TOS SITE CHARACTERIZATION REPORT: DOMAIN 14

PREPARED BY	ORGANIZATION	DATE
Rachel Krauss	SCI	03/17/2017
Michael Patterson	SCI	1/27/2017
Oliver Smith	SCI	03/17/2017

APPROVALS	ORGANIZATION	APPROVAL DATE
Dave Tazik	SCI	05/26/2017
Mike Stewart	SYS	05/24/2017

RELEASED BY	ORGANIZATION	RELEASE DATE
Judy Salazar	CM	06/05/2017

See configuration management system for approval history.

The National Ecological Observatory Network is a project solely funded by the National Science Foundation and managed under cooperative agreement by Battelle. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

CHANGE RECORD

REVISION	DATE	ECO#	DESCRIPTION OF CHANGE
A	06/05/2017	ECO-04703	Initial Release

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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 Desert Southwest 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, Productivity, and Leaf Area Index
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.011048	TIS Site Characterization Report
RD[05]	NEON.DOC.001592	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

2.3 Acronyms

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

3 DOMAIN 14 OVERVIEW: DESERT SOUTHWEST DOMAIN

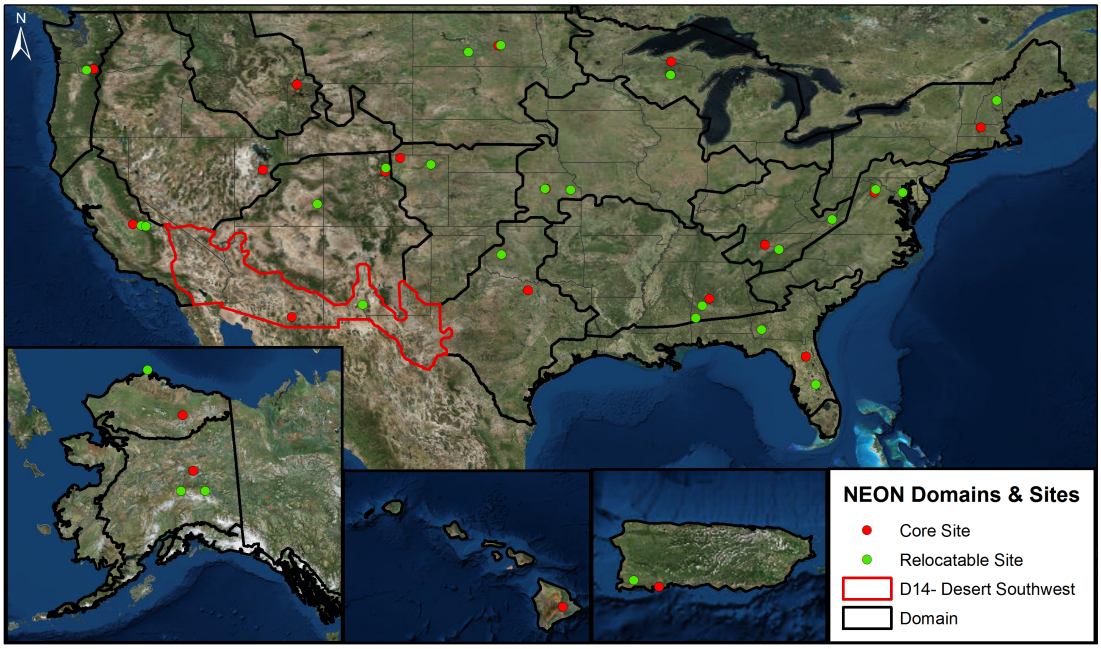

Figure 1: NEON project map with Domain 14 highlighted in red.

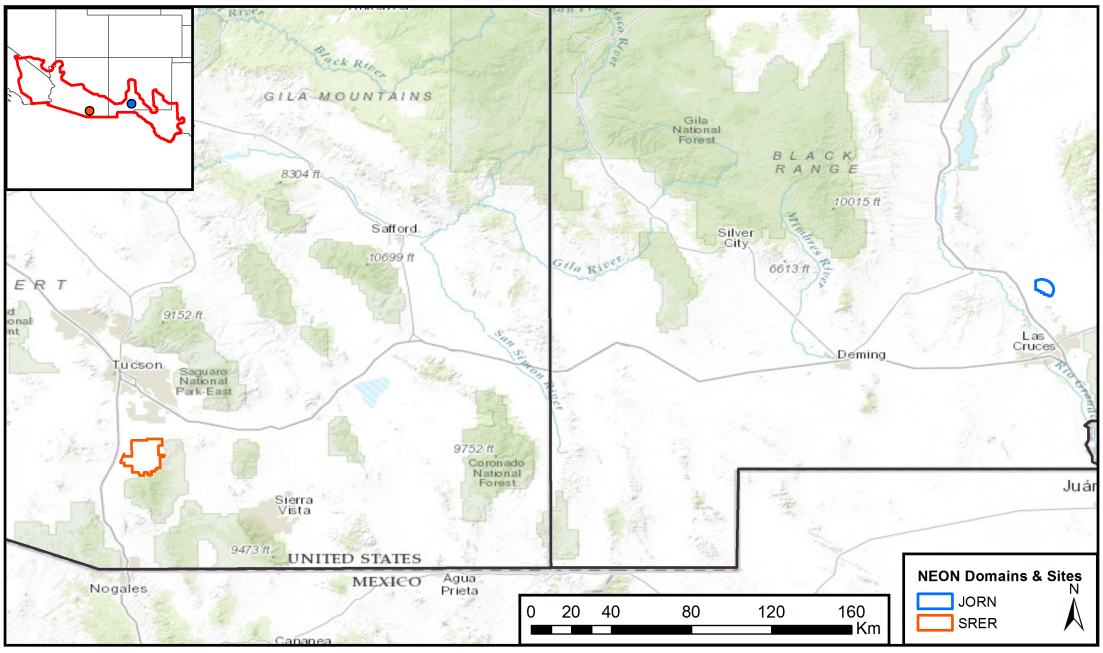

Figure 2: Site boundaries within Domain 14.

Domain 14 spans across the Mojave, Sonoran, and Chihuahuan Deserts along the Mexican border. Desert summers are long and hot and vegetation tends to be sparse, drought-resistant, and thorny. Both D14 sites have a long history of ecological research allowing opportunities for larger datasets and longer time series.

- States included in the domain: Arizona, California, Nevada, New Mexico, and Texas
- Core site: Santa Rita Experimental Range
- Relocatable 1: Jornada LTER
- Science themes: Climate Impacts, Invasives Species

4 CORE SITE- SANTA RITA EXPERIMENTAL RANGE (SRER)

The Santa Rita Experimental Range is located approximately 35 km south of the rapidly developing Phoenix-Tucson megalopolis. Running across the western alluvial skirt of the Santa Rita Mountains, the site is characterized by desert scrub and grassland species. The site is the longest continuously active rangeland research facility in the United States (McClaran 2003).

