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# Long-term monitoring and experimental manipulation of a Chihuahuan Desert ecosystem near Portal, Arizona (1977 – 2013).

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### **ABSTRACT**

Desert ecosystems have long served as model systems in the study of ecological concepts (e.g., competition, resource pulses, top-down/bottom-up dynamics). However, the inherent variability of resource availability in deserts, and hence consumer dynamics, can also make them challenging ecosystems to understand. Study of a Chihuahuan desert ecosystem near Portal, AZ began in 1977. At this site, 24 experimental plots were established in 1977 and divided among controls and experimental manipulations. Experimental manipulations over the years include removal of all or some rodent species, all or some ants, seed additions, and various alterations of the annual plant community. This dataset appends the latest 11 years of data to the previous data publication (Ernest et al 2009). It also includes additional ant and weather data not previously available.

These data have been used in a variety of publications documenting the effects of the experimental manipulations as well as the response of populations and communities to long-term changes in climate and habitat. Sampling is ongoing and additional data will be published in the future.

**D.** Key words: LTREB data, rodents, ants, plants, Chihuahuan Desert

# INTRODUCTION

If we are to understand how and why populations, communities, and ecosystems change through time, we need long-term data documenting temporal changes in ecological systems. Observational long-term data provides information on what aspects of nature are dynamic and what aspects are more resistant to perturbations. Long-term experimental data complements observational monitoring data by allowing scientists to assess how dynamic responses of the environment may be altered if the system was altered in some way.

We present here a database that provides data from both long-term monitoring and experimental manipulation of a Chihuahuan Desert ecosystem near Portal, AZ. A previous data paper published data from this study for the years 1977-2002. Initiated in 1977 by Drs. James H. Brown, Diane W. Davidson, and O. James Reichman, the Portal Project has been studying rodent, ant, and plant communities (and their interactions with each other) through a combination of observational and experimental approaches. This data paper extends the time series published in Ernest et al. (2009) by adding data from 2003-2013 on climate, plant, ant, and rodent dynamics. Additional information about the site can be found in Brown (1998) and in the previous data publication (Ernest et al 2009).

Since the database consists of four distinct datasets (rodent, plant, ant, weather), each of which has distinct methodology and dataset structure, there is a separate metadata file for each dataset. This metadata file contains the metadata for the site and an overall description of the structure of this data paper.

# METADATA AND DATA STRUCTURE

**A. Database identity**: This database contains 4 datasets - rodent, plant, ant, weather – and the metadata for each file.

Overall Title: Long-term monitoring and manipulation of a Chihuahuan Desert ecosystem near Portal, AZ (1977 – 2013).

*Rodent Dataset Title*: Long-term monitoring and experimental manipulation of a rodent community in the Chihuahuan Desert near Portal, AZ (1977 – 2013).

*Plant Dataset Title*: Long-term monitoring and experimental manipulation of a Chihuahuan Desert plant community near Portal, Arizona (1981 – 2013).

*Ant Dataset Title*: Long-term monitoring and manipulation of an ant community in the Chihuahuan Desert near Portal, AZ (1977 – 2009).

*Weather Dataset Title*: Long-term monitoring of weather at a long-term site in the Chihuahuan Desert near Portal, AZ (1980 – 2013).

**B. Dataset and metadata identification codes:** Each dataset has its own data file(s) and its own metadata documenting the data collection details and dataset structure.

**Site Info**: *Datafile* - Portal\_UTMcoords.csv

*Metadata -* Portal\_overview\_metadata\_2015.html *(this file)*

**Rodents:** *Datafiles* **-** Portal\_rodent\_19772013.csv

Portal\_rodent\_species.csv

Portal\_rodent\_trapping.csv

*Metadata -* Portal\_rodent\_metadata.html

**Plants:** *Datafiles –* Portal\_plant\_19811988.csv

Portal\_plant\_19892013.csv

Portal\_plant\_species.csv

Portal\_plant\_censuses.csv

*Metadata –* Portal\_plant\_metadata.html

**Ants:** *Datafiles –* Portal\_ant\_colony\_19772009.csv

Portal\_ant\_bait\_19882009.csv

*Metadata –* Portal\_ant\_metadata.html

**Weather***: Datafiles* *–* Portal\_weather\_19801989.csv

Portal\_weather\_19892013.csv

*Metadata –* Portal\_weather\_metadata.html

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# CLASS II. RESEARCH ORIGIN DESCRIPTORS

**A. Overall project description**

**Identity:** Long-term data for the four core data collection efforts for the Portal Project LTREB - rodents, plants, ants, precipitation.

