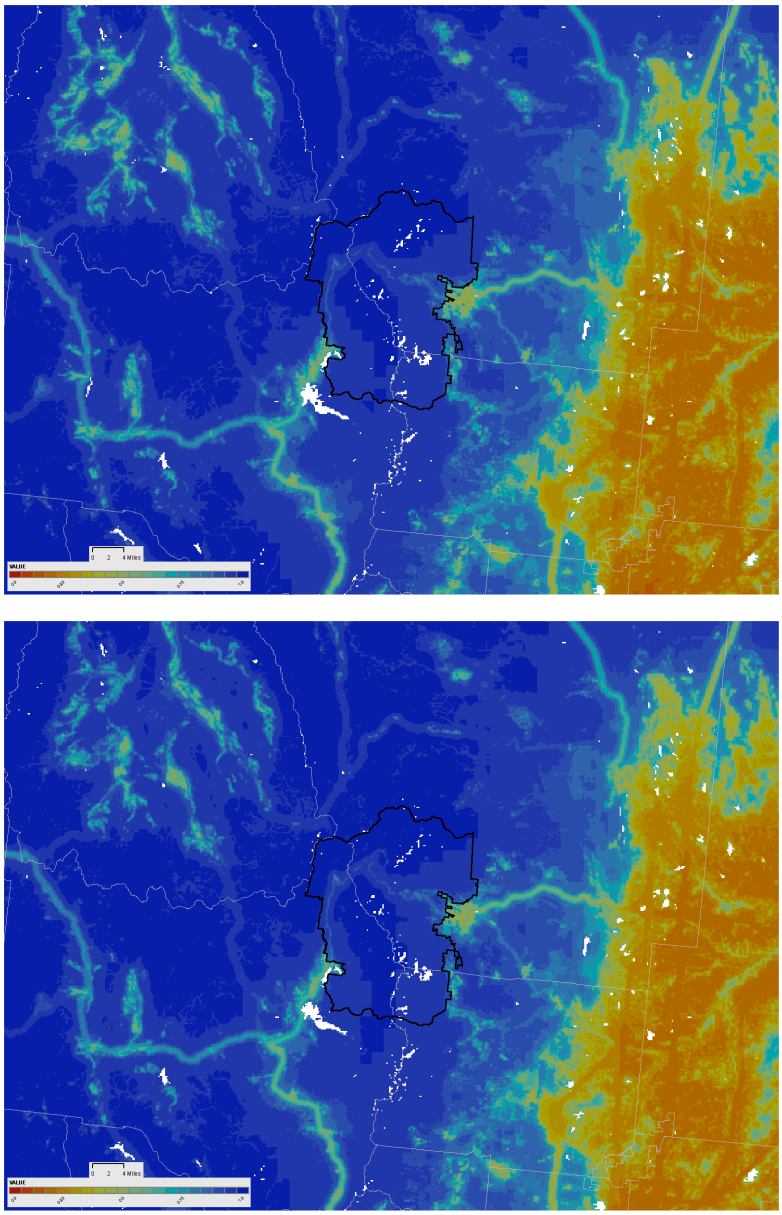
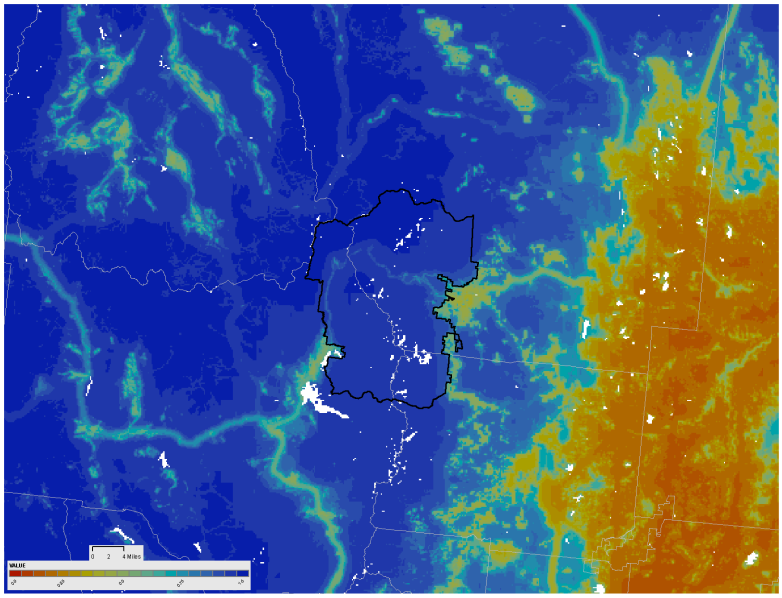
Biodiversity: Patterns of Natural Landscapes

