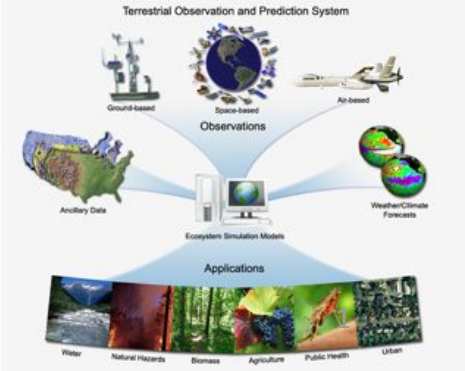
Ecological conditions of US National Parks: *Park Analysis of Landscapes and Monitoring Support (PALMS)*

Project summary for

Rocky Mountain National Park/Network

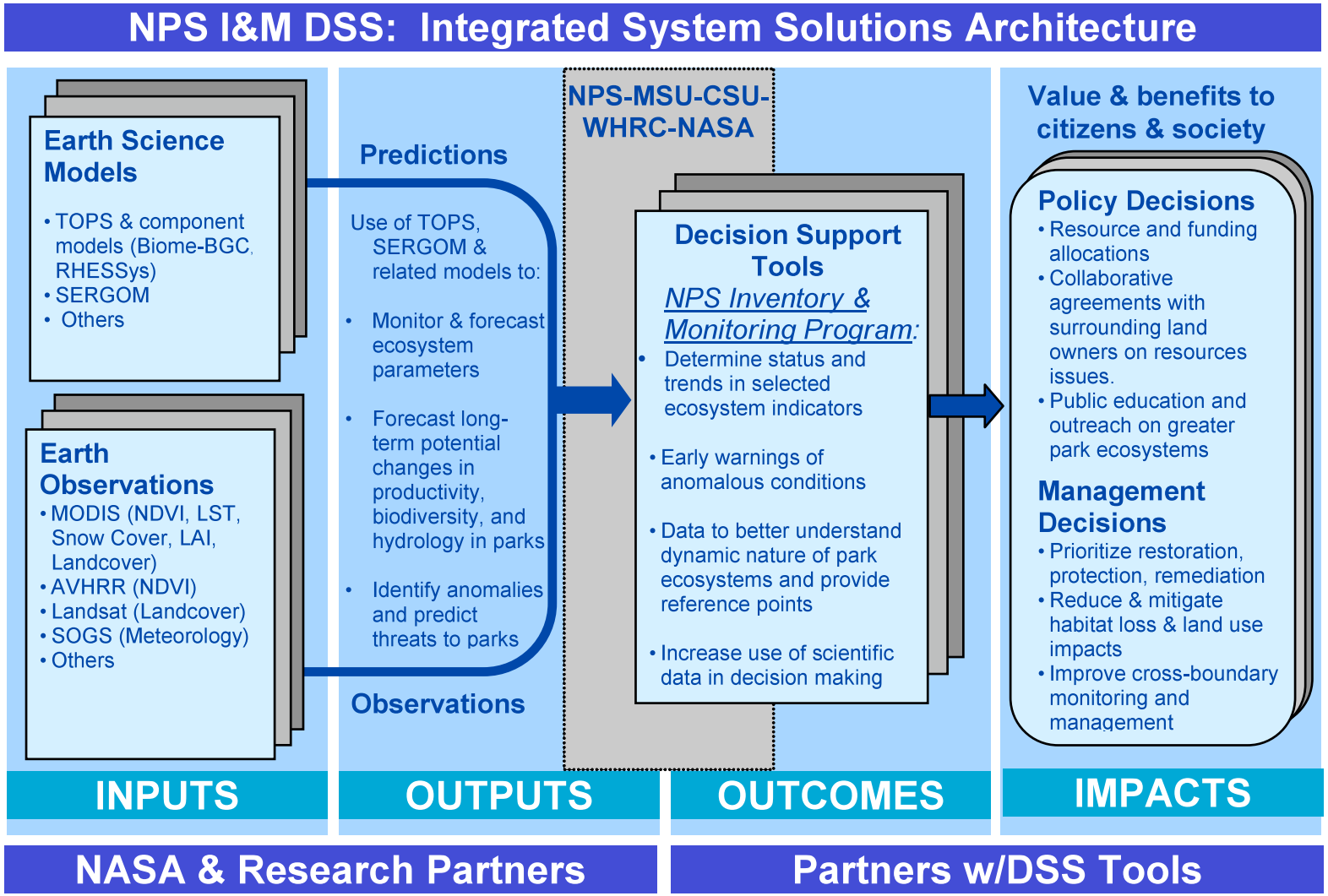
April 14, 2010



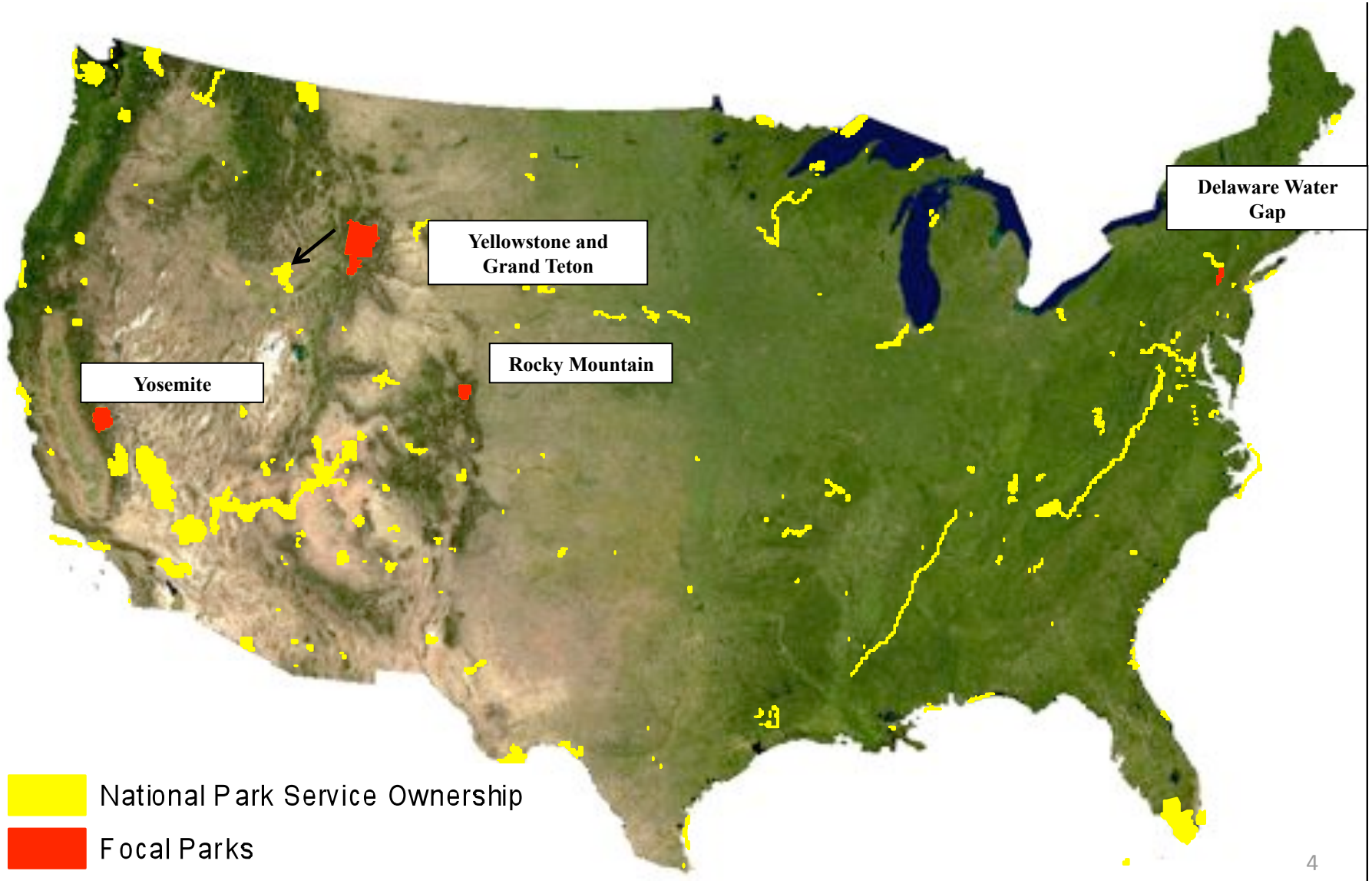
Science Team

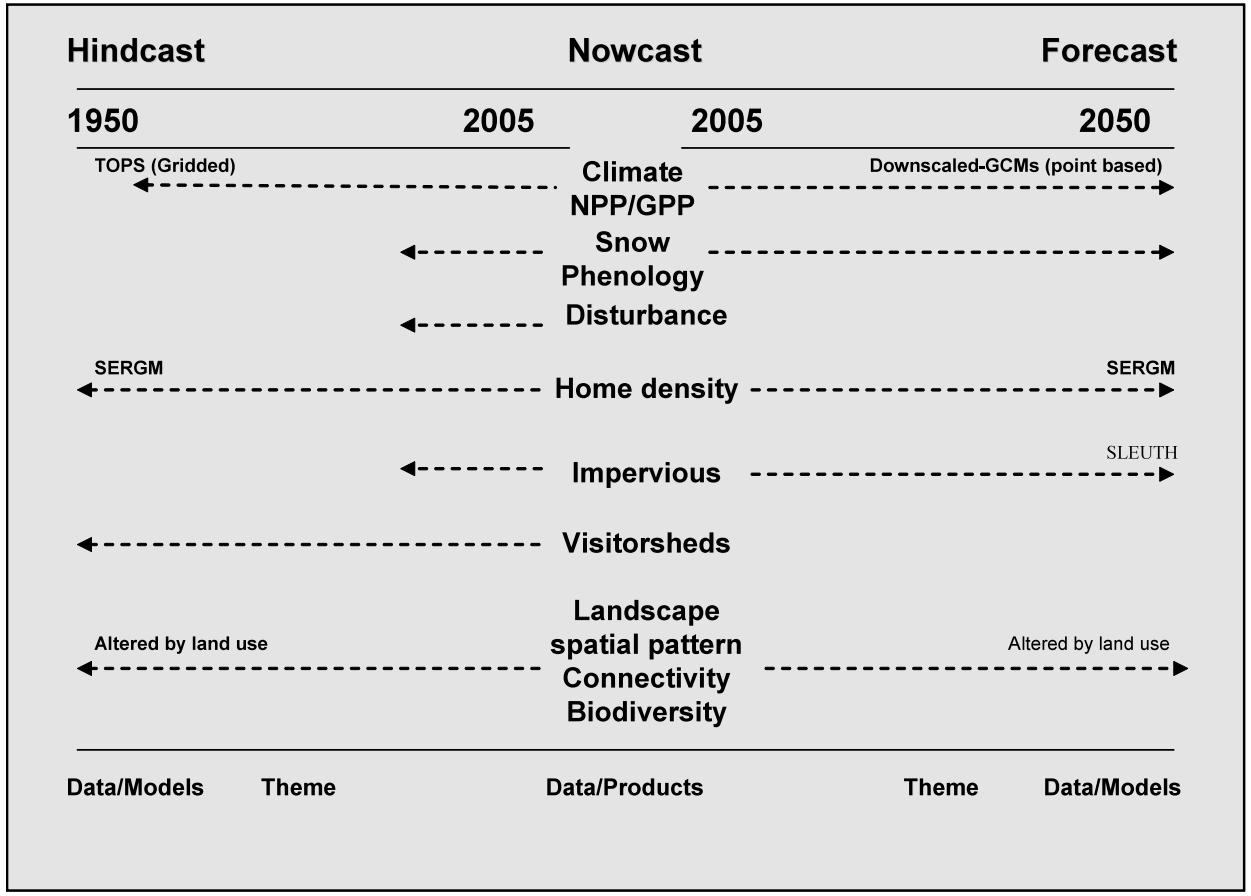
Name	Role	Lead Responsibilities
Andrew Hansen	P.I.	Overall coordination; Indicators and ecosystem boundaries; Habitat modeling
Scott Goetz	Co-P.I.	Land cover and use analysis; Hydrology modeling
John Gross	Co-P.I.	Coordination with NPS I&M; Benchmarking and performance standards; Integration of results into management
David Theobald	Co-P.I.	Land cover and use modeling; Land cover and use analysis; GIS tools with ModelBuilder
Forrest Melton	Co-P.I.	Data interface with TOPS; Climate modeling; NPP and hydrology modeling
Rama Nemani	Co-P.I.	Data interface with TOPS, Climate modeling; NPP and hydrology modeling
Nathan Piekielek	Gr Student	Indicators and ecosystem boundaries; Habitat modeling
Robert Daley	NPS	Integration with Greater Yellowstone Network
Billy Schweiger	NPS	Integration with Rocky Mountain Network
Matthew Marshall	NPS	Integration with Eastern Rivers and Mtns Network
Bill Kuhn	NPS	Integration with Sierra Network
Linda Mutch	NPS	Integration with Sierra Network
Andi Heard	NPS	Integration with Sierra Network

Study Design



Pilot National parks




Hindcast
Nowcast
Forecast
1950
2005
2005
2050
TOPS (Gridded)
Climate
NPP/GPP
Downscaled-GCMs (point based)
Snow
Phenology
Disturbance
SERGM
Home density
SERGM
SLEUTH
Impervious
