TOS SITE CHARACTERIZATION REPORT: DOMAIN 13

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CHANGE RECORD

REVISION	DATE	ECO#	DESCRIPTION OF CHANGE
A	4/20/2017	ECO-04593	Initial Release
B	11/19/2018	ECO-05656	• Added Phenocam images • Added Sampling Season Section • Added soil pit information table • 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 two sites in the Southern Rockies & Colorado Plateau 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.011064	TIS Site Characterization Report
RD[05]	NEON.DOC.002068	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 13 OVERVIEW: SOUTHERN ROCKIES & COLORADO PLATEAU DOMAIN

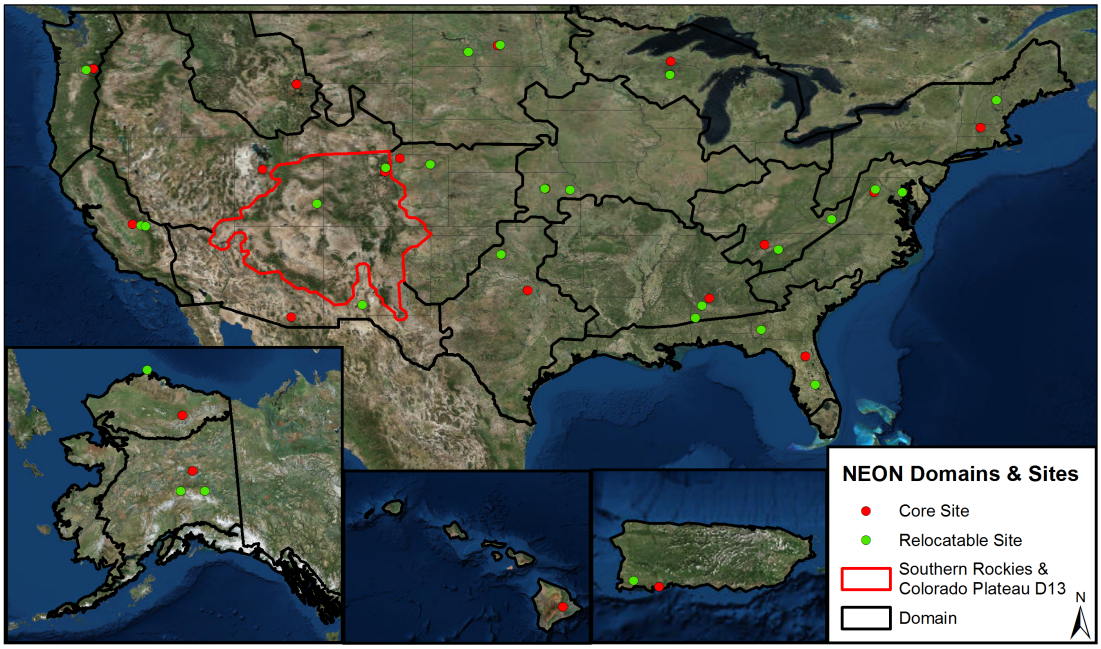

Figure 1: NEON project map with Domain 13 highlighted in red.

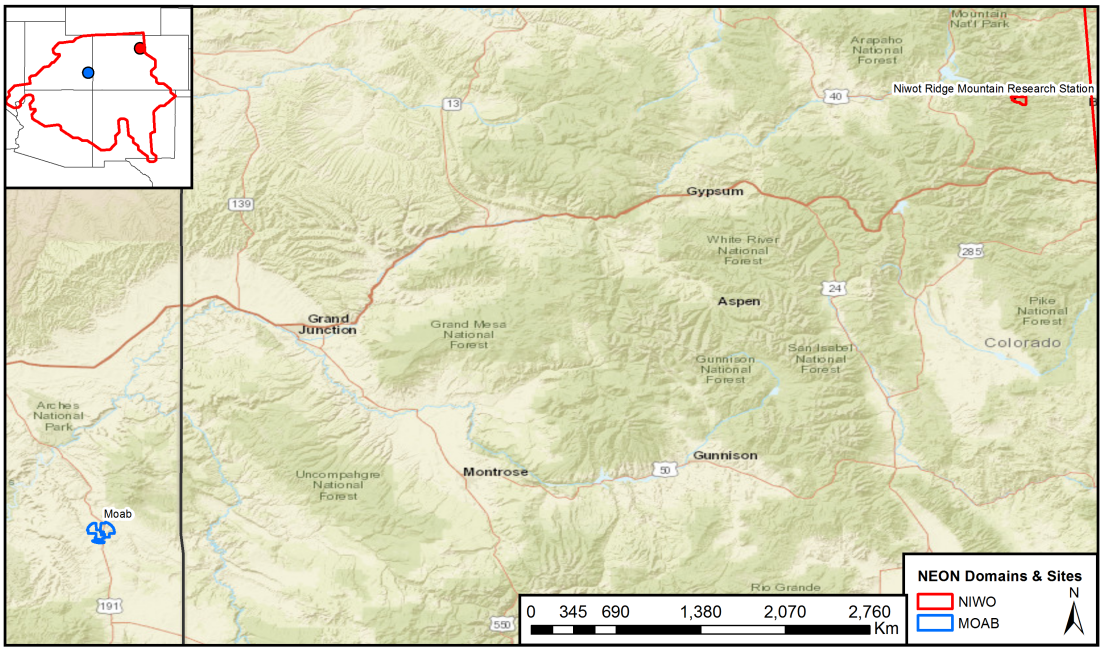

Figure 2: Site boundaries within Domain 13.

D13 NEON sites are designed to study NEON grand challenge questions centered around land use change, elevational gradient, climate impacts, and disturbance processes (e.g., dust deposition).

- States included in the domain: Arizona, Colorado, Nevada, New Mexico, Oklahoma, Texas, Utah, and Wyoming
- Core site: Niwot Ridge Mountain Research Station
- Relocatable 1: Moab
- Science themes: Climate Impacts

4 CORE SITE- NIWOT RIDGE MOUNTAIN RESEARCH STATION (NIWO)

The Niwot Ridge site sits approximately 27 km west of Boulder, Colorado. Topography, climate, and biota of the site are representative of Rocky Mountain alpine ecosystems, including alpine tundra, subalpine coniferous forests, and talus slopes. Located 6km east side of the Continental Divide at 3,000-3,600m elevation, the site receives atmospheric deposition produced along the Front Range and is positioned to observe other east/west flows across the Southern Rockies in conjunction with other NEON sites.

Figure 3: Phenocamera image for NIWO. 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: University of Colorado Boulder, U.S. Forest Service, Niwot Ridge LTER
- Located in: Boulder County, CO
- Sampling Area: 13.4 km^2
- Plot Elevation: 2975- 3590m
- Dominant vegetation type: Flora varies along an elevation gradient at NIWO. At lower elevations lodgepole pine (*Pinus contorta*) and aspen (*Populus tremuloides*) dominate. Subalpine spruce-fir forests then transition to the tundra with patches of stunted coniferous trees (krummholz). Above tree line, the tundra is

dominated by herbaceous species such as Ross' avens (*Geum rossii*) and curly sedge (*Carex rupestris*) ("Niwot Ridge Flora", 2016).

- General management: The site is home to the Niwot Ridge Long Term Ecological Research project, and is heavily used by researchers. Research themes include the movement of energy and nutrients across the subalpine-alpine landscape, the influence of nitrogen deposition on ecosystems and hydrology, and the influence of climate on diversity and ecosystem function ("The Niwot Ridge LTER program", 2016).
- The Niwot Ridge terrestrial site is collocated with NEON's D13 core aquatic site, Como Creek, situated at an elevation of 3,030 m in the subalpine. See the AIS site characterization report for more details (RD[05]).
- Plot Selection: All NEON TOS Plots except mosquitoes were allocated across the site following NEON standard criteria. In order to avoid conflicts with existing research, mosquito sampling points were placed systematically along the road and along a hiking loop instead of the standard random approach.

4.1 TOS Spatial Sampling Design

TOS Distributed Plots were allocated at NIWO according to a spatially balanced and stratified-random design (RD[3]). The 2006 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.