What: Measures the natural landscape context
Why: Movement of plants & animals and ecological processes connect to adjacent landscapes beyond the park boundary
Summary: ROMO scores slightly higher (0.02-0.03) above the Southern Rockies ecoregion, but is declining from 0.940 in 1992 to 0.937 in 2001 to 0.928 in 2030. However, the ecoregion as a whole is declining at a rate 3x of ROMO.

Figure. Pattern of Natural Landscapes in 1992, 2001, and 2030 (top, middle, bottom) using the multi-scale proportion metric. High NL values are shown in blue, areas dominated by urban and/or cropland agriculture appear as highly modified areas, shown in red. From Theobald, DM. 2010. Estimating natural landscape changes from 1992 to 2030 in the conterminous US. Landscape Ecology.





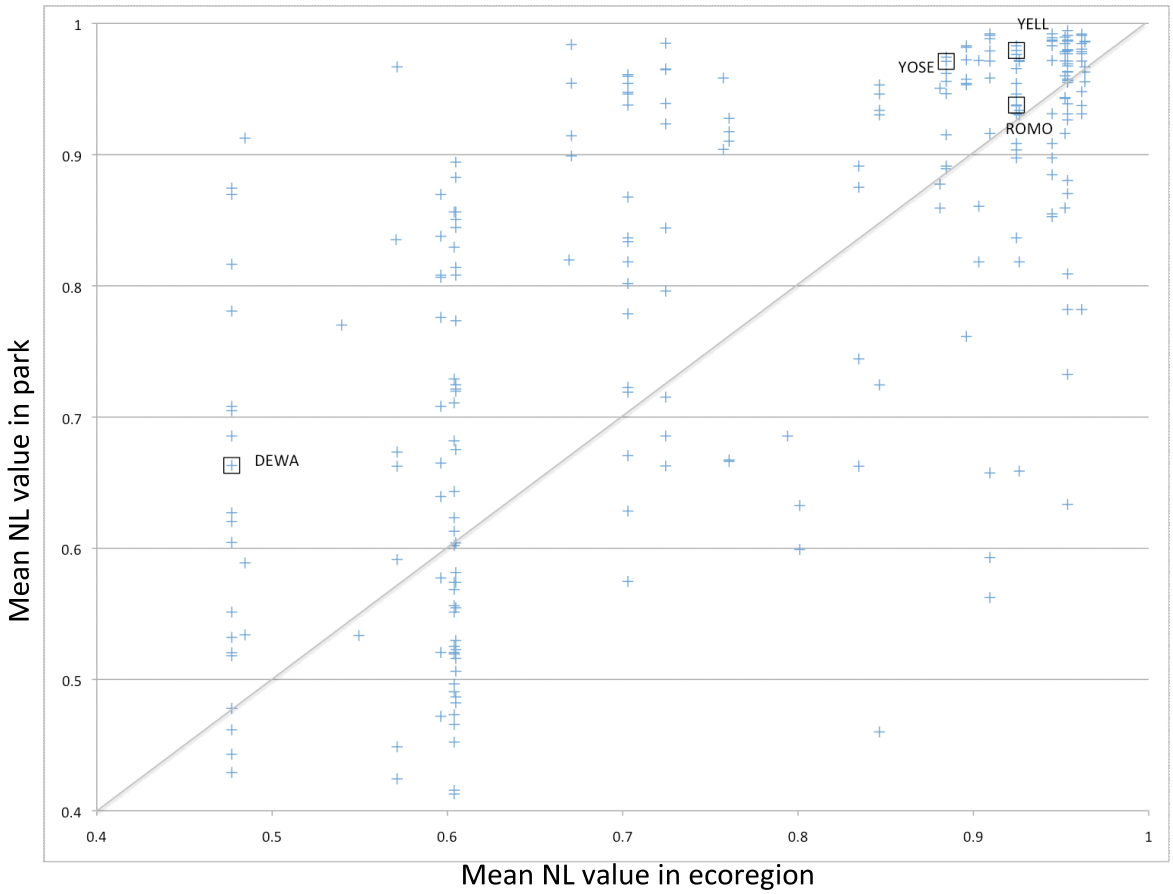


Figure. The mean natural landscape metric value for current (2001) landscape.

Biodiversity: Landscape Connectivity

What: Measures the connectivity of natural landscapes
Why: Movement of plants and animals and ecological processes connect to adjacent landscapes and beyond the park boundaries.
Summary: ROMO is situated on a pathway that provides much grater than average connectivity and serves as a key location of connectivity along the Southern Rockies.

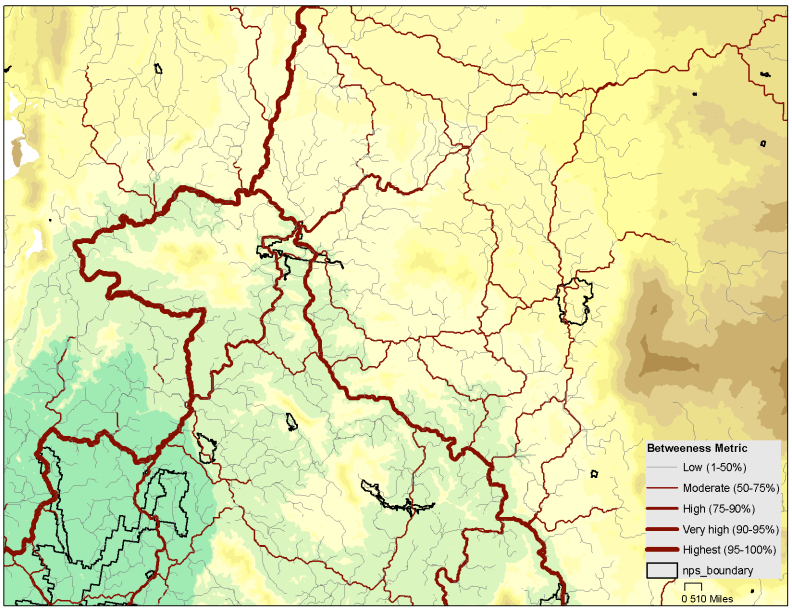
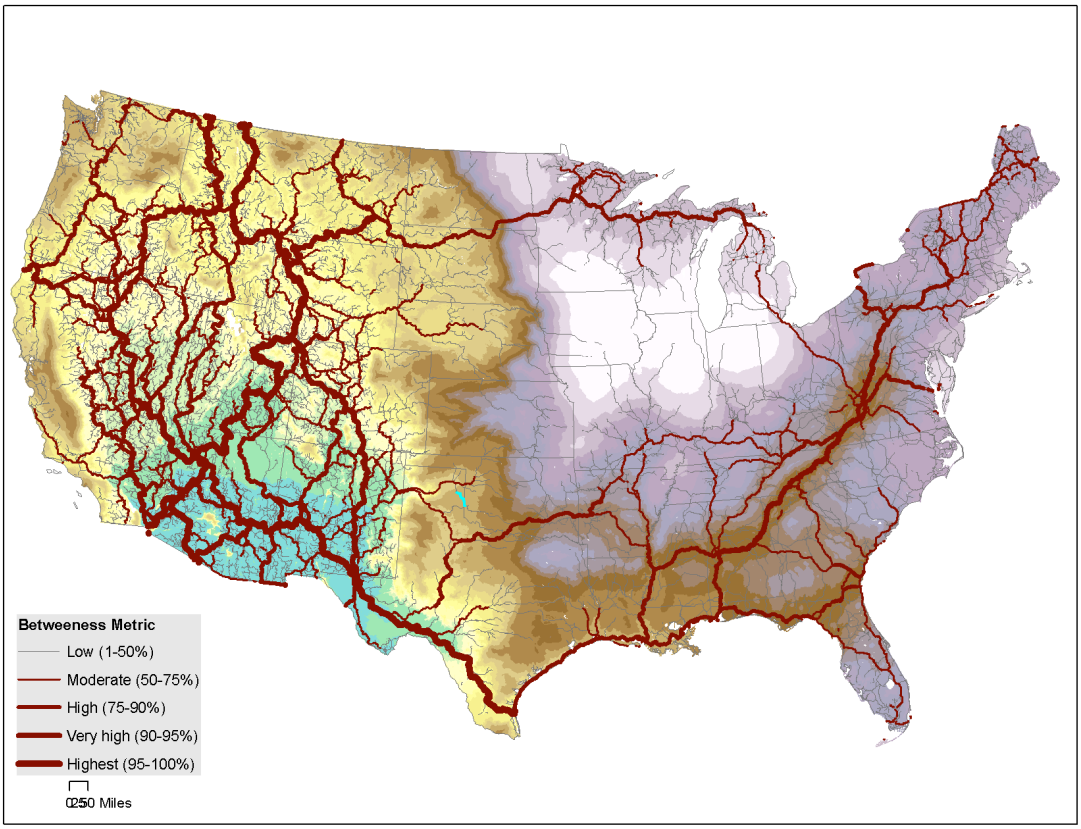