Visitorsheds
Landscape
spatial pattern
Connectivity
Biodiversity
Altered by land use
Altered by land use
Data/Models
Theme
Data/Products
Theme
Data/Models

PALMS Indicators in I&M Framework

Level	Category	Indicator	Extent	Resolution
Air and Climate	Weather and Climate	Phenology (NDVI, annual anomaly)	US 48	1 km (all); 8 & 16 day
		Climate gridded daily 2000-8	YOSE	1 km
		Climate scenarios (monthly)	YOSE, DEWA, GYE, US48	12 km
Water	Stream health	Sensitive taxa	DEWA	1:24K, 1:100K
Landscape dynamics	Land Cover	Ecosystem type composition Summary by spatial scale	DEWA, ROMO, YELL, YOSE	30 m
		Bird hotspots and key habitat types	GYE	1 km
		Impervious cover change	DEWA	30 m
		Housing density class (1940 – 2100, decadal)	US48	100 m
		Landscape connectivity of forests	Eastern US	270 m
		Pattern of natural landscapes	US 48	270 m
		Past to future modeling	DEWA	30 m
	Extreme Disturbance Events	Fire effects via changes in NDVI/EVI, FPAR/LAI	DEWA, ROMO, YELL, YOSE	1 km; monthly anomalies / persistent; annual trends
	Primary Production	GPP/NPP TOPS GPP	DEWA, ROMO, YELL, YOSE	1 km daily and/or monthly summaries
	Monitoring area	Greater park ecosystem boundaries	DEWA, ROMO, YELL, YOSE	30 m
	Land use	Land use	US48	90 m

Overview

The US NPS Inventory and Monitoring Program is developing scientifically sound information on the status and trends of national park condition. NASA data and products can have potential to enhance the success of the NPS I&M effort. Our goal of the project is to integrate the routine acquisition and analysis of NASA products and other data into the NPS I&M Program.