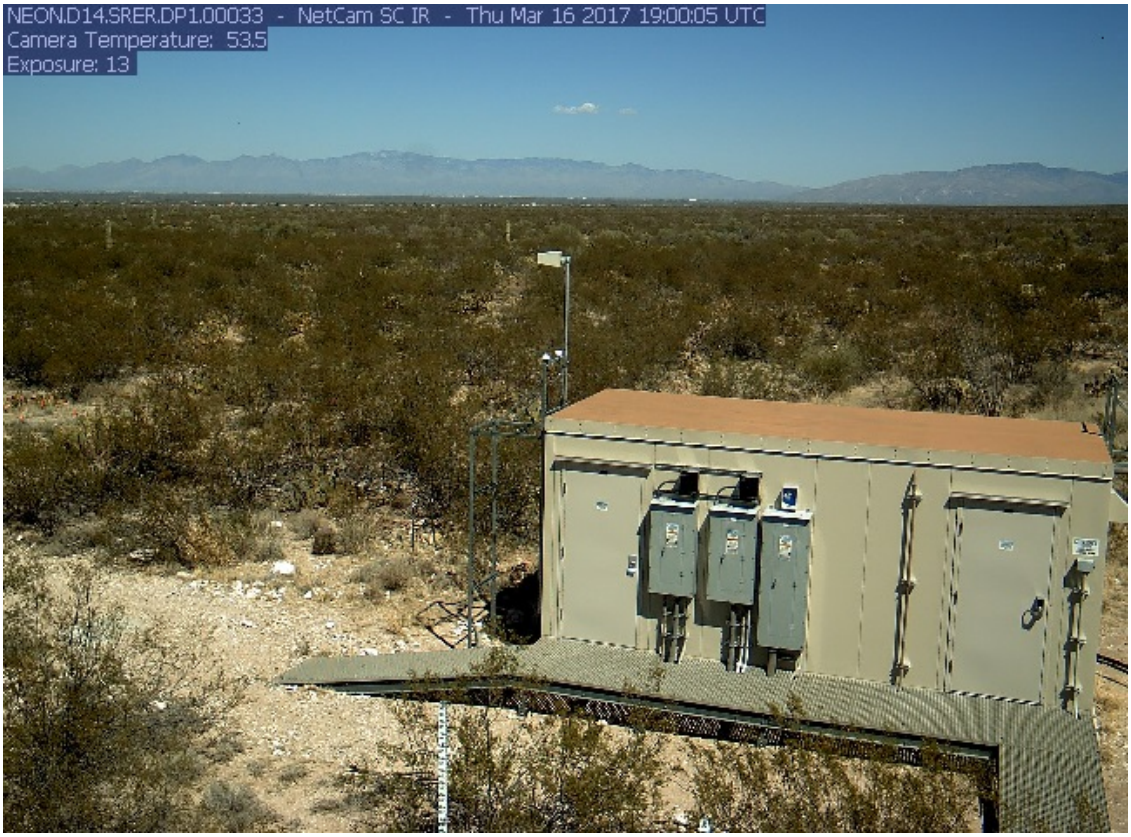

Figure 3: Phenocamera image for SRER. The phenocamera is located at the top of the NEON tower and faces north. Phenocamera images are available at https://phenocam.sr.unh.edu/webcam/network/table/.

Key Characteristics:

- Site host: University of Arizona
- Located in: Pima County, Arizona
- Area: 214.9 km^2
- Elevation: 890- 1461.07m
- Dominant vegetation type: The vegetation at SRER is a mix of short trees, shrubs, cacti and other succulents, perennial grasses, and herbaceous species. Over the last 100 years, velvet mesquite (*Prosopis juliflora* var. *velutina*) abundance has steadily increased across the range (McClaran 2003). Creosote bush (*Larrea tridentata*) dominates below 975m while burroweed (*Haplopappus tenuisectus*) and cholla cac-

tus (*Opuntia* spp.) attain their highest densities between 975-1,100m. At higher elevations above 1,200m prickly pear (*Opuntia* spp.), acacia (*Acacia greggii, A. angustissima*), mimosa (*Mimosa biuncifera, M. dysocarpa*), and false mesquite (*Calliandra eriophylla*) dominate (Martin and Reynolds 1973).

- General management: The Santa Rita Experimental Range was established in 1903 by President Theodore Roosevelt. Grazing was excluded at lower elevations from 1903-1915 to facilitate vegetation recovery. During this time qualitative and quantitative vegetation measurements were set in place to track vegetation change over time (McClaran 2003). Currently cattle graze in different parcels throughout the year in various densities and durations.
- Plot Selection: NEON TOS Plots were allocated across the site following NEON standard criteria and avoiding existing research. Due to the size of the airshed, 18 Tower Base Plots will be sampled instead of the standard 20.

4.1 TOS Spatial Sampling Design

TOS Distributed Plots were allocated at SRER 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.

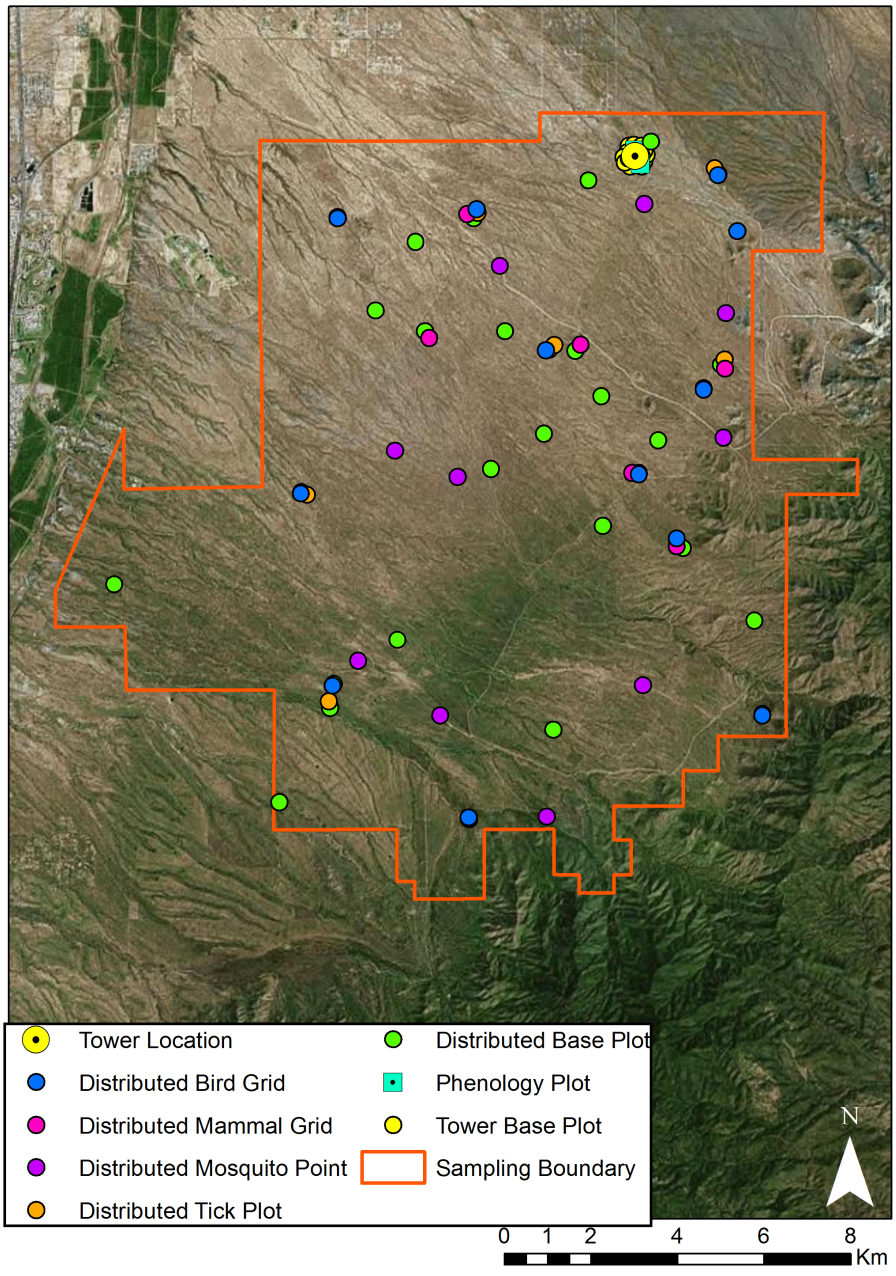

Figure 4: Map of TOS plot centroids within the NEON TOS sampling boundary at SRER.

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

RD[03].