Fig xx. Thicker red lines show more cumulative movement assuming animals are moving across the landscape avoiding human-modified areas, for Yellowstone region (above) and US (below). From Theobald & Reed (in prep).



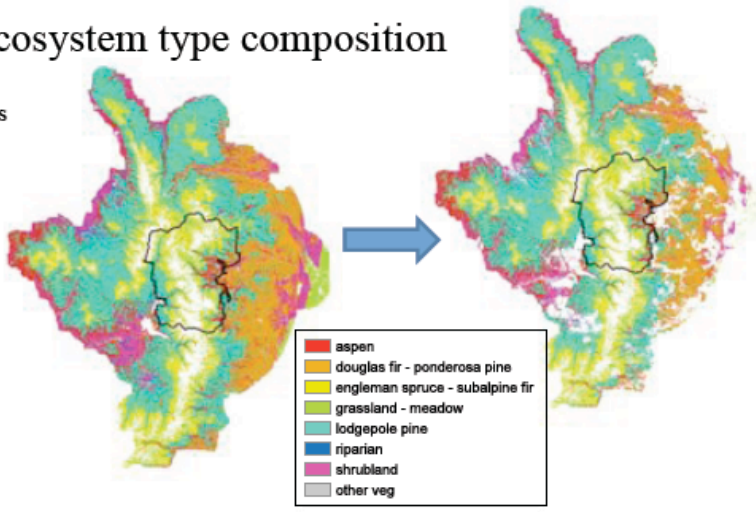
Landscape dynamics: Ecosystem type composition

What: Estimates reduction in area of potential pre-settlement ecosystem types due to current land use.

Why: Ecosystem types of greatest proportional loss are candidates for focused conservation, management and restoration.

Stressors: land use change.

Grasslands and meadows have undergone greatest proportional loss followed by shrubland and douglas fir ecosystems. Most losses have occurred on private lands where an average of half of each ecosystem type has been lost to human activity. Engelmann spruce – subalpine fir communities do not appear to have been significantly affected by land use change in this analysis.



