Rangeland Analysis Platform

Introducing a free, online tool to help manage and monitor western rangelands

Brady Allred, Rangeland Ecologist, University of Montana, Missoula, MT
Matthew O. Jones, Ecologist & Remote Sensing Scientist, University of Montana, Missoula, MT
Jeremy Maestas, Ecologist, USDA-NRCS West National Technology Support Center, Portland, OR

UNIVERSITY OF MONTANA

USDA NRCS

United States Department of Agriculture
Natural Resources Conservation Service

WORKING LANDS FOR WILDLIFE

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Conservation Effects Assessment Project (CEAP)

Google

Intermountain West Joint Venture
Conserving habitat through partnerships

The collective "we" – Thank You!

USDA/NRCS WLFW
Dave Naugle, Univ. of MT
Tim Griffiths, NHQ
Thad Heater, NHQ
Galon Hall, NHQ
Brianna Randall, SGI
Justin Fritscher, NHQ

USDA/NRCS CEAP
Charlie Rewa, CEAP-Wildlife
Lori Metz, CEAP-Grazing

Plutonic
Jeremy Malczyk

Univ. of Nebraska
Dirac Twidwell, Lincoln
Dan Uden, Lincoln

Univ. of Idaho
Jason Karl, Univ. of ID

BLM
Collin Dovichin, MT
John Carlson, MT
Sarah Burnett, AIM
Steve Small, NOC
Joe Tague, WO

Pheasants Forever
Ron Leathers, Minnesota
Joe Moore, Minnesota

The Nature Conservancy
Jay Kerby, Oregon

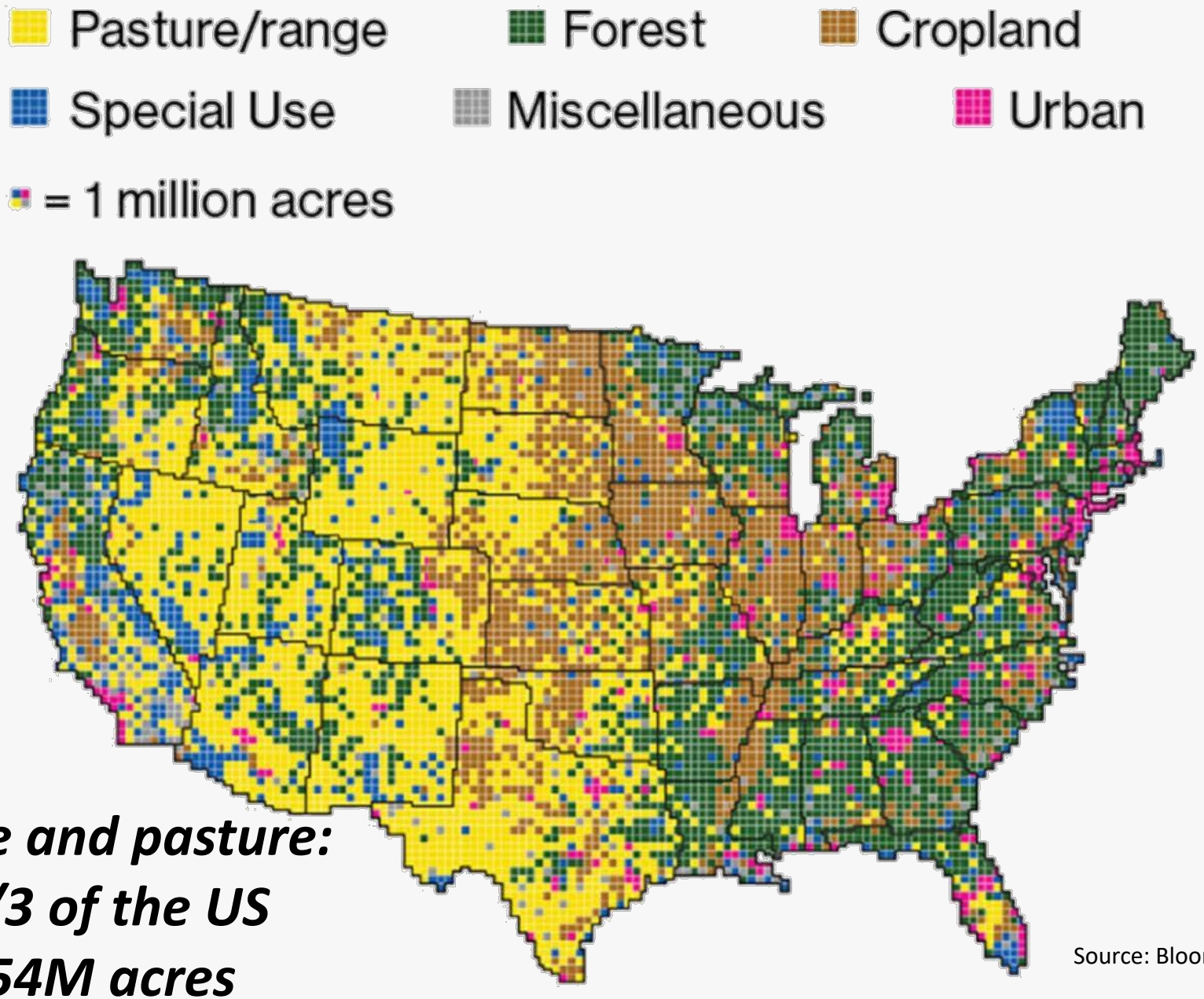
SageSTEP
Benjamin Rau, USFS
James McIver, Oregon St. Univ.

FWS/IWJV
Patrick Donnelly, Montana
Ali Duvall, Montana

USDA/ARS
Chad Boyd, EOARC-Burns
Brandon Bestelmeyer, Jornada

Google
Noel Gorelick, Google Inc.
Matt Hancher, Google Inc.
Tyler Erickson, Google Inc.

USDA/NRCS (Other)
Shane Green, Utah
Catherine Bailey, Oregon
Dana Larsen, CNTSC
Mitch Faulkner, South Dakota
Gene Fults, WNTSC
Steve Campbell, WNTSC
Rafael Guerrero, CNTSC
Dean Krehbiel, Kansas
Mike Merrill, Oregon
Whityn Owen, Oregon
Kyle Tackett, Montana
Dwain Daniels, CNTSC
Doug Spencer, Kansas

