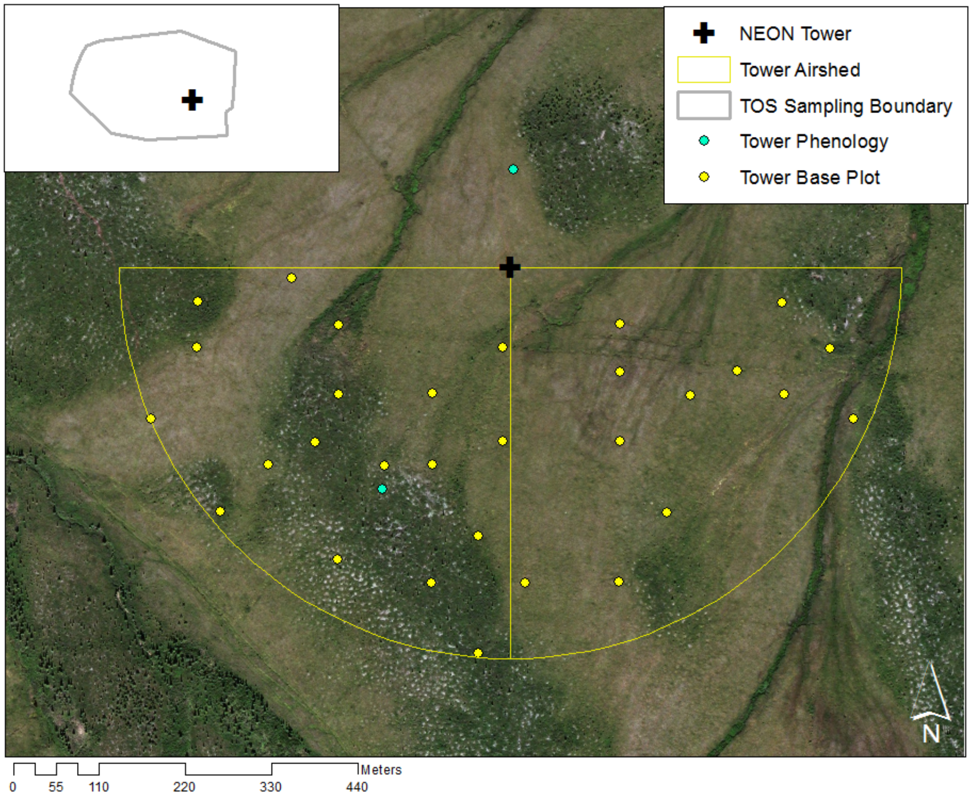

Figure 15: Map of the tower airshed and TOS plot centroids at HEAL.

More information about the tower airshed can be found in the TIS site characterization report (RD[04]).

Table 26: NLCD land cover classes and area within the TOS site boundary at HEAL.

NLCD Class	Site Area (km^2)	Percent (%)
Shrub Scrub	31.83	70.46
Dwarf Scrub	8.89	19.68
Evergreen Forest	3.13	6.93
Open Water	0.52	1.15
Mixed Forest	0.44	0.98
Developed Low Intensity	0.22	0.49
Deciduous Forest	0.11	0.25
Sedge Herbaceous	0.02	0.04
Developed Open Space	0.01	0.01

Note: Any NLCD land cover classes less than 5% will not be sampled. Additionally, no sampling will take place in Water, Developed, or Barren Land NLCD classes.

Table 27: NLCD land cover classes and TOS plot numbers at HEAL.

Plot Type	Plot Subtype	NLCD Class	Number of Plots Established
Distributed	Base Plot	Dwarf Scrub	9
Distributed	Base Plot	Evergreen Forest	5
Distributed	Base Plot	Shrub Scrub	16
Distributed	Bird Grid	Dwarf Scrub	2
Distributed	Bird Grid	Shrub Scrub	7
Distributed	Mammal Grid	Dwarf Scrub	1
Distributed	Mammal Grid	Shrub Scrub	5
Distributed	Mosquito Point	Dwarf Scrub	2
Distributed	Mosquito Point	Shrub Scrub	8
Distributed	Tick Plot	Dwarf Scrub	1
Distributed	Tick Plot	Evergreen Forest	1
Distributed	Tick Plot	Shrub Scrub	4
Tower	Base Plot	NA	30
Tower	Phenology Plot	NA	2

Note: NLCD land cover classes are not used to stratify Tower Plots which are located in and around the NEON tower airshed. The dominant NLCD land cover types within the airshed include shrub scrub and dwarf scrub.

