Data Papers

Ecology, 0(0), 2021, e03530

Quadrat-based monitoring of desert grassland vegetation at the Jornada Experimental Range, New Mexico, 1915–2016

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Citation: Christensen, E., D. James, C. J. Maxwell, A. Slaughter, P. B. Adler, K. Havstad, and B. Bestelmeyer. 2021. Quadrat-based monitoring of desert grassland vegetation at the Jornada Experimental Range, New Mexico, 1915–2016. Ecology 00(00):e03530. 10.1002/ecy.3530

Abstract. The data set covers a 101-yr period (1915–2016) of quadrat-based plant sampling at the Jornada Experimental Range in southern New Mexico. At each sampling event, a pantograph was used to record the location and perimeter of living plants within permanent quadrats. Basal area was recorded for perennial grass species, canopy cover area was recorded for shrub species, and all other perennial species were recorded as point data. The data set includes 122 1 × 1 m permanent quadrats, although not all quadrats were sampled in each year of the study and there is a gap in monitoring from 1980 to 1995. These data provide a unique opportunity to investigate changes in the plant community over 100 yr of variation in precipitation and other environmental conditions. We provide the following data and data formats: (1) the digitized maps in shapefile format; (2) a data table containing coordinates (x, y) of perennial species within quadrats, including cover area for grasses and shrubs; (3) a data table of counts of annual plant individuals per quadrat; (4) a species list indicating growth form and habit of recorded species; (5) a table of dates when each quadrat was sampled; (6) a table of the pasture each quadrat was located within (note that pasture boundaries have changed over time); (7) a table of depth to petrocalcic layer measurements taken at quadrat locations; (8) a table of particle size analysis of soil samples taken at quadrat locations; (9) a table of topographic characteristics of quadrat locations (e.g., concave or convex topography). Pantograph sampling is currently conducted at 5-yr intervals by USDA-ARS staff, and new data will be added periodically to the EDI Data Portal Repository (see section V.E.2). This information is released under the Creative Commons license—Attribution—CC BY and the consumer of these data is required to cite it appropriately in any publication that results from its use.

Key words: arid grasslands; Chihuahuan Desert; long-term research; New Mexico; particle size analysis; plant community; plant populations; quadrat; rangeland; soil texture.

The complete data set is available as Supporting Information at: http://onlinelibrary.wiley.com/doi/10.1002/ecy.3530.

Open Research

Data are also available from EDI: https://doi.org/10.6073/pasta/cf6b1f5845078fbbf82053bb3594faef.

Manuscript received 17 February 2021; revised 22 April 2021; accepted 22 June 2021. final version received 7 September 2021. Corresponding Editor: William K. Michener.
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Metadata S1. Christensen, E. D. James, C. Maxwell, A. Slaughter, P.B. Adler, K. Havstad, and B. Bestelmeyer. 2021. Quadrat-based monitoring of desert grassland vegetation at the Jornada Experimental Range, New Mexico, 1915–2016. Ecology.

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Key words: arid grasslands, Chihuahuan Desert, long-term research, New Mexico, particle size analysis, plant community, plant populations, quadrat, rangeland, soil texture

Open Research statement: Data are available from EDI (Havstad and Christensen, 2021): doi:10.6073/pasta/cf6b1f5845078fbbf82053bb3594faef

INTRODUCTION

The Jornada Experimental Range (JER) was established in 1912 to develop science-based principles to solve "the range problem" of that era, particularly the effects of livestock overgrazing that were observed throughout Southwestern U.S. at the end of the 19th Century and the beginning of the 20th Century. The permanent chart quadrat project was established in 1915 by William R. Chapline after the JER was transferred to the U.S. Forest Service. Initially, the quadrats were intended to provide yearly monitoring data for validating vegetation responses to science-based livestock management. The earliest 1 m^2 quadrats were established at intervals from watering points as a basis for measuring variations in the effects of grazing, recognizing that grazing pressure inevitably decreases with distance from water. The quadrat methodology followed that employed in vegetation studies by Roscoe Pound and Fredrick E. Clements at the end of the 19th Century, elaborated by John E. Weaver in the early 20th Century (Weaver, 1918), and embraced by early Forest Service scientists to study vegetation dynamics in non-forested environments. The quadrat monitoring effort was suspended in 1980 but was reinstituted in 1995 by Don Devine and K.M. Havstad, with records gathered at 5-year intervals thereafter. Quadrat data are now used to understand long-term vegetation change as influenced by the legacies of early overgrazing and the severe drought episodes of the early and middle 20th Century. For example, when the Jornada Experimental Range was founded in the early 20th century, the vegetation of the range was estimated to be 80% perennial grassland (Nelson, 1934) and 95% of the quadrats were grass-dominated. Over 101 years from 1915 to 2016, the percentage of grass-dominated quadrats has been reduced to 20%, and formerly grass-dominated areas have been replaced by either xerophytic shrubs (*Prosopis glandulosa, Larrea tridentata, Flourensia cernua*) or bare ground (Gibbens et al., 2005). Previous studies indicate that the greatest period of grass loss occurred during a severe drought in the early to middle 1950s, although grass was also lost during other time periods (Gibbens and Beck, 1988; Yao et al., 2006). Grazing pressure decreased dramatically since 1915, particularly following the 1950s drought (Fredrickson et al., 1998), so recent grazing pressure cannot explain the continuing decline of grasses and lack of grass recovery. Instead, likely causes of persistent grass loss include the spread of shrubs that compete with grasses for soil moisture alongside soil erosion and changes in interannual climate patterns (Bestelmeyer et al., 2018; Pierce et al., 2019).