Objectives and status:

Objective 1. Identify NASA and other products useful to park monitoring

- Products list finalized through workshops with NPS

Objective 2. Delineate the boundaries of the park-centered ecosystems appropriate for monitoring.

- Methods were developed and deployed for 12 national parks
- Draft boundaries were reviewed twice by NPS
- Final boundaries were completed
- A manuscript has been reviewed by NPS and is now nearly ready for submission for publication.

Objective 3. Add value to these data sets for understanding change through analysis and forecasting.

-The majority of products are completed.

-Remaining products and analyses are scheduled for completion in May 2010

Objective 4. Deliver these products and a means to integrate them into the NPS I&M decision support framework.

-Methods are being prepared as NPS Standard Operating Procedures.

-Data will be compiled and described within an ARC GIS geodata base.

-A series of three conference calls will be held with NPS I&M and NPS staff April to September 2010 to review, interpret, and finalize the results.

-Summary documents will use the results to communicate "stories" about condition and trends in the parks and surrounding areas.

-SOPS, the Geodatabase, summary reports of results, and publications will be delivered through the NPS I&M National Office and through the internet browser ECOCAST.

- A final survey of the NPS I&M collaborators will be used as the basis for a final report to NASA.

General: Protected Area Centered Ecosystems (PACE)

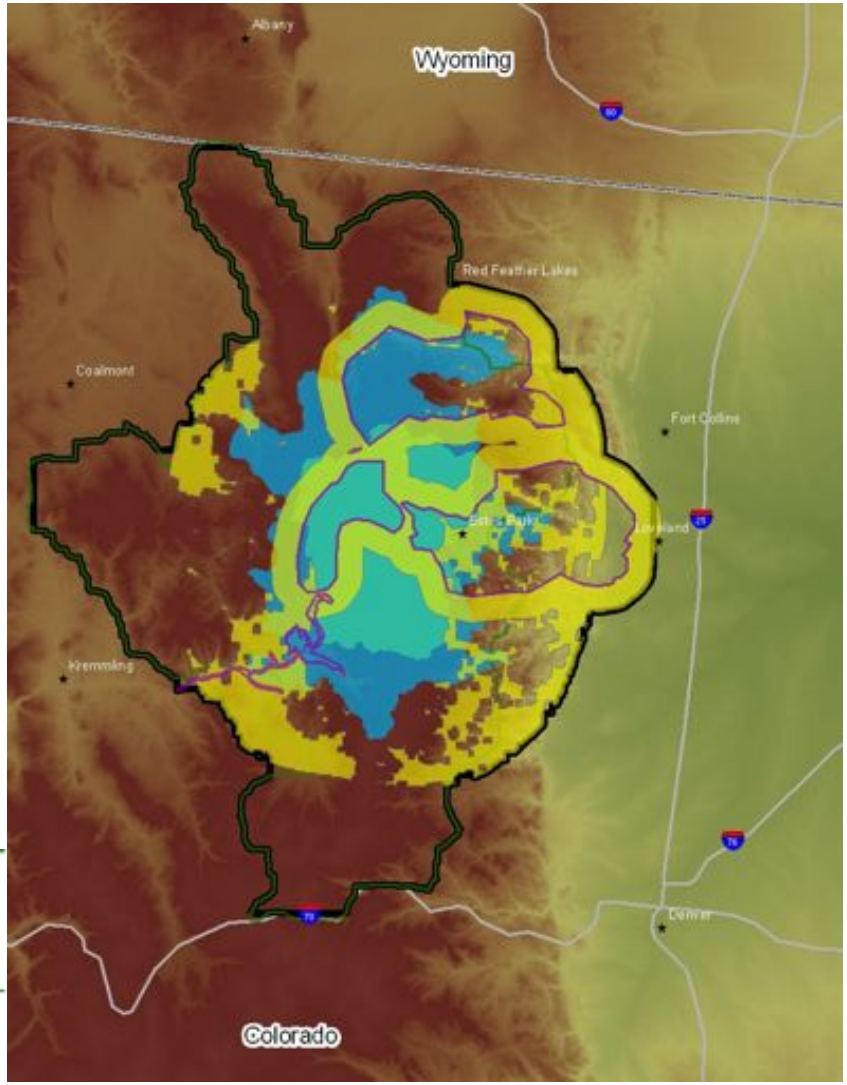
What: Area surrounding park with strong ecological connections to the park

Why: This area may be important for monitoring, research, and cooperative management to maintain park condition