Table 28: Number of Distributed Base plots per NLCD land cover class per protocol at HEAL.

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Dwarf Scrub	Beetles	2
Distributed	Base Plot	Evergreen Forest	Beetles	1
Distributed	Base Plot	Shrub Scrub	Beetles	7
Distributed	Base Plot	Dwarf Scrub	Canopy Foliage Chemistry	2
Distributed	Base Plot	Evergreen Forest	Canopy Foliage Chemistry	1
Distributed	Base Plot	Shrub Scrub	Canopy Foliage Chemistry	7
Distributed	Base Plot	Dwarf Scrub	Coarse Downed Wood	4
Distributed	Base Plot	Evergreen Forest	Coarse Downed Wood	2
Distributed	Base Plot	Shrub Scrub	Coarse Downed Wood	14
Distributed	Base Plot	Dwarf Scrub	Digital Hemispherical Photos for Leaf Area Index	4

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Evergreen Forest	Digital Hemispherical Photos for Leaf Area Index	2
Distributed	Base Plot	Shrub Scrub	Digital Hemispherical Photos for Leaf Area Index	14
Distributed	Base Plot	Dwarf Scrub	Herbaceous Biomass	4
Distributed	Base Plot	Evergreen Forest	Herbaceous Biomass	2
Distributed	Base Plot	Shrub Scrub	Herbaceous Biomass	14
Distributed	Base Plot	Dwarf Scrub	Plant Diversity	9
Distributed	Base Plot	Evergreen Forest	Plant Diversity	5
Distributed	Base Plot	Shrub Scrub	Plant Diversity	16
Distributed	Base Plot	Dwarf Scrub	Soil Biogeochemistry	1
Distributed	Base Plot	Evergreen Forest	Soil Biogeochemistry	1
Distributed	Base Plot	Shrub Scrub	Soil Biogeochemistry	4
Distributed	Base Plot	Dwarf Scrub	Soil Microbes	1
Distributed	Base Plot	Evergreen Forest	Soil Microbes	1
Distributed	Base Plot	Shrub Scrub	Soil Microbes	4
Distributed	Base Plot	Dwarf Scrub	Vegetation Structure	4
Distributed	Base Plot	Evergreen Forest	Vegetation Structure	2
Distributed	Base Plot	Shrub Scrub	Vegetation Structure	15

Note: Distributed Base Plots typically support more than one TOS protocol; 'Number of Plots' cannot be added to get total TOS Distributed Base Plot number.

Table 29: Number of Tower Plots per protocol at HEAL.

Plot Type	Plot Subtype	Protocols	Number of Plots
Tower	Base Plot	Canopy Foliage Chemistry	4
Tower	Base Plot	Coarse Downed Wood	30
Tower	Base Plot	Digital Hemispherical Photos for Leaf Area Index	3
Tower	Base Plot	Herbaceous Biomass	30
Tower	Base Plot	Litterfall and Fine Woody Debris	30
Tower	Base Plot	Mat-Forming Bryophyte Production	30
Tower	Base Plot	Plant Belowground Biomass	30
Tower	Base Plot	Plant Diversity	3
Tower	Base Plot	Soil Biogeochemistry	4
Tower	Base Plot	Soil Microbes	4

Plot Type	Plot Subtype	Protocols	Number of Plots
Tower	Base Plot	Vegetation Structure	30
Tower	Phenology	Plant Phenology	2

Note: Tower Base Plots typically support more than one TOS protocol; 'Number of Plots' cannot be added to get total TOS Tower Base Plot number.

6.2 Sampling Season Characterization: HEAL

For numerous TOS protocols, the length of the sampling season, the number of bouts, and when those bouts occur is dictated by the seasonal status of the plant community. By monitoring 'greenness' on a 16 day interval, the MODIS/Terra EVI phenology product provides consistent, reliable insight into plant community phenology and intensity at the continental scale. For those protocols for which timing is standardized by greenness transitions and/or peak green status, NEON has utilized these data as the primary means of guiding temporal aspects of TOS sampling at each site.