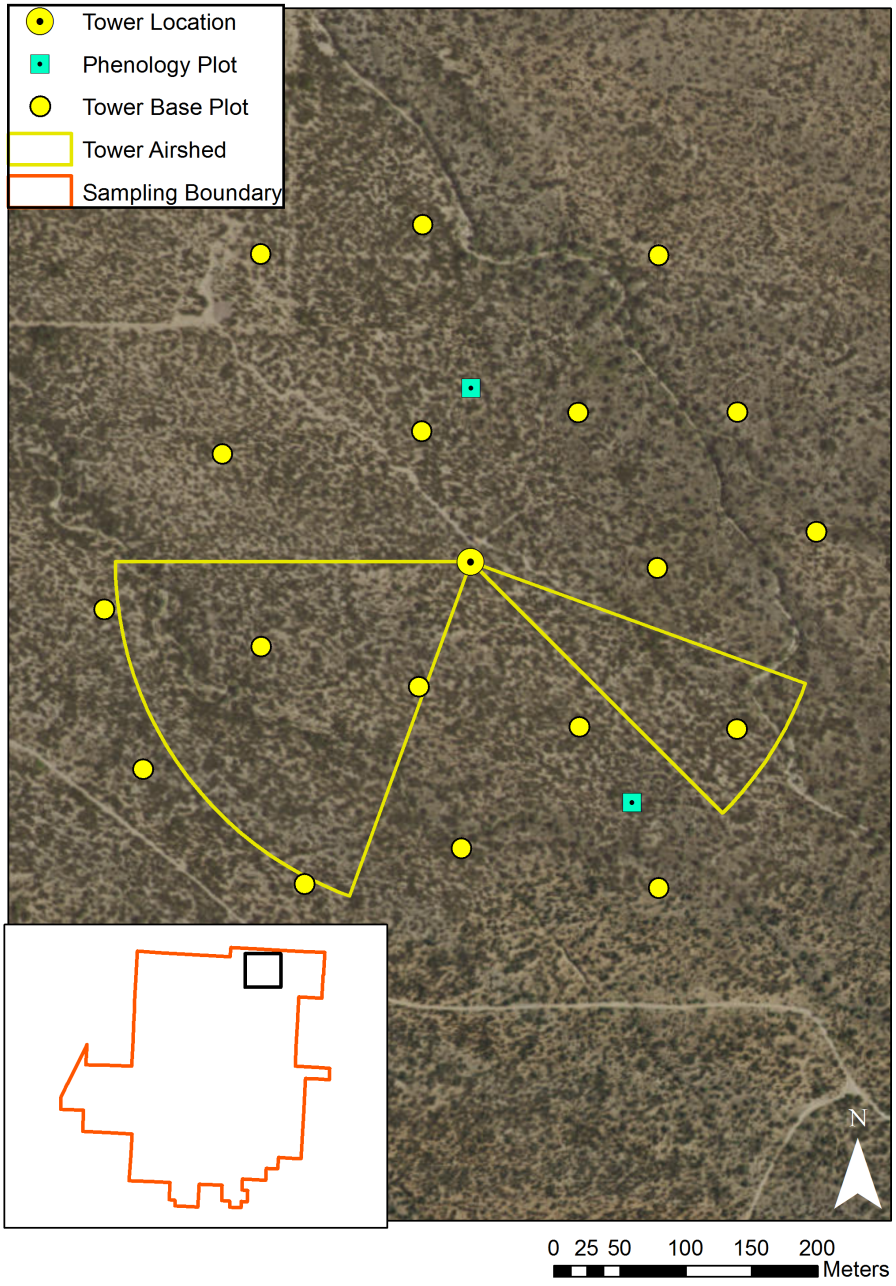

Figure 5: Map of the tower airshed and TOS plot centroids at SRER.

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 SRER.

NLCD Class	Site Area (km^2)	Percent (%)
Shrub Scrub	213.9	99.53
Evergreen Forest	0.64	0.3
Developed Open Space	0.21	0.1
Woody Wetlands	0.09	0.04
Grassland Herbaceous	0.06	0.03
Barren Land	0.02	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 SRER.

Plot Type	Plot Subtype	NLCD Class	Number of Plots Established
Distributed	Base Plot	Shrub Scrub	30
Distributed	Bird Grid	Shrub Scrub	12
Distributed	Mammal Grid	Shrub Scrub	6
Distributed	Mosquito Point	Shrub Scrub	10
Distributed	Tick Plot	Shrub Scrub	6
Tower	Base Plot	NA	18
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 3: Number of Distributed Base Plots per NLCD land cover class per protocol at SRER.

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Shrub Scrub	Beetles	10
Distributed	Base Plot	Shrub Scrub	Canopy Foliage Chemistry	10
Distributed	Base Plot	Shrub Scrub	Coarse Downed Wood	20
Distributed	Base Plot	Shrub Scrub	Digital Hemispherical Photos for Leaf Area Index	20
Distributed	Base Plot	Shrub Scrub	Herbaceous Biomass	20
Distributed	Base Plot	Shrub Scrub	Plant Diversity	30

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Shrub Scrub	Soil Biogeochemistry	6
Distributed	Base Plot	Shrub Scrub	Soil Microbes	6
Distributed	Base Plot	Shrub Scrub	Vegetation Structure	20

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 SRER.

Plot Type	Plot Subtype	Protocols	Number of Plots
Tower	Base Plot	Below Ground Biomass Coring	18
Tower	Base Plot	Canopy Foliage Chemistry	4
Tower	Base Plot	Coarse Downed Wood	18
Tower	Base Plot	Digital Hemispherical Photos for Leaf Area Index	18
Tower	Base Plot	Herbaceous Biomass	18
Tower	Base Plot	Litterfall and Fine Woody Debris	18
Tower	Base Plot	Plant Diversity	3
Tower	Base Plot	Soil Biogeochemistry	4
Tower	Base Plot	Soil Microbes	4
Tower	Base Plot	Vegetation Structure	18
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: SRER

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.

Secondarily, the timing of protocol implementation within sites may be modified according to on-the-ground observations. At SRER, domain staff reported that the relatively modest MODIS-EVI greenness peak between DOY 87-189 is associated with a different plant community than the larger greenness peak associated with the summer monsoon (see Figure below). As such, the sampling season duration and intra-season schedule at SRER is

based on two phenologically distinct greenness periods: one in the spring and another during the summer.

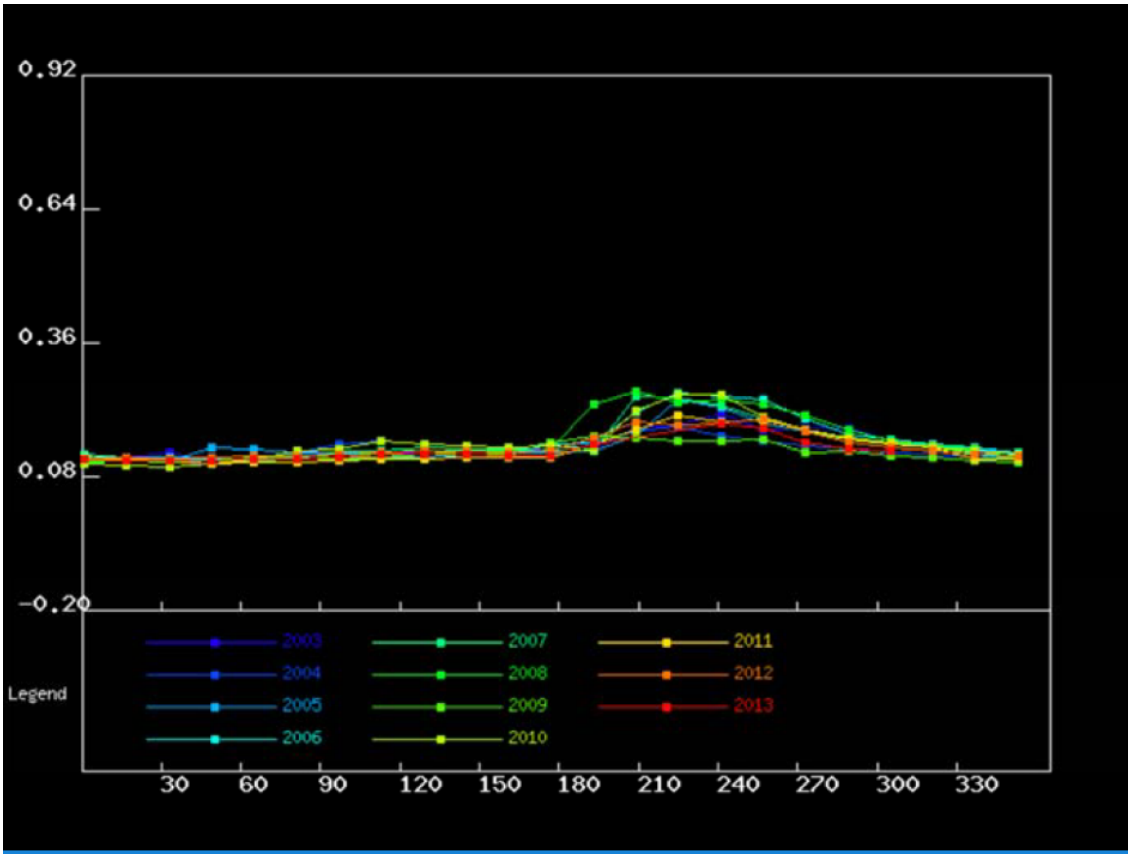

Figure 6: MODIS-EVI greenness (y-axis = EVI ratio) as a function of time (x-axis = DOY) for the years 2003-2013 at the NEON SRER site.