Stressors: Land use change, invasive species

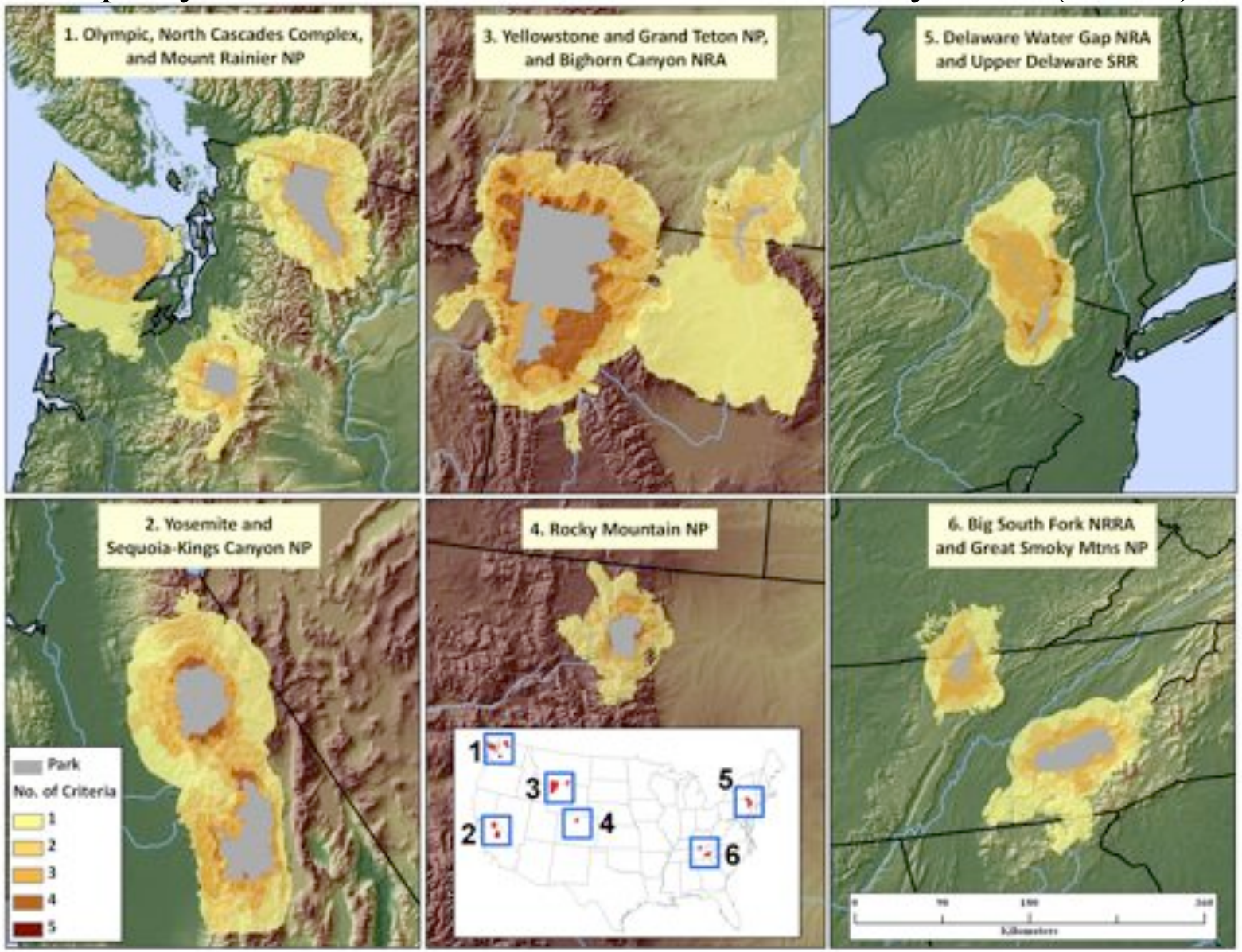
The ROMO PACE outside the park was 8.8 times larger than the park area. The contiguous habitat layer covered the largest unique portion of the PACE, followed by the human edge effects layer. Some 34.5% of the PACE was covered by two or more criteria. Only 24% of the PACE outside of the park is private land, a smaller amount than for many other PACEs.

Metric	Total	Criterion				
		Contiguous habitat	Water-shed	Disturbance	Crucial Habitats	Human Edge Effects
Area outside park (km^2)	9,450	6,768	1,690	---	1,398	1,986
% of PACE uniquely covered		42.75	0.0	---	0.25	10.25



Solid blue = watershed, Purple line = crucial hab., Green line = contiguous hab., Solid yellow = edge effects, Black line = draft PCE boundary

Landscape dynamics: Protected Area Centered Ecosystems (PACE)



Maps of protected-area centered ecosystems for Rocky Mountain and 12 US National Park units. Gradations in color in the PACES outside of the parks indicate the number of overlapping classification criteria. Places with many overlapping criterion may be considered more important for monitoring and management.

Air & climate: Temperature & precipitation 2000-2008

What: 100-year climate trends for PACEs of 6 parks using PRISM data

Why: Change in temperature & precipitation

Stressors: climate change

Three of the fastest changing temperature (of 60 parks) are highlighted in yellow. (Hass et al. in prep.)

Region	National Park	Precip. (mm)	Temp. (C)
Desert Southwest	Organ Pipe Cactus	0	2.615
Northeast	Delaware Water Gap	0	2.031
Northern Rockies	Grand Teton	0	0.982
	Yellowstone	0	0.856
Pacific Southwest	Sequoia	0	0.585
	Yosemite	0	0.522
Southern Rockies/Colorado Plateau	Rocky Mountain	0	1.928

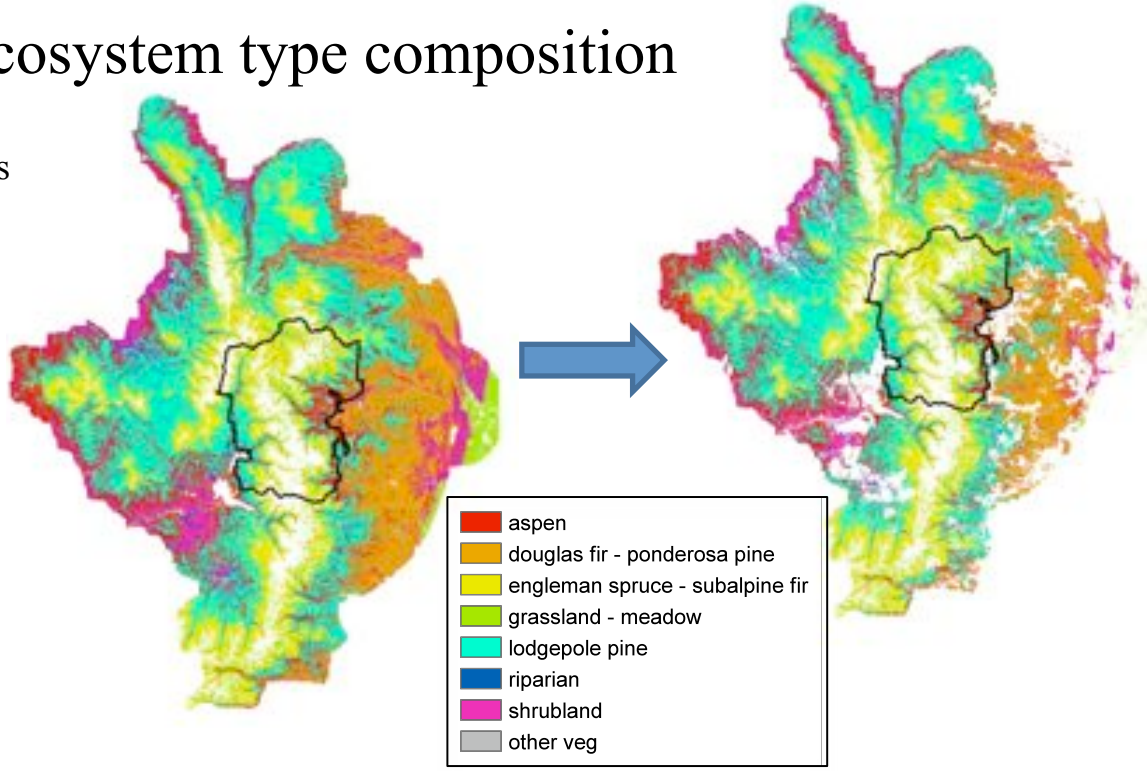
Landscape dynamics: Ecosystem type composition

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.