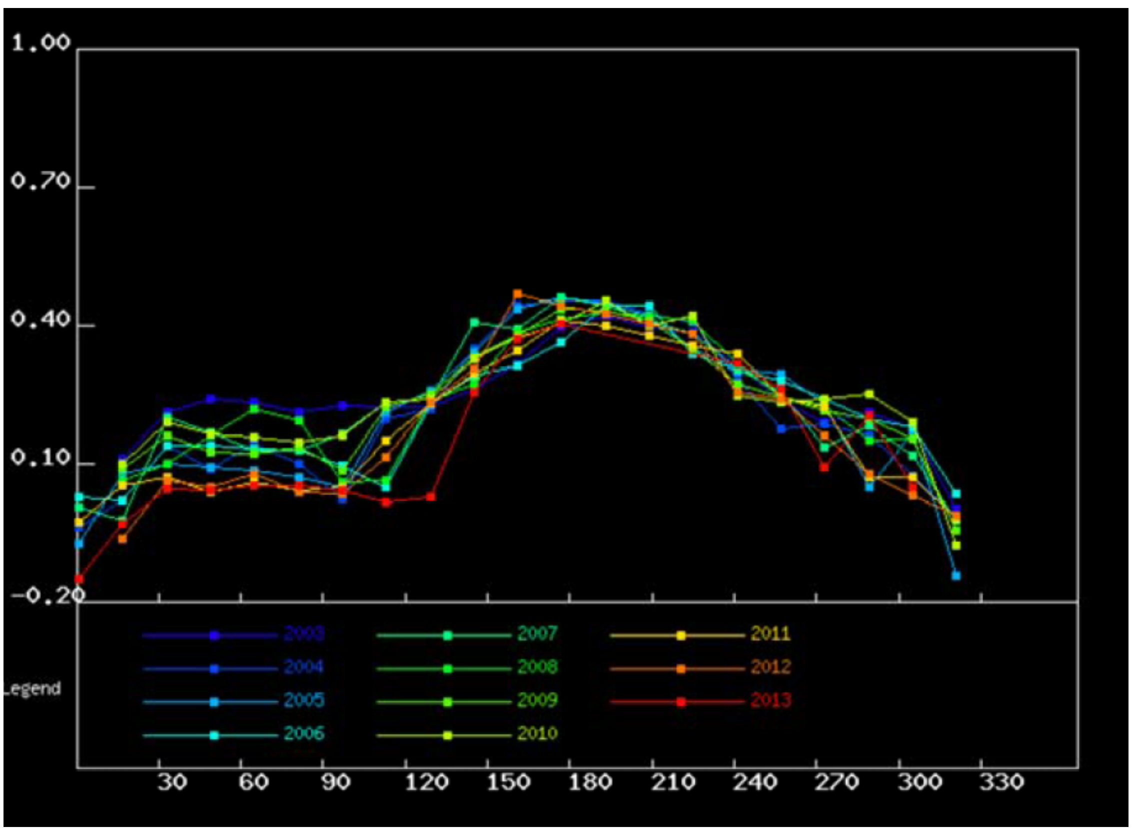

Figure 16: MODIS-EVI greenness (y-axis = EVI ratio) as a function of time (x-axis = DOY) for the years 2003-2013 at the NEON HEAL site.

Table 30: Average MODIS-EVI greenness dates for the NEON HEAL site, based on data from 2003-2013 (DOY, with MM/DD in parentheses).

Average Increase	Average Maximum	Average Decrease	Average Minimum
135 (05/16)	180 (06/30)	210 (07/30)	245 (09/03)

MODIS Product Details

- Product: MODIS-EVI phenology product, 16 day interval, 250 m grid, data included from all pixels with acceptable quality within user-defined square that roughly overlaps the TOS site boundary.
- Date range: 2003-2013
- User selected area: 10.25 km x 10.25 km box, centroid lat: 63.875841, centroid long: -149.21324