Ecosystem Type	Hectares (thousands)	% Loss total	% Loss pvt land	% Loss Pub. land
Aspen	111	12	35	0
Douglas fir – ponderosa pine	141	26	60	0
Engelmann spruce – subalpine fir	157	0	35	0
Grassland meadow	36	35	86	5
Lodgepole pine	280	9	45	2
Riparian	41	23	49	5
Shrubland	74	30	46	5
Other natural veg.	5	40	68	3
Mean		22	53	3

Note on methods: the distribution of pre-settlement ecosystem types were mapped by the LANDFIRE program based on biophysical factors and modeled disturbance conditions. This layer was validated within park boundaries using NPS Veg. Mapping program data with varying "accuracy". We evaluated the loss of ecosystem type area due to current land uses including residential and agricultural development and transportation networks.

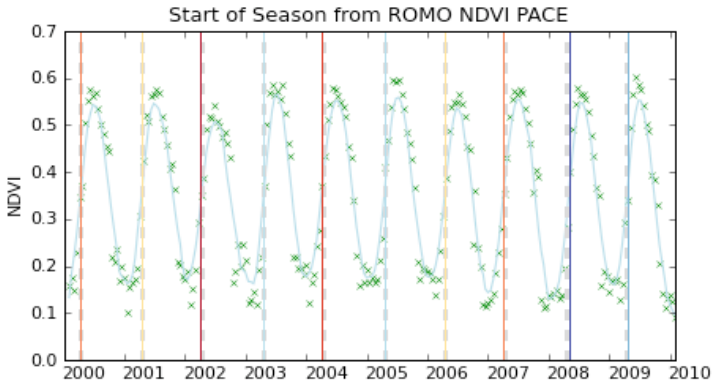
Weather and Climate: Landscape Phenology

What: Measures trends and anomalies in phenological indicators including the 'start-of-season' (SOS) date, derived from satellite timeseries of vegetation index data

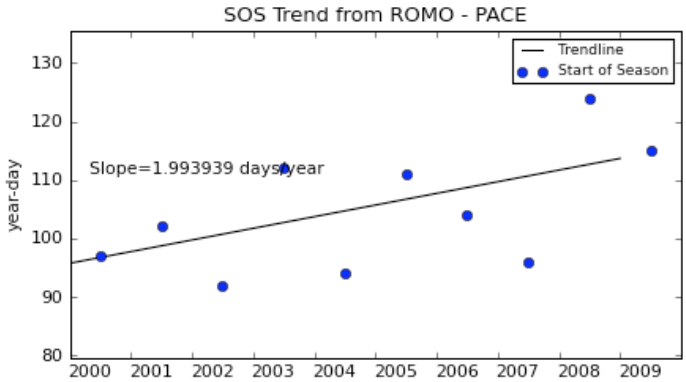
Why: Sustained shifts in vegetation phenology are a predicted consequence of climate change. Satellite-derived phenology indicators provide a useful supplement to surface measures, which may track only a subset of plant species.

Stressors: Climate change, land use change, drought

Summary: This indicator includes measures of the annual Start-of-Season anomaly, and graphs and plots to summarize spatial and temporal patterns in SOS by land cover type, as shown below. The indicator is intended to provide a relative measure of landscape phenology for use in detecting temporary and sustained shifts in SOS dates, as opposed to an absolute measure for specific plant species.



The indicator shows that the average SOS date for the ROMO PACE has varied by more than 35 days between 2000 and 2010. The average SOS date has ranged from April 1 to May 25, with the SOS dates for 2008-2010 occurring later than the dates for 2000-2007. The trend line shown on the graph is included for reference, and a longer data record will be required to distinguish long-term trends against the significant interannual background variability.



A draft 'dashboard' summarizing patterns from this indicator for particular land cover types is available at: http://ecocast.arc.nasa.gov/dgw/dboard/ROMO .