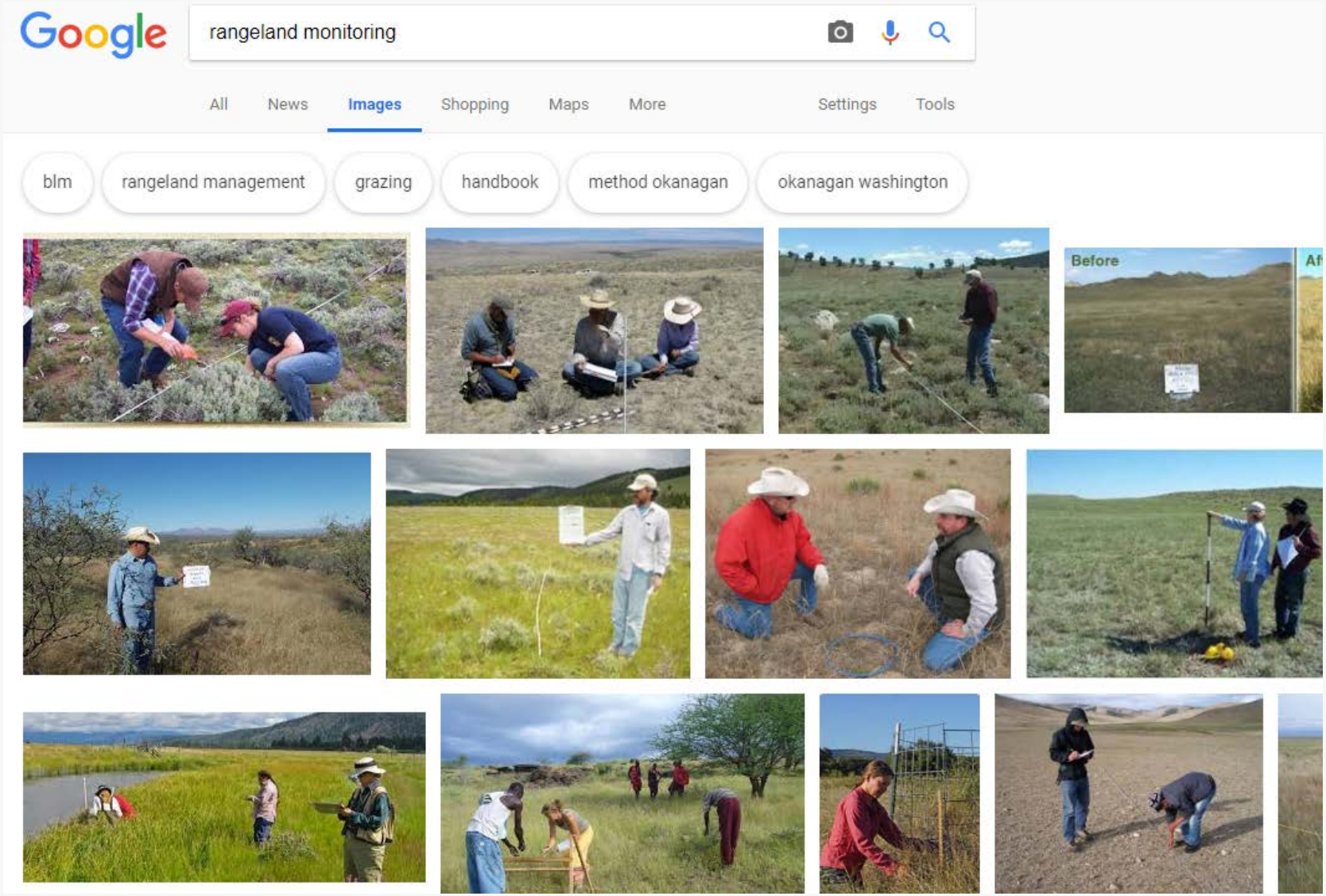


Range and pasture:
>1/3 of the US
654M acres

Source: Bloomberg

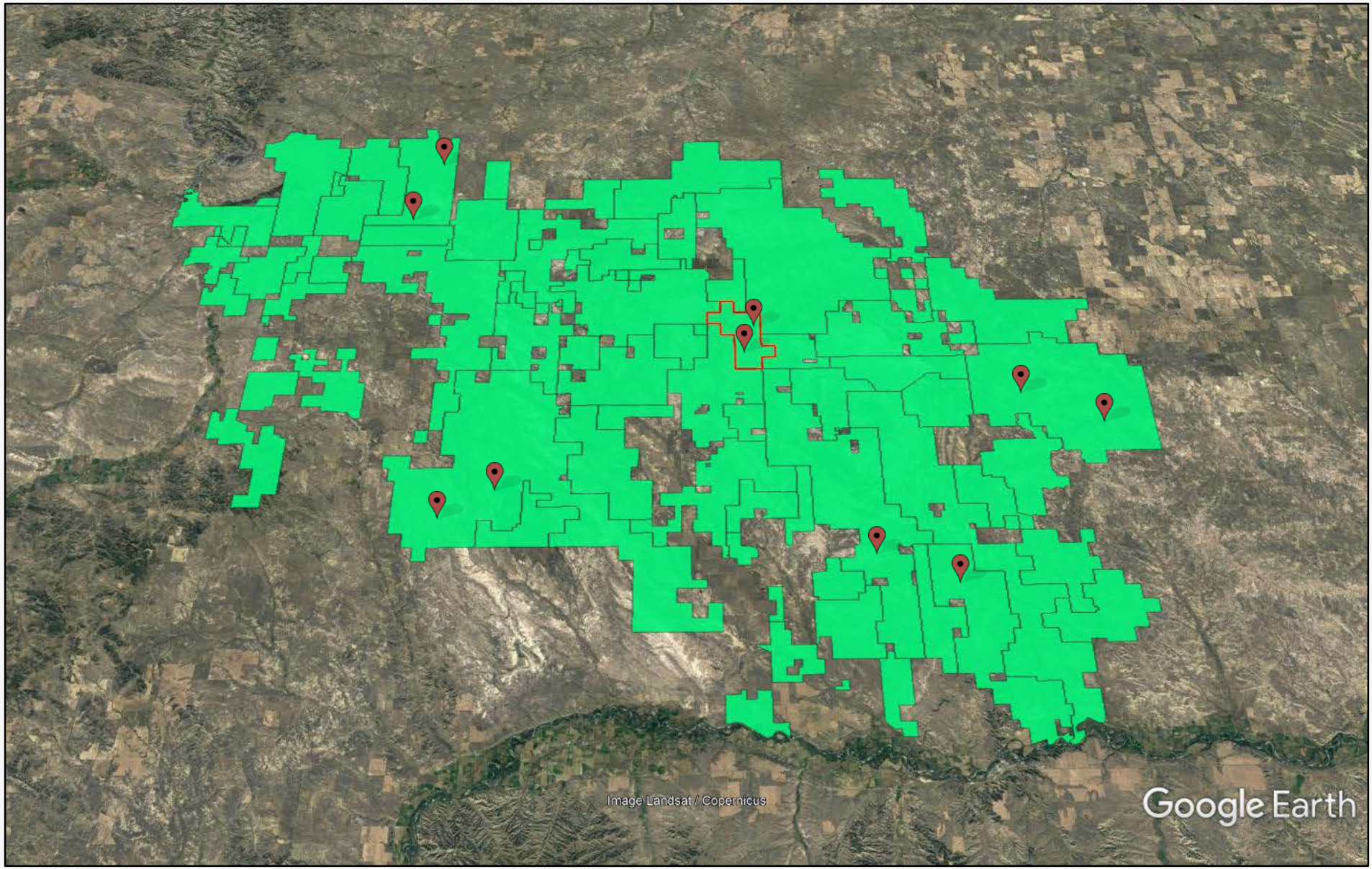
Plants *provide the foundation for profitable livestock production, abundant wildlife habitat, healthy soils, and clean water*

When you Google "rangeland monitoring"….

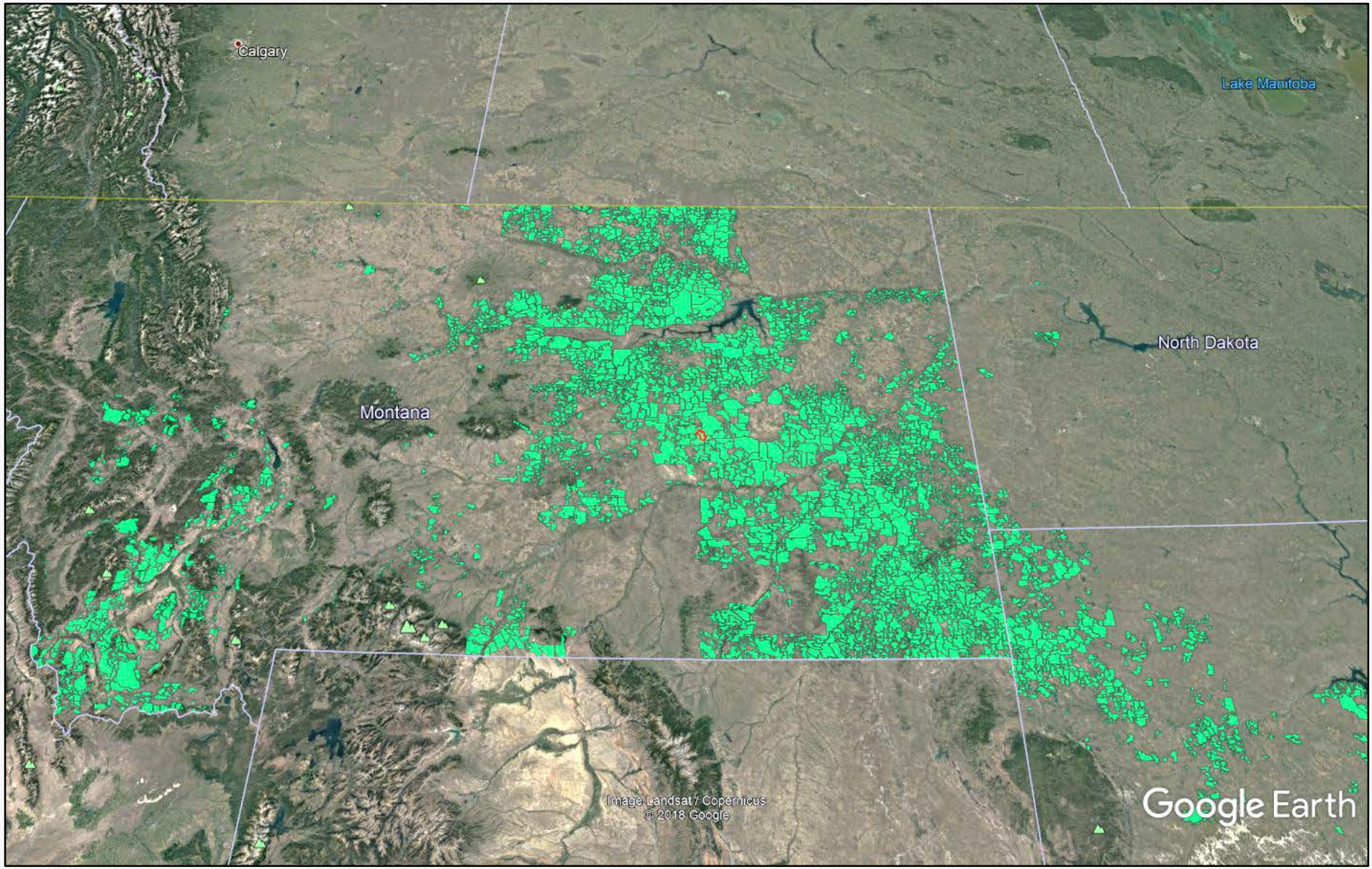


Field sampling is essential but…how can we monitor an allotment or pasture?