Here we present a database containing vegetation records and supporting information from 122 permanent quadrats on the Jornada Experimental Range in southern New Mexico. Supporting information includes soil particle size analysis, depth to petrocalcic layer measurements, and local topography at the quadrat locations. Soil texture influences hydrologic properties such as infiltration rates and soil water holding capacity, and is an important factor that is often used to explain spatial patterns in vegetation types (Bestelmeyer et al., 2006; McAuliffe, 1994). When present, a petrocalcic layer in the soil can act as a barrier to water and roots, and affect the amount of water available to plants (Duniway et al., 2007; Gibbens and Lenz, 2001). In southwest New Mexico, roughly half the annual precipitation falls during summer months as short, intense storms, resulting in low infiltration rates and high rates of overland flow. Therefore, local topography that affects water transport, i.e. whether or not a patch receives run-in water from overland flow, can be crucially important. We include a data table that categorizes the local topography around each quadrat as either run-on, run-off, or slope (neither run-on nor run-off).

In addition to explaining the patterns and mechanisms of long-term vegetation change (Gibbens and Beck, 1987, 1988; Neilson, 1986; Paulsen and Ares, 1961; Yao et al., 2006), earlier versions of this data set have been used to investigate plant demography (Chu and Adler, 2014; Chu et al., 2014), species interactions (Chu and Adler, 2015; Chu et al., 2016; Tredennick et al., 2017), and community transitions (Bagchi et al., 2017).

METADATA

CLASS I. DATA SET DESCRIPTORS

A. Data Set identity:

Title: Quadrat-based survey of desert plant communities at the Jornada Experimental Range, New Mexico, 1915–2016

B. Data set identification codes:

DataS1.zip contains Jornada shapefiles.
Data S2.zip contains:
Jornada_quadrat_perennials.csv
Jornada_quadrat_annual_plant_counts.csv
Jornada_quadrat_species_list.csv
Jornada_quadrat_sampling_dates.csv
Jornada_quadrat_pastures.csv
Jornada_quadrat_soil_petrocalcic_depth.csv
Jornada_quadrat_soil_PSA.csv
Jornada_quadrat_topography.csv

C. Data set description:

Principal investigators:

Brandon Bestelmeyer

Abstract: The data set covers a 101-year period (1915–2016) of quadrat-based plant sampling at the Jornada Experimental Range in southern New Mexico. At each sampling event, a pantograph was used to record the location and perimeter of living plants within permanent quadrats. Basal area was recorded for perennial grass species, canopy cover area was recorded for shrub species, and all other perennial species were recorded as point data. The data set includes 122 1 m by 1

m permanent quadrats, although not all quadrats were sampled in each year of the study and there is a gap in monitoring from 1980–1995. These data provide a unique opportunity to investigate changes in the plant community over 100 years of variation in precipitation and other environmental conditions. We provide the following data and data formats: (1) the digitized maps in shapefile format; (2) data table containing coordinates (x, y) of perennial species within quadrats, including cover area for grasses and shrubs; (3) data table of counts of annual plant individuals per quadrat; (4) species list indicating growth form and habit of recorded species; (5) table of dates when each quadrat was sampled; (6) table of the pasture each quadrat was located within (note that pasture boundaries have changed over time); (7) table of depth to petrocalcic layer measurements taken at quadrat locations; (8) table of particle size analysis of soil samples taken at quadrat locations; (9) table of topographic characteristics of quadrat locations (e.g. concave or convex topography). Pantograph sampling is currently conducted at 5-year intervals by USDA-ARS staff, and new data will be added periodically to the EDI Data Portal Repository (see section V.E.2). This information is released under the Creative Commons license - Attribution - CC BY and the consumer of these data is required to cite it appropriately in any publication that results from its use.
Key words: quadrat, rangeland, Chihuahuan Desert, plant populations, long-term research, arid grasslands, plant community, New Mexico, soil texture, particle size analysis

CLASS II. RESEARCH ORIGIN DESCRIPTORS

A. **Overall project description:** Permanent chart quadrats were initially intended as an observational study to demonstrate the efficacy of science-based grazing management for recovering and maintaining rangeland productivity. The catastrophic drought of the 1950s illustrated that what was considered at the time to be conservative grazing management was not sufficient to prevent abrupt and persistent loss of perennial grasses during multi-year droughts, particularly on erosion-prone soils (Bestelmeyer et al., 2011). More recently, the quadrats are used to investigate the patterns and mechanisms of vegetation dynamics in response to static variations in soils and landforms and temporal variations in climate across the JER. The unique length of observational record enables an unprecedented view of long-term vegetation change in desert grasslands of the Southwestern U.S.

