NPP Grassland: Rio Mayo, Argentina, 1972-1997, R1

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Revision date: May 14, 2015

Summary:

This data set contains three data files in text format (.txt) for a temperate dry steppe at Rio Mayo, Argentia. One file contains quarterly above-ground biomass data for grasses on the steepe (May 1984-May 1985). The second file contains average annual above-ground primary production (ANPP) data for grasses and shrubs for years 1972-1997 based upon peak above-ground biomass estimates. The third file contains precipitation and maximum/minimum temperature data for the Rio Mayo site for the period 1968 through 1990.

Rio Mayo is located in the Patagonia region of Argentina. The vegetation is chiefly composed of grasses and shrubs. Harvest methods were used to estimate grass and shrub production. Between 1972 and 1997, peak annual ANPP of grasses plus shrubs ranged from 21 to 75 g/m^2/yr, with an average of about 60 g/m^2/yr. Grasses accounted for about two-thirds of the productivity. ANPP was reduced in a drought year, but did not increase in relatively wet years, suggesting that it may not be linearly related to precipitation. ANPP for 1984-1985 was slightly higher (79 g/m^2/yr) when a different algorithm was used for estimation.

Revision Notes: The original npp data file (rmy_npp.txt) has been split into two files, one file containing seasonal biomass and the other containing annual ANPP estimates. The data file containing annual ANPP estimates has been revised to extend temporage coverage and add additional annual ANPP data. See the Revisions section in this document for details.

Additional Documentation

The Net Primary Productivity (NPP) data collection contains field measurements of biomass, estimated NPP, and climate data for terrestrial grassland, tropical forest, temperate forest, boreal forest, and tundra sites worldwide. Data were compiled from the published literature for intensively studied and well-documented individual field sites and from a number of previously compiled multi-site, multi-biome data sets of georeferenced NPP estimates. The principal compilation effort (Olson et al., 2001) was sponsored by the NASA Terrestrial Ecology Program. For more information, please visit the NPP web site at http://daac.ornl.gov/NPP/npp_home.html.

Data Citation:

Cite this data set as follows:

Sala, O.E., and E.G. Jobbagy. 2015. NPP Grassland: Rio Mayo, Argentina, 1972-1997, R1. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/574

This data set was originally published as:

Sala, O.E. 2001. NPP Grassland: Rio Mayo, Argentina, 1983-1989. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Table of Contents:

1. Data Set Overview:

Project: Net Primary Productivity (NPP)

The above-ground net primary productivity (ANPP) estimate presented in this data set has two components: peak annual grass production (green plus recent dead biomass) and peak annual shrub production (current-year leaf and twig biomass). Seasonal grass production and senescence were also measured.

The Rio Mayo study site (Latitude 45.68 S Longitude 70.27 W) is situated in southwestern Chubut and is typical of the temperate dry Patagonian steppe of South America where extremely low rainfall prevails. Patagonia is a large region of 500,000 km^2 where few estimates of NPP have been published. Rio Mayo is located in the Occidental District of Patagonia, one of five floristic divisions dominated by grasses or shrubs.

ANPP of the grass layer at Rio Mayo was measured by harvest technique quarterly from May 1984 to May 1985. Shrub layer production was estimated directly by a different method, based on observations of current-year growth.

ANPP was estimated for years 1972-1997 based upon peak above-ground biomass estimates. Over this period, total ANPP (grass + shrub) ranged from 21 to 75 $g/m^2/yr$, with an average of about 60 $g/m^2/yr$ (Jobbagy and Sala, 2000; Olson et al., 2012). Grasses accounted for about two-thirds of productivity. ANPP was reduced in a drought year, but did not increase in relatively wet years, suggesting that it may not be linearly related to precipitation. ANPP for 1984-1985 was slightly higher (79 $g/m^2/yr$) using a different algorithm for estimation (Fernandez et al., 1991).

2. Data Description:

Spatial Coverage

Site: Rio Mayo, Argentina

Site Boundaries: (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Elevation (m)
Rio Mayo, Argentina	-70.27	-70.27	-45.68	-45.68	500

Spatial Resolution

The 20 study areas for grass production were 1.0-m^2 plots, each 0.2 m x 5.0-m in shape, and randomly located and harvested. Shrub biomass was estimated from the height and orthogonal diameter of each shrub and the harvest of a rectangular 0.1 x 0.25-m quadrat projected vertically through the center of the canopy. Current-year growth of each entire individual plant was also harvested and measured.