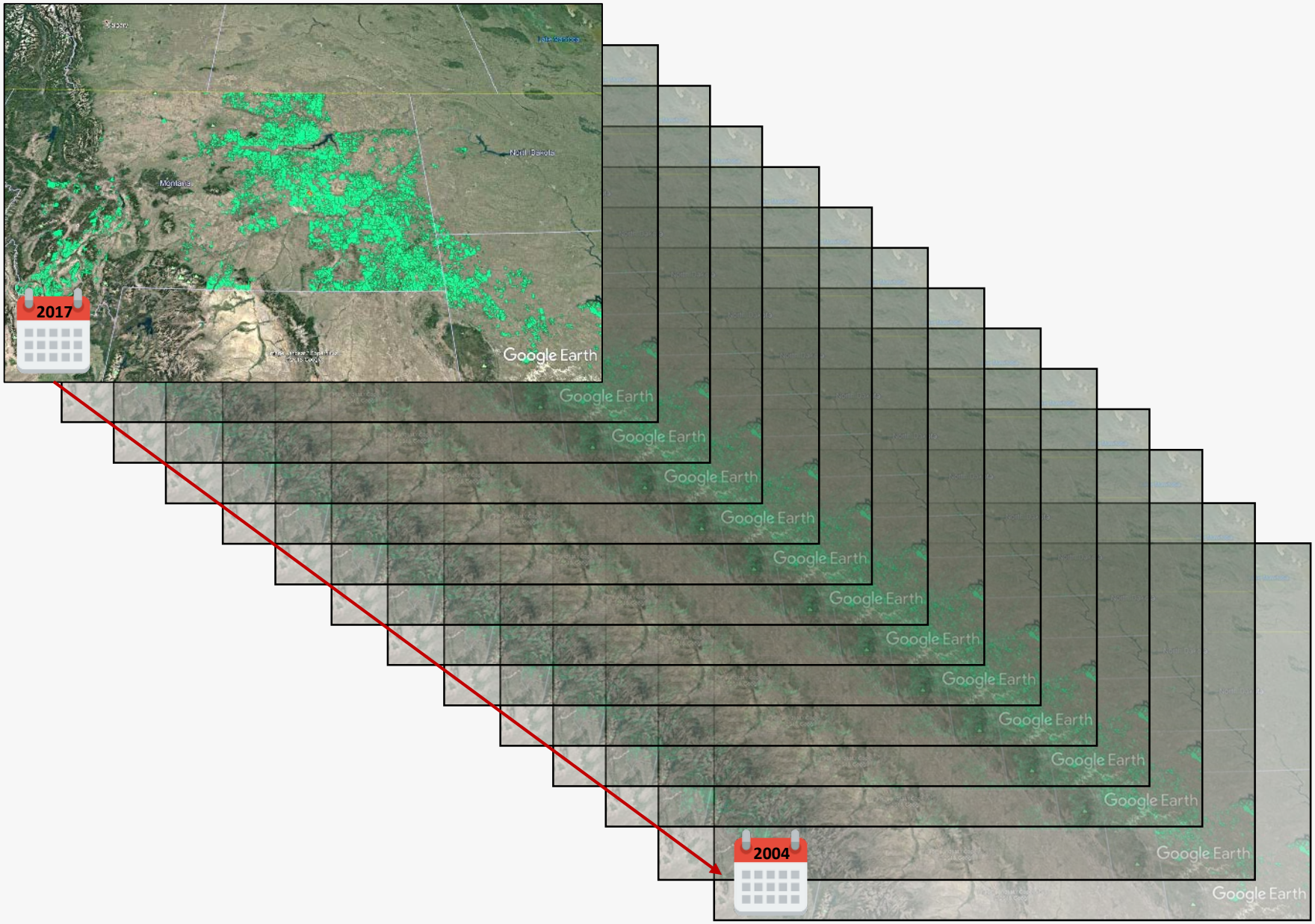
Field sampling is essential but…how can we monitor a region?



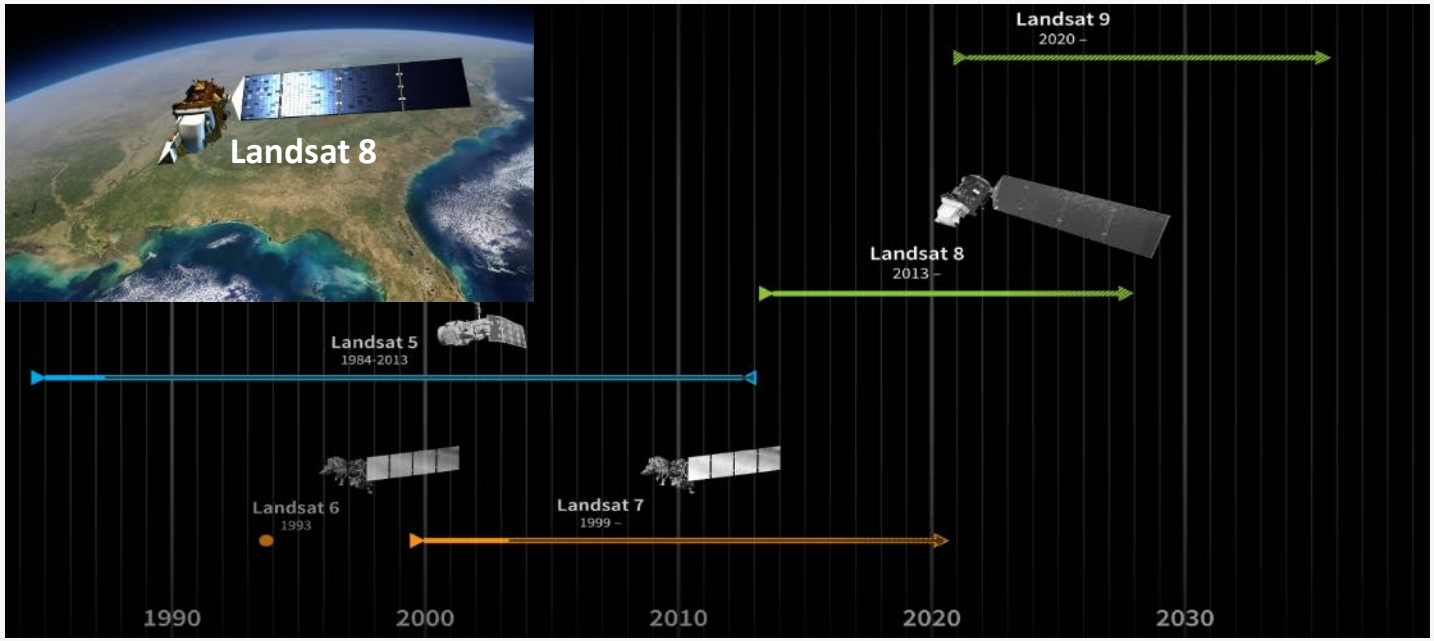
Field sampling is essential but…how can we monitor statewide?



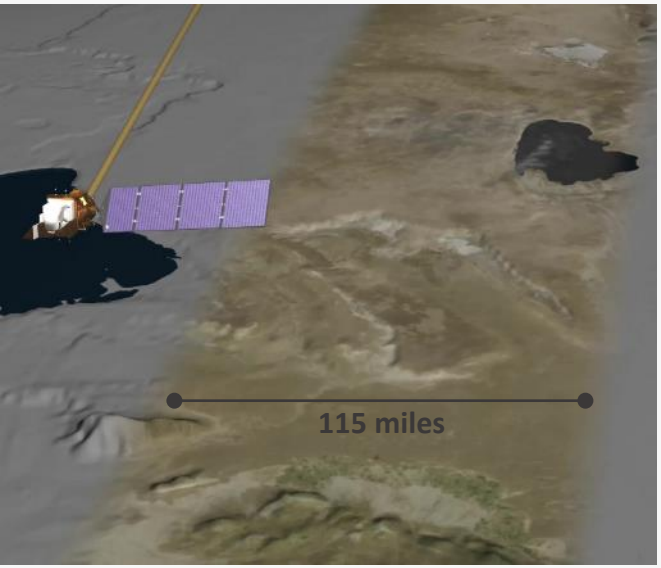
Field sampling is essential but…how can we monitor through time?

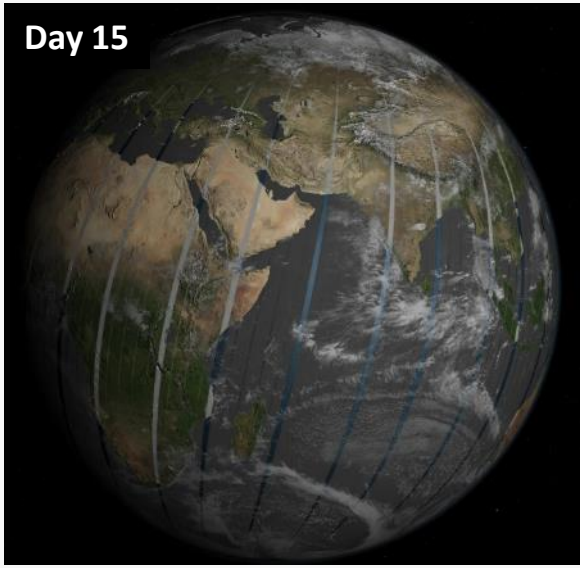


Landsat – an exceptional history of earth observation



- 438 miles above Earth
- 4.7 miles/second
- 1 orbit = 99 minutes
- 115 mile wide swath
- 16 Days = entire Earth surface coverage





Images courtesy of USGS & NASA

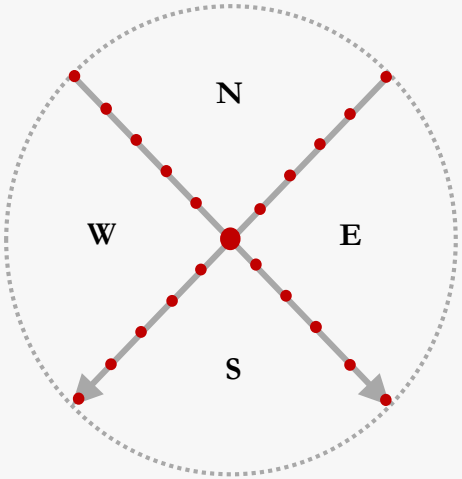
Variability not captured by past products