B. **Specific subproject description**
   1. **Site description:** The Jornada Experimental Range covers 78,266 hectares in the Chihuahuan Desert, approximately 37 km north of the city of Las Cruces, New Mexico, USA (32.62 N, 106.67 W).
      a. **Site type:** Chihuahuan Desert grassland/shrubland mix
      b. **Geography:** The study site is approximately 37 km north of Las Cruces, New Mexico (32.62 N, 106.67 W). It is bounded by the San Andres Mountains on the East, and reaches down to the basin floor of the Jornada Basin.

c. **Habitat:** The habitat is representative of the northern Chihuahuan Desert. Plant communities can be broadly categorized as one of five types: black grama (*Bouteloua eriopoda)* grassland, playa grassland dominated by *Pleuraphis mutica, Scleropogon brevifolius,* or other grasses, tarbush (*Flourensia cernua)* shrubland, creosotebush (*Larrea tridentata)* shrubland, and mesquite (*Prosopsis grandulosa)* shrubland. Habitat types have undergone substantial changes in the past 50–150 years, most noticeably an increase of shrub cover into former grassland (see Havstad et al., 2006 for more detail).

d. **Geology:** Soils are largely derived from alluvial deposits from the adjacent mountains and ancestral Rio Grande river deposits (Havstad et al., 2006). Most of the quadrats are located on the basin floor, at elevation 1,310–1,430 m. Six quadrats (S1–S6) are located on the western slope of the San Andres Mountains at the eastern extent of the Range, at approximately 1,600–1,800 m elevation.

e. **Watersheds/hydrology:** There is no permanent surface water at the site, although water from runoff may collect in low areas and playas during heavy rainfall periods.

f. **Site history:** Quadrats were established between 1915 and 1934. Initially, 33 quadrats were located within fenced exclosures to prevent grazing by cattle, of which 23 ceased to be protected from cattle as fences broke down over time, and 10 remained in exclosures until 2016 (see Table 5). The remaining 89 quadrats were located in livestock pastures and subjected to varying levels of grazing pressure over time. Over the history of JER, some pasture fences were moved and pastures re-named (see Table 5 and Jornada_quadrat_pastures.csv). Direct records of pasture changes from 1953–1979 have been lost, but we have filled in this information where possible from secondary information (e.g. pasture name was often written on quadrat data sheets). While information on pasture-level stocking rates is not currently available, annual total stocking rates from 1916–2001 can be found in (Havstad and Bestelmeyer, 2019).

g. **Climate:** Mean annual precipitation is 245 mm, with roughly half of this amount falling during the North American monsoon from July-October. Mean annual maximum temperature is 36 °C and mean annual minimum temperature is 13 °C (Havstad et al., 2006).

2. **Experimental or sampling design**

a. **Design characteristics:** 122 permanent quadrats are distributed across the Jornada Experimental Range. Sometimes quadrats were organized in linear series at the time of establishment (e.g. A1, A2, A3, etc.), with members of a series placed at ½ or 1-mile intervals radiating out from a livestock watering point (Nelson, 1934).

b. **Permanent plots:** Quadrats are 1 m x 1 m. GPS coordinates of quadrats can be obtained by request from the data manager.

c. **Data collection:** Quadrats were mapped annually from 1915–1947. From 1947–1979 a subset of the quadrats was sampled at irregular intervals. In 1995, quadrats were relocated and sampling resumed at 5- or 6-year intervals. Ongoing sampling (1995–present) occurs between September and March. Historical sampling (pre-1995) was typically conducted September–March as well, although there are exceptions. To account for the fact that a single sampling event often spanned several months, we include in the data table a column for "project_year" as well as actual month and year of the sample, so that data can be grouped appropriately. For example, the 1937 sampling event data was collected from October 1937 to March 1938, and so these data are labeled with project_year = 1937. In a small number of instances during the early years of the project, quadrats were sampled twice within a year. This was done in order to capture differences in vegetation at different points during the growing season, or to investigate the effect of an extreme event (e.g. extra sampling was performed in 1935 associated with an extreme drought). Information on dates each quadrat was sampled is contained in Jornada_quadrat_sampling_dates.csv. Soil sampling was performed only once for each quadrat. Most soil samples were taken and depth measurements made in October 2001. In February 2020 samples were taken to fill data gaps in the 2001 data. The data points added in 2020 are: particle size analysis for quadrats AR2, H3, L3, L4, and Y7; depth to petrocalcic measurement for quadrats L3, L4, V1, Y7.