6.3 Belowground Biomass

6.3.1 Site-Specific Methods

Belowground biomass characterization data were collected down to a depth of 85 cm by NEON staff in November 2015. Since the NEON protocol for long-term, operational sampling of belowground biomass only collects data to a depth of 30 cm, the belowground biomass site characterization data are critical for scaling belowground biomass measurements to greater depths; see the TOS Science Design for Plant Biomass, Productivity, and Leaf Area Index (AD[7]) for more information. Samples were collected following the standard methods outlined in TOS Site Characterization Methods (RD[6]). Roots were sorted to two diameter size categories ($\leq$ 2 mm and 2-30 mm) and by root status (live or dead). The tables below summarize all the belowground biomass less than or equal to 30 mm diameter; size class data and more information can be found by searching the NEON data portal for the data product numbers in Appendix A.

Belowground biomass sampling in the permafrost presented a unique set of challenges, and deviations from the standard sampling workflow are outlined below.

Field: In order to decrease disturbance, soil cores were collected during the winter when frozen conditions allowed equipment to be transported. A coring machine was used to ensure that soil was not mixed while extracted. Three cores were limited to a maximum depth of 85cm due to equipment limitation. The cores were kept frozen until they could be processed. HEAL cores were taken at Latitude 63.8798, Longitude -149.21539.

Processing Cores: Cores were split while frozen into 10cm depth increments using a handsaw and chisel. After the samples were thawed it was discovered that 0-10 depth layer also included above ground plant matter and litter. To maintain consistency with the other soil pits, the depth increments were shifted for the entire core so that “0” indicates where the soil started and not the upper limit of the soil core. For example, for HEAL core 1-46 what was initially called the “0-10” layer was in fact 0-2cm above ground plant material and 2-8cm soil. Subsequent depth increments were shifted so 10-20 cm became 8-18cm, 20-30 cm became 18-28 cm, etc. HEAL cores 1-21 and 1-42 were too degraded after thawing to determine a soil line.

Due to the extremely high density of fine roots, core samples were divided length-wise into quarters for per depth increment, and a random subsample was selected for sieving and sorting. Because the majority of the samples were dense with fine roots and roots were relatively homogeneously distributed, we are confident that subsampling did not affect final root dry mass values.

Sieving: We had low confidence in out ability to distinguish live vs. dead roots isolated from arctic tundra soils. To maintain consistency with the standard sampling workflow, roots that could not be confidently parsed were assumed to be 'live.'Additionally, distinguishing roots from other plant material was challenging, due to the fact that some dominant species (e.g., *Eriophorum vaginatum*) have thin, flat roots with no branching patterns, and thus have a root morphology that mimics small graminoid leaf litter. There are also moss skeleton structures that are difficult to distinguish from roots. To ensure consistent sorting given these challenges, a list of morphological criteria was developed, and this checklist was used for all samples.

6.3.2 Results

Table 31: Fine root mass per depth increment (cm) at HEAL.

Upper Depth	Lower Depth	Mean (mg per cm^3)	Std Dev
0	8-10	26.91	26.47
8-10	18-20	7.73	5.92
18-20	28-30	9.84	6.51
28-30	38-40	4.68	4.87
38-40	48-50	7.71	5.73
48-50	58-60	2.42	1.58
58-60	68-70	0.85	0.75
68-70	78-80	0.51	0.38
78-80	83-85	0.35	0.53

Note: The upper and lower depth values reflect the ranges between the three cores. See the “Processing Cores” section above for more information.

Table 32: Cumulative fine root mass as a function of depth (cm) at HEAL.

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
0	8-10	2604.42	2718.62
8-10	18-20	3377.38	3296.39
18-20	28-30	4361.84	3771.79
28-30	38-40	4829.56	3753.26
38-40	48-50	5600.26	4080.01
48-50	58-60	5842.35	4176.89

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
58-60	68-70	5927.58	4246.98
68-70	78-80	5978.34	4283.25
78-80	83-85	5995.92	4308.15

Note: The upper and lower depth values reflect the ranges between the three cores. See the "Processing Cores" section above for more information.