Temporal Coverage

This data set includes annual harvests of grass biomass for 15 years and of shrub biomass for 10 years. Grass biomass was measured with a seasonal frequency during seven years, although only seasonal biomass measurements made from 1984/05/12 through 1985/05/09 are presented here. Annual above-ground biomass measurements for grasses and shrubs were made once a year during the period 1972 through 1997. No data are available for 1973-1974, 1976-1982, 1987, and 1989. Climate data are available from 1968/08/01 through 1990/12/31.

Temporal Resolution

Above-ground biomass measurements were made quarterly in 1984-1985 to estimate seasonal grass ANPP. Single grass and shrub biomass measurements were made at the end of the growing season (January) for each year of the study to estimates of annual ANPP. Seasonal biomass estimates are based on plant dry matter accumulation, expressed as g/m^2. Annual ANPP estimates, also based on plant dry matter accumulation, are expressed as $g/m^2/yr$. Climate data are expressed as monthly and annual precipitation amounts (mm) and monthly and annual average maximum/minimum temperature (degrees C). Monthly and annual climatic means are provided for the 1968-1990 period.

Data File Information

Table 1. Data file descriptions

FILE NAME	TEMPORAL COVERAGE	FILE CONTENTS
rmy1_npp_r1.txt	1984/05/12-1985/05/09	Quarterly biomass data for grasses at Rio Mayo, Argentina
rmy2_npp_r1.txt	1972/01/01-1997/01/01	Annual ANPP data for grasses and shrubs at Rio Mayo, Argentina
rmy_cli.txt	1968/01/01-1990/12/31	Monthly and annual climate data for Rio Mayo, Argentina

NPP Data. Data for the Rio Mayosite are provided in two files, one containing quarterly above-ground grass biomass data and the other containing annual ANPP estimates for grasses and shrubs (Table 1). The data sets are ASCII files (.txt format). The first 18 lines are metadata; data records begin on line 19. The variable values are delimited by semicolons. Quarterly biomass units are reported as g/m^2 (dry matter weight) and annual ANPP are reported as $g/m^2/yr$ (dry matter weight). Two different algorithms were used to estimate annual grass ANPP, hence two column headings for ANPP values in the data file (labeled ANPP_total1 and ANPP_total2, respectively). The value -999.9 is used to denote missing values.

Table 2. Column headings in <rmy1_npp_r1.txt> file

COLUMN HEADING	DEFINITION	UNITS
Site	Site where data were gathered (code refers to site identification)	text
Treatmnt	Long term management of site (code refers to treatment described in metadata in data file)	
Year	Year in which data were collected	numeric
Mo	Month in which data were collected	
Dy	Day on which data were collected	
AGbiomass	Above-ground living biomass (green grass biomass)	g/m^2
Stdead	Above-ground recent dead standing grass biomass	

Sample NPP Data Record <**rmy1_npp_r1.txt**>

```
Site;Treatmnt;Year;Mo;Dy; AGbiomass; Stdead [units g/m2]

rmy; none;1984; 5; 12; 12.7; 37.6;
rmy ; none;1984; 9; 22; 8.4; 9.6;
...
```

Table 3. Column headings in <rmy2_npp_r1.txt> file

COLUMN HEADING	DEFINITION	UNITS
Site	Site where data were gathered (code refers to site identification)	text
Treatmnt	Long term management of site (code refers to treatment described in metadata in data file)	
Year	Year in which data were collected	numeric
Mo	Month in which data were collected	
Dy	Day on which data were collected	
ANPP_shrub	Annual above-ground living shrub biomass (current-year leaf and twig biomass)	g/m^2 yr
ANPP_grass	Annual above-ground grass biomass (living plus recent dead biomass) (method 1 in Singh et al., 1975)	
ANPP_total1	Annual above-ground total biomass [annual peak live (green) grass biomass (method 1 in Singh et al., 1975) plus current-year shrub biomass]	
ANPP_total2	Annual above-ground total biomass [cumulative positive seasonal changes in live (green) plus recent dead grass biomass (method 7a in Singh et al., 1975) plus current-year shrub biomass]	

Sources: Data for 1972 are from Ares (1978). Data for 1975 are from Soriano et al. (1976). Data for 1983-1988 are from Fernandez et al. (1991). Data for 1990-1997 are from Jobbagy and Sala (2000).