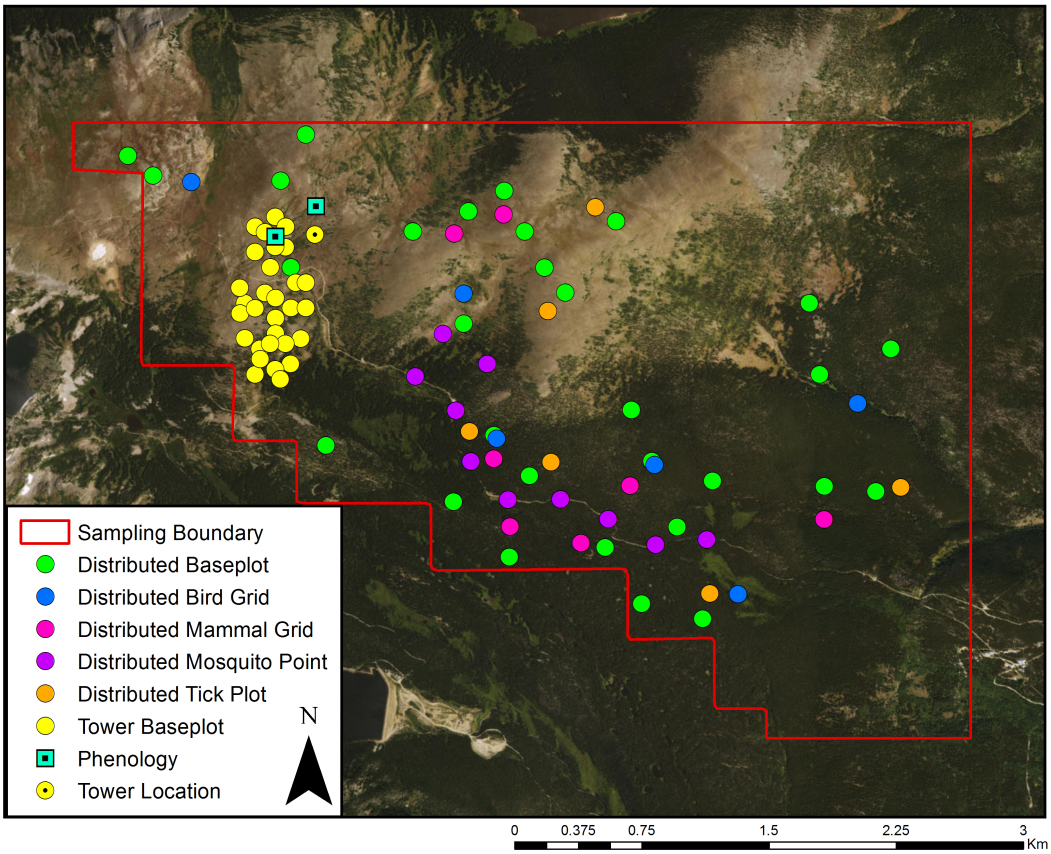

Figure 4: Map of TOS plot centroids within the NEON TOS sampling boundary at NIWO.

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

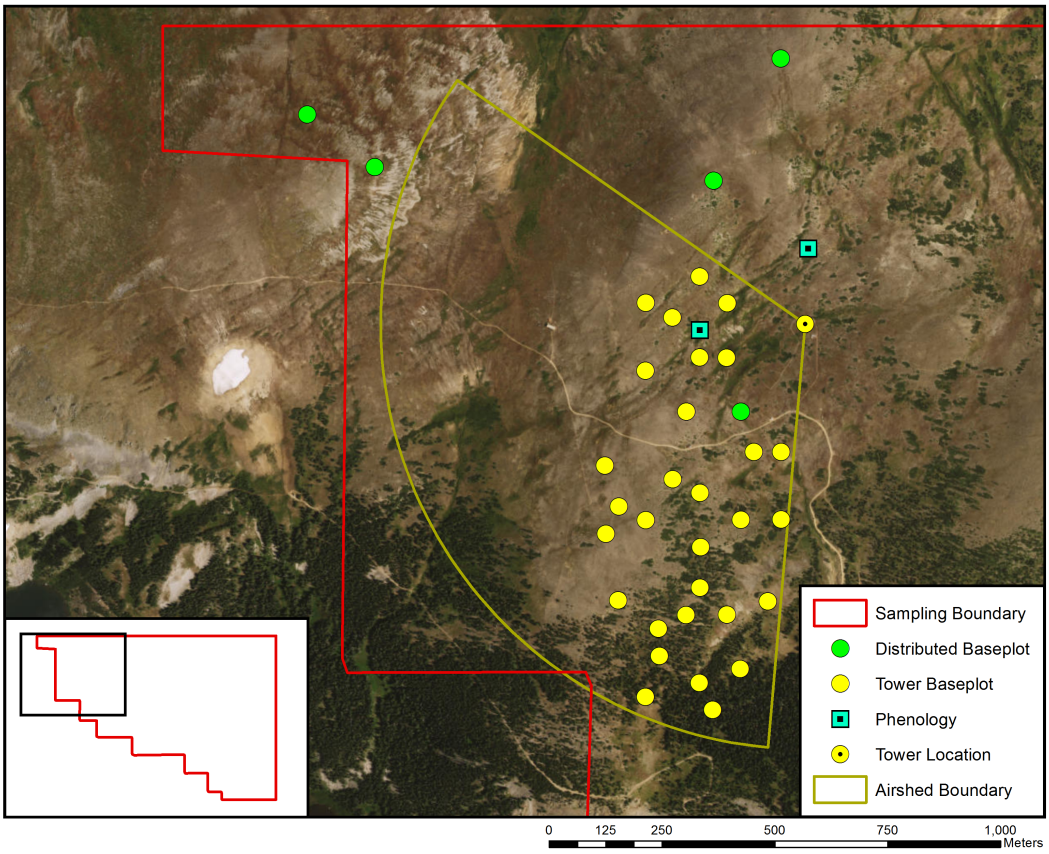

Figure 5: Map of the tower airshed and TOS plot centroids at NIWO.

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 NIWO.

NLCD Class	Site Area (km^2)	Percent (%)
Evergreen Forest	7.38	55.57
Grassland Herbaceous	3.98	30
Perennial Ice Snow	1.74	13.13
Deciduous Forest	0.09	0.68
Woody Wetlands	0.04	0.32
Barren Land	0.04	0.3

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 NIWO.

Plot Type	Plot Subtype	NLCD Class	Number of Plots Established
Distributed	Base Plot	Evergreen Forest	17
Distributed	Base Plot	Grassland Herbaceous	13
Distributed	Bird Grid	Evergreen Forest	4
Distributed	Bird Grid	Grassland Herbaceous	2
Distributed	Mammal Grid	Evergreen Forest	4
Distributed	Mammal Grid	Grassland Herbaceous	2
Distributed	Mosquito Point	Evergreen Forest	9
Distributed	Mosquito Point	Grassland Herbaceous	1
Distributed	Tick Plot	Evergreen Forest	4
Distributed	Tick Plot	Grassland Herbaceous	2
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: evergreen forest, grassland herbaceous, and shrub scrub.

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

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Evergreen Forest	Beetles	6
Distributed	Base Plot	Grassland Herbaceous	Beetles	4
Distributed	Base Plot	Evergreen Forest	Canopy Foliage Chemistry	6
Distributed	Base Plot	Grassland Herbaceous	Canopy Foliage Chemistry	4
Distributed	Base Plot	Evergreen Forest	Coarse Downed Wood	13
Distributed	Base Plot	Grassland Herbaceous	Coarse Downed Wood	7
Distributed	Base Plot	Evergreen Forest	Digital Hemispherical Photos for Leaf Area Index	13
Distributed	Base Plot	Grassland Herbaceous	Digital Hemispherical Photos for Leaf Area Index	7
Distributed	Base Plot	Evergreen Forest	Herbaceous Biomass	13
Distributed	Base Plot	Grassland Herbaceous	Herbaceous Biomass	7
Distributed	Base Plot	Evergreen Forest	Plant Diversity	17
Distributed	Base Plot	Grassland Herbaceous	Plant Diversity	13
Distributed	Base Plot	Evergreen Forest	Soil Biogeochemistry	4

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Grassland Herbaceous	Soil Biogeochemistry	2
Distributed	Base Plot	Evergreen Forest	Soil Microbes	4
Distributed	Base Plot	Grassland Herbaceous	Soil Microbes	2
Distributed	Base Plot	Evergreen Forest	Vegetation Structure	13
Distributed	Base Plot	Grassland Herbaceous	Vegetation Structure	7

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 NIWO.

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	Plant Belowground Biomass	30
Tower	Base Plot	Plant Diversity	3
Tower	Base Plot	Soil Biogeochemistry	4
Tower	Base Plot	Soil Microbes	4
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 the total TOS Tower Base Plot number.

4.2 Sampling Season Characterization: NIWO

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.