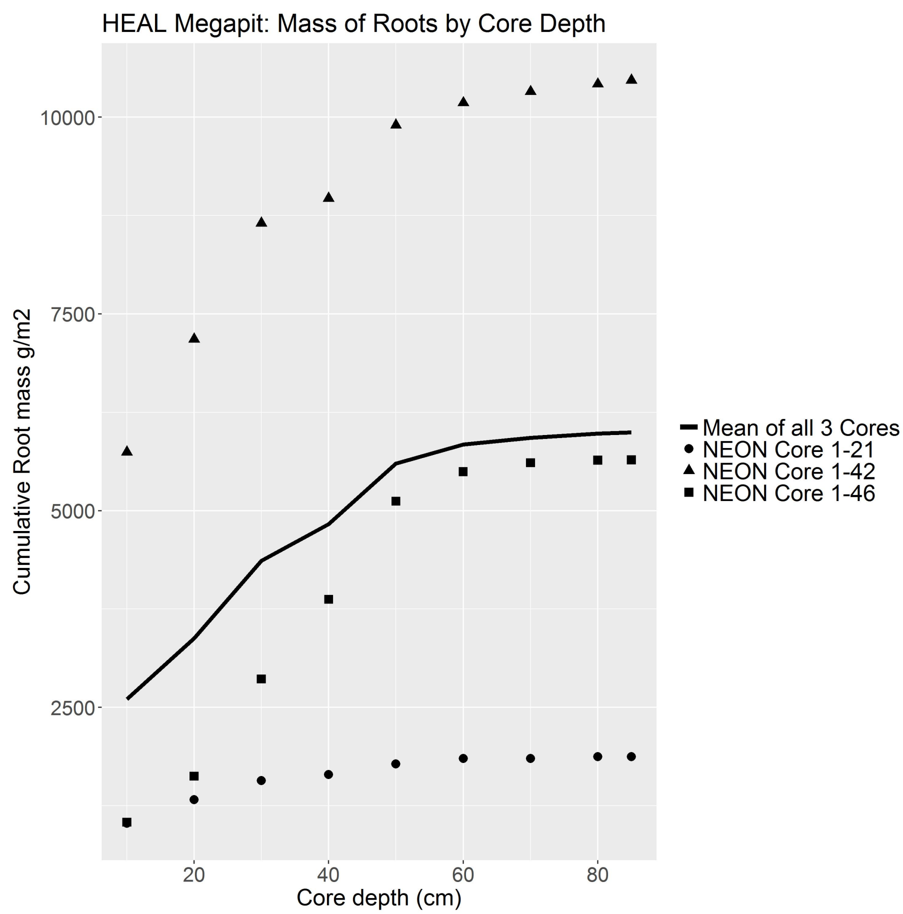

Figure 17: Cumulative root mass by core depth at HEAL.

Table 33: Fine root biomass sampling summary data at HEAL.

Total Mean Core Depth (cm)	84
Total Mean Cumulative Mass at 30cm (g per m^2)	4361.84
Total Mean Cumulative Mass at 100cm (g per m^2)	NA
Total Mean Cumulative Mass (g per m^2)	5995.92

6.4 Plant Characterization and Phenology Species Selection

6.4.1 Site-Specific Methods

Plant characterization data were collected by NEON staff during June of 2015. Plant characterization data inform sampling procedures for plant phenology and plant productivity protocols.

The overall ranking ("Rank" in the table below) was calculated based on three separate measurements. Overall ranking weights are influenced by the number of species within each grouping.

1. Mean percent cover values were calculated based on species specific cover estimation for all plant species under 3m tall in eight 1m by 1m subplots per plot; see the TOS Protocol and Procedure: Plant Diversity Sampling (RD[09]) for more information.
2. Mean canopy area values were calculated based on all species specific shrub canopy diameter measurements within the entire plot or subplot; see the TOS Protocol and Procedure: Measurement of Vegetation Structure (RD[10]) for more information.
3. Mean ABH (area at breast height) measurements were calculated based on diameter at breast height measurements for all woody vegetation with a diameter greater than 1cm at 130cm height within the entire plot or subplot; see the TOS Protocol and Procedure: Measurement of Vegetation Structure (RD[10]) for more information.

The standard field methods and ranking calculations are further outlined in TOS Site Characterization Methods (RD[6]). For more information on this protocol and data product numbers see Appendix A.

6.4.2 Results

Table 34: Site plant characterization and phenology species summary at HEAL.