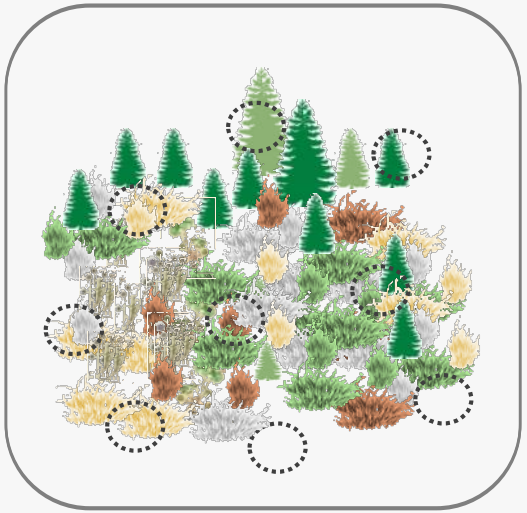
NLCD
Land Cover
30m resolution

GRASS	SHRUB	GRASS

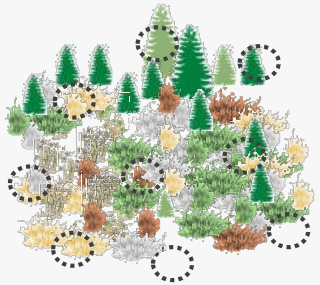
5 years →

GRASS	SHRUB	SHRUB

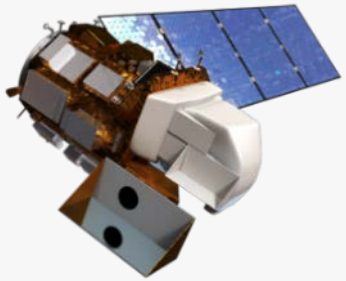




Field Plots + Landsat + Cloud-Computing = Innovation

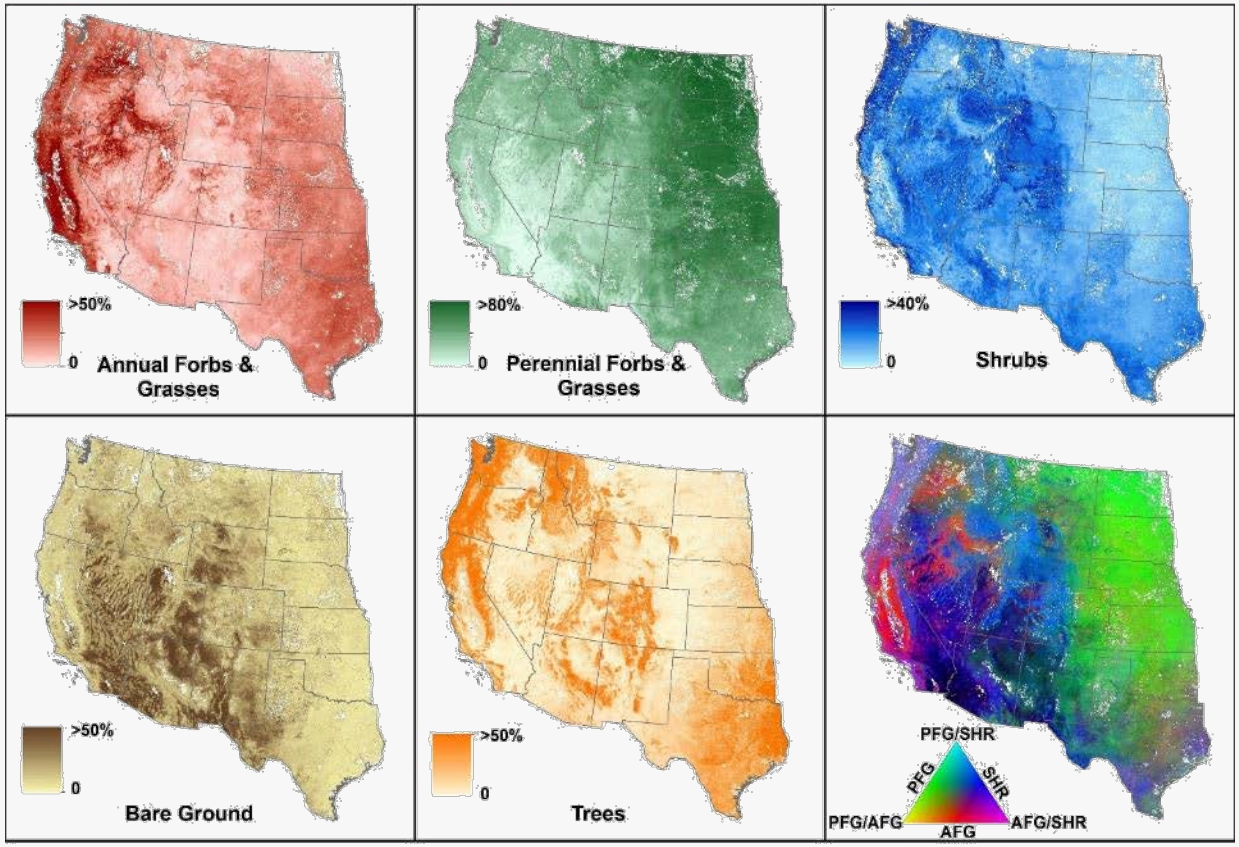


+

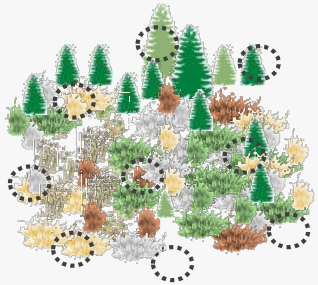


+

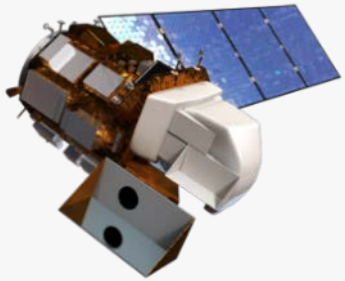
Google Earth Engine



Field Plots + Landsat + Cloud-Computing = Innovation

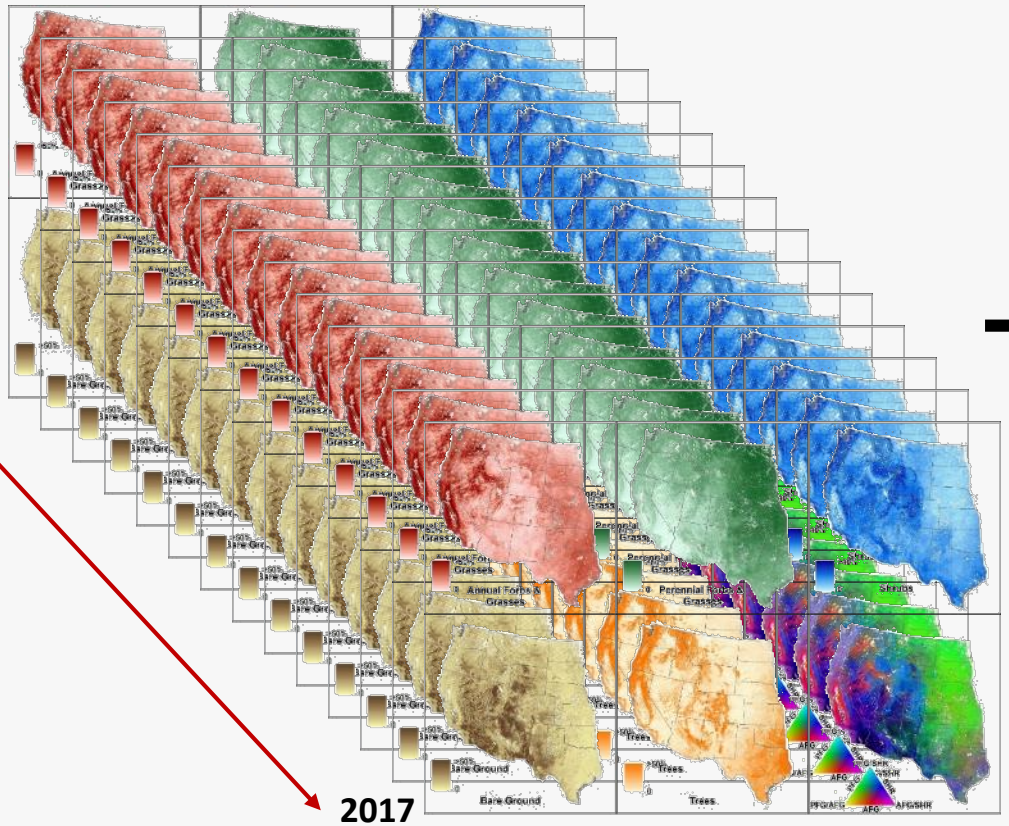


+

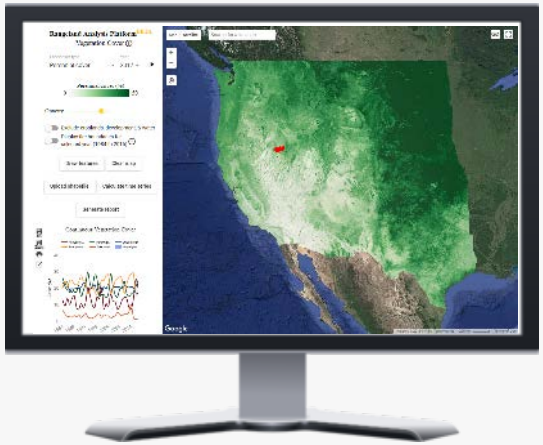


+

Google Earth Engine

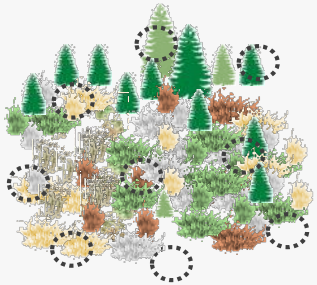


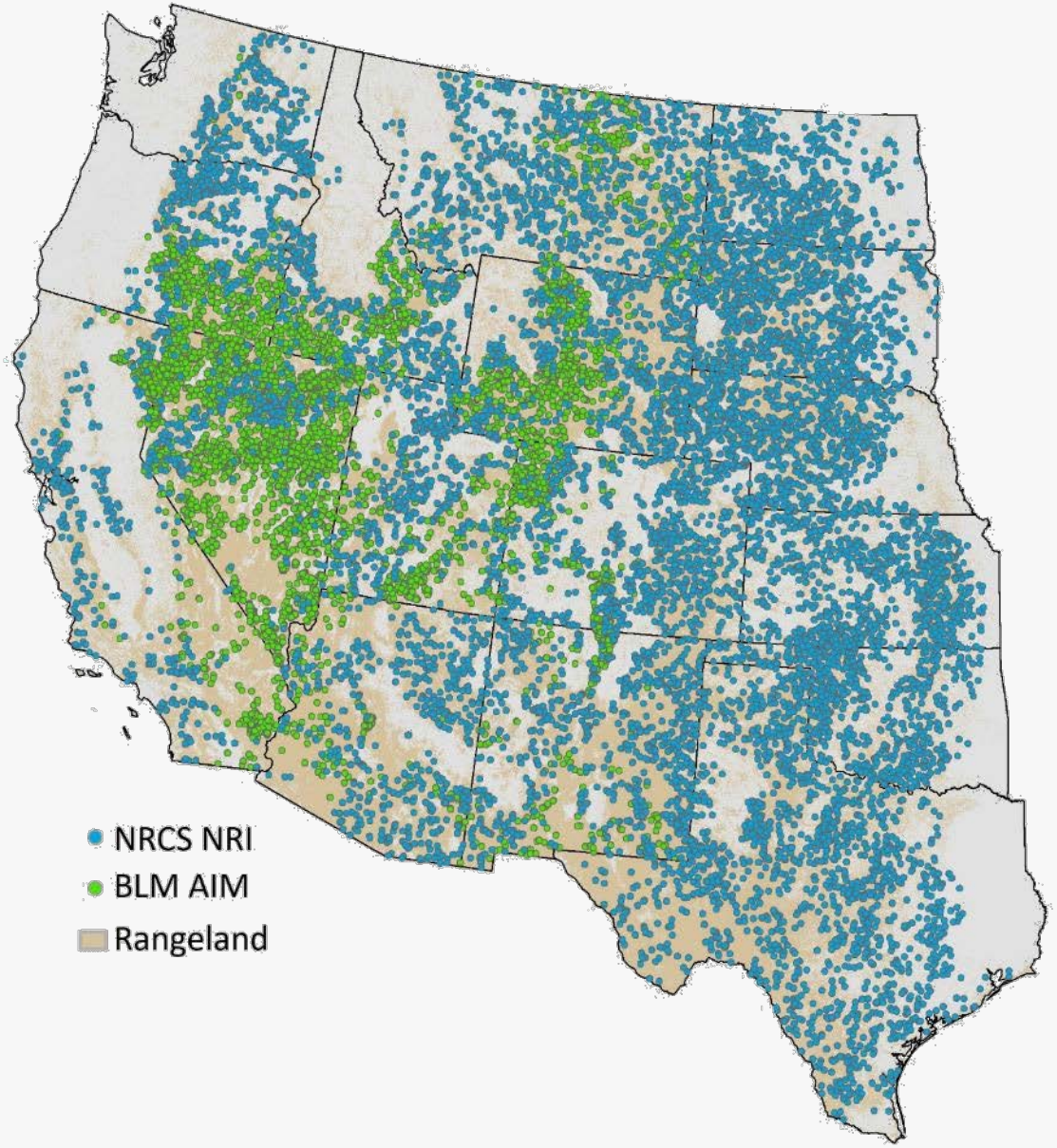
The Rangeland Analysis Platform (RAP)



rangelands.app

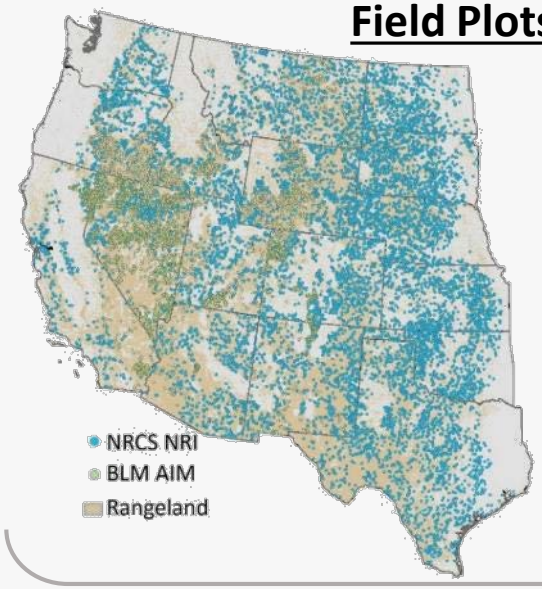
If you collected NRI or AIM data…THANK YOU!





Methods

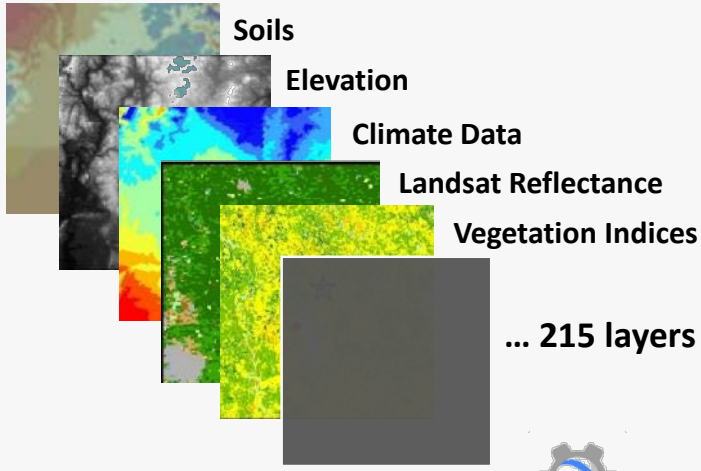