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

Phenology Peak	Average Increase	Average Maximum	Average Decrease	Average Minimum	Remarks
Peak 1	87 (03/28)	139 (05/19)	189 (07/08)	219 (08/07)	Highly variable from year to year, and peak not visible in all years; used data from 2001, 2004, 2005, and 2009
Peak 2	186 (07/05)	215 (08/03)	259 (09/16)	334 (11/30)	

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: 36.25 km x 36.25 km box, centroid lat: 31.911, centroid long: -110.836 (WGS84 datum)

4.3 Belowground Biomass

4.3.1 Site-Specific Methods

Belowground biomass characterization data were collected down to a depth of 180 cm by NEON staff in November 2013. 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.

4.3.2 Results

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

Upper Depth	Lower Depth	Mean (mg per cm^3)	Std Dev
0	10	0.72	0.59
10	20	0.84	0.47
20	30	0.58	0.48
30	40	1	0.96
40	50	0.19	0.13
50	60	0.16	0.05
60	70	0.05	0.05
70	80	0.1	0.1
80	90	0.15	0.18
90	100	0.17	0.23
100	120	0.08	0.06
120	140	0.1	0.07
140	160	0.12	0.06
160	180	0.06	0.02

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

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
0	10	71.75	58.97
10	20	155.86	13.05
20	30	213.91	37.65
30	40	313.65	99.48
40	50	333.15	111.89
50	60	349.2	114.84
60	70	354.21	114.9
70	80	364.3	115.39
80	90	379.42	119.46
90	100	396.02	96.58
100	120	412.82	100.68
120	140	432.92	110.23
140	160	457.49	102.89
160	180	470.31	103.38

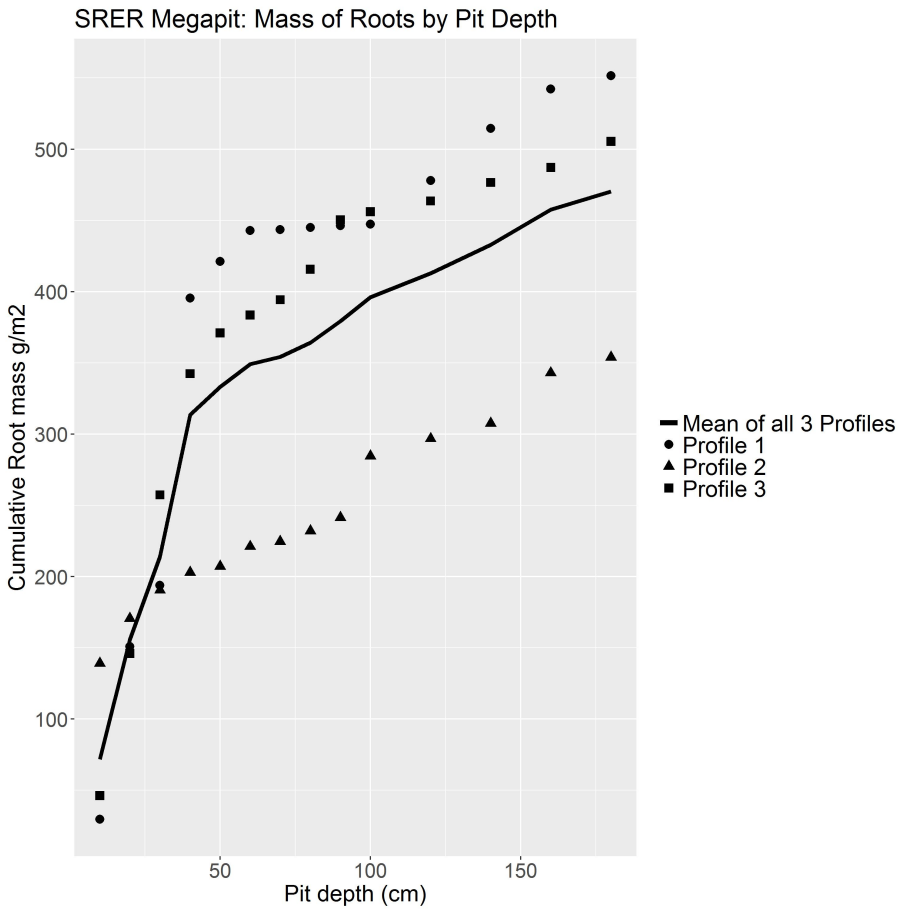

Figure 7: Cumulative root mass by pit depth at SRER.

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

Total Pit Depth (cm)	180
Total Mean Cumulative Mass at 30cm (g per m^2)	213.91
Total Mean Cumulative Mass at 100cm (g per m^2)	396.02
Total Mean Cumulative Mass (g per m^2)	470.31

4.4 Plant Characterization and Phenology Species Selection

4.4.1 Site-Specific Methods

Plant characterization data were collected by NEON staff during January of 2016. Plant characterization data informs sampling procedure 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; 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 SRER.

Taxon ID	Scientic Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
LATR2	*Larrea tridentata* (DC.) Coville	1	3	0.17	NA
PRVE	*Prosopis velutina* Woot.	2	<1	0.07	0.03

Taxon ID	Scientic Name	Rank	Mean Percent Cover	Mean Canopy Area per m^2	Mean ABH (cm^2 per m^2)
PAFL6	*Parkinsonia florida* (Benth. ex A. Gray) S. Watson	3	<1	0.01	NA
ZIGR	*Zinnia grandiflora* Nutt.	4	2	NA	NA
EPTR	*Ephedra trifurca* Torr. ex S. Watson	5	<1	0.01	NA
ACGR	*Acacia greggii* A. Gray	6	NA	0.01	NA
MUPO2	*Muhlenbergia porteri* Scribn. ex Beal	7	1	NA	NA
FOSP2	*Fouquieria splendens* Engelm.	8	NA	<1	NA
OPEN3	*Opuntia engelmannii* Salm-Dyck ex Engelm.	9	<1	NA	NA
DAPU7	*Dasyochloa pulchella* (Kunth) Willd. ex Rydb.	10	<1	NA	NA
BOHI2	*Bouteloua hirsuta* Lag.	11	<1	NA	NA
FEWI	*Ferocactus wislizeni* (Engelm.) Britton & Rose	12	<1	NA	NA
ASTERA	*Asteraceae* sp.	13	<1	NA	NA
ACNA2	*Acourtia nana* (A. Gray) Reveal & R.M. King	14	<1	NA	NA
ALWR	*Aloysia wrightii* (A. Gray) A. Heller	15	NA	<1	NA
CYLE8	*Cylindropuntia leptocaulis* (DC.) F.M. Knuth	17	<1	NA	NA
LYCIU	*Lycium* sp.	18	NA	<1	NA
CEEH	*Celtis ehrenbergiana* (Klotzsch) Liebm.	19	NA	<1	NA
YUEL	*Yucca elata* (Engelm.) Engelm.	20	NA	<1	NA
ARPU9	*Aristida purpurea* Nutt.	21	<1	NA	NA
CYSP8	*Cylindropuntia spinosior* (Engelm.) F.M. Knuth	22	<1	NA	NA
STREP2	*Streptanthus* sp.	23	<1	NA	NA
ATCA2	*Atriplex canescens* (Pursh) Nutt.	24	NA	<1	NA