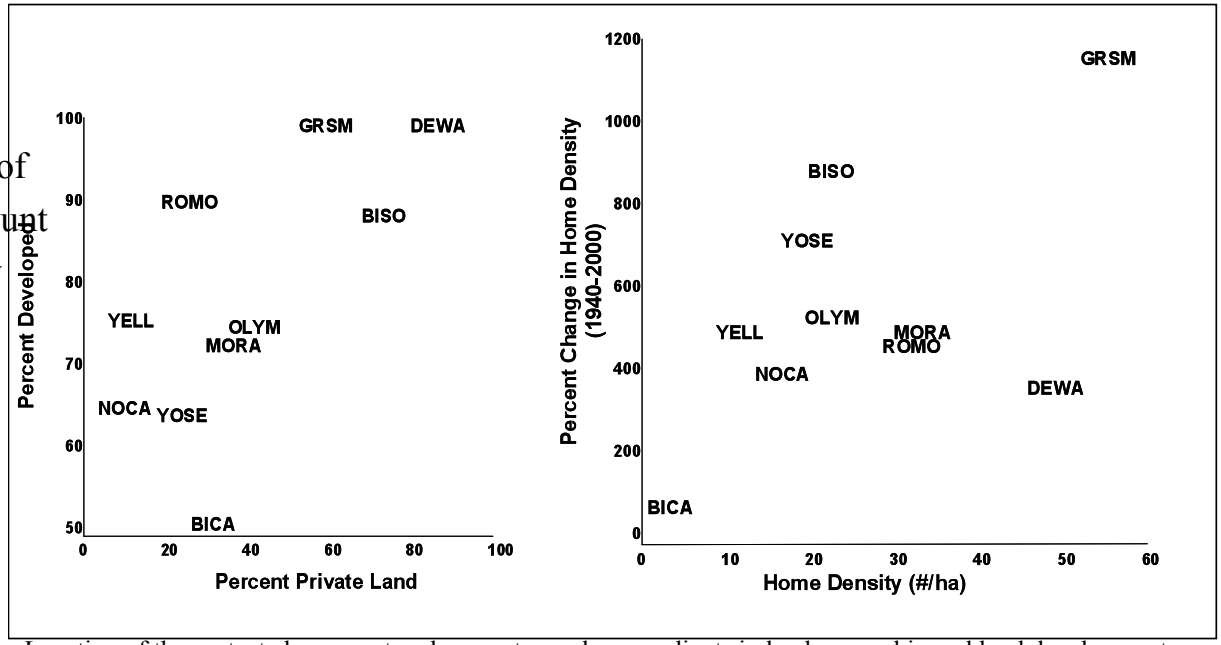
Landscape dynamics: Land use within PACEs

What: Metric of land use and change in PACES outside of parks.

Why: These data provide indication of challenges in maintaining park condition given the characteristics of the surrounding PACE.

Stressors: Land use change

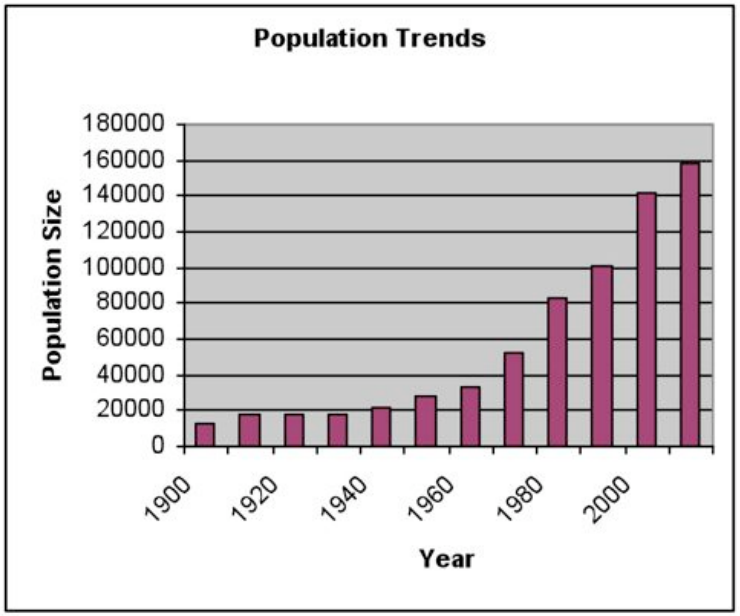
Only 24% of the ROMO PACE outside of parks is private land, a smaller amount than for many other PACEs. Nearly 90% of those private lands are in agriculture, roads, homes, or other "developed" land uses. Home density in these private lands and growth in home density since 1940 are medial relative to the PACES examined thus far.

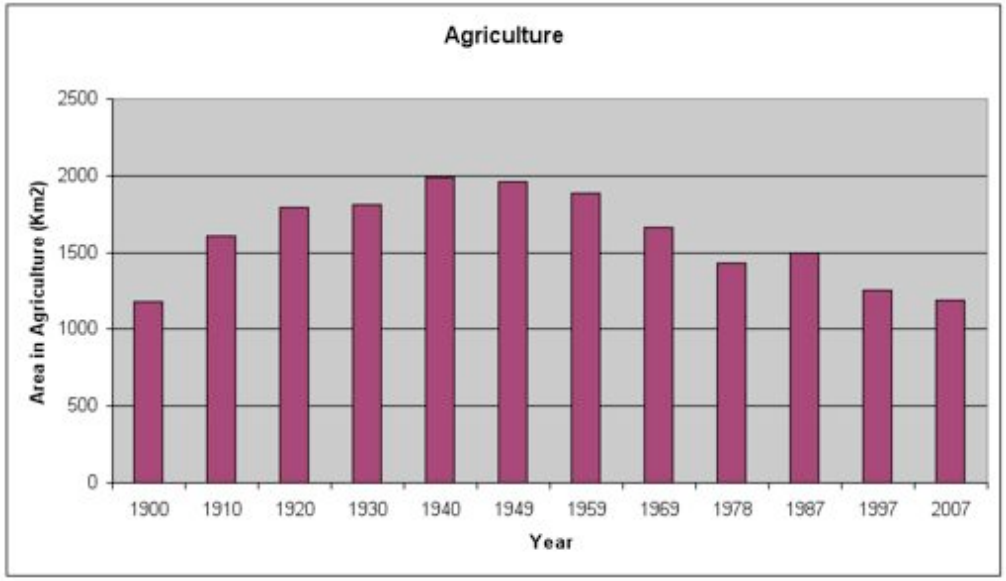


Location of the protected area centered ecosystems along gradients in land ownership and land development (home densities of >0.031 units/ha, roads, or agriculture lands) (left) and home density (units/ha) and percent change in home density from 1940 to 2000 (right). Note: Developed lands included buffers of 1000 m adjacent agriculture or home densities>0.031 units/ha and 500 m of primary roads railroads and 100 m of secondary roads.