Field Plots



31,000+ NRI & AIM plots from 2004-2016 converted to percent cover of:

Annual Forbs & Grasses, Perennial Forbs & Grasses, Shrubs, Bare Ground, Trees

Predictor Variables



Machine Learning and Cloud Computing

Geographic Coverage at 30m	✓
Land Surface Variability	✓
Temporal Coverage Historic to Present*	✓

*Maps immediately produced at year's end

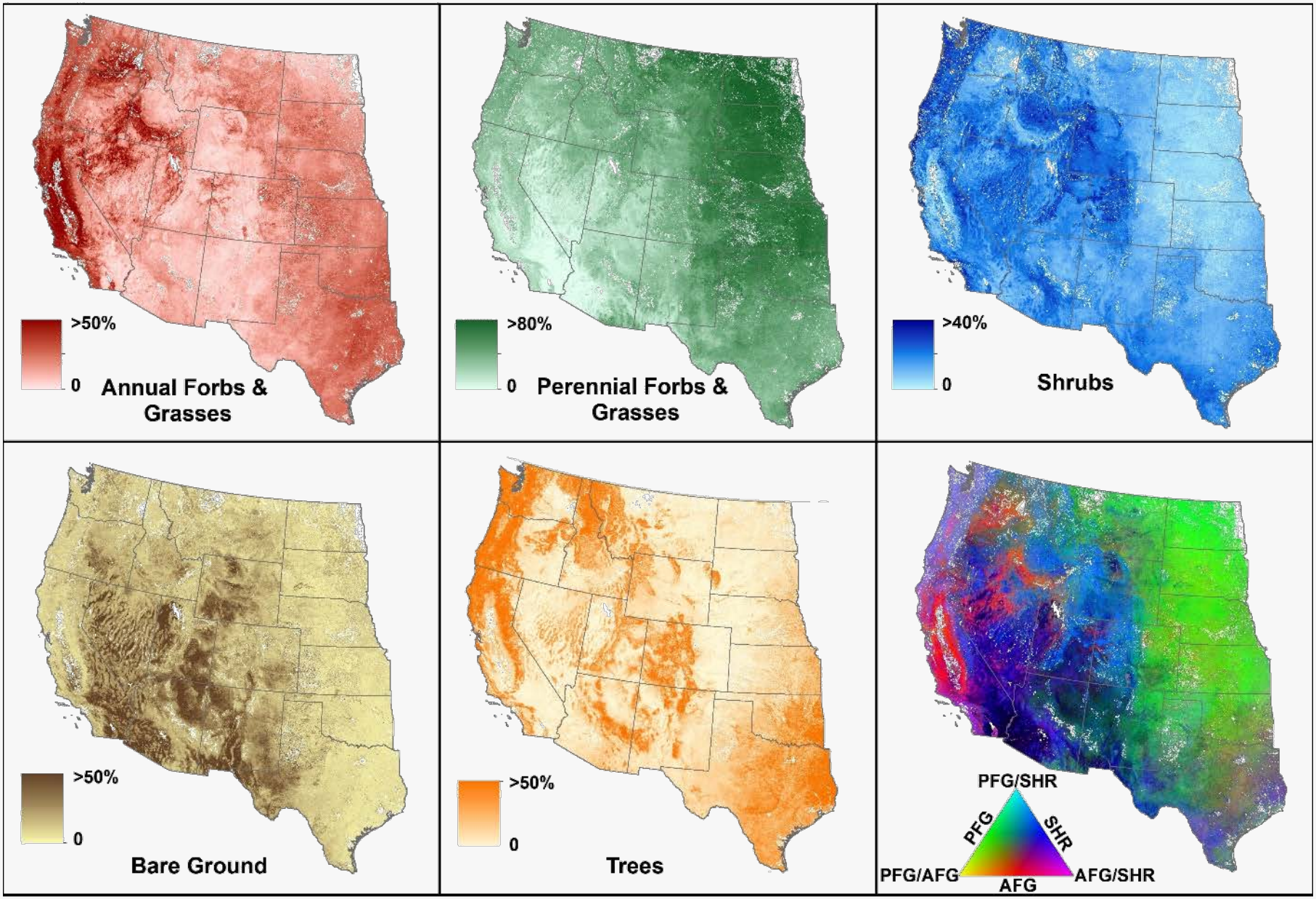
Google Earth Engine

- Train Random Forests model
- Build data cubes from 1984-2017
- Predict % cover at 30m from 1984-2017 of:

Annual Forbs & Grasses, Perennial Forbs & Grasses, Shrubs, Bare Ground, Trees

Random Forests machine learning algorithm

The Land Cover Maps



Peer Reviewed Publication

esa ECOSPHERE

EMERGING TECHNOLOGIES

Innovation in rangeland monitoring: annual, 30 m, plant functional type percent cover maps for U.S. rangelands, 1984–2017