Weather and Climate: Gridded Climate (1980-1999)

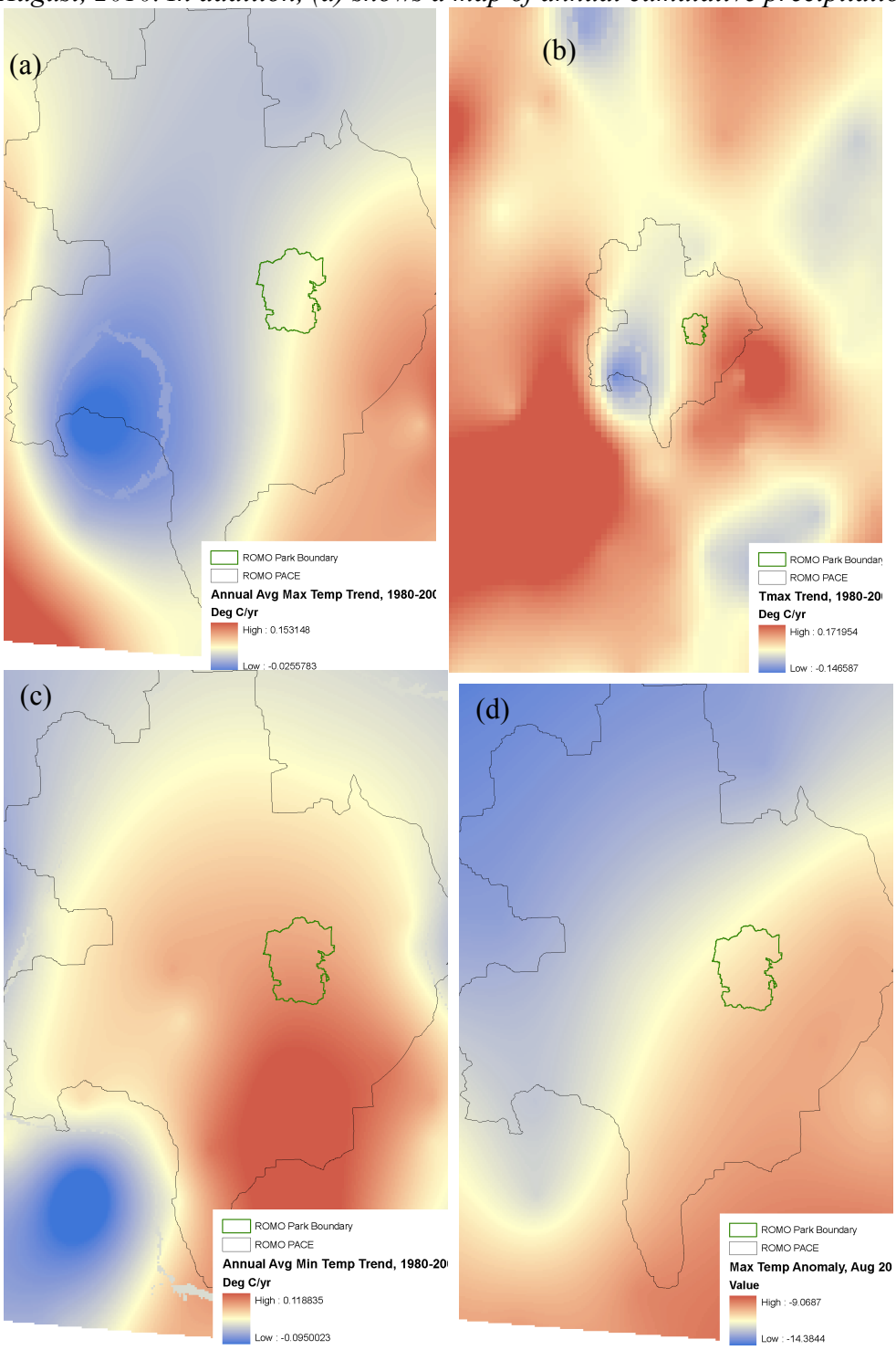
What: Measures spatial patterns in trends and anomalies in temperature and precipitation using interpolated meteorological surfaces from the Terrestrial Observation and Prediction System.

