

Information on data collection and organization for the manuscript: *Using high-resolution future climate scenarios to forecast *Bromus tectorum* invasion in Rocky Mountain National Park.*

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This data package contains the following stand-alone files:

Bromus_points.csv: a comma delimited file of *Bromus tectorum* occurrence data , collected in Rocky Mountain National Park from four prior field surveys conducted in 1996, 1999, 2007, and 2008 (n=211). Column headings are Species, Longitude, and Latitude. These surveys were conducted using a modified-Whittaker plot design¹

¹ Stohlgren TJ, Falkner MB, and Schell LD (1995). A Modified-Whittaker nested vegetation sampling method. Vegetatio 117: 133-121

Demfull_90mvalues_gcs: a comma delimited file created from a 90 m spatial resolution digital elevation model (DEM; source: CGIAR_CSI Geoportal)) of Rocky Mountain National Park. Column headings are ID1 (number), ID2 (RMNP1, RMNP2, RMNP3...), lat (latitude), long (longitude) and el (elevation). This .csv file is ready for use in the ClimateWNA software program² to download climate data.

1981_2010_AS: a comma delimited file that contains annual and seasonal climate averages for the years 1981 to 2010 for Rocky Mountain National Park at a 90m spatial resolution. These data were derived from the ClimateWNA software program² using the **DEM_90mvalues_gcs.csv**. The first five column headings are ID1 (number), ID2 (RMNP1, RMNP2, RMNP3...), Latitude), Longitude, and Elevation. The following 69 column headings follow the naming convention outlined in the help file included in this data package; **ClimateWNAhelp_v472.rtf**.

²Wang T Hamann A, Spittlehouse DL, and Murdock TQ (2012). Climate WNA – High-Resolution Spatial Climate Data for Western North America. J Appl Meteorol Climatol 51:16-29

This data package contains the following folders, each containing ascii files of data that were employed in the current and future(year 2050) potential habitat of cheatgrass model for Rocky Mountain National Park. All data were downloaded from ClimateWNA² using the **Demfull_90mvalues_gcs.csv** file and processed in ArcMap v.10 (ESRI).

Current_ASCIIIS folder: this folder contains .asc and .prj files corresponding to the climate variables in Table 1 (see below; from **ClimateWNAhelp_v472.rtf**) that were employed in the final MaxEnt models, as well as all other climate variables, a distance to roads ascii (distanceroads.asc and distanceroads.prj), and a vegetation community type ascii (**vegtype.asc** and **vegtype.prj**) that were used in correlation and principle component analysis. Naming conventions for the climate data column headings can be found in

ClimateWNAhelp_v472.rtf. Projection: NAD_1983_UTM_Zone_13N. These climate data were from climate normal for the years 1981-2010.

BCCR_ASCIS folder: this folder contains .asc and .prj files corresponding to the climate variables in Table 1 (see below; from **ClimateWNAhelp_v472.rtf**) that were employed in the final MaxEnt models. Projection: NAD_1983_UTM_Zone_13N. These climate data were from the BCCR (Bjerknes Centre for Climate Research) global circulation model (GCM), A2 climate change scenario for the year 2050 (Intergovernmental Panel on Climate Change).

CCCMA5_ASCIS folder: this folder contains .asc and .prj files corresponding to the climate variables in Table 1 (see below; from **ClimateWNAhelp_v472.rtf**) that were employed in the final MaxEnt models. Projection: NAD_1983_UTM_Zone_13N. These climate data were from the CCCMA (Canadian Centre for Climate Modeling and Analysis) global circulation model (GCM), A2 climate change scenario, run 5 for the year 2050 (Intergovernmental Panel on Climate Change).

CCCMA_ASCIS folder: this folder contains .asc and .prj files corresponding to the climate variables in Table 1(see below; from **ClimateWNAhelp_v472.rtf**) that were employed in the final MaxEnt models. Projection: NAD_1983_UTM_Zone_13N. These climate data were from the CCCMA (Canadian Centre for Climate Modeling and Analysis) global circulation model (GCM), A2 climate change scenario for the year 2050 (Intergovernmental Panel on Climate Change).