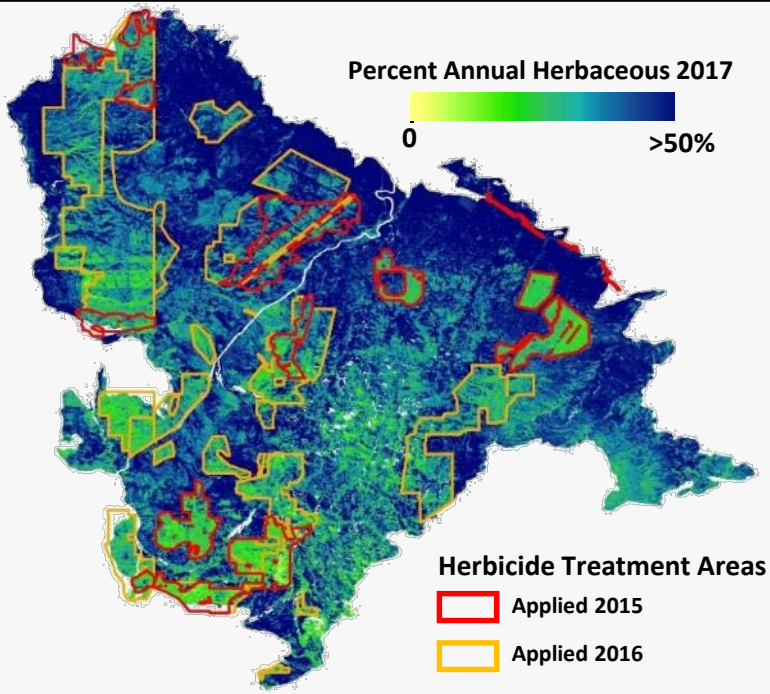
Matthew O. Jones[1,2,†] Brady W. Allred,[1,2] David E. Naugle,[2] Jeremy D. Maestas,[3] Patrick Donnelly,[4] Loretta J. Metz,[5] Jason Karl,[6] Rob Smith,[7] Brandon Bestelmeyer,[8] Chad Boyd,[9] Jay D. Kerby,[10] and James D. McIver[11]

[1]*Numerical Terradynamic Simulation Group, University of Montana, 32 Campus Drive, Missoula, Montana 59812 USA*
[2]*W.A. Franke College of Forestry and Conservation, University of Montana, 32 Campus Drive, Missoula, Montana 59812 USA*
[3]*Natural Resources Conservation Service, West National Technology Support Center, Portland, Oregon 97232 USA*
[4]*Intermountain West Joint Venture, United States Fish and Wildlife Service, 32 Campus Drive, Forestry Building 302, Missoula, Montana 59812 USA*
[5]*Resource Assessment Division, USDA-Natural Resources Conservation Service, Temple, Texas 76502 USA*
[6]*Department of Forest, Rangeland, and Fire Sciences, University of Idaho, Moscow, Idaho 83844 USA*
[7]*Department of Computer Science, College of Humanities and Sciences, University of Montana, 32 Campus Drive, Missoula, Montana 59812 USA*
[8]*Jornada Experimental Range, USDA Agricultural Research Service, P.O. Box 30003, MSC 3JER, NMSU, Las Cruces, New Mexico 88003 USA*
[9]*Eastern Oregon Agricultural Research Center, USDA Agricultural Research Service, 67826-A Hwy. 205, Burns, Oregon 97720 USA*
[10]*The Nature Conservancy, 67826-A Hwy. 205, Burns, Oregon 97720 USA*
[11]*Eastern Oregon Agriculture Research Center, Oregon State University, 372 S 10th Street, Union, Oregon 97883 USA*

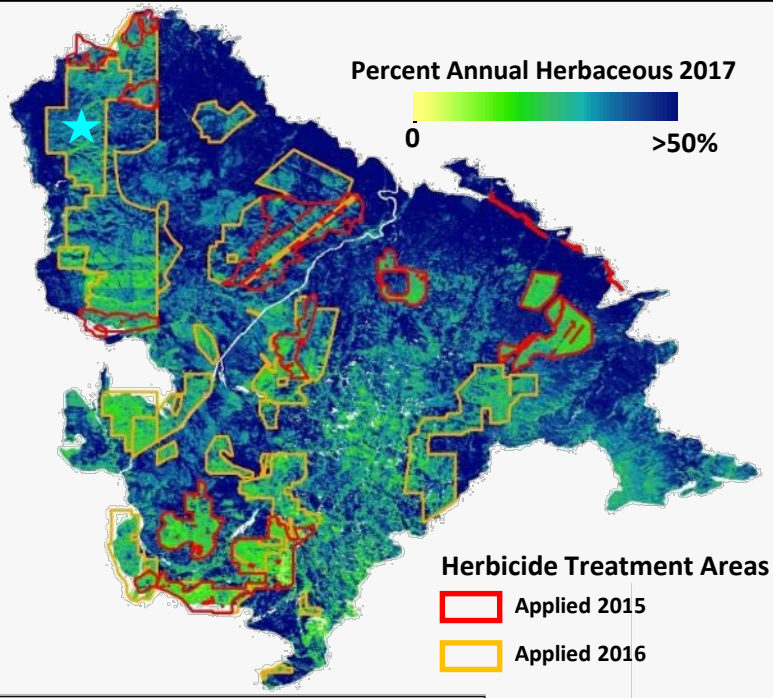
Citation: Jones, M. O., B. W. Allred, D. E. Naugle, J. D. Maestas, P. Donnelly, L. J. Metz, J. Karl, R. Smith, B. Bestelmeyer, C. Boyd, J. D. Kerby, and J. D. McIver. 2018. Innovation in rangeland monitoring: annual, 30 m, plant functional type percent cover maps for U.S. rangelands, 1984–2017. Ecosphere 9(9):e02430. 10.1002/ecs2.2430

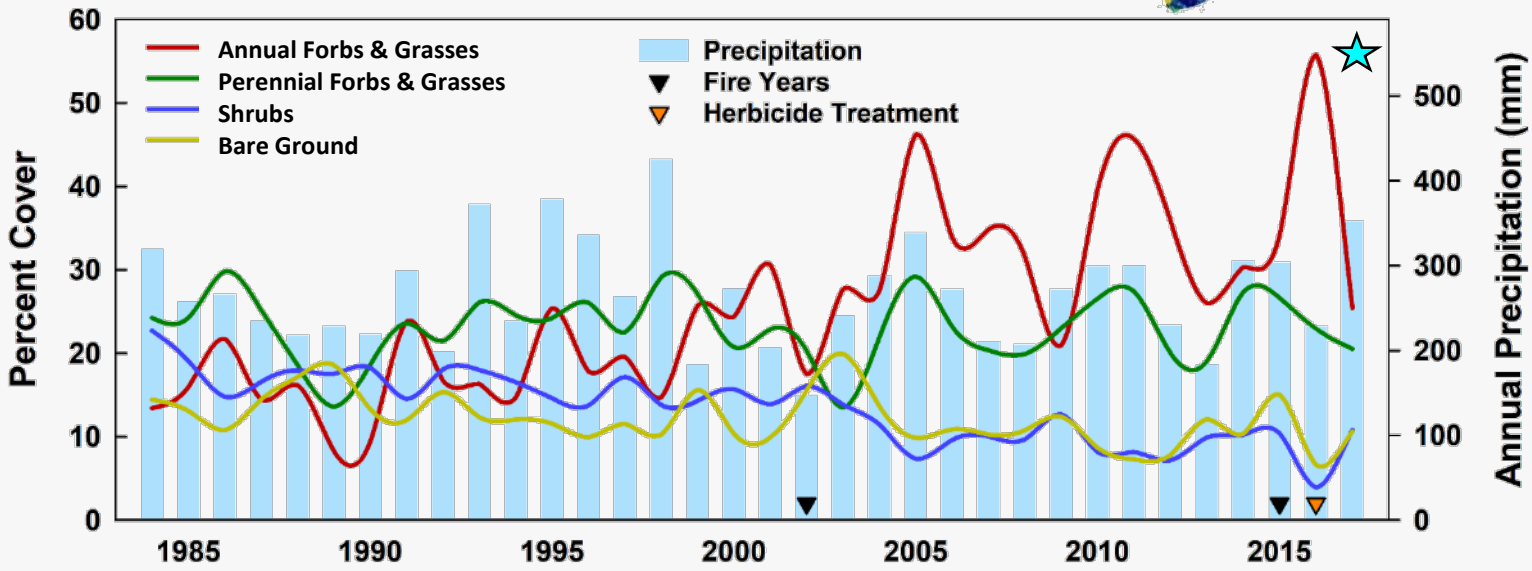
Abstract. Innovations in machine learning and cloud-based computing were merged with historical remote sensing and field data to provide the first moderate resolution, annual, percent cover maps of plant functional types across rangeland ecosystems to effectively and efficiently respond to pressing challenges facing conservation of biodiversity and ecosystem services. We utilized the historical Landsat satellite record, gridded meteorology, abiotic land surface data, and over 30,000 field plots within a Random Forests model to predict per-pixel percent cover of annual forbs and grasses, perennial forbs and grasses, shrubs, and bare ground over the western United States from 1984 to 2017. Results were validated using three independent collections of plot-level measurements, and resulting maps display land cover variation in response to changes in climate, disturbance, and management. The maps, which will be updated annually at the end of each year, provide exciting opportunities to expand and improve rangeland conservation, monitoring, and management. The data open new doors for scientific investigation at an unprecedented blend of temporal fidelity, spatial resolution, and geographic scale.