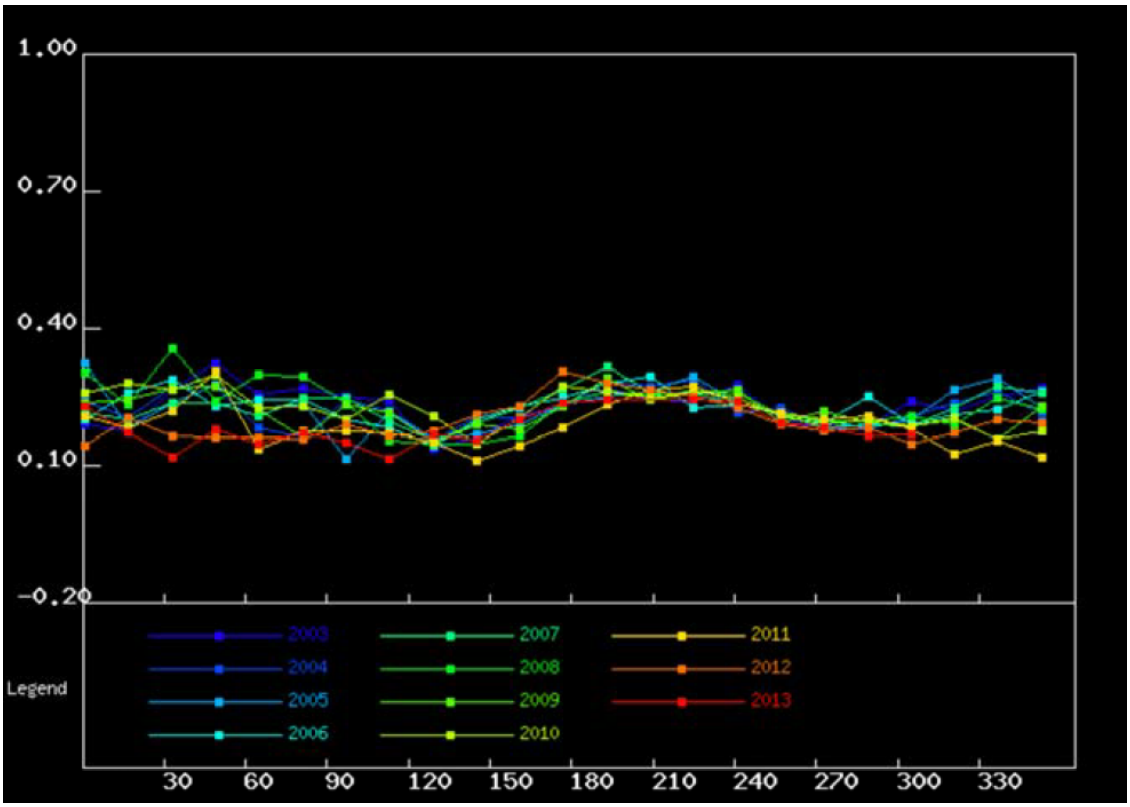

Figure 6: MODIS-EVI greenness (y-axis = EVI ratio) as a function of time (x-axis = DOY) for the years 2003-2013 at the NEON NIWO site.

Table 5: Average MODIS-EVI greenness dates for the NEON NIWO site, based on data from 2003-2013 (DOY, with MM/DD in parentheses).

Average Increase	Average Maximum	Average Decrease	Average Minimum
140 (05/21)	190 (07/10)	220 (08/09)	270 (09/28)

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: 12.25 km x 12.25 km box, Centroid Latitude: 40.05425, Longitude: -105.58237 (WGS84 datum)

4.3 Belowground Biomass

4.3.1 Site-Specific Methods

Belowground biomass characterization data were collected down to a depth of 140 cm by NEON staff in August 2014. 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.

4.3.2 Results

Table 6: Soil Pit Information at NIWO.

Latitude	Longitude	Soil Family	Soil Order
40.05236	-105.58324	Coarse-loamy - mixed - superactive Typic Haplocryolls	Mollisol

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

Table 7: Fine root mass per depth increment (cm) at NIWO.

Upper Depth	Lower Depth	Mean (mg per cm^3)	Std Dev
0	10	16.92	19.46
10	20	5.24	5.64
20	30	0.85	0.17
30	40	0.29	0.19
40	50	0.3	0.36
50	60	0.19	0.19
60	70	0.06	0.07
70	80	0.03	0.04
80	90	0	0
90	100	0.01	0.01
100	120	0.01	0.01
120	140	0	0

Table 8: Cumulative fine root mass as a function of depth (cm) at NIWO.

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
0	10	1691.9	1946.45
10	20	2216.05	2508.5
20	30	2300.84	2525.56
30	40	2329.77	2523.11
40	50	2359.83	2498.21
50	60	2378.78	2484.33
60	70	2385.04	2482.14
70	80	2387.83	2480.99
80	90	2388.24	2481.03
90	100	2389.18	2480.9
100	120	2390.29	2480.29
120	140	2390.88	2480.99

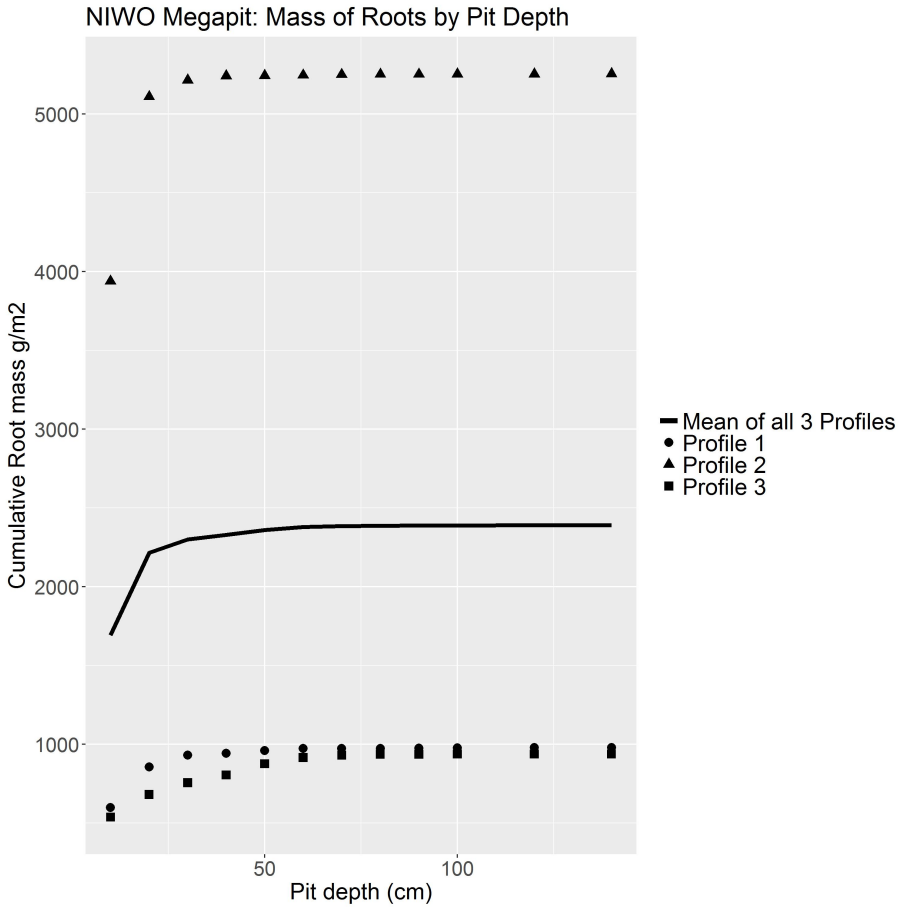

Figure 7: Cumulative root mass by pit depth at NIWO.

Table 9: Fine root biomass sampling summary data at NIWO.

Total Pit Depth (cm)	140
Total Mean Cumulative Mass at 30cm (g per m^2)	2300.84
Total Mean Cumulative Mass at 100cm (g per m^2)	2389.18
Total Mean Cumulative Mass (g per m^2)	2390.88

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 2015. Plant characterization data informs 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 10: Site plant characterization and phenology species summary at NIWO.

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
ABLAL	*Abies lasiocarpa* (Hook.) Nutt. var. *lasiocarpa*	1	1	0.14	3.26
PIEN	*Picea engelmannii* Parry ex Engelm.	2	1	0.05	3.26