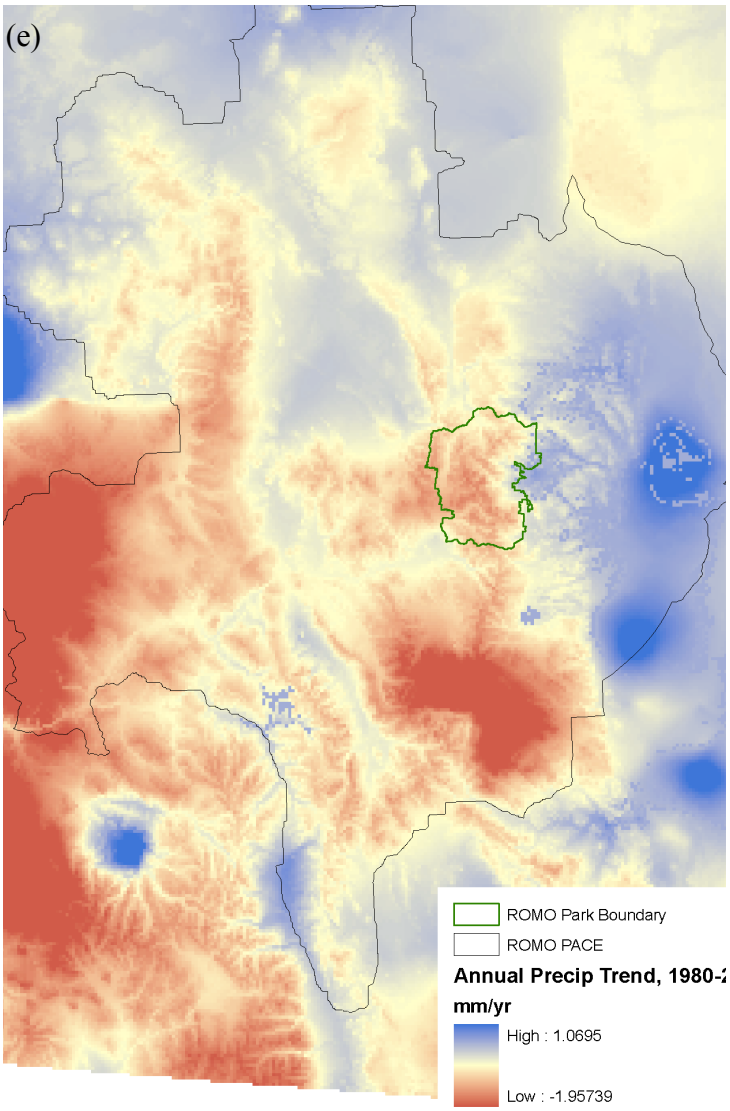
Why: By presenting the distribution of climate trends across latitudinal and elevational gradients, climate trends and anomalies calculated from spatially continuous meteorological surfaces can support interpretation of climate indicators calculated from individual stations or the average of all stations in a region of interest. Meteorological anomalies (relative to historical normals) can also be useful for assessing the magnitude of heat waves, cold snaps, and other short term climate phenomena.

Stressors: Climate change and climate variability

Summary: This indicator has been calculated for ROMO and the ROMO PACE region for the 30-year period from 1980-2009. Trends in the annual average daily maximum and minimum temperature indicate conflicting trends from regional meteorological stations. Overall, for the park, it appears that both maximum and minimum temperatures have increased, though the heterogenous patterns underscore the importance of carefully screening data from multiple stations to calculate temperature trends for the park. Trends in precipitation for the region are mixed, though trends in precipitation should be interpreted with caution. This indicator was originally intended to support indicators derived from the NPClime project.