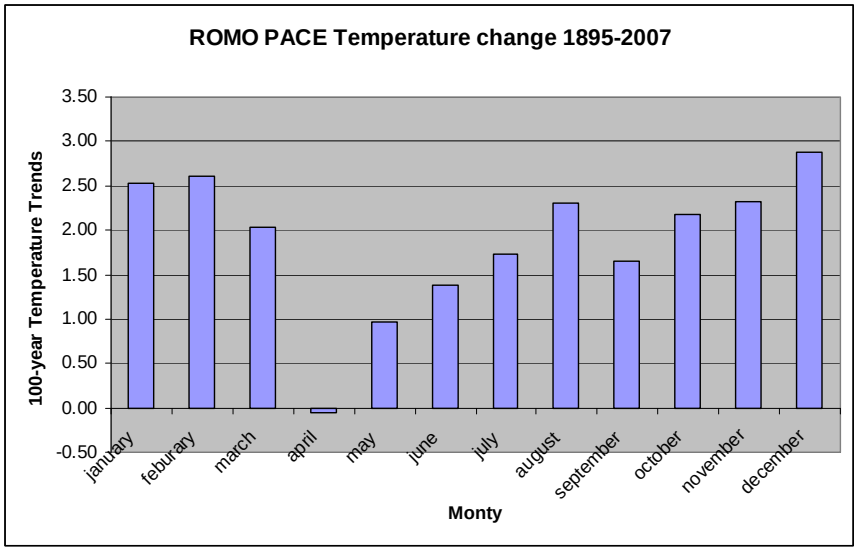
Percent of ROMO PACE private	Percent of private land developed in 2000	Home density on private lands in 2000 (#/km^2)	Change in home density on private lands during 1940-2000 (%)
24.0	89.3	0.323	455.2

Landscape dynamics: Land use within PACEs

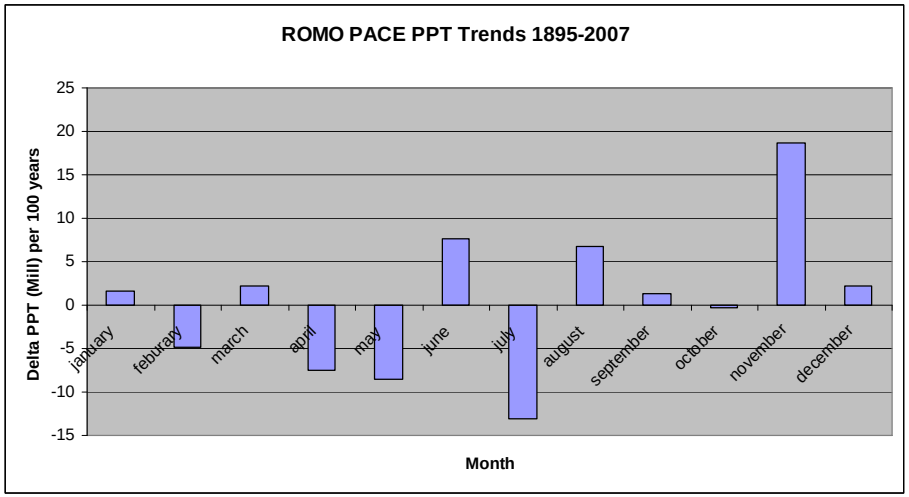




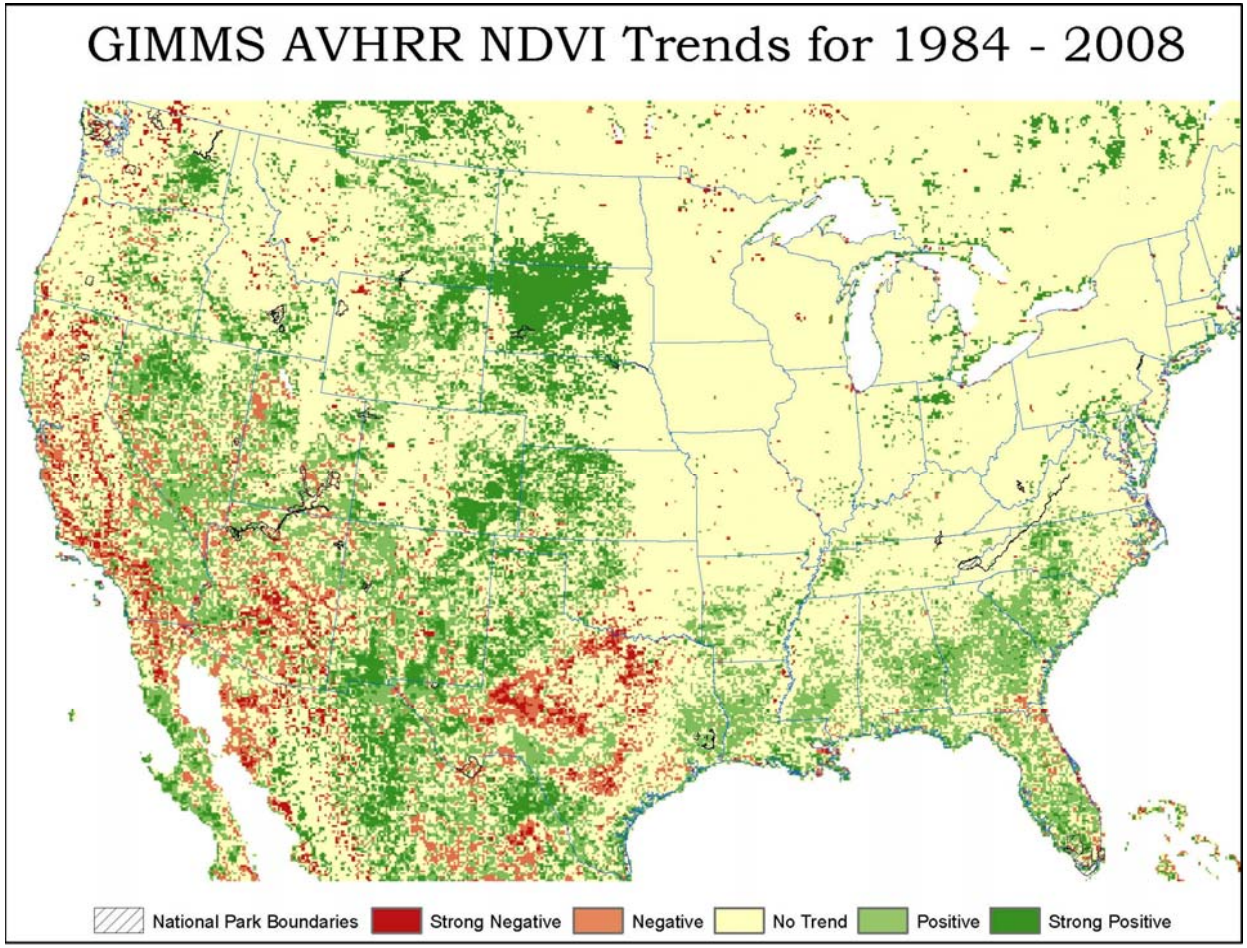
Pop distributed was distributed within PACE based on housing density. Ag data are for counties that cover >=10% of PACE or >=40% of the county is covered by the PACE.



Note: Trends for all months but April are statistically significant. From Haas et al. in prep.



Note: Trends for July and November ate statistically significant. From Haas et al. in prep.



Note: Initial results from Haas et al.