Sample NPP Data Record <**rmy2_npp_r1.txt**>

```
Site;Treatmnt;Year;Mo;Dy; ANPP_shrub; ANPP_grass; ANPP_total1; ANPP_total2 [units
g/m2/yr]

rmy ; none;1972; -999.9; -999.9; -999.9; 32.5; -999.9; -999.9
rmy ; none;1975; -999.9; -999.9; -999.9; 48.7; -999.9; -999.9
rmy ; none;1988; -999.9; -999.9; 23.9; 36.4; 60.3; -999.9
rmy ; none;1990; -999.9; -999.9; -999.9; 20.4; -999.9; -999.9
...
```

Climate Data. The climate data set is an ASCII file. The first 18 lines are metadata; data records begin on line 19. The variable values are delimited by semicolons. The value -999.9 is used to denote missing values.

Sample Climate Data Record

```
Temp;Parm; Jan; Feb; Mar; Apr; May; Jun; Jul; Aug; Sep; Oct; Nov; Dec; Year

rmy ;mean;prec; 7.2; 6.5; 9.8; 15.5; 23.6; 16.6; 24.0; 18.8; 10.3; 8.6; 6.1; 6.7; 153.0
rmy ;mean;tmax; 22.2; 22.1; 19.4; 14.8; 10.1; 8.4; 7.4; 9.7; 12.4; 16.1; 18.9; 21.0; 15.2
rmy ;mean;tmin; 7.4; 6.6; 4.9; 1.3; -1.4; -4.2; -4.4; -1.9; -0.6; 1.3; 4.0; 4.7; 1.3
rmy ;numb;prec; 15; 15; 15; 15; 15; 15; 15; 16; 16; 16; 15; 15; 14
rmy ;numb;tmax; 14; 14; 14; 14; 15; 14; 14; 15; 15; 15; 15; 15; 13
rmy ;numb;tmin; 8; 8; 8; 8; 7; 7; 7; 9; 9; 9; 8; 8; 6
rmy ;stdv;prec; 13.2; 8.9; 13.2; 21.8; 20.8; 15.6; 21.9; 23.8; 9.9; 11.0; 5.5; 12.0; 52.3
rmy ;stdv;tmax; 1.6; 2.8; 2.1; 2.2; 1.9; 2.1; 1.9; 1.9; 1.4; 1.8; 2.1; 1.2; 1.0
rmy ;stdv;tmin; 1.9; 2.2; 1.8; 1.7; 2.4; 1.4; 2.4; 2.1; 1.6; 1.5; 2.2; 1.8; 1.0
rmy ;1968;prec; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; 11.0; 16.0; 0.0; 0.0; 46.0; -999.9
rmy ;1968;tmax; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; 11.7; 12.6; 16.2; 19.3; 19.5; -999.9
rmy ;1968;tmin; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -3.5; -1.7; -0.8; 3.2; 1.6; -999.9
rmy ;1969;prec; 0.0; 16.5; 6.5; 1.3; 17.7; 24.0; 45.5; 3.5; 15.0; 2.5; 10.5; 0.0; 143.0
rmy ;1969;tmax; 22.5; 18.3; 14.3; 13.7; 9.5; 10.7; 5.2; 10.0; 11.0; 16.5; 19.0; 22.7; 14.5
rmy ;1969;tmin; 4.0; 3.4; 1.5; -2.0; -2.3; -4.6; -5.9; -1.3; -2.8; 1.0; 4.0; 5.0; 0.0
…
Where,
Temp (temporal) - specific year or long-term statistic:
  mean = mean based on all years
  numb = number of years
  stdv = standard deviation based on all years
Parm (parameter):
  prec = precipitation for month or year (mm)
  tmax = mean maximum temperature for month or year (C)
  tmin = mean minimum temperature for month or year (C)
```

3. Data Application and Derivation:

The accumulation of biomass, or NPP, is the net gain of carbon by photosynthesis that remains after plant respiration. While there are many fates for this carbon, this data set accounts for seasonal grass production, cumulative annual above-ground grass production, and peak growth of both grasses and shrubs.

The grassland biomass dynamics data for the Rio Mayo site are provided for comparison with models and estimation of NPP. This data set gives an initial basis for ANPP forecasting in the Occidental District of the Patagonian steppe. The methods allow for comparisons between years, sites, and treatments.

Climate data are provided for use in driving ecosystem/NPP models.