**Originators:** Drs. James H. Brown, Diane W Davidson, James Reichman

**Period of Study:** 1977-2013

**Objectives:** To monitor the long-term community dynamics of the rodent, ant and plant communities of a Chihuahuan Desert ecosystem in response to natural variation in climate and experimental manipulation of various plant and animal groups.

**Sources of funding:** The 1977 – 2003 data collection activities were supported by National Science Foundation grants: DEB 76-83858, BSR 80-21535, BSR 85-06729, BSR 87-18139, DEB 92-21238, DEB 97-07406, DEB-0129298/0211069, DEB-0348896/0348255, and a grant from the Department of Energy. The 2003-2013 data collection activities were supported by National Science Foundation grants: DEB-0348896/0348255, DEB-0702875, DEB- 1100664, DEB-1353139, and seed grant funding from Utah State University.

Figure 1: A: Aerial view of the Portal Project study area showing the 24 experimental plots (numbered) within the 20 ha study area. Each plot is 50 m X 50 m. Plot fences are outlined in white. The weather station is located near the northeast corner of plot 7 (orange flag). The fence surrounding the site to exclude cattle is outlined in blue. B: Detail of an individual plot (plot 2). The location of plot corners (brown circles) are available in the GPS data, in addition to the census locations (purple diamonds). Rodent trapping locations (also ant census locations) are numbered by column and row (purple diamonds), starting in the northwest corner. Trapping locations are spaced 6.25 meters apart. C: Plant quadrats are numbered according to the same system as the rodent trapping locations except quadrats are only established at odd-numbered rows and columns (teal triangles). Quadrats are located 1 m south of the corresponding rodent stake.



**Site type:**  The site occurs in an upper-elevation Chihuahuan Desert habitat (1330 m), dominated by a mixture of shrubs (e.g. *Flourensia cernua*, *Acacia* sp., *Prosopis* sp.) and grasses (e.g. *Aristida* sp. *Bouteloua* sp., *Muhlenbergia* *porteri*.). Dominance of grasses versus shrubs has shifted over the 30 years of the study, shifting from what was mainly a desertified open grassland to a mixed shrubland (Brown et al 1997). The site itself sits on a bajada at the base of the Chiricahua Mountains and consists of mainly sandy soils.

**1. Site description:** The entire study area is approximately 20 ha and within this area there are 24 experimental plots (Fig 1). Each plot is 0.25 ha (50m x 50m) and fenced with hardware cloth topped with aluminum flashing. Access to these plots by rodents is regulated by gates cut into fencing. On each plot there are permanent census grids: one for rodents and ants and another for plants. For the rodent/ant grid, 49 permanent trapping stations are marked by rebar stakes forming a 7x7 grid, with 6.25 m between stakes. Every stake on a plot has a unique identifying number denoting the coordinate of that stake on that plot. For example, stake 11 is the first stake on the first row. Rows are numbered 1 through 7 going from the most northern row to the most southern. Columns are numbered 1 through 7 going from the most western column to the most eastern (Fig 1). The plant grid contains fewer rows and columns (4 rows, 4 columns). Numbering of the plant stakes follows similar rules to the rodent/ant grid, except that even numbered rows and columns are skipped (censuses use rows 1, 3, 5, 7 and columns 1, 3, 5, 7). Each plant quadrat is 1 m south of the rodent/ant stake of the corresponding number. Details for how these grids are used for data collection can be found in the metadata for the specific dataset files. We have provided GPS coordinates for the rodent stakes, plant quadrats, and plot corners (file *Portal\_UTMcoords.csv*, see Table 1). These data were collected March 12 – 17, 2011.