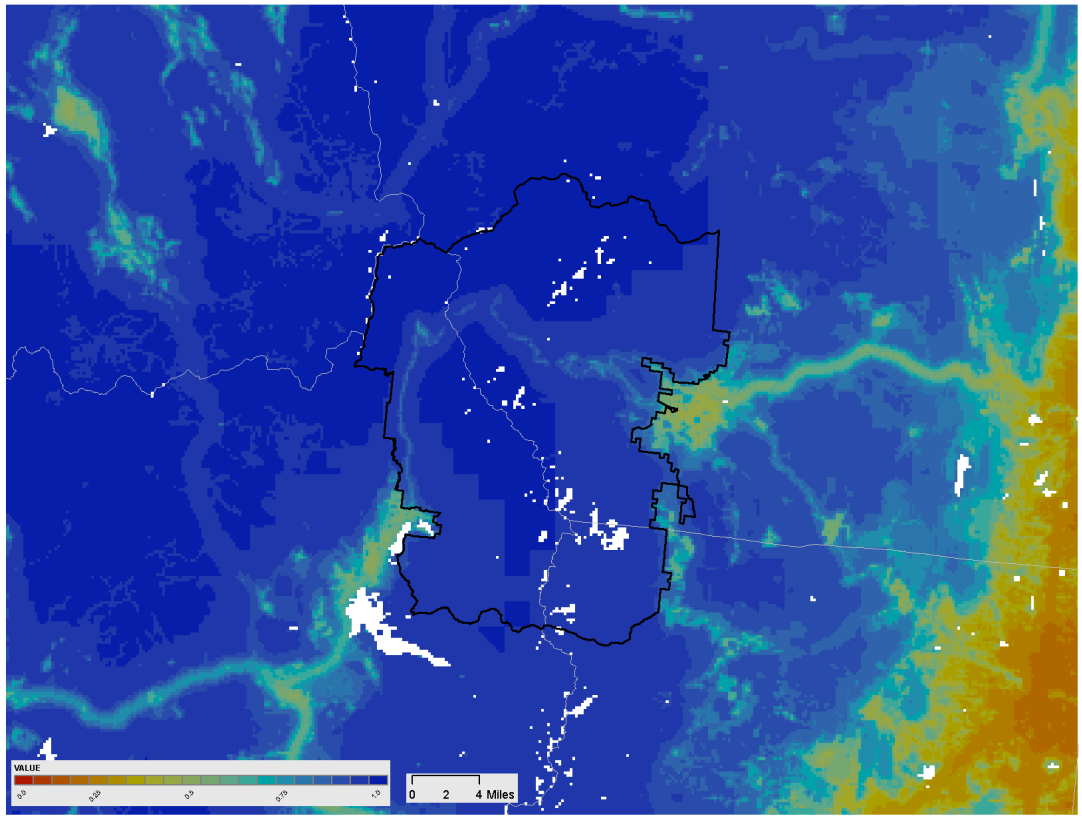
Landscape dynamics: Pattern of natural landscapes

What: Measures the natural landscape context

Why: Movement of plants & animals and ecological processes connect to adjacent landscapes beyond the park boundary

Stressors: Land use change, climate change

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.



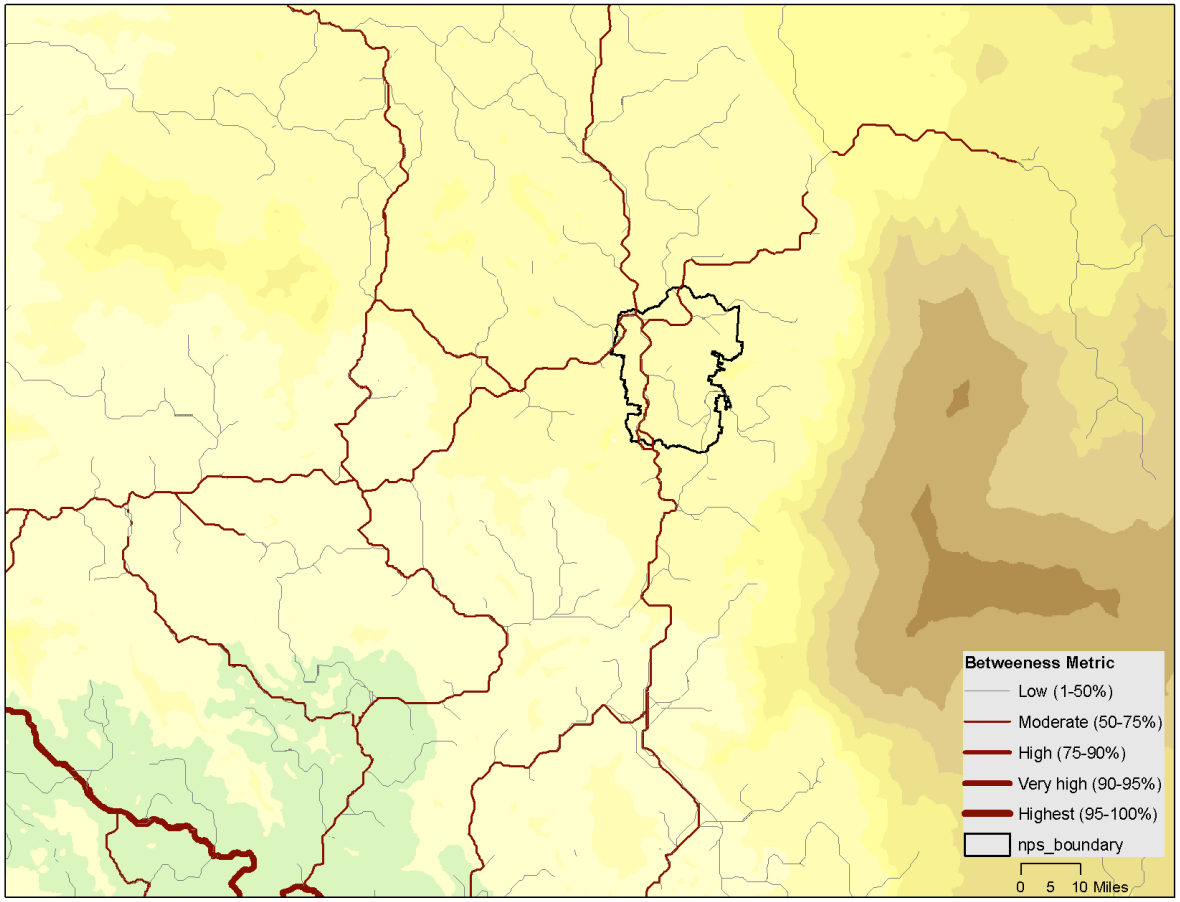
Landscape dynamics: Connectivity of natural landscapes