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
BEGL/BENA	*Betula glandulosa* or *nana*	1	11	0.15	NA
PIGL	*Picea glauca* (Moench) Voss	2	1	<1	0.11
LEPA11	*Ledum palustre* L.	3	8	NA	NA
VAUL	*Vaccinium uliginosum* L.	4	8	<1	NA
VAVI	*Vaccinium vitis-idaea* L.	5	6	NA	NA
SAPU15	*Salix pulchra* Cham.	6	<1	0.03	NA
PIMA	*Picea mariana* (Mill.) Britton, Sterns & Poggenb.	7	<1	<1	0.02
EMNI	*Empetrum nigrum* L.	8	2	NA	NA

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
CABI5	*Carex bigelowii* Torr. ex Schwein. or *NA* Torr. ex Schwein.	9	2	NA	NA
SAGL	*Salix glauca* L.	10	<1	0.01	NA
RUCH	*Rubus chamaemorus* L.	11	1	NA	NA
ERVA4	*Eriophorum vaginatum* L.	12	1	NA	NA
BEOC2	*Betula occidentalis* Hook.	13	NA	0.01	NA
PEFR5	*Petasites frigidus* (L.) Fr.	14	<1	NA	NA
ANPO	*Andromeda polifolia* L.	15	<1	NA	NA
VAOX	*Vaccinium oxycoccos* L.	16	<1	NA	NA
POACEA	Poaceae sp.	17	<1	NA	NA
LOPR	*Loiseleuria procumbens* (L.) Desv.	18	<1	NA	NA
ERAN6	*Eriophorum angustifolium* Honck.	19	<1	NA	NA
CAST36	*Calamagrostis stricta* (Timm) Koeler	20	<1	NA	NA
ARAL2	*Arctostaphylos alpina* (L.) Spreng.	21	<1	NA	NA
CARO5	*Carex rossii* Boott	22	<1	NA	NA
SABE2	*Salix bebbiana* Sarg.	23	NA	<1	NA
CASTI3	*Calamagrostis stricta* (Timm) Koeler ssp. *inexpansa* (A. Gray) C.W. Greene	24	<1	NA	NA
LYAN2	*Lycopodium annotinum* L.	25	<1	NA	NA
POBI5	*Polygonum bistorta* L.	26	<1	NA	NA
PELA	*Pedicularis labradorica* Wirsing	27	<1	NA	NA
PIVI	*Pinguicula villosa* L.	27	<1	NA	NA
SPST3	*Spiraea stevenii* (C.K. Schneid.) Rydb.	27	<1	NA	NA
CHANA2	*Chamerion angustifolium* (L.) Holub ssp. *angustifolium*	30	<1	NA	NA

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
DAFRF	*Dasiphora fruticosa* (L.) Rydb. ssp. *floribunda* (Pursh) Kartesz or *NA* (L.) Rydb. ssp. *floribunda* (Pursh) Kartesz	30	<1	NA	NA
ORSE	*Orthilia secunda* (L.) House	30	<1	NA	NA
ALVI5	*Alnus viridis* (Chaix) DC.	34	<1	NA	NA
APIACE	Apiaceae sp.	34	<1	NA	NA
ARLA2	*Arctagrostis latifolia* (R. Br.) Griseb.	34	<1	NA	NA
CAST10	*Carex stylosa* C.A. Mey.	34	<1	NA	NA
PEDIC	*Pedicularis* sp.	34	<1	NA	NA
PELA14	*Pedicularis lanata* Cham. & Schltdl.	34	<1	NA	NA
STLO2	*Stellaria longipes* Goldie	34	<1	NA	NA

Note: Taxon IDs and scientific names are based on the USDA Plants database (plants.usda.gov). *Orthilia secunda* is difficult to distinguish from other species in the *Pyrolaceae* family without flowers and may include misidentified *Pyrola grandifolia* and/or *Monicies unifolra*.

Table 35: Per plot breakdown of species richness, diversity, and herbaceous cover at HEAL.