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
VACCI	*Vaccinium* sp.	3	6	NA	NA
SALIX	*Salix* sp.	4	<1	0.03	NA
GEROT	*Geum rossii* (R. Br.) Ser. var. *turbinatum* (Rydb.) C.L. Hitchc.	5	2	NA	NA
CARUD	*Carex rupestris* All. var. *drummondiana* (Dewey) L.H. Bailey	6	2	NA	NA
MIOB2	*Minuartia obtusiloba* (Rydb.) House	7	<1	NA	NA
SIACS2	*Silene acaulis* (L.) Jacq. var. *subacaulescens* (F.N. Williams) Fernald & H. St. John	8	<1	NA	NA
SOSI3	*Solidago simplex* Kunth	9	<1	NA	NA
TRDA2	*Trifolium dasyphyllum* Torr. & A. Gray	10	<1	NA	NA
CYPERA	Cyperaceae sp.	11	<1	NA	NA
ARSC	*Artemisia scopulorum* A. Gray	12	<1	NA	NA
VACCISPP	*Vaccinium* sp.	13	<1	NA	NA
PIFL2	*Pinus flexilis* James	14	NA	<1	0.05
PHPU5	*Phlox pulvinata* (Wherry) Cronquist	15	<1	NA	NA
JUDR	*Juncus drummondii* E. Mey.	16	<1	NA	NA
CAREX	*Carex* sp.	17	<1	NA	NA
RIMO2	*Ribes montigenum* McClatchie	17	<1	NA	NA
SIPR	*Sibbaldia procumbens* L.	19	<1	NA	NA
ARFEF3	*Arenaria fendleri* A. Gray var. *fendleri*	20	<1	NA	NA
TRSP2	*Trisetum spicatum* (L.) K. Richt.	21	<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)
POPUD3	*Polemonium pulcherrimum* Hook. ssp. *delicatum* (Rydb.) Brand	22	<1	NA	NA
POA	*Poa* sp.	23	<1	NA	NA
PACHC	*Paronychia chartacea* Fernald ssp. *chartacea*	24	<1	NA	NA
TEACC	*Tetraneuris acaulis* (Pursh) Greene var. *caespitosa* A. Nelson	25	<1	NA	NA
SECR	*Senecio crassulus* A. Gray	26	<1	NA	NA
ANME2	*Antennaria media* Greene	27	<1	NA	NA
ORAL	*Oreoxis alpina* (A. Gray) J.M. Coult. & Rose	28	<1	NA	NA
ERSI3	*Erigeron simplex* Greene	29	<1	NA	NA
PICOL	*Pinus contorta* Douglas ex Loudon var. *latifolia* Engelm. ex S. Watson	30	NA	<1	0.05
POBI6	*Polygonum bistortoides* Pursh	31	<1	NA	NA
ACMI2	*Achillea millefolium* L.	33	<1	NA	NA
HIGRG	*Hieracium gracile* Hook. var. *gracile*	34	<1	NA	NA
CARO2	*Campanula rotundifolia* L.	35	<1	NA	NA
VAACA	*Valeriana acutiloba* Rydb. var. *acutiloba*	36	<1	NA	NA
CAREXSPP	*Carex* sp.	37	<1	NA	NA
LUSP4	*Luzula spicata* (L.) DC.	38	<1	NA	NA
LEPY2	*Lewisia pygmaea* (A. Gray) B.L. Rob.	39	<1	NA	NA
LLSE	*Lloydia serotina* (L.) Salisb. ex Rchb.	40	<1	NA	NA
PODI2	*Potentilla diversifolia* Lehm.	41	<1	NA	NA
PRAN	*Primula angustifolia* Torr.	42	<1	NA	NA
DRST4	*Draba streptocarpa* A. Gray	43	<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)
ERCO4	*Erigeron compositus* Pursh	43	<1	NA	NA
PEWH	*Penstemon whippleanus* A. Gray	45	<1	NA	NA
TRPA5	*Trifolium parryi* A. Gray	46	<1	NA	NA
ERIGE2	*Erigeron* sp.	47	<1	NA	NA
FEBR	*Festuca brachyphylla* Schult. ex Schult. & Schult. f.	48	<1	NA	NA
PERA	*Pedicularis racemosa* Douglas ex Benth.	50	<1	NA	NA
ASTERA	Asteraceae sp.	51	<1	NA	NA
JUCOD	*Juniperus communis* L. var. *depressa* Pursh	52	<1	<1	NA
AGGL	*Agoseris glauca* (Pursh) Raf.	53	<1	NA	NA
CASC12	*Carex scopulorum* T. Holm	53	<1	NA	NA
CHANC	*Chamerion angustifolium* (L.) Holub ssp. *circumvagum* (Mosquin) Hoch	55	<1	NA	NA
SELA	*Sedum lanceolatum* Torr.	56	<1	NA	NA
CASTI2	*Castilleja* sp.	57	<1	NA	NA
VILA10	*Viola labradorica* Schrank	58	<1	NA	NA
ERNAE	*Eritrichium nanum* (Vill.) Schrad. ex Gaudin var. *elongatum* (Rydb.) Cronquist	59	<1	NA	NA
LIFI	*Ligusticum filicinum* S. Watson	60	<1	NA	NA
RAAD	*Ranunculus adoneus* A. Gray	60	<1	NA	NA
PEPA3	*Pedicularis parryi* A. Gray	62	<1	NA	NA
TOPY	*Tonestus pygmaeus* (Torr. & A. Gray) A. Nelson	63	<1	NA	NA
ALGE	*Allium geyeri* S. Watson	64	<1	NA	NA
POVI3	*Polygonum viviparum* L.	65	<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)
TEGR3	*Tetraneuris grandiflora* (Torr. & A. Gray ex A. Gray) K.F. Parker	66	<1	NA	NA
POASPP	*Poa* sp.	67	<1	NA	NA
MELA3	*Mertensia lanceolata* (Pursh) DC.	68	<1	NA	NA
SEDUM	*Sedum* sp.	68	<1	NA	NA
POOV2	*Potentilla ovina* Macoun ex J.M. Macoun	70	<1	NA	NA
POGLR2	*Poa glauca* Vahl ssp. *rupicola* (Nash ex Rydb.) W.A. Weber	71	<1	NA	NA
POTEN	*Potentilla* sp.	71	<1	NA	NA
ANSE4	*Androsace septentrionalis* L.	73	<1	NA	NA
POCUE	*Poa cusickii* Vasey subsp. epilis (Scribn.) W.A. Weber	73	<1	NA	NA
CYPERASPP	Cyperaceae sp.	75	<1	NA	NA
NOFEG	*Noccaea fendleri* (A. Gray) Holub subsp. glauca (A. Nelson) Al-Shehbaz & M. Koch	75	<1	NA	NA
PACA15	*Packera cana* (Hook.) W.A. Weber & Á. Löve	75	<1	NA	NA
SARH2	*Saxifraga rhomboidea* Greene	75	<1	NA	NA
TRIFO	*Trifolium* sp.	79	<1	NA	NA
POACEA	Poaceae sp.	80	<1	NA	NA
ERICAC	Ericaceae sp.	81	<1	NA	NA
ARCO9	*Arnica cordifolia* Hook.	82	<1	NA	NA
ARRY	*Arnica rydbergii* Greene	82	<1	NA	NA
CAPU19	*Castilleja puberula* Rydb.	82	<1	NA	NA
PHAL2	*Phleum alpinum* L.	85	<1	NA	NA
POLE3	*Poa lettermanii* Vasey	85	<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)
DAIN	*Danthonia intermedia* Vasey	87	<1	NA	NA
CYAB2	*Cylindropuntia abysii* (Hester) Backeb.	88	<1	NA	NA
ARPA18	*Artemisia pattersonii* A. Gray	89	<1	NA	NA
CHJA	*Chionophila jamesii* Benth.	89	<1	NA	NA
JUNCAC	Juncaceae sp.	89	<1	NA	NA
PENST	*Penstemon* sp.	89	<1	NA	NA
SEDUMSPP	*Sedum* sp.	89	<1	NA	NA
PEDIC	*Pedicularis* sp.	94	<1	NA	NA
ANEMO	*Anemone* sp.	95	<1	NA	NA
PEBRP2	*Pedicularis bracteosa* Benth. var. *paysoniana* (Pennell) Cronquist	95	<1	NA	NA
PEGR2	*Pedicularis groenlandica* Retz.	95	<1	NA	NA
POVI	*Polemonium viscosum* Nutt.	95	<1	NA	NA
ASTER	*Aster* sp.	99	<1	NA	NA
CEARS2	*Cerastium arvense* L. ssp. *strictum* (L.) Ugborogho	99	<1	NA	NA
MIRU3	*Minuartia rubella* (Wahlenb.) Hiern.	99	<1	NA	NA
PINACE	Pinaceae sp.	99	<1	NA	NA
PORU3	*Potentilla rubricaulis* Lehm.	99	<1	NA	NA
TRIFOSPP	*Trifolium* sp.	99	<1	NA	NA
ANTEN	*Antennaria* sp.	105	<1	NA	NA
ARTEM	*Artemisia* sp.	105	<1	NA	NA
CALEL8	*Caltha leptosepala* DC. var. *leptosepala*	105	<1	NA	NA
CAOC4	*Castilleja occidentalis* Torr.	105	<1	NA	NA
CASTI2SPP	*Castilleja* sp.	105	<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)
DRST	*Draba standleyi* J.F. Macbr. & Payson	105	<1	NA	NA
ERCA14	*Erysimum capitatum* (Douglas ex Hook.) Greene	105	<1	NA	NA
HEPA11	*Heuchera parvifolia* Nutt. ex Torr. & A. Gray	105	<1	NA	NA
MELA	*Mentzelia laciniata* (Rydb.) J. Darl.	105	<1	NA	NA
ORAL	*Oreoxis alpina* (A. Gray) J.M. Coult. & Rose	105	<1	NA	NA
POTENSPP	*Potentilla* sp.	105	<1	NA	NA
TRNA2	*Trifolium nanum* Torr.	105	<1	NA	NA
DAFRF	*Dasiphora fruticosa* (L.) Rydb. ssp. *floribunda* (Pursh) Kartesz	117	NA	<1	NA

Note:Taxon IDs and scientific names are based on the USDA Plants database (plants.usda.gov). The two main species lumped within the Cyperaceae sp. group are *Kobresia myosuroides* and *Carex elynoides*.