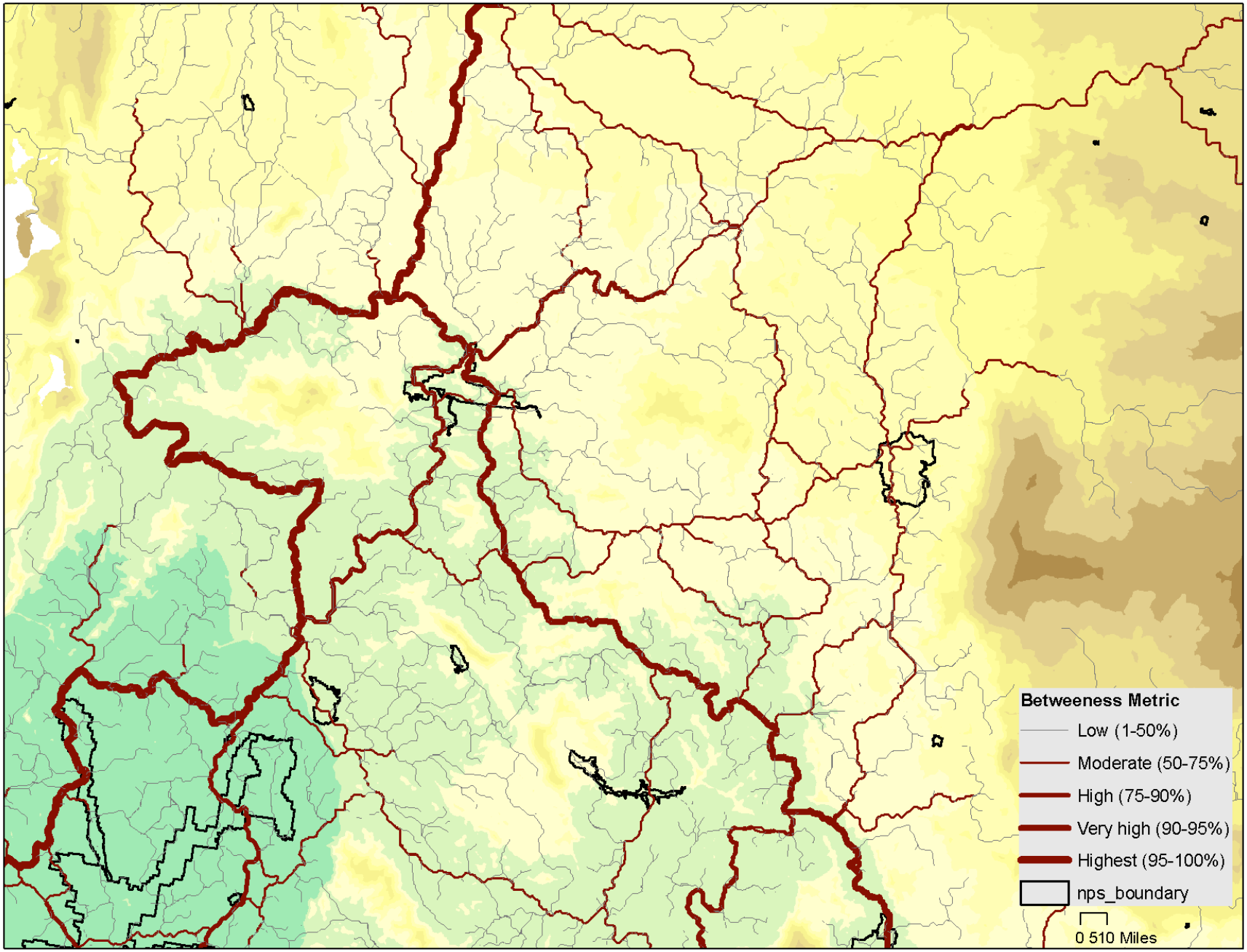
What: Measures the connectivity of natural landscapes

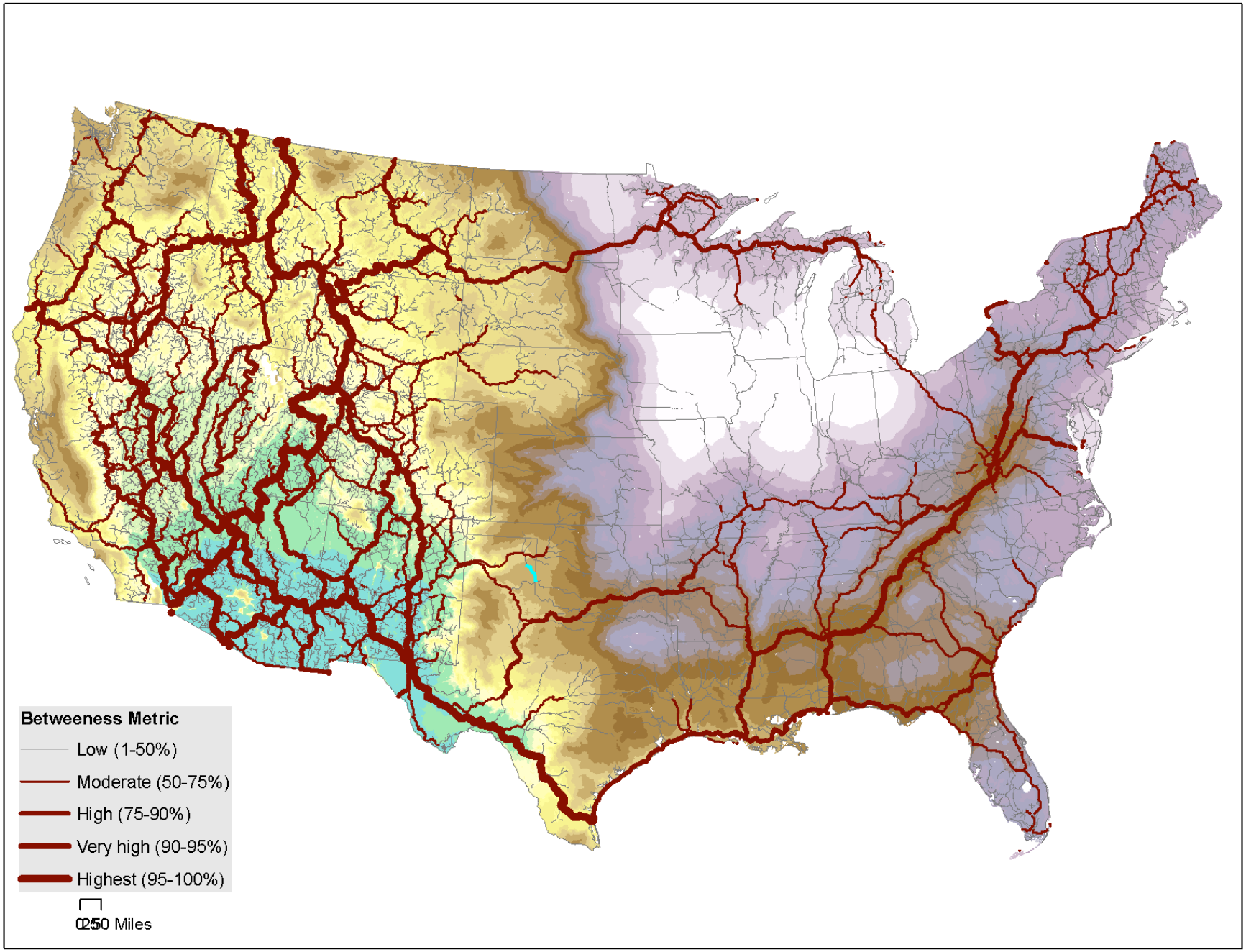
Why: Movement of plants & animals and ecological processes connect to adjacent landscapes beyond the park boundary

Stressors: Land use change, climate change

ROMO is situated on a pathway that provides greater than average connectivity (compared nationwide) and serves as a key location of connectivity in the Southern Rockies ecoregion.




Betweeness Metric
Low (1-50%)
Moderate (50-75%)
High (75-90%)
Very high (90-95%)
Highest (95-100%)
nps_boundary
0 510 Miles


Betweeness Metric
Low (1-50%)
Moderate (50-75%)
High (75-90%)
Very high (90-95%)
Highest (95-100%)
0 250 Miles