Applications #1 – Wildfire and Cheatgrass

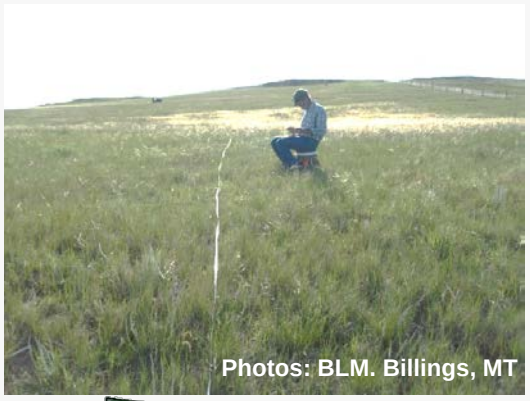


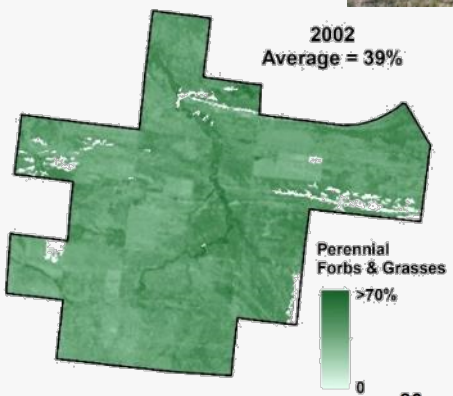
Applications #1 – Wildfire and Cheatgrass

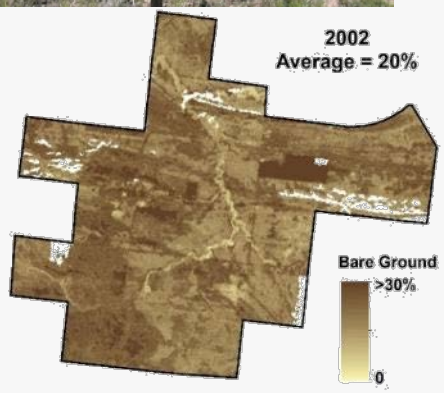


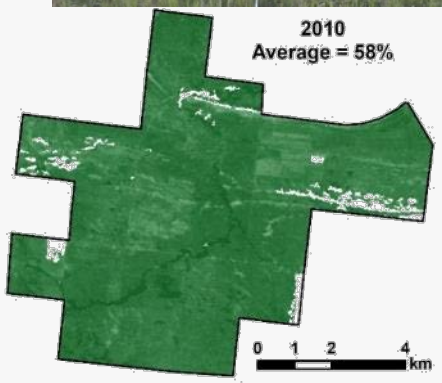


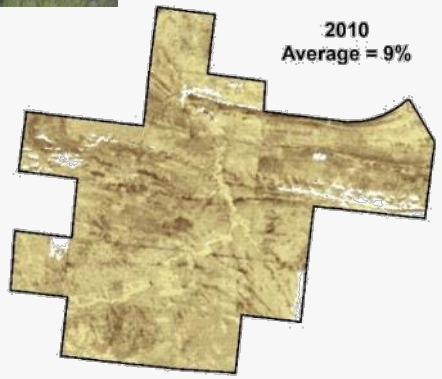
Applications #2 – Grazing and Rangeland Health

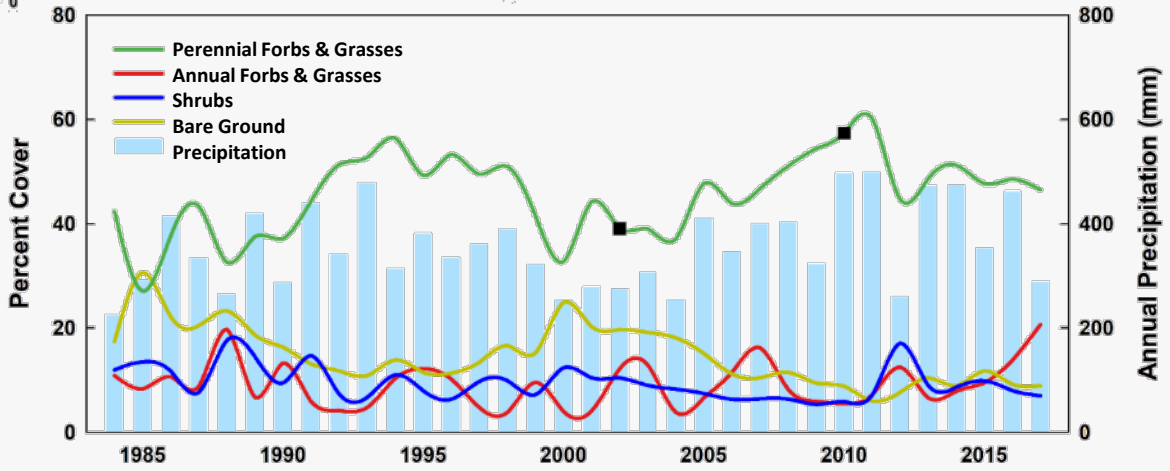




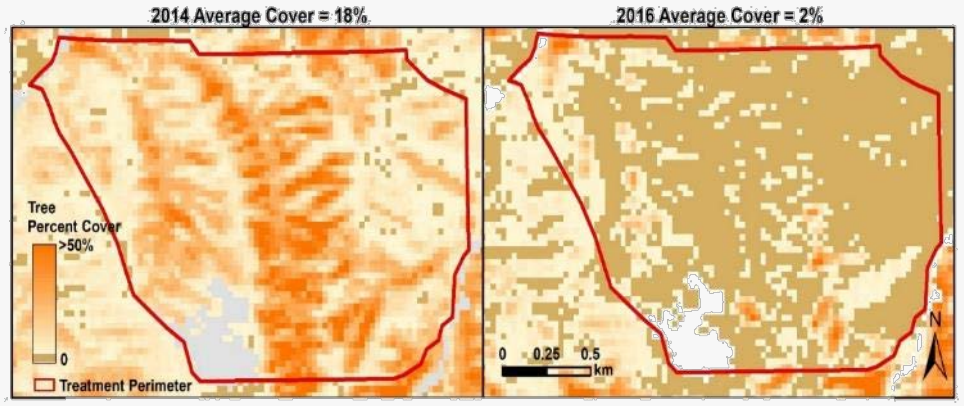


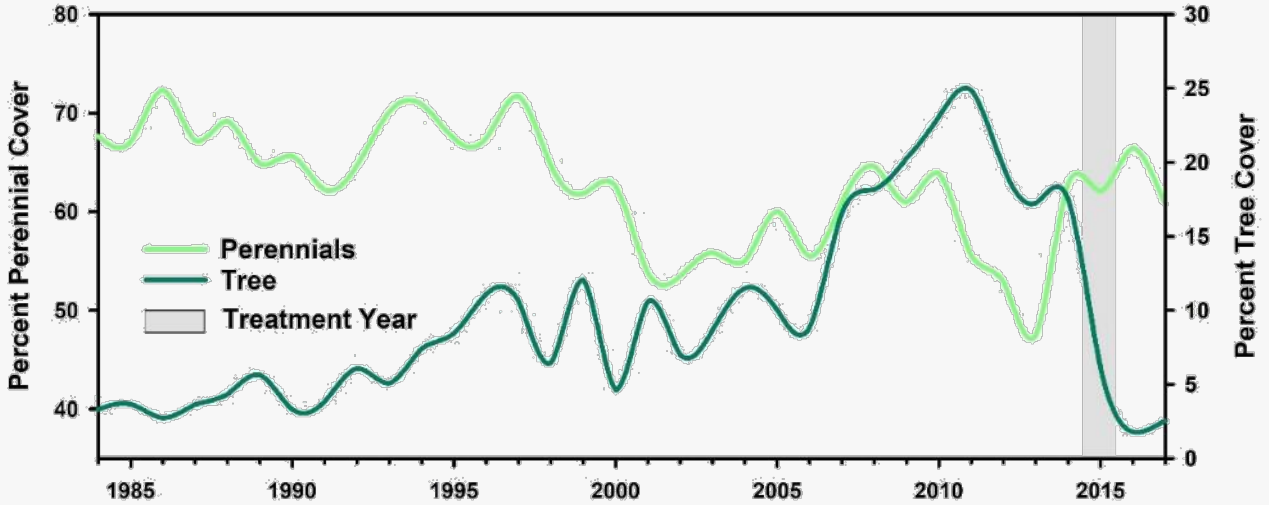






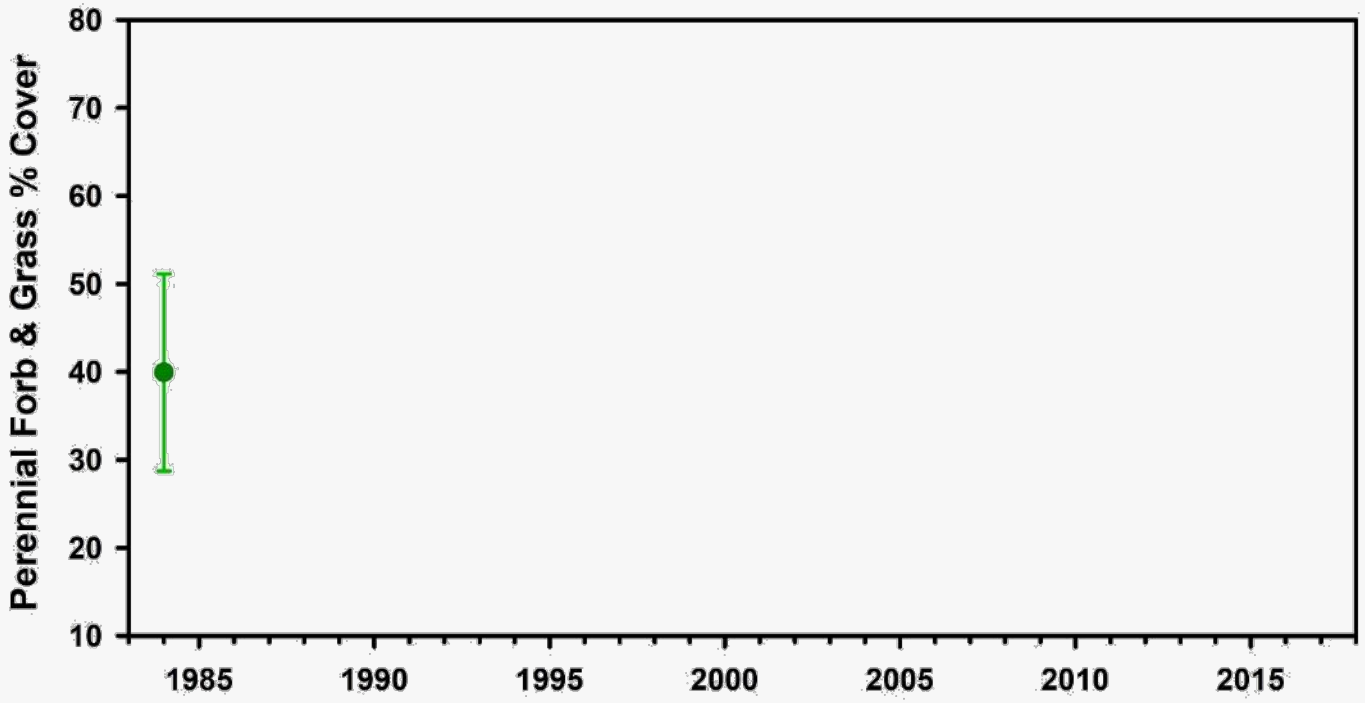
Applications #3 – Prescribed Fire & Woody Plant Expansion