**Table 1**. Description of GPS data structure. Data were collected in March of 2011 and are provided in file *Portal\_UTMcoords.csv*.

|  |  |  |  |
| --- | --- | --- | --- |
| *Variable name* | *Variable definition* | *Storage type* | *Variable codes, definitions, and notes* |
| gps\_num | Unique identifier | Integer | 999 - 2714 |
| plot | Plot number | Integer | 1 - 24 |
| type | Type of location | Character | “corner” = plot corner, “stake” = rodent trapping stake, “quadrat” = plant quadrat |
| number | Stake number | Integer | 11 – 77 |
| east | Easting | Double | UTM Zone 12 R |
| north | Northing | Double | UTM Zone 12 R |
| elev | Elevation | Double | Meters |
| hor\_error | Horizontal error | Double | Meters |
| vert\_error | Vertical error | Double | Meters |
| flag | Location approximate (or see notes) | Integer | 0, or 1 if an issue |
| notes |  | Character |  |

**Fence Replacement:** By 2004, almost 30 years of desert climate had caused the fences around each plot to begin to deteriorate. A local contractor was hired to gradually replace fences on each plot. Generally, fences were taken down and replaced quickly. In a few cases, fences were down when rodent trapping occurred. These events are marked in the rodent database with a note1=10 flag. Records indicate that fence replacement occurred from 3/1/2004-5/8/2005. During fence replacement, the northeast corner of plot 24 was cut off. After this point, rodent stake 17, and plant quadrat 17, were outside the plot fencing and so are no longer used during trapping and censusing.

**Geography:**  The study site is located approximately 6.5 km north and 2 km east of the town of Portal, AZ (31°56'20.29"N 109° 4'47.44"W).

**Site history:** The site is on U.S. Bureau of Land Management property. This area has a long history of cattle grazing and is currently still stocked with cattle. No grazing has occurred on the 20 ha site since a cattle fence was erected around the study area in 1977 (Fig 1).

**Climate:** There are two rainy seasons at the site, occurring roughly from Oct-April and July-Sept. The two rainy seasons result in generally two distinct annual plant communities, with a few bi-seasonal annual species.

**2. Experimental design:** The study consists of 24 experimental plots, assigned to various ant, rodent, and plant manipulations. At the onset of the study, one rodent species and one ant species each were suspected to potentially have a disproportionate effect on species interactions at the site. Both southwestern desert specialists, these were *Dipodomys spectabilis* (Banner-tailed kangaroo rat) and *Pogonomyrmex rugosus* (Rough Harvester Ant), respectively. In addition to overall rodent and ant plot treatments, a subset of treatments were designed to target these important species specifically. However, these two species were also locally rare and declining over time. (Its rarity motivated an exception to the ant census protocol for *Pogonomyrmex rugosus*, to count all colonies on a plot, rather than only colonies in the census area. See Portal Ant Metadata for more information). Once it became clear that these specialized treatments were no longer necessary, the plots were converted to one of the general ant or rodent treatment types.

**Treatments:**As a result of direct changes to the plots, or the termination of experimental manipulations, changes in treatment assignment occurred in 1985, 1987, 2005, and 2009. These changes are outlined in Table 2. The plots with no entry after the first column are the subset of plots that have maintained a consistent manipulation since 1977.

*Rodent treatments:* Rodents are manipulated using gates in the fencing of each plot. Rodent removals contain no gates and any rodents captured on those plots are removed. All other plots contain 16 gates (4 per plot side); gates consist of holes cut through the hardware cloth of the fencing. Gate size is used to exclude subsets of the rodent community (larger gates allow all rodents access, smaller gates exclude kangaroo rats). Dimensions for gates on kangaroo rat removal plots are 1.9 cm x 1.9 cm, *D. spectabilis* removals were 2.6 cm x 3.0 cm, and control plots are 3.7 cm x 5.7 cm. In 2005, *Dipodomys spectabilis* removals were converted to controls – a state these plots had effectively been in with the local extinction of *Dipodomys spectabilis* in the late 1990s. Species caught on plots from which they are supposed to be excluded are removed from the site and the access point to the plot is located and eliminated. Plots affected by these treatments are listed in Table 2.