Table 11: Per plot breakdown of species richness, diversity, and herbaceous cover at NIWO.

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover	Bryophyte Percent Cover
NIWO_040	8	1.57	67	0.42
NIWO_043	34	3.02	45	0.01
NIWO_044	46	3.21	80	0.03
NIWO_045	20	2.2	73	0.28
NIWO_046	38	2.55	159	0.02
NIWO_047	54	3.21	114	0.04
NIWO_048	28	2.87	39	1.69
NIWO_049	40	2.18	98	0.25
NIWO_050	38	2.69	68	0.2
NIWO_051	25	2.25	91	0.16
NIWO_052	38	2.69	52	0.07
NIWO_053	30	2.72	49	0.04

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover	Bryophyte Percent Cover
NIWO_054	28	3.05	29	0.05
NIWO_055	26	2.54	40	0.02
NIWO_056	43	3.03	97	0.09
NIWO_057	15	1.84	51	0.1
NIWO_058	41	2.55	57	0.05
NIWO_059	33	2.55	84	0.11
NIWO_060	34	3.31	26	0.03
NIWO_061	20	1.97	107	0.17
NIWO_062	28	2.49	37	0.18
NIWO_063	32	1.89	234	0.11
NIWO_064	20	2.21	52	0.96
NIWO_065	35	3.13	34	0.11
NIWO_066	32	3.16	31	0.03
NIWO_067	37	2.04	126	0.04
NIWO_068	27	2.91	26	0.08
NIWO_069	34	3.12	37	0.04
Bryophyte Mean				0.19

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

Bryophyte percent cover data were used to determine which sites qualify for implementation of the Bryophyte Productivity protocol. 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 July and August 2009 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 beetle samples were pooled before being sent for identification. For DNA sequence data generated as a result of these efforts, visit the Barcode of Life Datasystems (BOLD) at http://www.boldsystems.org. For more information on this protocol and data product numbers see Appendix A.

4.5.2 Results

Table 12: Beetle identification results at NIWO.

Sample ID	Scientific Name	Collection Date
NEONTcarabid189	*Amara quenseli*	7/23/2009
NEONTcarabid190	*Pterostichus surgens*	7/23/2009
NEONTcarabid193	*Carabus taedatus*	7/23/2009
NEONTcarabid195	*Amara quenseli*	7/23/2009
NEONTcarabid197	*Cymindis cribricollis*	7/23/2009
NEONTcarabid198	*Cymindis cribricollis*	7/23/2009
NEONTcarabid203	*Carabus taedatus*	7/23/2009
NEONTcarabid206	*Carabus taedatus*	7/23/2009
NEONTcarabid209	*Cymindis unicolor*	7/23/2009
NEONTcarabid221	*Cymindis cribricollis*	7/23/2009
NEONTcarabid222	*Cymindis cribricollis*	7/23/2009
NEONTcarabid223	*Cymindis cribricollis*	7/23/2009
NEONTcarabid224	*Amara quenseli*	7/23/2009
NEONTcarabid271	*Amara cupreolata*	8/6/2009
NEONTcarabid272	*Cymindis unicolor*	8/6/2009
NEONTcarabid274	*Cymindis unicolor*	8/6/2009
NEONTcarabid275	*Amara cupreolata*	8/6/2009
NEONTcarabid276	*Amara cupreolata*	8/6/2009
NEONTcarabid277	*Amara cupreolata*	8/6/2009
NEONTcarabid281	*Pterostichus protractus*	7/23/2009
NEONTcarabid285	*Notiophilus aquaticus*	7/23/2009
NEONTcarabid313	*Cymindis unicolor*	7/23/2009
NEONTcarabid314	*Amara* sp.	7/23/2009
NEONTcarabid556	*Cymindis unicolor*	7/23/2009
NEONTcarabid695	*Cymindis cribricollis*	7/30/2009
NEONTcarabid696	*Cymindis cribricollis*	8/6/2009
NEONTcarabid697	*Cymindis cribricollis*	8/6/2009
NEONTcarabid878	*Amara quenseli*	8/6/2009
955	*Cymindis unicolor*	unknown
1175	*Carabus taedatus agassii*	unknown
1186	*Amara quenseli*	unknown

Note: Samples that include "NEONTcarabid" in their sample ID indicate BOLD records are available. Samples without "NEONTcarabid" were identified by a parataxonimist.

4.6 Mosquitoes

4.6.1 Site-Specific Methods

Mosquito site characterization was conducted in July and August 2009 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 mosquito samples were pooled before being sent for identification. For DNA sequence data generated as a result of these efforts, visit the Barcode of Life Datasystems (BOLD) at http://www.boldsystems.org. For more information on this protocol and data product numbers see Appendix A.

4.6.2 Results

Table 13: Mosquito identification results at NIWO.

Sample ID	Scientific Name	Collection Date
NEONTculicid826	*Culiseta impatiens*	2009-07-28
NEONTculicid772	*Aedes communis*	2009-07-14
NEONTculicid835	*Aedes hexodontus*	2009-08-11
NEONTculicid808	*Aedes hexodontus*	2009-07-21
NEONTculicid758	*Culiseta inornata*	2009-07-14
NEONTculicid760	*Culiseta inornata*	2009-07-14
NEONTculicid761	*Culiseta inornata*	2009-07-14
NEONTculicid769	*Culiseta impatiens*	2009-07-14
NEONTculicid773	*Aedes communis*	2009-07-14
NEONTculicid809	*Aedes cataphylla*	2009-07-21
NEONTculicid829	*Aedes pullatus*	2009-08-04
NEONTculicid836	*Aedes hexodontus*	2009-08-11
NEONTculicid775	*Aedes cataphylla*	2009-07-14
NEONTculicid759	*Culiseta inornata*	2009-07-14
NEONTculicid762	*Culiseta inornata*	2009-07-14
NEONTculicid771	*Aedes fitchii*	2009-07-14
NEONTculicid774	*Aedes cataphylla*	2009-07-14
NEONTculicid776	*Aedes cataphylla*	2009-07-14
NEONTculicid770	*Aedes communis*	2009-07-14

4.7 Ticks

4.7.1 Site-Specific Methods

Tick site characterization work was not conducted at NIWO. 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.

Humphries, Hope. Walker, Marilyn. 2017. Plant species composition data for Saddle grid plots from 1989 - ongoing, yearly from 2010. http://niwot.colorado.edu

Niwot Ridge Flora. 2016. Niwot Ridge: Long Term Ecological Research. http://niwot.colorado.edu/life/flora-topic/niwot-_ridge_flora

Species Profiles. 2016. Colorado Parks and Wildlife. http://cpw.state.co.us/learn/Pages/SpeciesProfiles.aspx

The Niwot Ridge LTER program. 2016. Niwot Ridge: Long Term Ecological Research. http://niwot.colorado.edu/

Tolbert, W., Tolbert, V., & Ambrose, R. (1977). Distribution, Abundance, and Biomass of Colorado Alpine Tundra Arthropods. Arctic and Alpine Research, 9(3), 221-234. doi:10.2307/1550539

Walker, Marilyn. Humphries, Hope. 2017. Plant species list for Indian Peaks wilderness Green Lakes Valley Niwot Ridge from 1970 - ongoing, variable. http://niwot.colorado.edu

5 RELOCATABLE SITE 1- MOAB (MOAB)

The NEON MOAB site is located approximately 40 km south of the town of Moab and is characteristic of the Colorado Plateau. MOAB was selected with other sites that share a similar latitude in domains 10, 13, and 15, to assess dust generation, nutrient transport, and nutrient deposition. The western half of the site, including the tower airshed, is a grazed shrub land, often with pockets of barren soil. To the east, in the higher elevations, evergreen

forests sit atop the mesas. Biological soil crust, dominated by cyanobacteria, is a living groundcover across the site.