Figure: *Trends for the thirty-year period from January 1, 1980 through December 31, 2009 are shown for the annual average daily maximum temperature (a, b), annual average daily minimum temperature (c), and an example of a monthly anomaly map (current conditions relative to historical normals) for maximum temperature is shown for August, 2010. In addition, (d) shows a map of annual cumulative precipitation (d).*




(e)
ROMO Park Boundary
ROMO PACE
Annual Precip Trend, 1980-
mm/yr
High : 1.0695
Low : -1.95739

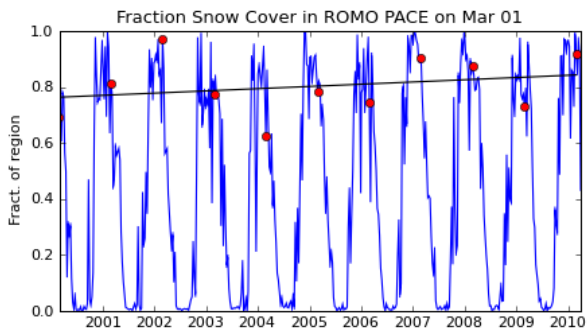
Weather and Climate: Snow Cover (2001-2009)

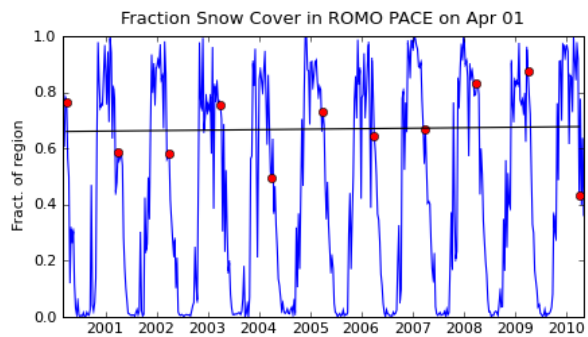
What: Graph of snow cover extent and trend in % of park or PACE area with snow cover on Mar 1, Apr 1, and May 1 as derived from the MODIS satellite snow cover data product.

Why: The timing of snowfall is an important driver of many hydrologic and ecologic processes within parks. One predicted consequence of climate change is a shift toward earlier complete melt of the winter snow pack, affecting runoff patterns and water availability for many parks in the western U.S. This measure provides an indicator designed to supplement indicators derived from station observations, such as measures of the snow water equivalent on April 1.

Stressors: Climate change, drought

Summary: The indicator captures the interannual variability in snow cover from 2000-2010 for the ROMO parks and PACE. For the PACE overall, the fraction of the region with snow cover on April 1 ranged from 0.4 to 0.9, with no trend evident from 2000-2010. April 1 snow cover over the past decade has typically ranged from 50-85% of the total ROMO PACE. The indicator is intended to supplement measures of snow water equivalent from SNOTEL sites or other monitoring networks within or near the PACE.





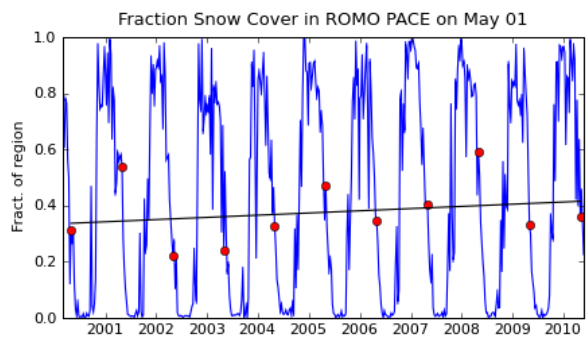


Figure a. Graph of fractional snow cover for the ROMO PACE for 2000-2010, wit each date.

Summary and Prospects

Story Lines Emerging from Trends (see table 3 below for reference)

- Spatial patterning of the natural component of the system
  - Climate, ecosystem / habitat types, productivity, hydrology
- Change in climate averages and spatial patterning over time

- Temporal and spatial patterns of human communities and use
  - Human population density
  - Change in land cover and use & agriculture
  - Exurban expansion & impervious cover
  - Spatial pattern of intensive land uses

- Interactions among biophysical patterns, productivity, human environment, habitat connectivity and climate.
  - Human transformation of the ecological system
  - Future prospects based on spatial predictive modeling

- Key current and emerging management challenges

Feedback & thoughts on refining / updating / delivering / using these analyses?

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<additional reference material for this section is welcome / desired >

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