3. **Research Methods**

a. **Field/laboratory:** Data collection consists of chart quadrat maps, in which the locations and shapes of all living plants located within the quadrat were mapped onto data sheets. From 1915–1924 mapping was done by dividing the quadrat frame into a decimeter grid using straps and reproducing locations of plants on graph paper. From 1925–2016 mapping was done using a pantograph, a device which allows for more accurate mapping of size and location of plants (Hill, 1920). Perennial grass species were mapped as polygons representing the boundary of each individual grass bunch at a point 1 inch above the soil surface (i.e. basal area); shrubs were mapped as polygons representing the canopy cover of each individual; and perennial forbs/subshrubs were mapped as point locations only. As annual grasses and forbs were not initially a primary focus of this study, it is unclear whether these species were recorded consistently 1915–1979. From 1995–2016 all annual species located within quadrats were identified, counted, and recorded as a tally on data sheets (but not mapped). Information on which species belong to each category (perennial grass, shrub, etc.) is contained in Jornada_quadrat_species_list.csv.

Digitization and data compilation: All paper data sheets (1915–2016) were scanned using an Epson 12000 XL scanner, then digitized as shapefiles using ArcMap software. Perennial grass basal area and shrub canopy cover were digitized as polygons, and area/perimeter of each polygon were calculated by ArcMap. Stolons attached to perennial grasses were digitized as lines. Forbs and subshrubs were digitized as points. To protect the GPS locations of the quadrats, shapefiles were converted from GPS reference systems to a generic 1 m^2 box with the origin (0, 0) at the southwest corner of the quadrat by using the elide function in the maptools R package (Bivand and Lewin-Koh, 2019). Attribute tables from these shapefiles were then extracted, compiled, and error-checked using R (R Core Team, 2018) to produce the final .csv files. Locations of individual plants (x, y coordinates for points, centroid coordinates for polygons and lines) are within-quadrat coordinates.

Particle size analysis: Soil cores for particle size analysis were taken from 1–4 locations around each quadrat at bare (non-vegetated) areas. Note: quadrats AR5 and AR6 were too close together to obtain independent samples, and so a single set of samples applies to both permanent quadrats. This is also the case for quadrats L3 and L3A. The number of soil cores varied based on availability of bare patches at each quadrat. At each location cores were taken at two depths: 0–5 cm below surface and 5–20 cm below surface. In 2001, the 0–5 cm core had a diameter of 6.1 cm, and the 5–20 cm core had a diameter of 4.6 cm. In 2020, a 5.8 cm-diameter core was used for both depths. If multiple cores were taken from a quadrat, samples from each depth were combined for analysis resulting in a single particle size analysis per quadrat and depth layer. Soil samples were air dried at room temperature, then hand sieved to 2 mm to remove large inorganic material and the >2 mm fraction. Particle size analysis by the hydrometer method was performed on a 60 g subsample. If the sand sample left over from the hydrometer analysis (>53 µm) was sufficiently large (>15 g), sand fractionation analysis was performed. The sand sample was washed through a 53 µm sieve, dried at 105° C for 24 hours to remove moisture, then separated into five sand size classes (53–106 µm, 106–250 µm, 250–500 µm, 500–1000 µm, and 1000–2000 µm) in an ultrasonic sifter for 5 minutes, then weighed to determine percent sand fractionation. Sand fractionation was not performed on the samples collected in 2020.

Depth to petrocalcic horizon: Depth to petrocalcic horizon was measured outside the bounds of the quadrat. In 2001, this was done at all four corners, close to the quadrat, by pounding a steel rod into the ground until it met resistance. If the rod reached its maximum depth of 125 cm without encountering the petrocalcic horizon at all four corners, the quadrat received a "0" in the "pc_horizon_125cm" column and no depths are reported. In some cases, the rod met significant resistance but there was no evidence of white petrocalcic horizon on the tip, indicating the rod may have hit rock instead. In these cases, or if the rod reached its maximum depth of 125 cm without encountering the petrocalcic horizon on at least one but not all of the four measurements, the data is marked with a flag in the "notes_pc" column to indicate the measurements may be underestimates. In 2020, depth to petrocalcic horizon was measured at points 2.7 m away from quadrat corners using a soil auger. At quadrats L3, L4, and Y7 soils are known to be deep and so only one measurement was taken to confirm that there was no petrocalcic horizon shallower than 125 cm. If the soil was too rocky or gravelly, depth measurements were not possible.

   b. **Instrumentation:** Pantograph, scanner, soil corer, steel rod, soil auger, sieves, hydrometer, and computers running ArcGIS and R.
   c. **Taxonomy and systematics:** Historical plant names were checked against the USDA PLANTS Database (USDA, 2020).
   d. **Permit history:** N/A
   e. **Legal/organizational requirements:** None.