Taxon ID	Scientic Name	Rank	Mean Percent Cover	Mean Canopy Area per m^2	Mean ABH (cm^2 per m^2)
2PLANT	Unknown plant	25	<1	NA	NA
BOER4	*Bouteloua eriopoda* (Torr.) Torr.	25	<1	NA	NA
MALVAC	Malvaceae sp.	25	<1	NA	NA
BORO2	*Bouteloua rothrockii* Vasey	28	<1	NA	NA
HILAR	*Hilaria* sp.	29	<1	NA	NA
BRASSI	Brassicaceae sp.	30	<1	NA	NA
SOEL	*Solanum elaeagnifolium* Cav.	31	<1	NA	NA
APIACE	Apiaceae sp.	32	<1	NA	NA
BAAB	*Bahia absinthifolia* Benth.	33	<1	NA	NA
OPPH	*Opuntia phaeacantha* Engelm.	33	<1	NA	NA
CRYP	*Cryptantha* sp.	33	<1	NA	NA
PROSO	*Prosopis* sp.	37	NA	<1	NA
MAGR9	*Mammillaria grahamii* Engelm.	38	<1	NA	NA
CYFU10	*Cylindropuntia fulgida* (Engelm.) F.M. Knuth	39	<1	NA	NA
PLPA2	*Plantago patagonica* Jacq.	39	<1	NA	NA
ANCO2	*Anthemis cotula* L.	41	<1	NA	NA
BOBA2	*Bouteloua barbata* Lag.	41	<1	NA	NA
ASNU4	*Astragalus nuttallianus* DC.	43	<1	NA	NA
CRYPT	*Cryptantha* sp.	43	<1	NA	NA
OPMA8	*Opuntia macrocentra* Engelm.	43	<1	NA	NA
STREP2	*Streptanthus* sp.	43	<1	NA	NA
SELE6	*Setaria leucopila* (Scribn. & Merr.) K. Schum.	49	<1	NA	NA
APIACE	Apiaceae sp.	51	<1	NA	NA
ECFA	*Echinocereus fasciculatus* (Engelm. ex B.D. Jacks.) L.D. Benson	51	<1	NA	NA

Taxon ID	Scientic Name	Rank	Mean Percent Cover	Mean Canopy Area per m^2	Mean ABH (cm^2 per m^2)
PHCA8	*Phoradendron californicum* Nutt.	51	<1	NA	NA
SPCR	*Sporobolus cryptandrus* (Torr.) A. Gray	51	<1	NA	NA
ANTU	*Anemone tuberosa* Rydb.	55	<1	NA	NA
BOAR	*Bouteloua aristidoides* (Kunth) Griseb.	55	<1	NA	NA
CABU2	*Capsella bursa-pastoris* (L.) Medik.	55	<1	NA	NA
ERLE	*Eragrostis lehmanniana* Nees	55	<1	NA	NA
POJA5	*Pomaria jamesii* (Torr. & A. Gray) Walp.	55	<1	NA	NA
VUOC	*Vulpia octoflora* (Walter) Rydb.	55	<1	NA	NA

Note:Taxon IDs and scientific names are based on the USDA Plants database (plants.usda.gov).The two main species lumped within the *Lycium* sp. group are *L. berlandieri* and *L. exsertum*.

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

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover
SRER_042	8	1.56	23
SRER_043	8	0.79	30
SRER_044	13	0.87	46
SRER_045	15	1.92	48
SRER_046	9	1.13	34
SRER_047	9	1.77	11
SRER_048	10	1.35	47
SRER_049	14	1.98	18
SRER_050	14	2.26	17
SRER_051	15	2.05	24
SRER_052	15	1.77	56
SRER_053	14	1.66	40
SRER_054	13	2.03	22

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover
SRER_055	27	2.01	97
SRER_056	12	2.42	6
SRER_057	4	1.19	2
SRER_058	20	2.3	57
SRER_059	19	2.07	52

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

4.5 Beetles

4.5.1 Site-Specific Methods

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

4.6 Mosquitoes

4.6.1 Site-Specific Methods

Mosquito site characterization was conducted in November 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 mosquito specimens from the site were pooled before identification. For more information on this protocol and data product numbers see Appendix A.

4.6.2 Results

Table 11: Mosquito identification results at SRER.

Sample ID	Scientific Name	Sex	count
SRER.November2013.SC.1	*Anopheles franciscanus*	female	3
SRER.November2013.SC.1	*Culex tarsalis*	female	2
SRER.November2013.SC.1	*Culiseta inornata*	female	12

4.7 Ticks

4.7.1 Site-Specific Methods

Tick drags were conducted at SRER in November of 2013 to test protocol methods and calculate capture rates. No ticks were captured or seen by field personnel. 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.

McClaran, Mitchel P. 2003. A century of vegetation change on the Santa Rita Experimental Range. In: Santa Rita Experimental Range: 100 years (1903 to 2003) of accomplishments and contributions; conference proceedings; 2003 October 30-November 1; Tucson, AZ. Proc. RMRS-P-30. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 16-33.

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Rickel, Bryce 2005. Small Mammals, Reptiles, and Amphibians. Assessment of grassland ecosystem conditions in the Southwestern United States: wildlife and fish-volume 2. Gen. Tech. Rep. RMRS-GTR-135-vol. 2. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 35-70

5 RELOCATABLE SITE 1- JORNADA LTER (JORN)

The JORN site is located approximately 20 miles north of Las Cruces, New Mexico and lies within the Chihuahuan Desert, the largest desert in North America . The Jornada Basin is home to multiple research groups including the Jornada Long Term Ecological Research (LTER) and the Chihuahuan Desert Rangeland Research Center (CDRRC).

Figure 8: Phenocamera image for JORN. 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: U.S. Department of Agriculture, Agricultural Research Service
- Located in: Dona Ana County, New Mexico
- Area: 45.7 km^2
- Elevation: 1315 - 1335m
- Dominant vegetation type: Vegetation cover at Jornada is dominated by desert scrub and grassland, which together represent ~90% of the Domain. Large upland areas that were formerly dominated by perennial grasses, including black grama (*Bouteloua eriopoda*) and mesa dropseed (*Sporobolus flexuosus*), have been replaced by desert shrubland species, in particular creosote bush (*Larrea tridentata*) and honey mesquite (*Prosopis glandulosa*) (Gibbens et al, 2005).

- General management: Data sets on climate, hydrology, soils, plants, and animals are maintained by the Jornada Experimental Range and the Jornada LTER data management programs (Havstad et all, 2000). Early research at Jornada focused on livestock management practices but over time the scope has broaden to better integrate ecological and agricultural research.
- 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 JORN 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.

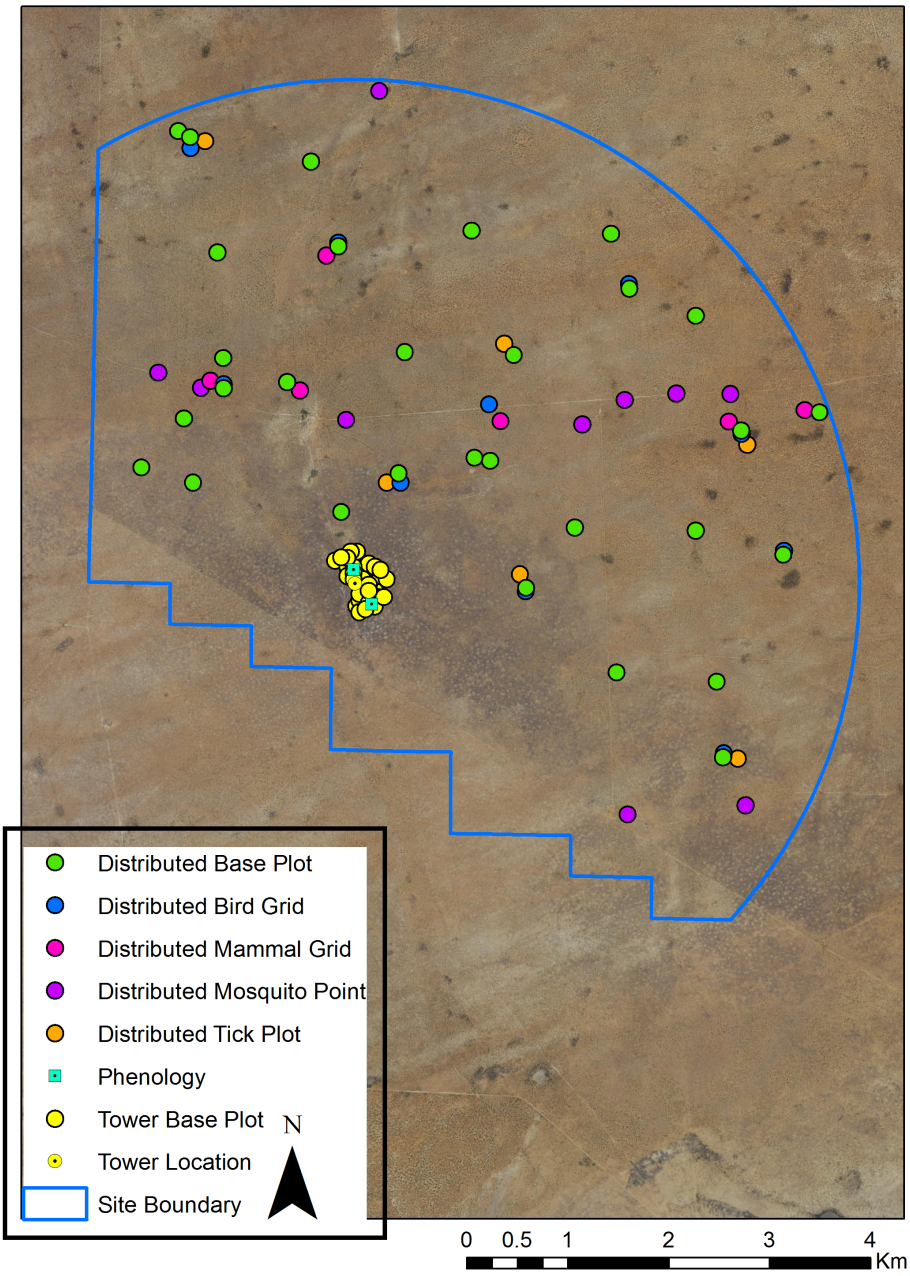

Figure 9: Map of TOS plot centroids within the NEON TOS sampling boundary at JORN.