4. Quality Assessment:

Few estimates of ANPP have been published for the Patagonia region of Argentina. ANPP estimates for Rio Mayo (this study) fall within the sample production range of 30-200 g/m^2/yr for arid zones, and are close to the lower limit of 100 g/m^2/yr ascribed to semiarid zones (Noy-Meir, 1973). Predictions from four published models relating ANPP to annual precipitation agree (± 17%) with data in this study (Fernandez et al., 1991).

Sources of Error

A single estimate of biomass at the end of the growing season was considered an adequate basis to estimate shrub production because current year shoots and leaves remain attached to the plant and are easily identifiable. Diameter increases in branches of shrubs was not considered, only their elongation; thus,

the data may have a bias towards underestimation.

The elongated shape of rectangular plots used to estimate grass production has more error associated with the edge effect than, for example, a circle. However, it reduces sampling variance by encompassing a large fraction of within-community heterogeneity.

5. Data Acquisition Materials and Methods:

Site Information

The Patagonian steppe study site is located near Rio Mayo, Chubut (Argentina) at 45.68 S, 70.27 W, Elevation is 500 m. The vegetation is chiefly composed of grasses and shrubs. Grasses have a basal cover of 25% and are represented principally by *Stipa speciosa*, *S. humilis*, and *Poa ligularis*. Shrubs, which are less than 1 m in height, have a cover of 12% and are represented mainly by *Mulinum spinosum*, *Adesmia campestris*, and *Senecio filaginoides*. Forbs account for less than 1% of total cover and they were not taken into account in this study. The rest of the basal cover is bare ground. The area is representative of the vegetative community which covers most of the Patagonian Occidental District (Soriano, 1983). It is classified as a modified Bailey ecoregion temperate dry steppe (#331/332). Large herbivores have been excluded from the sampling area since 1983.

Grasses and shrubs are the dominant plant functional types of the steppes of the Occidental District (Soriano 1956, Golluscio et al. 1982). The grass and shrub have contrasting rooting systems, phenologies, and water utilization patterns. Grasses have shallow roots and green leaves all year round while shrubs have deep roots and include deciduous and evergreen species.

The Patagonian steppe is located in a cold, semiarid region. The area is a flat plateau where long-term (1968-1990) mean annual precipitation is 153 mm. More than 70% of the precipitation occurs during fall and winter and recharges the soil profile almost every year, wetting the deep soil layers. Spring and summer precipitation events are rare and only wet the upper soil layers (Sala et al., 1989; Jobbagy et al., 1995). Mean monthly maximum and minimum temperatures for the 1968-1990 period were 15.2 degrees C and 1.3 degrees C, respectively. Previous studies have shown a lag between the rainy season (fall-winter) and onset of the growing season (spring) (Fernandez et al., 1991).

Soils are derived from glacial and volcanic materials. Their texture is coarse, and gravel and stones are commonly found throughout the soil profile. Pebbles account for 47% of soil mass. A caliche layer is found at approximately a depth of 60 cm.

Methods

ANPP of the Patagonian steppe in south-western Chubut (Argentina) was estimated quarterly during one year using a harvest technique to assess the herbaceous (mainly grass) component and a double sampling technique to evaluate shrub production. The latter technique involved the measurement of plant dimensions and the harvest of shrub biomass in small plots. A simpler method was used to assess interannual variability. Seasonal grass ANPP and senescence was also measured by considering changes in green and standing dead biomass for grasses between consecutive seasonal sampling dates during the 1984/85 period.

Grass Production

To estimate seasonal and annual production of grasses, biomass was harvested five times throughout a year (1984/85). Harvest months were May, September, and November in 1984, and January and May in 1985. Twenty 0.2 x 5.0-m (1-m^2) plots were randomly located and harvested on each sampling date. This plot shape was used because it reduces sampling variance by encompassing a large proportion of the community heterogeneity. Grass biomass was divided into three categories (green, recent dead, and old dead) and then was oven-dried and weighed. Biomass data for different grass species were pooled because previous estimates showed no differences in seasonality among them (Soriano, 1983). Annual production was calculated by summing positive changes in live plus recent dead grass biomass (method 7a in Singh et al., 1975). The standard error associated with grass production estimates was calculated according to Sala et al. (1988).