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover	Bryophyte Percent Cover
HEAL_045	10	2.07	27	29.86
HEAL_046	14	2.1	78	65.88
HEAL_047	12	1.89	83	25.75
HEAL_048	12	2.14	27	12.62
HEAL_049	12	2.24	26	34.62
HEAL_050	12	2.07	23	44.75
HEAL_051	10	1.62	56	73.75
HEAL_052	13	2.22	37	62.5
HEAL_053	14	2.1	58	64
HEAL_054	11	2.01	35	57.12
HEAL_055	9	1.91	56	22.62

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover	Bryophyte Percent Cover
HEAL_056	14	1.12	107	57.5
HEAL_057	13	1.94	86	71.75
HEAL_058	11	1.94	37	54.38
HEAL_059	19	1.78	181	50
HEAL_060	12	2.18	24	43.38
HEAL_061	12	1.84	72	42.38
HEAL_062	15	2.05	57	65.5
HEAL_063	16	2.31	45	59
HEAL_064	18	2.25	55	54.5
HEAL_065	12	2.18	75	46
HEAL_066	11	1.83	54	43.69
HEAL_067	14	2.29	24	50.25
HEAL_068	16	1.96	43	57.62
HEAL_069	21	2.45	81	58.25
HEAL_070	11	2.07	20	24.38
HEAL_071	10	1.79	44	24.88
HEAL_072	12	1.69	47	73.25
HEAL_073	19	1.76	138	75.75
HEAL_074	10	1.53	89	81.88
Bryophyte Mean				50.93

Note: Percent herbaceous cover was measured by species and then added together to calculate the percent total herbaceous cover for each plot.

According to AD[07], sites qualify for bryophyte productivity sampling when average bryophyte cover is $\geq$ 20% across all Tower plots. However, bryophyte productivity sampling was discontinued in 2018 and NEON no longer implements this protocol.

6.5 Beetles

6.5.1 Site-Specific Methods

Beetle site characterization was conducted in September of 2013 by NEON staff following the standard methods outlined in TOS Site Characterization Methods (RD[6]). Beetle site characterization data were collected to start site level teaching collections. For DNA sequence data generated as a result of these efforts, visit the Barcode of Life Datasystems (BOLD) at http://www.boldsystems.org. All samples were pooled before identification. For more information on this protocol and data product numbers see Appendix A.

6.5.2 Results

Table 36: Beetle identification results at HEAL.

Sample ID	Scientific Name	Sex
NEONcarabid8179	*Pterostichus* sp.	U
NEONcarabid8183	*Pterostichus* sp.	U
NEONcarabid8182	*Pterostichus* sp.	U
NEONcarabid8194	*Pterostichus adstrictus*	F
NEONcarabid8180	*Pterostichus* sp.	U
NEONcarabid8181	*Pterostichus* sp.	U
NEONcarabid8189	*Pterostichus* sp.	U
NEONcarabid8188	*Pterostichus* sp.	U
NEONcarabid8187	*Pterostichus* sp.	U
NEONcarabid8184	*Pterostichus* sp.	U
NEONcarabid8185	*Pterostichus* sp.	U
NEONcarabid8186	*Pterostichus* sp.	U

6.6 Mosquitoes

6.6.1 Site-Specific Methods

No mosquito site characterization was conducted at HEAL. For more information on this protocol and data product numbers see Appendix A.

6.7 Ticks

6.7.1 Site-Specific Methods

Tick site characterization was conducted in September of 2013 by NEON staff following the standard methods outlined in TOS Site Characterization Methods (RD[6]) to test protocol methods and start site level species lists. No ticks were collected. For more information on this protocol and data product numbers see Appendix A.

6.8 Species Reference Lists

A review of the literature for taxonomic lists of interest for each site was conducted prior to field work. In the case of vertebrates that NEON may capture (e.g., reptiles, amphibians, small mammals), these lists were often required to secure permits. Key references identified in this effort are listed below. Species lists and associated references for small mammals and breeding landbirds can be found in the appendices of the respective protocols (RD[07], RD[08]).

Bousquet, Y. 2012. Catalogue of Geadephaga (Coleoptera, Adephaga) of America, north of Mexico. ZooKeys, (245), 1-1722.

Centers for Disease Control and Prevention. (2015). *Geographic distribution of ticks that bite humans.* Retrieved from http://www.cdc.gov/ticks/geographic_distribution.html

Darsie Jr., R. F., and R. A. Ward. 2005. Identification and geographical distribution of the mosquitoes of North America, North of Mexico. University Press of Florida, Gainesville.