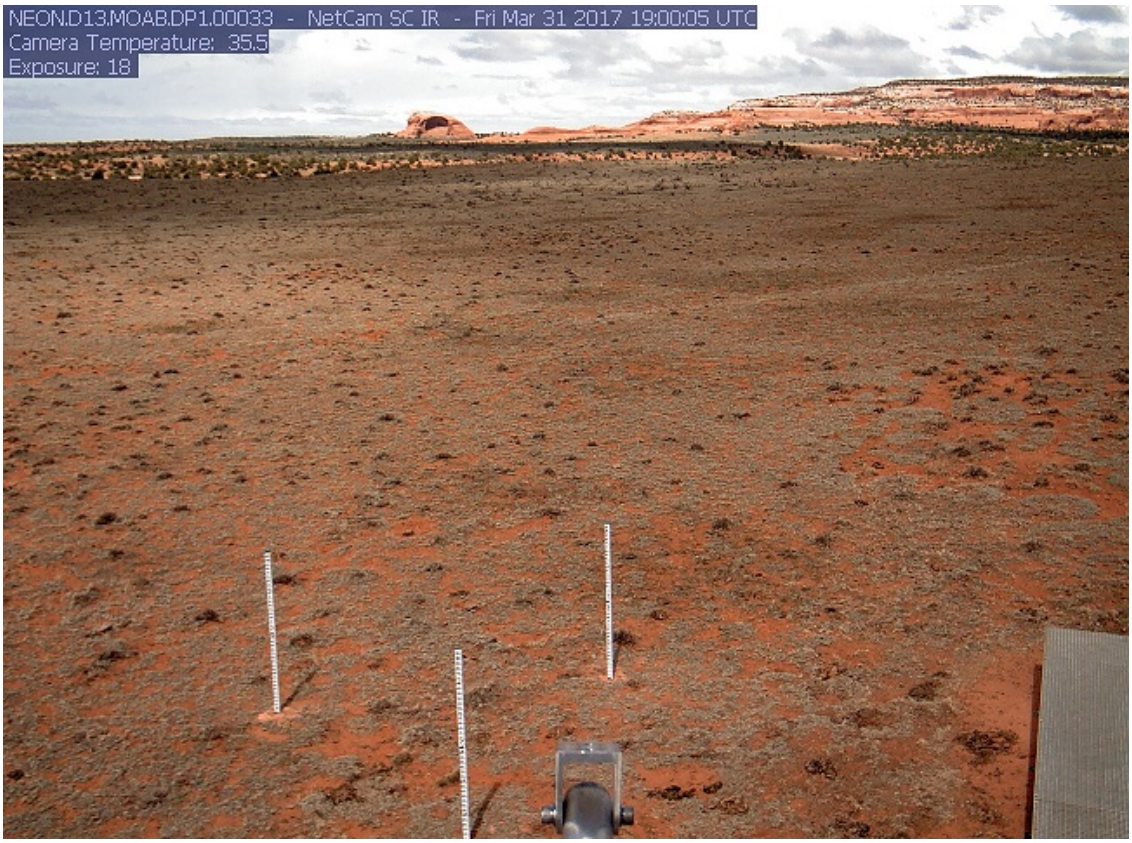

Figure 8: Phenocamera image for MOAB. The phenocamera is located at the top of the NEON tower and faces north. Phenocamera images are available at https://phenocam.sr.unh.edu/webcam/network/table/.

Key Characteristics:

- Site host: Bureau of Land Management
- Located in: San Juan County, UT
- Sampling Area: 50.4 km^2
- Plot Elevation: 1720- 2050m
- Dominant vegetation type: Dominant plant species around the tower include fourwing saltbush (*Atriplex canescens*), Mormon tea (*Ephedra viridis*), and blue grama (*Bouteloua gracilis*). Pinyon Pine (*Pinus edulis*) and Utah Juniper (*Juniperus osteosperma*) make up the canopy composition in the higher elevations.
- General management: The site is open to the public and includes the Looking Glass Rock and Wilson Arch recreation areas. Cattle grazing occurs throughout the site.
- 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 MOAB according to a spatially balanced and stratified-random design (RD[3]). The 2006 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.

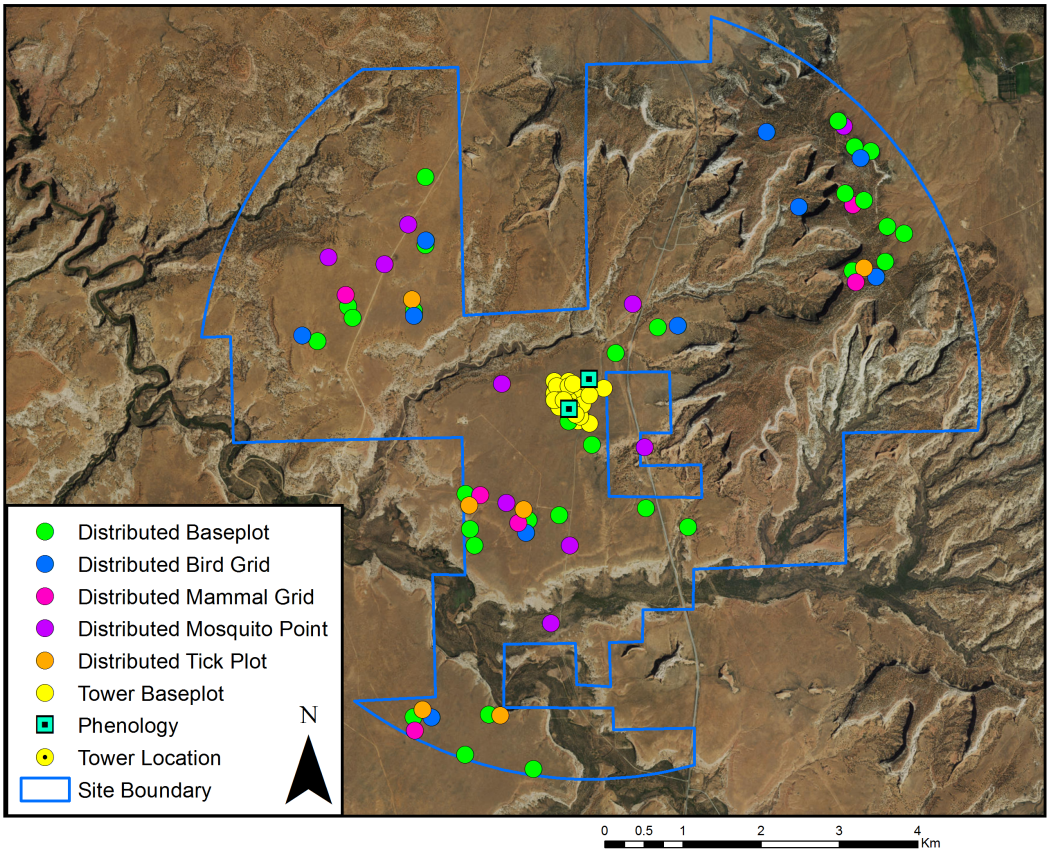

Figure 9: Map of TOS plot centroids within the NEON TOS sampling boundary at MOAB.

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

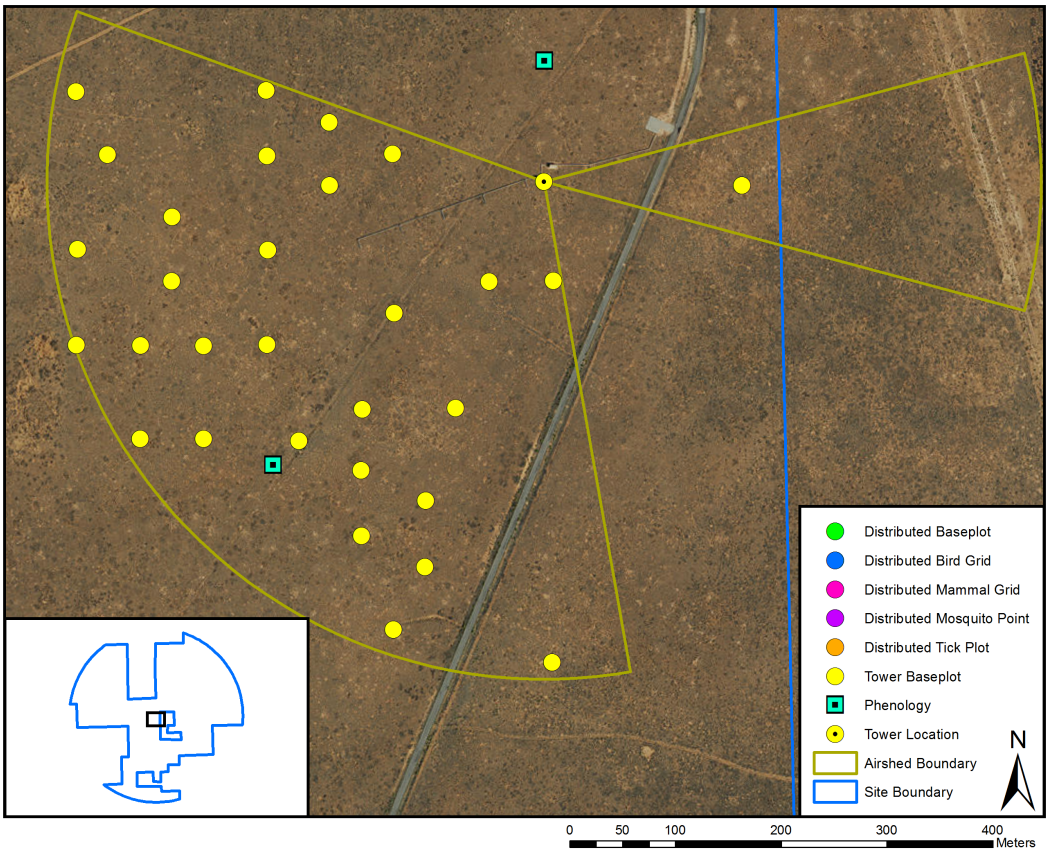

Figure 10: Map of the tower airshed and TOS plot centroids at MOAB.