4. **Project personnel:** Digitization was performed by Jed Anderson, Luke Zachmann, Amy Slaughter, Connie Maxwell, and Laura Burkett. Soil field sampling was done by Jin Yao, Amy Slaughter, David Toledo, Connie Maxwell, Laura Burkett, and Erica Christensen. Lab analysis of soil samples was performed by Justin Van Zee. Data compilation and cleaning was performed by Erica Christensen. Kris Havstad was the driving force behind re-starting the project in 1995. Plant data collection was performed by dozens of people over the 100-year history, including Amy Slaughter, Connie Maxwell, Kirsten Romig, Jim Lenz, Don Devine, and Robert Gibbens.

CLASS III. DATA SET STATUS AND ACCESSIBILITY

A. Status

1. **Latest update:** 11 February 2021
2. **Latest archive date:** 11 February 2021
3. **Metadata status:** The metadata are complete and up to date.
4. **Data verification:**

   Plant data were validated to ensure quality in the following ways:

   - Species names were checked against the USDA PLANTS Database and updated where necessary to reflect modern taxonomy.
   - Tables were checked to ensure that each identified species has the correct associated data according to habit and growth form. Any individuals of perennial grass or shrub species that had been originally recorded as points (this was done if the individual was a seedling) were assigned a polygon shape of 0.25 cm^2, and the record was flagged in the "area_is_estimate" column in the data table. Note: if a perennial grass seedling was originally recorded as a point, it will appear as a point in the digitized shapefiles.
   - If abundance information was missing for annual plant species, abundance was assumed to be 1 and the record was flagged in the "notes" column in the data table.

- We sought to minimize species switching, i.e. an individual plant being identified as a different species in subsequent years. Particular attention was paid to species that may be confused for each other: EPTO/EPTR/EPHED; YUBA/YUEL; MUAR/MUAR2; ARIST/ARPA9/ARPU9/ARPUL; SPAI/SPCO4/SPCR/SPNE/SPFL2. As with any historical data set, it was not always possible to resolve potential conflicts in species identification, and so care should be used when using data for easily confused species.

Depth to petrocalcic data: In order for a measurement to be considered the highest quality, the measuring rod must meet resistance and display evidence of contact with caliche when pulled up (white residue on tip). Measurements that did not display evidence of caliche are included in the data table but marked with a "1" in the "notes_pc" column. If the full length of the rod was pounded into the soil without meeting resistance, a depth of 125 cm was recorded and the data marked with a "2" in the "notes_pc" column to indicate the measurement is an underestimate. Quadrats where the ground was too hard or gravelly to obtain reliable measurements were excluded from the data set: I1–I4, J22, K1, K2, MG2–MG7, N6, P1–P4, S1–S6, T1–T11, U4, U5, V6, Y1–Y3.

Particle size analysis: Particle size analysis was run a second time on a randomly selected subset of samples (n = 12) to test for consistency. Average differences in percent composition of each size class between the two runs was 0.2–1.8%.

B. Accessibility

1. **Storage location and medium:** The data are available in the Ecological Society of America's journal *Ecology* with this publication. Duplicate copies of the data and original data sheets are stored at the USDA-ARS Jornada Experimental Range office building, 2996 Knox St, Las Cruces, NM 88003.
2. **Contact person:** Jornada Data Manager, datamanager.jrn.lter@gmail.com
3. **Copyright restrictions:** This information is released under the Creative Commons license - Attribution - CC BY (https://creativecommons.org/licenses/by/4.0/). The consumer of these data ("Data User" herein) is required to cite it appropriately in any publication that results from its use. The Data User should realize that these data may be actively used by others for ongoing research and that coordination may be necessary to prevent duplicate publication. The Data User is urged to contact the authors of these data if any questions about methodology or results occur. Where appropriate, the Data User is encouraged to consider collaboration or co-authorship with the authors. The Data User should realize that misinterpretation of data may occur if used out of context of the original study. While substantial efforts are made to ensure the accuracy of data and associated documentation, complete accuracy of data sets cannot be guaranteed. All data are made available "as is." The data authors and the repository where these data were obtained shall not be liable for damages resulting from any use or misinterpretation of the data.

4. **Proprietary restrictions:** GPS coordinates of quadrats are available upon request. GPS coordinates of quadrats are considered sensitive information, requests can be made to the Jornada Data Manager (datamanager.jrn.lter@gmail.com)
5. **Costs:** None.

CLASS IV. DATA STRUCTURAL DESCRIPTORS

SPATIAL DATA

A. Data set file:

Identity: DataS1.zip
Size: (46,416 kilobytes) (compressed)
Format and storage mode: Shapefiles compressed and submitted in a zipped folder
Header information: The fields in the attribute tables of the shapefiles are also contained in the tabular data file "Jornada_quadrat_perennials.csv" (see Table 1 below). Long attribute field names were abbreviated for shapefiles: "project_year" has been shortened to "prjct_y"; "species_code" has been shortened to "species"; "area_is_estimate" has been shortened to "area_est."