7 REFERENCES

Alaska Climatology, 2017. The Alaska Climate Research Center. Retrieved from: http://akclimate.org/Climate

Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and Wickham, J., 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States, *PE&RS*, Vol. 77(9):858-864.

Osterkamp, T.E., Jorgenson, M.T., Schuur, E.A.G., Shur, Y.L., Kanevskiy, M.Z., Vogel, J.G. and Tumskoy, V.E., 2009. Physical and ecological changes associated with warming permafrost and thermokarst in interior Alaska. Permafrost and Periglacial Processes, 20(3), pp.235-256.

USDA, NRCS. 2016. The PLANTS Database (http://plants.usda.gov, 1 August 2016). National Plant Data Team, Greensboro, NC 27401-4901 USA.

8 APPENDIX A: DATA PRODUCT NUMBERS

For more information on the sampling protocols and the latest observatory data visit http://data.neonscience.org/data-product-catalog and search by name or code number.

Table 37: NEON data product names and descriptions.

Name	Description	Identification Code
Root sampling (megapit)	Fine root biomass in 10cm increments (first 1m depth) and 20cm increments (from 1m to 2m depth) from soil pit sampling	NEON.DOM.SITE.DP1.10066

Name	Description	Identification Code
Soil physical properties (Megapit)	Soil taxonomy, horizon names, horizon depths, as well as soil bulk density, porosity, texture (sand, silt, and clay content) in the <= 2 mm soil fraction for each soil horizon. Data were derived from a sampling location expected to be representative of the area where the Instrumented Soil Plots per site are located and were collected once during site construction. Also see distributed soil data products.	NEON.DOM.SITE.DP1.00096
Soil chemical properties (Megapit)	Total content of a range of chemical elements, pH, and electrical conductivity in the <= 2 mm soil fraction for each soil horizon. Data were derived from a sampling location expected to be representative of the area where the Instrumented Soil Plots per site are located and were collected once during site construction. Also see distributed soil data products.	NEON.DOM.SITE.DP1.00097
Woody plant vegetation structure	Structure measurements, including height, canopy diameter, and stem diameter, as well as mapped position of individual woody plants	NEON.DOM.SITE.DP1.10098
Plant presence and percent cover	Plant species presence as observed in multi-scale plots: species and associated percent cover at 1-m2 and plant species presence at 10-m2, 100-m2 and 400-m2	NEON.DOM.SITE.DP1.10058
Plant phenology observations	Phenophase status and intensity of tagged plants	NEON.DOM.SITE.DP1.10055
Plant foliar stable isotopes	Field collection metadata describing the sampling of sun-lit canopy foliar tissues for stable isotope compositions. Also includes raw data returned from the laboratory.	NEON.DOM.SITE.DP1.10053
Plant foliar physical and chemical properties	Plant sun-lit canopy foliar physical (e.g., leaf mass per area) and chemical properties reported at the level of the individual.	NEON.DOM.SITE.DP1.10026
Non-herbaceous perennial vegetation structure	Field measurements of individual non-herbaceous perennial plants (e.g. cacti, ferns)	NEON.DOM.SITE.DP1.10045.
Ground beetles sampled from pitfall traps	Taxonomically identified ground beetles and the plots and times from which they were collected.	NEON.DOM.SITE.DP1.10022
Ground beetle sequences DNA barcode	CO1 DNA sequences from select ground beetles	NEON.DOM.SITE.DP1.10020
Mosquitoes sampled from CO2traps	Taxonomically identified mosquitoes and the plots and times from which they were collected	NEON.DOM.SITE.DP1.10043
Mosquito-borne pathogen status	Presence/absence of a pathogen in a single mosquito sample (pool)	NEON.DOM.SITE.DP1.10041

Name	Description	Identification Code
Mosquito sequences DNA barcode	CO1 DNA sequences from select mosquitoes	NEON.DOM.SITE.DP1.10038
Ticks sampled using drag cloths	Abundance and density of ticks collected by drag and/or flag sampling (by species and/or lifestage)	NEON.DOM.SITE.DP1.10093
Tick-borne pathogen status	Presence/absence of a pathogen in each single tick sample	NEON.DOM.SITE.DP1.10092