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

RD[03].

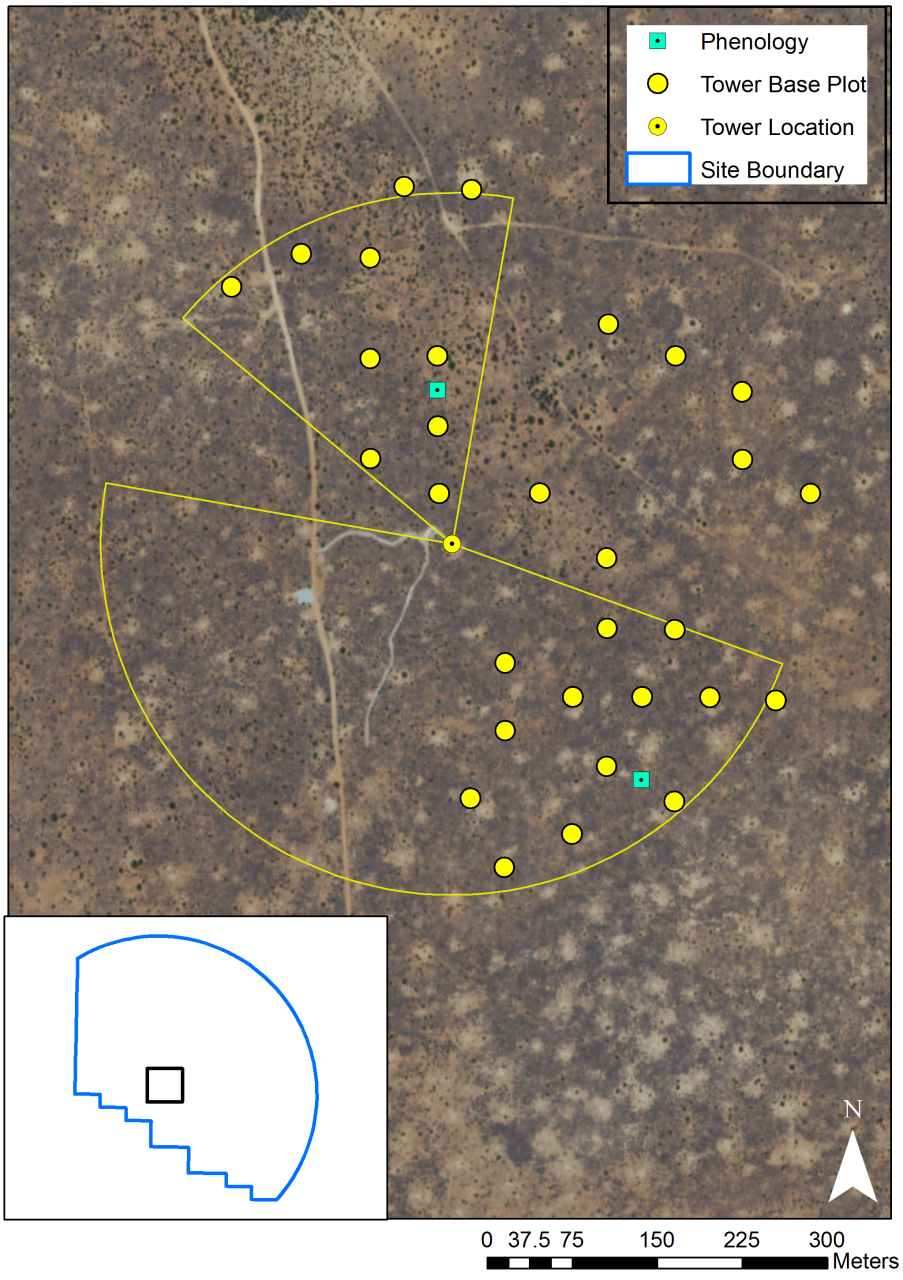

Figure 10: Map of the tower airshed and TOS plot centroids at JORN.

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

Table 12: NLCD land cover classes and area within the TOS site boundary at JORN.

NLCD Class	Site Area (km^2)	Percent (%)
Shrub Scrub	45.75	100

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 13: NLCD land cover classes and TOS plot numbers at SRER.

Plot Type	Plot Subtype	NLCD Class	Number of Plots Established
Distributed	Base Plot	Shrub Scrub	30
Distributed	Bird Grid	Shrub Scrub	10
Distributed	Mammal Grid	Shrub Scrub	6
Distributed	Mosquito Point	Shrub Scrub	10
Distributed	Tick Plot	Shrub Scrub	6
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 grassland herbaceous.

Table 14: Number of Distributed Base plots per NLCD land cover class per protocol at JORN.

Plot Type	Plot Subtype	NLCD Class	Protocols	Number of Plots
Distributed	Base Plot	Shrub Scrub	Beetles	10
Distributed	Base Plot	Shrub Scrub	Canopy Foliage Chemistry	10
Distributed	Base Plot	Shrub Scrub	Coarse Downed Wood	20
Distributed	Base Plot	Shrub Scrub	Digital Hemispherical Photos for Leaf Area Index	20
Distributed	Base Plot	Shrub Scrub	Herbaceous Biomass	20
Distributed	Base Plot	Shrub Scrub	Plant Diversity	30
Distributed	Base Plot	Shrub Scrub	Soil Biogeochemistry	6
Distributed	Base Plot	Shrub Scrub	Soil Microbes	6
Distributed	Base Plot	Shrub Scrub	Vegetation Structure	20

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 15: Number of Tower Plots per protocol at JORN.

Plot Type	Plot Subtype	Protocols	Number of Plots
Tower	Base Plot	Below Ground Biomass Coring	30
Tower	Base Plot	Canopy Foliage Chemistry	4
Tower	Base Plot	Coarse Downed Wood	30
Tower	Base Plot	Digital Hemispherical Photos for Leaf Area Index	30
Tower	Base Plot	Herbaceous Biomass	30
Tower	Base Plot	Litterfall and Fine Woody Debris	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: JORN

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.