B. Variable information

DataS1.zip is a zipped directory containing shapefiles for all digitized chart quadrats. Shapefiles are organized into subfolders based on the 122 quadrat names. Shapefile names are of the form "QQ_YYYY_MM_shape," where QQ = quadrat name, YYYY = year of sample, MM = month of sample, and shape = geometry. The geometry of the file is either "pnt" = point data, "pol" = polygon data, or "lin" = line data. Line type shape files are not common: these objects represent stolons attached to certain species of perennial grasses, and should be combined with associated polygon and point objects, not be treated as independent individuals. All spatial data has been projected into a generic 1 m^2 box and GPS location information has been removed to protect the locations of the quadrats.

PERENNIAL GRASS AND SHRUB COVER

A. Data set file:

Identity: DataS2.zip / Jornada_quadrat_perennials.csv
Size: 218,255 rows; 15,428 kilobytes
Format and storage mode: ASCII text, comma delimited.
Header information: The first row of the file contains variable names, described in Table 1.
Alphanumeric attributes: Mixed

B. Variable information: See Table 1.

Table 1. Column information for Jornada_quadrat_perennials.csv. Each row of the data file represents measurements from a single plant individual.

Variable name	*Variable definition*	*Storage type*	*Variable codes, definitions, and notes*
quadrat	Permanent quadrat name	Character	
project_year	"Project year" data was collected.	Integer	Range: 1915–2016 "Project year" is included to account for the fact that sampling of all quadrats sometimes spanned January 1 (and therefore multiple years), but should be considered a single sampling event. A "project year" begins in May and goes until April of the following year (e.g. "project year" 1947 goes from May 1947 – April 1948). In a few cases, a May sample was indicated on the data sheet to be part of the previous year's sampling.
year	Year data was collected	Integer	Range: 1915–2016
month	Month data was collected	Integer	Range: 1–12
species_code	Species code	Character	See Jornada_quadrat_species_list.csv for information on species codes and additional species information
area	Area of individual plant (basal area for perennial grasses and canopy cover for shrubs)	Numeric	Units are m^2
length	Perimeter length of individual plant	Numeric	Units are meters
area_is_estimate	Flag indicating if area and perimeter were estimated from point data	Integer	1 = individual was originally recorded as a point, area and perimeter are estimates 0 = individual was originally recorded as a polygon, area and perimeter are true measurements

x_coordinate	Location of individual plant within quadrat; centroids for polygon and line objects	Numeric	Range: 0–1 The origin (0, 0) is located at the southwest corner of the quadrat Values of 'NA' indicate the individual was mistakenly recorded as a tally and not mapped
y_coordinate	Location of individual plant within quadrat; centroids for polygon and line objects	Numeric	Range: 0–1 The origin (0, 0) is located at the southwest corner of the quadrat Values of 'NA' indicate the individual was mistakenly recorded as a tally and not mapped

ANNUAL PLANT ABUNDANCE

A. **Data set file:**
   Identity: DataS2.zip / Jornada_quadrat_annual_plant_counts.csv
   Size: 3,795 rows; 118 kilobytes
   Format and storage mode: ASCII text, comma delimited.
   Header information: The first row of the file contains variable names, described in Table 2.
   Alphanumeric attributes: Mixed
B. **Variable information:** See Table 2.

Table 2. Column information for Jornada_quadrat_annual_plant_counts.csv. Each row of the data file represents the total count of a species on a quadrat.

Variable name	*Variable definition*	*Storage type*	*Variable codes, definitions, and notes*
quadrat	Permanent quadrat name	Character	
project_year	"Project year" data was collected.	Integer	Range: 1915–2016 See Table 1 for additional explanation
year	Year data was collected	Integer	Range: 1915–2016
month	Month data was collected	Integer	Range: 1–12
species_code	Species code	Character	See Jornada_quadrat_species_list.csv for information on species codes and additional species information

count	Abundance of the indicated species	Integer	
notes	Provides additional information about the record if needed	Integer	1 = abundance is an estimate, not exact. Estimates were necessary if: 1) abundance was illegibly written on the data sheet; 2) abundance was omitted from the data sheet; or 3) a high number of individuals was present and data collectors estimated abundance in the field

PLANT SPECIES LIST

A. **Data set file:**
   Identity: DataS2.zip / Jornada_quadrat_species_list.csv
   Size: 253 rows; 14 kilobytes
   Format and storage mode: ASCII text, comma delimited.
   Header information: The first row of the file contains variable names, described in Table 3.
   Alphanumeric attributes: Mixed
B. **Variable information:** See Table 3.

Table 3. Column information for Jornada_quadrat_species_list.csv. Each row of the data file contains taxonomic and classification information on a single species.