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

Table 14: NLCD land cover classes and area within the TOS site boundary at MOAB.

NLCD Class	Site Area (km^2)	Percent (%)
Shrub Scrub	38.16	75.64
Evergreen Forest	5.64	11.19
Barren Land	4.27	8.45
Grassland Herbaceous	1.59	3.15
Developed Open Space	0.6	1.19
Developed Low Intensity	0.15	0.3
Pasture Hay	0.03	0.05
Woody Wetlands	0.02	0.03

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 15: NLCD land cover classes and TOS plot numbers at MOAB.

Plot Type	Plot Subtype	NLCD Class	Number of Plots Established
Distributed	Base Plot	Evergreen Forest	8
Distributed	Base Plot	Shrub Scrub	22
Distributed	Bird Grid	Evergreen Forest	1
Distributed	Bird Grid	Shrub Scrub	8
Distributed	Mammal Grid	Evergreen Forest	1
Distributed	Mammal Grid	Shrub Scrub	5
Distributed	Mosquito Point	Evergreen Forest	1
Distributed	Mosquito Point	Shrub Scrub	9
Distributed	Tick Plot	Evergreen Forest	1
Distributed	Tick Plot	Shrub Scrub	5
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 type within the airshed is shrub scrub.

Table 16: Number of Distributed Base plots per NLCD land cover class per protocol at MOAB.

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Evergreen Forest	Beetles	1
Distributed	Base Plot	Shrub Scrub	Beetles	9
Distributed	Base Plot	Evergreen Forest	Canopy Foliage Chemistry	2
Distributed	Base Plot	Shrub Scrub	Canopy Foliage Chemistry	8
Distributed	Base Plot	Evergreen Forest	Coarse Downed Wood	3
Distributed	Base Plot	Shrub Scrub	Coarse Downed Wood	17
Distributed	Base Plot	Evergreen Forest	Digital Hemispherical Photos for Leaf Area Index	3
Distributed	Base Plot	Shrub Scrub	Digital Hemispherical Photos for Leaf Area Index	17
Distributed	Base Plot	Evergreen Forest	Herbaceous Biomass	3
Distributed	Base Plot	Shrub Scrub	Herbaceous Biomass	17
Distributed	Base Plot	Evergreen Forest	Plant Diversity	8
Distributed	Base Plot	Shrub Scrub	Plant Diversity	22

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Evergreen Forest	Soil Biogeochemistry	1
Distributed	Base Plot	Shrub Scrub	Soil Biogeochemistry	5
Distributed	Base Plot	Evergreen Forest	Soil Microbes	1
Distributed	Base Plot	Shrub Scrub	Soil Microbes	5
Distributed	Base Plot	Evergreen Forest	Vegetation Structure	3
Distributed	Base Plot	Shrub Scrub	Vegetation Structure	17

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 17: Number of Tower Plots per protocol at MOAB.

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	Plant Belowground Biomass	30
Tower	Base Plot	Plant Diversity	3
Tower	Base Plot	Soil Biogeochemistry	4
Tower	Base Plot	Soil Microbes	4
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.

5.2 Sampling Season Characterization: MOAB

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.

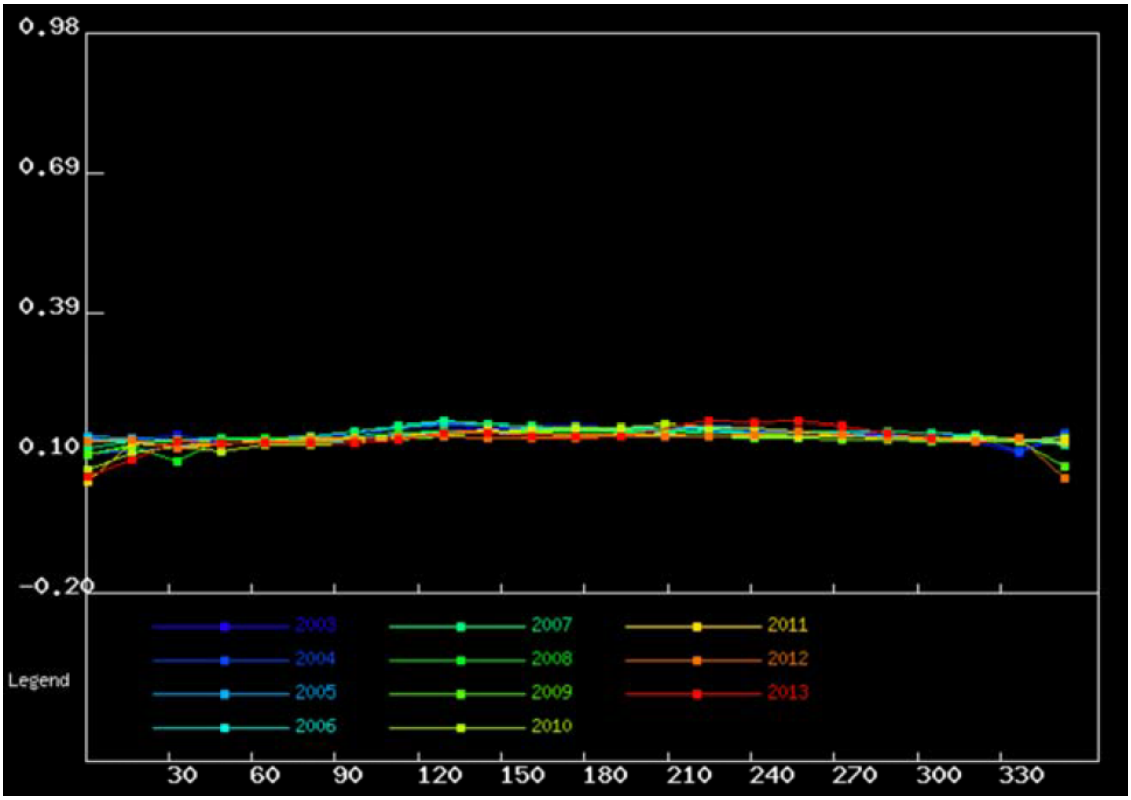

Figure 11: MODIS-EVI greenness (y-axis = EVI ratio) as a function of time (x-axis = DOY) for the years 2003-2013 at the NEON MOAB site.

Table 18: Average MODIS-EVI greenness dates for the NEON MOAB site, based on data from 2003-2013 (DOY, with MM/DD in parentheses).

Average Increase	Average Maximum	Average Decrease	Average Minimum
85 (03/27)	165 (06/15)	225 (08/14)	300 (10/28)

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, Latitude: 38.248417, Longitude: -109.38845 (WGS84 datum)

5.3 Belowground Biomass

5.3.1 Site-Specific Methods

Belowground biomass characterization data were collected down to a depth of 180 cm by NEON staff in February 2014. 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.

5.3.2 Results

Table 19: Soil Pit Information at MOAB.

Latitude	Longitude	Soil Family	Soil Order
38.25136	-109.38882	Coarse-loamy - mixed - superactive - mesic Ustic Haplocalcids	Aridisol

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

Table 20: Fine root mass per depth increment (cm) at MOAB.

Upper Depth	Lower Depth	Mean (mg per cm^3)	Std Dev
0	10	1.42	0.05
10	20	1.75	0.88
20	30	1.52	0.21
30	40	0.81	0.2
40	50	0.08	0.01
50	60	0.04	0.01
60	70	0.03	0.01
70	80	0.05	0.04
80	90	0.05	0.06
90	100	0.04	0.03
100	120	0.03	0.01
120	140	0.03	0.02
140	160	0.13	0.18

Upper Depth	Lower Depth	Mean (mg per cm^3)	Std Dev
160	180	0.04	0.03

Table 21: Cumulative fine root mass as a function of depth (cm) at MOAB.