GFDL_ASCIS folder: this folder contains .asc and .prj files corresponding to the climate variables in Table 1 (see below; from **ClimateWNAhelp_v472.rtf**)that were employed in the final MaxEnt models. Projection: NAD_1983_UTM_Zone_13N. These climate data were from the GFDL (United States National and Atmospheric Administration Geophysical Fluid Dynamics Laboratory) global circulation model (GCM), A2 climate change scenario for the year 2050 (Intergovernmental Panel on Climate Change).

MIROC_ASCIS folder: this folder contains .asc and .prj files corresponding to the climate variables in Table 1 (see below; from **ClimateWNAhelp_v472.rtf**) that were employed in the final MaxEnt models. Projection: NAD_1983_UTM_Zone_13N. These climate data were from the MIROC-H (Centre for Climate Research, Japan) global circulation model (GCM), A2 climate change scenario for the year 2050 (Intergovernmental Panel on Climate Change).

MRI_ASCIS folder: this folder contains .asc and .prj files corresponding to the climate variables in Table 1 (see below; from **ClimateWNAhelp_v472.rtf**) that were employed in the final MaxEnt models. Projection: NAD_1983_UTM_Zone_13N. These climate data were from the MIROC-H (Centre for Climate Research, Japan) global circulation model (GCM), A2 climate change scenario for the year 2050 (Intergovernmental Panel on Climate Change).

Table 1. Naming conventions for climate ascii files listed in the folders above:

File Name	Variable
mat	Mean annual temperature
dd_18_sp	Spring degree days below 18°C

distanceroads	Distance to roads
bffp	Beginning of frost-free period
map	Mean summer precipitation
td	Continentality

This data package also contains the **niche_shift_data_and_code folder**. This folder contains four comma delimited files and one R script that were used in the niche shift model portion of the manuscript.

Bromus_occur_current.csv: This comma delimited file contains the *Bromus tectorum* occurrence points from the **Bromus_points.csv** file found in this data package, and current (climate normal for the years 1981-2010) values for non-correlated climatic variables were extracted for these points in ArcMap v.10. Column headings follow naming conventions in the **ClimateWNAhelp_v472.rtf** file found in this data package.

Bromus_occur_future2050_ensemb.csv: This comma delimited file contains the *Bromus tectorum* occurrence points from the **Bromus_points.csv** file found in this data package, and future (year 2050; ensemble from averaging the six GCMs) values for non-correlated climatic variables were extracted for these points in ArcMap v.10. Column headings follow naming conventions in the **ClimateWNAhelp_v472.rtf** file found in this data package.

clim_rmnp_current.csv: This comma delimited file contains 10,000 random points that were selected from the entire study area of the Park, and future (year 2050; ensemble from averaging the six GCMs) values for non-correlated climatic variables were extracted for these points in ArcMap v.10. Column headings follow naming conventions in the **ClimateWNAhelp_v472.rtf** file found in this data package.

clim_rmnp_future2050_ensemb.csv: This comma delimited file contains 10,000 random points that were selected from the entire study area of the Park, and future (year 2050; ensemble from averaging the six GCMs) values for non-correlated climatic variables were extracted for these points in ArcMap v.10. Column headings follow naming conventions in the **ClimateWNAhelp_v472.rtf** file found in this data package.

Script.nich.dynamic_Kumar.r

This code was written by Sunil Kumar, Natural Resource Ecology Laboratory, Colorado State University, 2014; The niche.overlap, occ.prep, and niche.dynamic functions in R were utilized and code was modified from Broenniman et al. (2012)³.

³Broennimann O, Fitzpatrick MC, Pearman PB, Petitpierre B, Pellissier L, Yoccoz NG, Thuiller W, Fortin M, Randin C, Zimmermann NE, Graham CH, and Guisan A (2012). Measuring ecological niche overlap from occurrence and spatial environmental data. *Glob Ecol and Biogeogr* 21: 481-497

Details about the R code: Converts the *B. tectorum* presence points ($n = 211$) to density values via kernel smoothing. The density values were then ordered along PCA axes of the current environmental grid (10,000 random background points) and then the future (2050) environmental grid (same 10,000 random background points) for niche overlap analysis.