Variable name	*Variable definition*	*Storage type*	*Variable codes, definitions, and notes*
species_code	Species code	Character	
genus	Genus	Character	
species	Species	Character	"sp." in this column denotes that species was not able to be completely identified
habit	Growth habit of species	Character	P = perennial; A = annual; B = biennial A species may have multiple habits designated in this column, indicating that

			the species behaves differently in different parts of its range
form	Growth form of species	Character	Species are classified as one of: GRASS, FORB, SHRUB, or S-SHR (subshrub)
common_name	Common name of species	Character	Common name associated with species_code. Note that multiple common names often exist for a single species. Unidentified species or species identified to genus only contain "Unknown" in common_name
category	Category species belongs to, i.e. in which data table the species_code can be found	Character	Annual = this species_code is found in Jornada_quadrat_annual_plant_counts.csv PerennialForb = this species_code is found in Jornada_quadrat_perennials.csv, but will have no area/perimeter values Cover = this species_code is found in Jornada_quadrat_perennials.csv, and will have area/perimeter values When blank, the species_code represents an unidentified or incompletely identified plant, and therefore this code may be found in either table

QUADRAT SAMPLING DATES

A. **Data set file**

Identity: DataS2.zip / Jornada_quadrat_sampling_dates.csv
Size: 4,750 rows; 99 kilobytes
Format and storage mode: ASCII text, comma delimited.
Header information: The first row of the file contains variable names, described in Table 4.
Alphanumeric attributes: Mixed.

B. **Variable information:** See Table 4.

Table 4: Column information for Jornada_quadrat_sampling_dates.csv. Each row of the data file represents one sample of one quadrat.

Variable name	*Variable definition*	*Storage type*	*Variable codes, definitions, and notes*

quadrat	Permanent quadrat name	Character	
year	Year data was collected	Integer	Range: 1915–2016
month	Month data was collected	Integer	Range: 1–12 Unknowns (denoted "NA") exist if date was not written on data sheet
day	Day data was collected	Integer	Range: 1–31 Unknowns (denoted "NA") exist if date was not written on data sheet
project_year	"Project year" data was collected	Integer	Range: 1915–2016 See Table 1 for additional explanation.

PASTURES

A. **Data set file:**
   Identity: DataS2.zip / Jornada_quadrat_pastures.csv
   Size: 4,299 rows; 58 kilobytes
   Format and storage mode: ASCII text, comma delimited.
   Header information: The first row of the file contains variable names, described in Table 5.
   Alphanumeric attributes: Mixed.

B. **Variable information:** See Table 5.

Table 5: Column information for Jornada_quadrat_pastures.csv. Each row of the data file represents a single quadrat/year combination.

Variable name	*Variable definition*	*Storage type*	*Variable codes, definitions, and notes*
quadrat	Permanent quadrat name	Character	
year	Year	Numeric	Range: 1915–2016
pasture	Pasture name	Character	Pasture names are often numeric but may be a combination of letters and numbers. Value of "NA" indicates pasture is not known for the quadrat/year combination.

exclosure	Indicates whether or not quadrat is located within a fenced cattle exclosure	Numeric	1 = quadrat is inside a grazing exclosure 0 = quadrat is not inside an exclosure NA = unknown Some quadrats were established within exclosures, but fences broke down at an unknown time due to lack of maintenance. If a data sheet indicated a quadrat was inside a grazing exclosure during that year's sampling, it was assumed that the fence held for all years up to that point.

DEPTH TO CALICHE LAYER

A. **Data set file:**
   Identity: DataS2.zip / Jornada_quadarat_soil_petrocalcic_depth.csv
   Size: 80 rows; 3 kilobytes
   Format and storage mode: ASCII text, comma delimited
   Header information: The first row of the file contains the variable names described in Table 6
   Alphanumeric attributes: Mixed
B. **Variable information:** See Table 6.

Table 6: Column information for Jornada_quadrat_soil_petrocalcic_depth.csv. Each row of the file represents depth measurements from a single permanent quadrat.

Variable name	*Variable definition*	*Storage type*	*Variable codes, definitions, and notes*
quadrat	Name of permanent quadrat where soil sample was taken	Character	
pc_horizon_125cm	Indicates whether or not there was a measurable petrocalcic horizon <125 cm from soil surface	Numeric	1 = there was a measureable petrocalcic horizon at a minimum of 1 of the 4 corners of the quadrat that was <125 cm 0 = no petrocalcic horizon observed <125 cm

depth_1	Corner depth measurement	Numeric	Measurement unit: cm; missing values denoted by 'NA'
depth_2	Corner depth measurement	Numeric	Measurement unit: cm; missing values denoted by 'NA'
depth_3	Corner depth measurement	Numeric	Measurement unit: cm; missing values denoted by 'NA'
depth_4	Corner depth measurement	Numeric	Measurement unit: cm; missing values denoted by 'NA'
mean_depth	Mean of four corner depth measurements, ignoring any missing values	Numeric	Measurement unit: cm; missing values denoted by 'NA'
notes_pc	Provides additional note or comment about the record if needed	Integer	1 = reached hard layer but no evidence of caliche on rod tip, mean_depth should be considered an underestimate; 2 = reached maximum measurable depth of 125 cm at at least one corner, mean_depth should be considered an underestimate