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
0	10	142.17	5.15
10	20	317.47	92.78
20	30	469.66	76.97
30	40	550.32	86.27
40	50	558.15	85.18
50	60	562.38	85.61
60	70	565	85.75
70	80	570.13	81.62
80	90	574.67	79.19
90	100	578.47	81.99
100	120	584.86	82.74
120	140	590.08	83.11
140	160	615.2	118.73
160	180	623.04	112.64

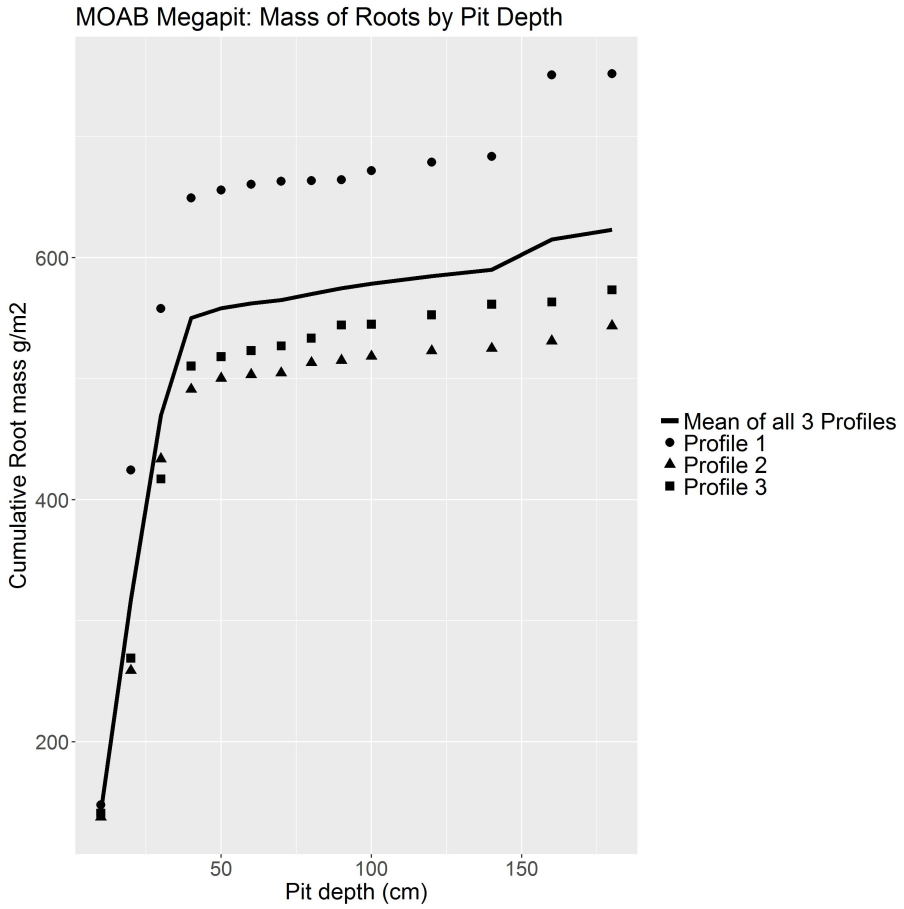

Figure 12: Cumulative root mass by pit depth at MOAB.

Table 22: Fine root biomass sampling summary data at MOAB.

Total Pit Depth (cm)	180
Total Mean Cumulative Mass at 30cm (g per m^2)	469.66
Total Mean Cumulative Mass at 100cm (g per m^2)	578.47
Total Mean Cumulative Mass (g per m^2)	623.04

5.4 Plant Characterization and Phenology Species Selection

5.4.1 Site-Specific Methods

Plant characterization data were collected by NEON staff during April of 2015. Plant characterization data informs 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 23: Site plant characterization and phenology species summary at MOAB.

Taxon ID	Scientific Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
ATCA2	*Atriplex canescens* (Pursh) Nutt.	1	<1	<1	NA
EPVI	*Ephedra viridis* Coville	2	<1	<1	NA
BOGR2	*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths	3	4	NA	NA
KRLA2	*Krascheninnikovia lanata* (Pursh) A. Meeuse & Smit	4	<1	<1	NA
GUSA2	*Gutierrezia sarothrae* (Pursh) Britton & Rusby	5	<1	<1	NA
PLJA	*Pleuraphis jamesii* Torr.	6	1	NA	NA
VUOC	*Vulpia octoflora* (Walter) Rydb.	7	<1	NA	NA
PLPA2	*Plantago patagonica* Jacq.	8	<1	NA	NA
ARPU9	*Aristida purpurea* Nutt.	9	<1	NA	NA
CRYPTSPP	*Cryptantha* sp.	10	<1	NA	NA
DESCUSPP	*Descurainia* sp.	11	<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)
SPCO	*Sphaeralcea coccinea* (Nutt.) Rydb.	12	<1	NA	NA
SPCO	*Sphaeralcea coccinea* (Nutt.) Rydb.	13	<1	NA	NA
SPPA2	*Sphaeralcea parvifolia* A. Nelson	15	<1	NA	NA
BRTE	*Bromus tectorum* L.	16	<1	NA	NA
ELEL5	*Elymus elymoides* (Raf.) Swezey	17	<1	NA	NA
OEAL	*Oenothera albicaulis* Pursh	17	<1	NA	NA
CLLU2	*Cleome lutea* Hook.	19	<1	NA	NA
CRYPT	*Cryptantha* sp.	19	<1	NA	NA
ERCI6	*Erodium cicutarium* (L.) L'Hér. ex Aiton	19	<1	NA	NA
ANBR4	*Androstephium breviflorum* S. Watson	22	<1	NA	NA
CHER2	*Chaetopappa ericoides* (Torr.) G.L. Nesom	22	<1	NA	NA
COAU2	*Corydalis aurea* Willd.	22	<1	NA	NA
EPTO	*Ephedra torreyana* S. Watson	22	<1	NA	NA
KRASC	*Krascheninnikovia* sp.	22	<1	NA	NA
PAMU11	*Packera multilobata* (Torr. & A. Gray ex A. Gray) W.A. Weber & Á. Löve	22	<1	NA	NA
PHIV	*Phacelia ivesiana* Torr.	22	<1	NA	NA
ALLIU	*Allium* sp.	22	<1	NA	NA
BOUTE	*Bouteloua* sp.	22	<1	NA	NA
CRYPTSPP	*Cryptantha* sp.	22	<1	NA	NA
DESCU	*Descurainia* sp.	22	<1	NA	NA

Note:Taxon IDs and scientific names are based on the USDA Plants database (plants.usda.gov). SPCO is listed twice due to rank 13 misidentified as SPCOC in the field and corrected after analysis.

Table 24: Per plot breakdown of species richness, diversity, and herbaceous cover at MOAB.

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover
MOAB_044	8	0.98	36
MOAB_045	9	1.78	11
MOAB_046	12	2.45	7
MOAB_047	10	1.9	12
MOAB_048	10	2.06	10
MOAB_049	9	2.05	7
MOAB_050	9	1.71	12
MOAB_051	10	1.64	13
MOAB_052	13	2.27	10
MOAB_053	9	1.79	9
MOAB_054	13	2.13	15
MOAB_055	11	2.2	8
MOAB_056	11	2.15	9
MOAB_057	9	1.9	8
MOAB_058	12	2.27	10
MOAB_059	11	2.3	7
MOAB_060	9	1.2	15
MOAB_061	8	1.19	17
MOAB_062	14	2.43	12
MOAB_063	9	1.97	10
MOAB_064	9	2.07	6
MOAB_065	9	1.83	9
MOAB_066	12	2.16	14
MOAB_067	10	1.88	15
MOAB_068	12	2.13	14
MOAB_069	13	1.79	18
MOAB_070	10	1.9	11
MOAB_071	11	1.93	12
MOAB_072	10	1.54	14
MOAB_073	11	2.37	7

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

Bryophyte percent cover data were used to determine which sites qualify for implementation of the Bryophyte Productivity protocol. However, bryophyte productivity sampling was discontinued in 2018 and NEON no longer implements this protocol. No bryophyte cover was recorded in MOAB Tower Base Plots.

5.5 Beetles

5.5.1 Site-Specific Methods

Beetle site characterization was conducted in May 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 being sent for identification. For DNA sequence data generated as a result of these efforts, visit the Barcode of Life Datasystems (BOLD) at http://www.boldsystems.org. For more information on this protocol and data product numbers see Appendix A.

5.5.2 Results

Table 25: Beetle identification results at MOAB.

Sample ID	Scientific Name
NEONTcarabid8141	*Selenophorus planipennis*
NEONTcarabid8142	*Selenophorus planipennis*
NEONTcarabid8140	*Selenophorus planipennis*

5.6 Mosquitoes

5.6.1 Site-Specific Methods

Mosquito site characterization was conducted in May 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. All samples were pooled before being sent for identification. No pathogen testing was performed. For more information on this protocol and data product numbers see Appendix A.

5.6.2 Results

Table 26: Mosquito identification results at MOAB.

Sample ID	Scientific Name	Sex	count
MOAB.May2013.SC.1	*Culiseta incidens*	female	9
MOAB.May2013.SC.1	*Culistea inornata*	female	1
MOAB.May2013.SC.1	*Culex tarsalis*	female	5

5.7 Ticks

5.7.1 Site-Specific Methods

Tick site characterization work was not conducted at MOAB. 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]).

Atwood, D., J. Holland, R. Bolander, B. Franklin, D. E. House, L. Armstrong, K. Thorne, and L.England. 1991. Utah threatened, endangered, and sensitive plant field guide. BLM, Utah State Office

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.

MacMahon, J. A. 1988. Introduction to Vegetation of Utah In Atlas of the Vascular Plants of Utah, edited by B. J. Albee, L. M. Shultz, and S. Goodrich. Occasional Publication No. 7. Salt Lake City: Utah Museum of Natural History.

Northern Colorado Plateau Network (NCPN): Park Species Lists. December 30, 2016. National Park Service: Inventory and Monitoring. https://science.nature.nps.gov/im/units/ncpn/speciesSelect.cfm

6 REFERENCES

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.

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

7 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 27: 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
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

Name	Description	Identification Code
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
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