*Plant treatments*: Since 1988 there have been no direct manipulations of the plant community. Before 1988, annuals were “removed” by applying an herbicide (brand: Roundup), but this removal was not considered successful and was discontinued (Brown 1998). Plots affected by these treatments are listed in Table 2.

*Seed additions:* Since 1985 there have been no seed additions to any plot. Before 1985, seed additions were conducted by applying 96 kg of milo (*Sorghum vulgare*) and/or millet (*Panicum miliaceum*) seeds to designated plots (Davidson et al 1985). Plots affected by these treatments are listed in Table 2.

*Ant treatments:* Ant manipulations were conducted by applying a commercial poison (Mirex [Allied Chemical Corporation] through 1980 and AMDRO [American Cyanamide Company] afterwards) to designated plots (Davidson et al 1985). Plots affected by these treatments are listed in Table 2. After the July 2009 census, ant treatments and ant censuses were discontinued.

**Table 2**. Changes in treatment assignments to the 24 experimental plots from 1977-2013. Blank cells denote no changes in treatment from the previous time period. *Pogonomyrmex rugosus* is an ant species that built very large colonies at the site, but eventually declined until removal treatments were no longer necessary. *Dipodomys spectabilis* is a large and typically dominant rodent granivore that also declined during the 1980s. (Table modified from Brown 1998).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Plot** | **1977-1985** | **1985-1987** | **1988-2004** | **2005-2009** | **2010-2013** |
| **1** | Mixed-size seeds added in pulse | All annuals removed | *Dipodomys spectabilis* removed | Unmanipulated control |  |
| **2** | Small seeds added | Summer annuals removed | Unmanipulated control |  |  |
| **3** | Kangaroo rats removed  *Pogonomyrmex rugosus* removed |  | Kangaroo rats removed  All ants removed |  | Kangaroo rats removed |
| **4** | All ants removed |  |  |  | Unmanipulated control |
| **5** | *Dipodomys spectabilis* removed |  | All rodents removed |  |  |
| **6** | Large seeds added | Winter annuals removed | Kangaroo rats removed |  |  |
| **7** | All rodents removed |  |  |  |  |
| **8** | *Pogonomyrmex rugosus* removed |  | All ants removed |  | Unmanipulated control |
| **9** | Mixed-size seeds added | Bi-seasonal annuals removed | *Dipodomys spectabilis* removed | Unmanipulated control |  |
| **10** | All rodents removed  All ants removed |  |  |  | All rodents removed |
| **11** | Unmanipulated control |  |  |  |  |
| **12** | *Pogonomyrmex rugosus* removed |  | All ants removed |  | Unmanipulated control |
| **13** | Large seeds added | Winter annuals removed | Kangaroo rats removed  All ants removed |  | Kangaroo rats removed |
| **14** | Unmanipulated control |  |  |  |  |
| **15** | Kangaroo rats removed |  |  |  |  |
| **16** | All rodents removed |  |  |  |  |
| **17** | All ants removed |  |  |  | Unmanipulated control |
| **18** | Mixed-sized seeds added in pulse | All annuals removed | Kangaroo rats removed |  |  |
| **19** | Kangaroo rats removed  *Pogonomyrmex rugosus* removed |  | Kangaroo rats removed  All ants removed |  | Kangaroo rats removed |
| **20** | Mixed-sized seeds added | Biseasonal annuals removed | Kangaroo rats removed  All ants removed |  | Kangaroo rats removed |
| **21** | Kangaroo rats removed |  |  |  |  |
| **22** | Small seeds added | Summer annuals removed | Unmanipulated control |  |  |
| **23** | All rodents removed  All ants removed |  |  |  | All rodents removed |
| **24\*** | *Dipodomys spectabilis* removed |  | All rodents removed |  |  |

**C. Publications using the data sets, study site, or other resources**

Publications listed here either used data collected by the Portal Project, cited the previous data paper, used the research site for their own data collection, or significantly used other Portal Project resources to accomplish the research. This list includes papers published after the publication of the previous data paper (Ernest et al. 2009). Older papers using this dataset are listed in Ernest et al. (2009).

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