SOIL PARTICLE SIZE ANALYSIS

A. **Data set file:**
 Identity: DataS2.zip / Jornada_quadarat_soil_PSA.csv
 Size: 235 rows; 33 kilobytes
 Format and storage mode: ASCII text, comma delimited
 Header information: The first row of the file contains the variable names described in Table 7
 Alphanumeric attributes: Mixed

B. **Variable information:** See Table 7.

Table 7. Column information for Jornada_quadrat_soil_PSA.csv. Each row of the data file contains particle size analysis of a soil sample at a certain depth level at a single permanent quadrat. Each permanent quadrat has soil samples at two depth levels: shallow (0–5 cm) and deep (5–20 cm).

Variable name	*Variable definition*	*Storage type*	*Variable codes, definitions, and notes*
quadrat	Name of permanent quadrat where soil sample was taken	Character	Note: quadrats AR5 and AR6 were too close together to obtain independent samples, and so a single set of samples applies to both permanent quadrats. This is also the case for quadrats L3 and L3A.
depth_layer	Depth layer of soil core	Character	"shallow" = 0–5 cm below surface; "deep" = 5–20 cm below surface
pct_sand	Percent sand	Numeric	
pct_silt	Percent silt	Numeric	
pct_clay	Percent clay	Numeric	
pct_vfs	Percent very fine sand (53–106 micrometer particles)	Numeric	
pct_fs	Percent fine sand (106–250 micrometer particles)	Numeric	
pct_ms	Percent medium sand (250–500 micrometer particles)	Numeric	
pct_cos	Percent coarse sand (0.5–1.0 millimeter particles)	Numeric	

pct_vcs	Percent very coarse sand (1.0–2.0 millimeter particles)	Numeric	
notes_psa	Provides additional note or comment about the record if needed	Integer	1 = record contains missing or incomplete data; 2 = small sand sample, percent sand fraction measurements may be suspect; 3 = maximum depth of sample < 20 cm

QUADRAT TOPOGRAPHY

A. **Data set file:**
   Identity: DataS2.zip / Jornada_quadrat_topography.csv
   Size: 121 rows; 3 kilobytes
   Format and storage mode: ASCII text, comma delimited.
   Header information: The first row of the file contains variable names, described in Table 8.
   Alphanumeric attributes: Mixed.
B. **Variable information:** See Table 8.

Table 8: Column information for Jornada_quadrat_topography.csv. Each row of the data file represents a single permanent quadrat.

Variable name	*Variable definition*	*Storage type*	*Variable codes, definitions, and notes*
quadrat	Permanent quadrat name	Character	Three of the 122 permanent quadrats are missing this data: PBR3, PBR4, and V1
topo_local	Topography of the immediate 1 m x 1 m quadrat area	Character	Topography is classified as one of: Off = run-off; area is convex and water will tend to run off On = run-on; area is concave and water will tend to run on Slope = area is neither concave nor convex, water will tend to run on and run off

topo_patch	Topography of the 20 m x 20 m patch surrounding the quadrat	Character	Topography is classified as one of: Off = run-off; area is convex and water will tend to run off On = run-on; area is concave and water will tend to run on Slope = area is neither concave nor convex, water will tend to run on and run off

CLASS V. SUPPLEMENTAL DESCRIPTORS

A. **Data acquisition**
   1. **Data forms or acquisition methods:** See II and III above.

B. **Quality assurance/quality control procedures:** The procedures described in section III.A above ensure that there was accurate transfer of information during the digitization and data entry stages. Effort was made to ensure species identification in the field was consistent through time, but proper species identification cannot always be assured. In addition, it is not known whether annual or biennial species were recorded consistently before 1995, so care should be used when interpreting these data.

C. **Related materials**

D. **Computer programs and data processing algorithms**

E. **Archiving**
   1. **Archival procedures**
   2. **Redundant archival sites:** Data tables of quadrat cover data and count data of forbs can be found on the EDI Data Portal Repository: at https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-jrn.210351001.49 and https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-jrn.210351002.77

F. **Publications and results**

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ACKNOWLEDGMENTS

This research was supported by appropriated funds to the USDA-ARS Jornada Experimental Range project 3050-11210-009-00D, the Jornada Basin Long-Term Ecological Research Program DEB-1832194, and is a contribution from the Long-Term Agroecosystem Research (LTAR) network. LTAR is supported by the United States Department of Agriculture. Peter Adler was supported by NSF DEB-0614068 and DEB-1054040 and the Utah Agriculture Experiment Station. We also want to thank the many personnel who contributed to data collection over the Jornada quadrat program's 100-year history, with special thanks to Kris Havstad for reviving the project in 1995.

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