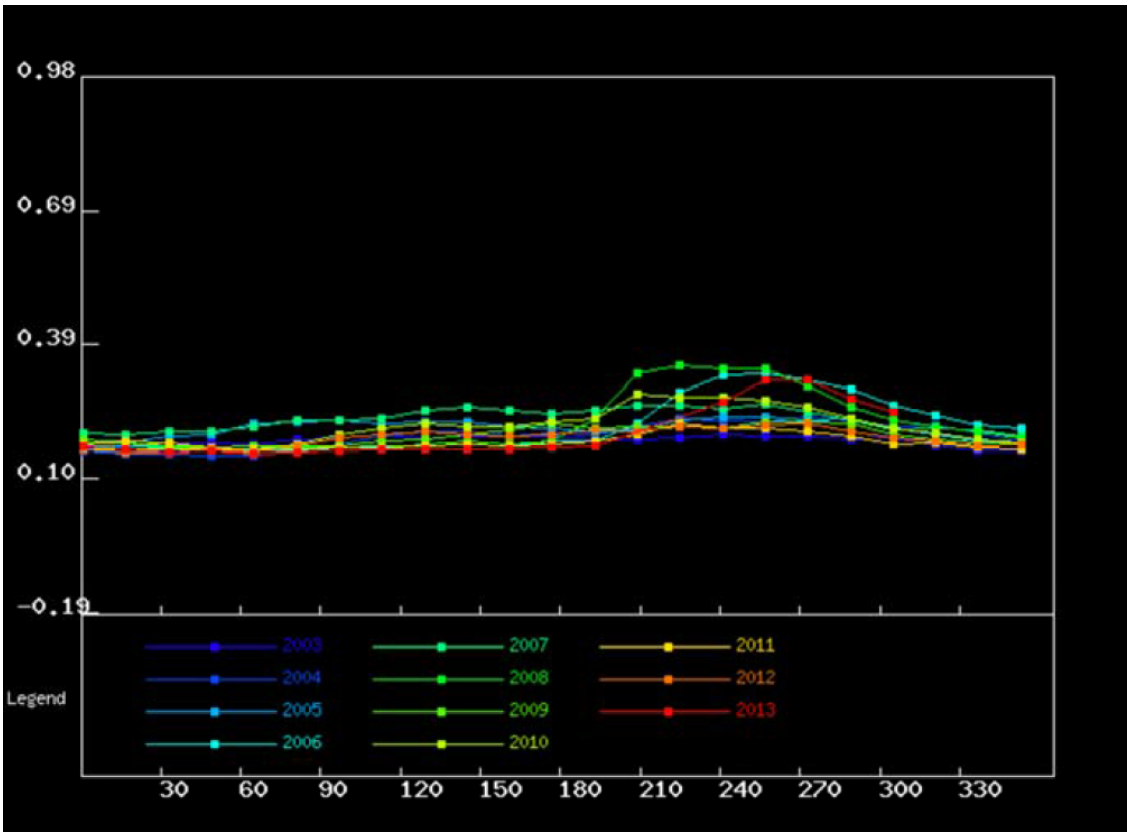

Figure 11: MODIS-EVI greenness (y-axis = EVI ratio) as a function of time (x-axis = DOY) for the years 2003-2013 at the NEON JORN site.

Table 16: Average MODIS-EVI greenness dates for the NEON JORN site, based on data from 2003-2013 (DOY, with MM/DD in parentheses).

Average Increase	Average Maximum	Average Decrease	Average Minimum
80 (03/21)	185 (07/04)	245 (09/02)	340 (12/06)

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: 64.25 km x 64.25 km box, centroid lat: 32.590598, centroid long: -106.84239 (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 March 2013. 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 17: Fine root mass per depth increment (cm) at JORN.

Upper Depth	Lower Depth	Mean (mg per cm^3)	Std Dev
0	10	0.96	0.45
10	20	0.59	0.12
20	30	0.22	0.08
30	40	0.08	0.03
40	50	0.18	0.2
50	60	0.14	0.17
60	70	0.1	0.09
70	80	0.11	0.15
80	90	0.1	0.13
90	100	0.01	0.01
100	120	0.01	0
120	140	0.02	0.02
140	160	0.1	0.16
160	180	0.02	0.01

Table 18: Cumulative fine root mass as a function of depth (cm) at JORN.

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
0	10	95.51	45.06

Upper Depth	Lower Depth	Mean Cumulative (g per m^2)	Cumulative Std Dev
10	20	154.58	47.32
20	30	176.19	54.48
30	40	184.1	51.97
40	50	202.16	67.73
50	60	215.9	69.69
60	70	226.22	77.89
70	80	237.46	89.74
80	90	247	100.64
90	100	248.06	101.16
100	120	249.5	100.38
120	140	253.7	98.69
140	160	274.56	128.12
160	180	279.42	129.83

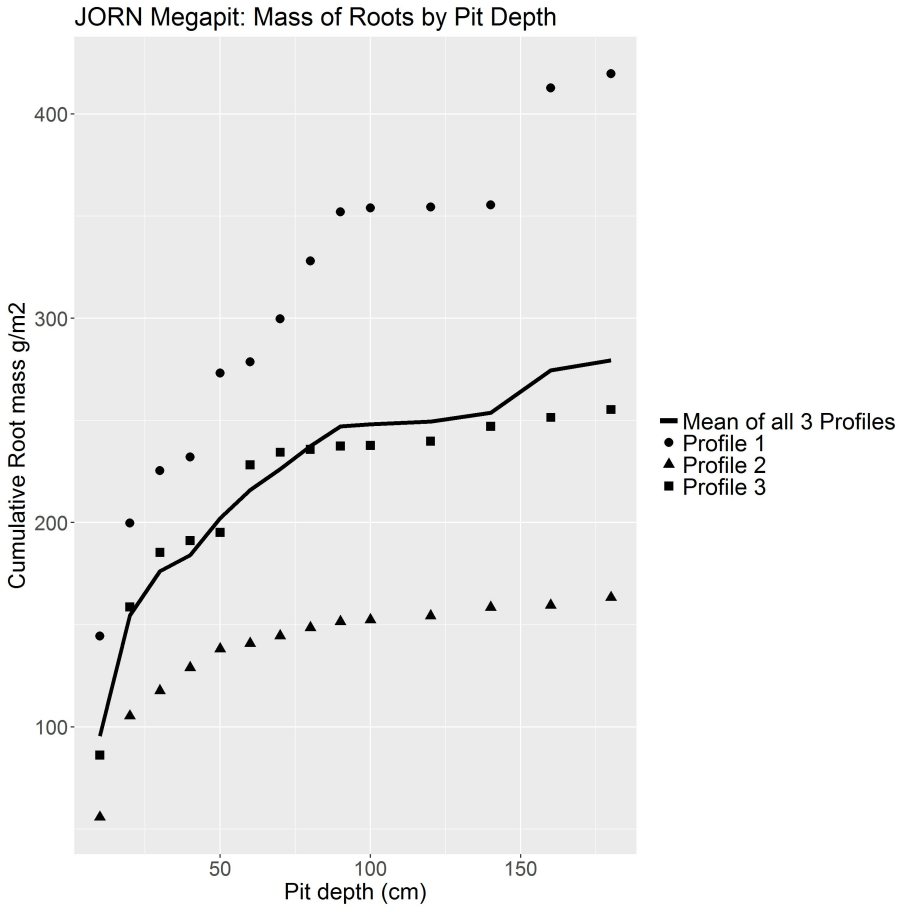

Figure 12: Cumulative root mass by pit depth at JORN.

Table 19: Fine root biomass sampling summary data at JORN.

Total Pit Depth (cm)	180
Total Mean Cumulative Mass at 30cm (g per m^2)	176.19
Total Mean Cumulative Mass at 100cm (g per m^2)	248.06
Total Mean Cumulative Mass (g per m^2)	279.42

5.4 Plant Characterization and Phenology Species Selection

5.4.1 Site-Specific Methods

Plant characterization data were collected by NEON staff during May of 2015. Plant characterization data informs sampling procedure 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; 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 20: Site plant characterization and phenology species summary at JORN.

Taxon ID	Scientic Name	Rank	Mean Percent Cover	Mean Canopy Area (m^2 per m^2)	Mean ABH (cm^2 per m^2)
PRGL2	*Prosopis glandulosa* Torr.	1	<1	0.04	NA
YUEL	*Yucca elata* (Engelm.) Engelm.	2	NA	0.02	NA
BOER4	*Bouteloua eriopoda* (Torr.) Torr.	3	4	NA	NA
APRA	*Aphanostephus ramosissimus* DC.	4	1	NA	NA
SPFL2	*Sporobolus flexuosus* (Thurb. ex Vasey) Rydb.	5	1	NA	NA
EPTR	*Ephedra trifurca* Torr. ex S. Watson	6	<1	<1	NA
SEBA3	*Senna bauhinioides* (A. Gray) Irwin & Barneby	7	<1	NA	NA
POJA5	*Pomaria jamesii* (Torr. & A. Gray) Walp.	8	<1	NA	NA
ARPU9	*Aristida purpurea* Nutt.	9	<1	NA	NA
PLPA2	*Plantago patagonica* Jacq.	10	<1	NA	NA
NAHI	*Nama hispidum* A. Gray	11	<1	NA	NA