Shrub Production

Current-year biomass was estimated using a double sampling technique (Wilm et al., 1944). In late January 1985, 10 *Senecio filaginoides*, 10 *Adesmia campestris*, and 15 *Mulinum spinosum* individuals were selected by employing a stratified random procedure to encompass a wide range of plant sizes. For each one of these shrubs, the height and two orthogonal diameters were measured. Green shrub biomass and current-year twigs were harvested from a rectangular 0.1 x 0.25-m quadrat projected vertically through the center of the canopy. Then current-year growth of the entire individual plant was harvested. The biomass of each shrub individual was estimated assuming a hemispherical shape. The total biomass for each shrub species was calculated as the product of the mean individual biomass and the species density. Shrub dry matter production per unit ground surface area was estimated with the closest individual method (Greig-Smith, 1983; Fernandez et al., 1991) applied to 4 transects of about 100 individuals each. The same data base (N = 394) was used to estimate average area per plant for each species.

Interannual Variability

A less-detailed method of estimating annual grass production was employed to assess the interannual variability of ANPP (Jobbagy and Sala, 2000). Single biomass measurements were made at the end of the growing season (January) as estimates of annual ANPP. Green biomass for grasses and current-year leaf and twig biomass for shrubs, which was easily recognized by direct observation of color and structure, were harvested. Peak green biomass was regressed against precipitation and temperature, considering sum and mean, respectively, for 1–24 mo prior to the date of peak green biomass (January). The association between the ANPP of contiguous years was evaluated. The coefficients of variation of ANPP among functional types was compared using Levene's test for relative variation based on the absolute deviations of each value from the series median, standardized by the median.

Climate Data

Climate data are available for Rio Mayo but the location of the weather station is not identified in the climate data file. The reported data include precipitation,

minimum temperature, and maximum temperature for the period 1968-1990.

6. Data Access:

This data set is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Data Archive:

Web Site: http://daac.ornl.gov

Contact for Data Center Access Information:

E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

7. References:

Fernandez, R.J., O.E. Sala, and R.A. Gulluscio. 1991. Woody and herbaceous above-ground production of a Patagonian steppe. J. Range Management 44: 434-437.

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Additional Sources of Information:

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8. Data Set Revisions:

Revision Summary:

The original npp data file (**rmy_npp.txt**) has been split into two files, one file containing seasonal biomass (**rmy1_npp_r1.txt**) and the other (**rmy2_npp_r1.txt**) containing annual ANPP estimates. The data file containing annual ANPP estimates has been revised to extend temporage coverage and add additional annual ANPP data.

Data File Changes:

The temporal coverage of this data set has been extended back to 1972 and forward to 1997. ANPP estimates for the period 1983 through 1988 have been corrected to agree with the values reported on page 544 of Jobbagy and Sala (2000). Additional ANPP estimates, previously not reported in this data set, have been added from Jobbagy and Sala (2000). The data values in **rmy2_npp_r1.txt** are now correct.

Parameter Field	Uncorrected in rmy2_npp.txt	Corrected in rmy2_npp_r1.txt
Temporal coverage	1983-1989	1972-1997

	Uncorrected in rmy2_npp.txt			Corrected in rmy2_npp_r1.txt		
Year	ANPP_shrub	ANPP_grass	ANPP_total1	ANPP_shrub	ANPP_grass	ANPP_total1
1972	NR	NR	NR	-999.9	32.5	-999.9
1975	NR	NR	NR	-999.9	48.7	-999.9
1983	10.5	10.5	21.0	10.8	10.6	21.4
1984	27.7	39.1	66.8	25.7	39	64.7
1985	33.2	42.0	75.2	33.6	41.8	75.4
1986	29.4	34.0	63.4	34	29.5	63.5
1988	23.9	36.6	60.5	23.9	36.4	60.3
1990	NR	NR	NR	-999.9	20.4	-999.9
1991	NR	NR	NR	-999.9	29.9	-999.9
1992	NR	NR	NR	-999.9	24.2	-999.9
1993	NR	NR	NR	26.5	30.5	57
1994	NR	NR	NR	31.3	23.8	55.1
1995	NR	NR	NR	33.9	24.9	58.8
1996	NR	NR	NR	27.8	14.7	42.6
1997	NR	NR	NR	45.8	17.9	63.7

Note: NR=Not Reported.

Cited References:

Jobbagy, E.G., and O.E. Sala. 2000. Controls of Grass and Shrub Aboveground Production in the Patagonian Steppe. Ecological Applications 10(2): 541–549.

Data User Action: If you downloaded the referenced data set from the ORNL DAAC on-line archive before September 16, 2014, you should download it again from the ORNL DAAC.

Original Citation:

Sala, O.E. 2001. NPP Grassland: Rio Mayo, Argentina, 1983-1989. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.