Taxon ID	Scientic Name	Rank	Mean Percent Cover	Mean Canopy Area per m^2	Mean ABH (cm^2 per m^2)
DANA	*Dalea nana* Torr. ex A. Gray	12	<1	NA	NA
GUSA2	*Gutierrezia sarothrae* (Pursh) Britton & Rusby	13	NA	<1	NA
GUTIE	*Gutierrezia* sp.	14	<1	<1	NA
CRCR3	*Cryptantha crassisepala* (Torr. & A. Gray) Greene	15	<1	NA	NA
CRPO5	*Croton pottsii* (Klotzsch) Müll. Arg.	16	<1	NA	NA
HOHU	*Houstonia humifusa* (A. Gray) A. Gray	17	<1	NA	NA
LEFE	*Lesquerella fendleri* (A. Gray) S. Watson	18	<1	NA	NA
HODR	*Hoffmannseggia drepanocarpa* A. Gray	19	<1	NA	NA
SELE6	*Setaria leucopila* (Scribn. & Merr.) K. Schum.	20	<1	NA	NA
ZIGR	*Zinnia grandiflora* Nutt.	21	<1	NA	NA
ALIN	*Allionia incarnata* L.	22	<1	NA	NA
MUPO2	*Muhlenbergia porteri* Scribn. ex Beal	23	<1	NA	NA
SPIN2	*Sphaeralcea incana* Torr. ex A. Gray	24	<1	NA	NA
TECO	*Tetraclea coulteri* A. Gray	25	<1	NA	NA
2PLANT	Unknown plant	26	<1	NA	NA
CHIN2	*Chenopodium incanum* (S. Watson) A. Heller	27	<1	NA	NA
SOEL	*Solanum elaeagnifolium* Cav.	28	<1	NA	NA
DIWI2	*Dimorphocarpa wislizeni* (Engelm.) Rollins	29	<1	NA	NA
DALA3	*Dalea lanata* Spreng.	30	<1	NA	NA
ERAB2	*Eriogonum abertianum* Torr.	30	<1	NA	NA
HYFL	*Hymenopappus flavescens* A. Gray	30	<1	NA	NA

Taxon ID	Scientic Name	Rank	Mean Percent Cover	Mean Canopy Area per m^2	Mean ABH (cm^2 per m^2)
ERIGE2	*Erigeron* sp.	33	<1	NA	NA
BAAB	*Bahia absinthifolia* Benth.	34	<1	NA	NA
CHAL11	*Chamaesyce albomarginata* (Torr. & A. Gray) Small	34	<1	NA	NA
DAPU7	*Dasyochloa pulchella* (Kunth) Willd. ex Rydb.	34	<1	NA	NA
LELA	*Lepidium lasiocarpum* Nutt.	34	<1	NA	NA
OEAL	*Oenothera albicaulis* Pursh	34	<1	NA	NA
SPFE	*Sphaeralcea fendleri* A. Gray	39	<1	NA	NA
ASTERA	Asteraceae sp.	40	<1	NA	NA
ASTRA	*Astragalus* sp.	40	<1	NA	NA
DEPI	*Descurainia pinnata* (Walter) Britton	40	<1	NA	NA
ERNE9	*Erioneuron nealleyi* (Vasey) Tateoka	40	<1	NA	NA
GAPI	*Gaillardia pinnatifida* Torr.	40	<1	NA	NA
LIAU4	*Linum australe* A. Heller	40	<1	NA	NA
MAPI	*Machaeranthera pinnatifida* (Hook.) Shinners	40	<1	NA	NA
STEX	*Stephanomeria exigua* Nutt.	40	<1	NA	NA
STPA4	*Stephanomeria pauciflora* (Torr.) A. Nelson	40	<1	NA	NA
OPMA8	*Opuntia macrocentra* Engelm.	49	NA	NA	NA

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

Table 21: Per plot breakdown of species richness, diversity, and herbaceous cover at JORN.

Plot ID	Species Richness	Shannon Diversity Index	Percent Total Herbaceous Cover
JORN_042	15	2.18	22
JORN_043	14	2.35	16
JORN_044	14	2.32	19
JORN_045	16	1.47	46
JORN_046	10	1.97	23
JORN_047	9	1.81	11
JORN_048	15	2.43	16
JORN_049	8	1.58	15
JORN_050	11	1.87	16
JORN_051	12	2.23	13
JORN_052	14	2.41	14
JORN_053	12	2.37	21
JORN_054	16	2.43	15
JORN_055	12	2.18	16
JORN_056	17	2.47	17
JORN_057	15	2.46	22
JORN_058	12	2.17	15
JORN_059	13	2.19	18
JORN_060	18	2.69	19
JORN_061	12	1.99	16
JORN_062	14	2.34	16
JORN_063	10	1.69	18
JORN_064	15	1.62	51
JORN_065	12	2.11	14
JORN_066	12	2.1	25
JORN_067	15	2.48	20
JORN_068	17	2.47	19
JORN_069	19	2.41	28
JORN_070	10	1.87	13
JORN_071	12	2.09	17

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

5.5 Beetles

5.5.1 Site-Specific Methods

Beetle site characterization was conducted in August of 2014 by NEON staff following the standard methods outlined in TOS Site Characterization Methods (RD[6]). Beetle site characterization data was collected to start site level teaching collections. All beetle specimens from the site were pooled before 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 22: Beetle identification results at JORN.

Sample ID	Scientific Name	Sex
NEONcarabid8259	*Selenophorus planipennis*	M
NEONcarabid8262	*Pasimachus obsoletus*	U
NEONcarabid8256	*Tetragonoderus pallidus*	U
NEONcarabid8261	*Calosoma peregrinator*	M
NEONcarabid8260	*Pasimachus obsoletus*	U
NEONcarabid8257	*Selenophorus* spp.	F
NEONcarabid8255	*Tetragonoderus pallidus*	U
NEONcarabid8258	*Selenophorus planipennis*	F
NEONcarabid8254	*Tetragonoderus pallidus*	U

5.6 Mosquitoes

5.6.1 Site-Specific Methods

Mosquito site characterization was conducted in August of 2014 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 specimens from the site were pooled before identification.For more information on this protocol and data product numbers see Appendix A.

5.6.2 Results

Table 23: Mosquito identification results at JORN.

Sample ID	Scientific Name	Sex	Count
JORN.6August2014.SC.1	*Aedes dorsalis*	female	10
JORN.6August2014.SC.1	*Anopheles franciscanus*	female	1
JORN.6August2014.SC.1	*Psorophora columbiae*	female	138
JORN.6August2014.SC.1	*Psorophora columbiae*	male	1

5.7 Ticks

5.7.1 Site-Specific Methods

Tick drags were conducted at JORN in August 2014 to test protocol methods and calculate capture rates. No ticks were captured or seen by field personnel. 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

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.

Degenhardt, W. G., C. W. Painter, and A. Price. 1996. Amphibians and reptiles of New Mexico. University of New Mexico Press.

Gibbens, R.P., McNeely, R.P., Havstad, K.M., Beck, R.F., Nolen, B., 2005. Vegetation changes in the Jornada Basin from 1858 to 1998. Journal of Arid Environments 61, 651-668.

Herbel, C.H. and Gibbens, R.P. 1996. Post-drought vegetation dynamics on arid rangelands in southern New Mexico. New Mexico Agriculture Experimental Station Bulletin 776, 102 pp.

Plant List- Jornada Experimental Range. December 4, 2014. The Jornada Rangeland Research Programs. https://jornada.nmsu.edu/data-catalogs/species/lter-plants

Reptiles and Amphibians of the Jornada: Reptiles and amphibians present on the Jornada del Muerto including the Dona Ana Mountains. The Jornada Rangeland Research Programs. https://jornada.nmsu.edu/data-catalogs/species/reptiles-amphibians

Williamson, M.A., P.W. Hyder, J.S. Applegarth. 1994. Snakes, lizards, turtles, frogs, toads, & salamanders of New Mexico. Sunstone Press, Santa Fe. NM. 176 p.

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Havstad, K. M., Kustas, W. P., Rango, A., Ritchie, J. C., & Schmugge, T. J.2000. Jornada experimental range: a unique arid land location for experiments to validate satellite systems. Remote Sensing of Environment, 74, 13 - 25.

Martin, S.C., and H.G. Reynolds. 1973. The Santa Rita Experimental Range: Your facility for research on semidesert ecosystems. Arizona Acad. Sci. 8:56-67.

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 24: 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

Name	Description	Identification Code
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
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