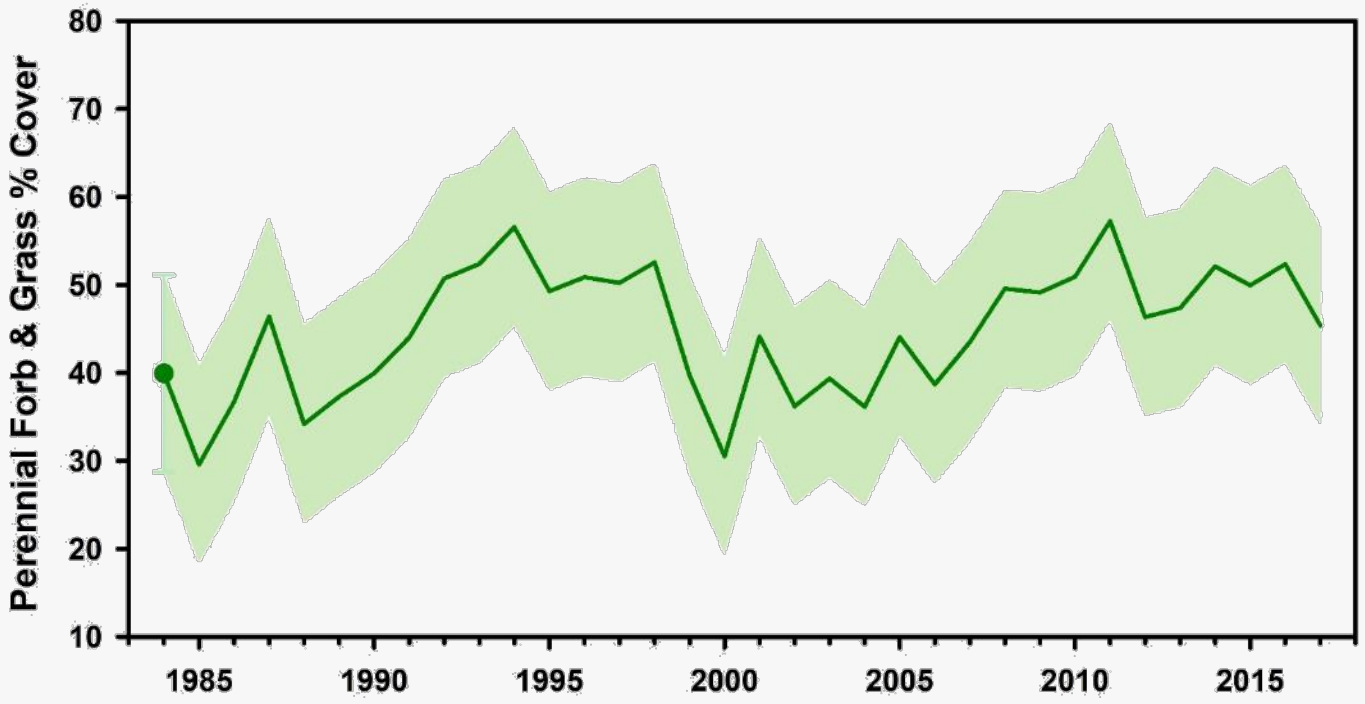
It's a Model, there is error.

Cover Class	Annual Forbs & Grasses	Perennial Forbs & Grasses	Shrubs	Trees	Bare Ground
Mean Absolute Error (%)	7.8%	11.2%	6.9%	4.7%	7.3%

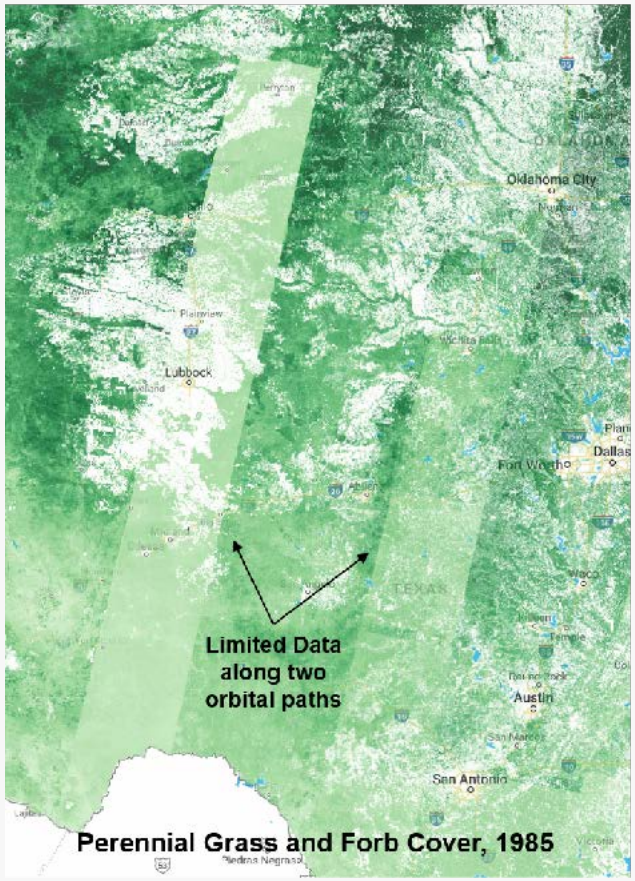


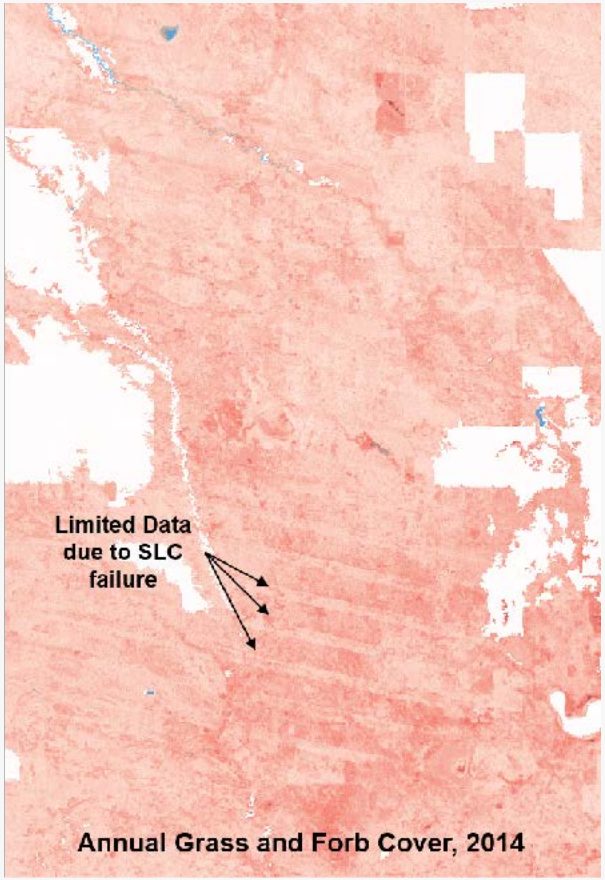
It's a Model, there is error.

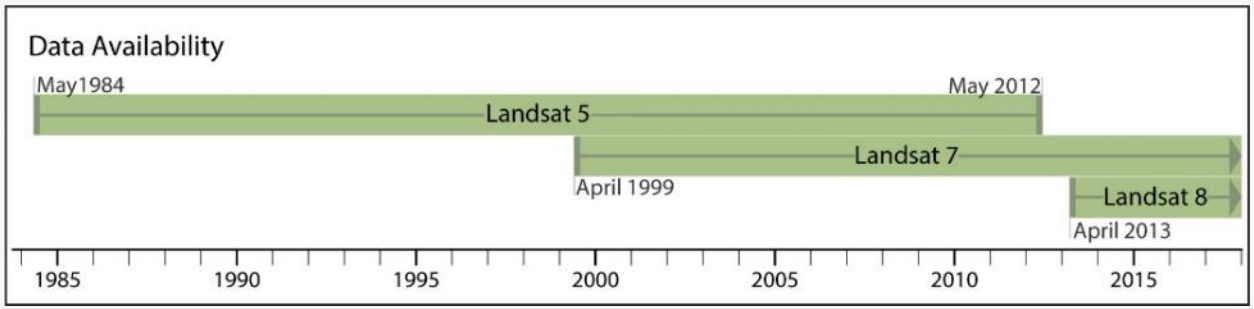
Cover Class	Annual Forbs & Grasses	Perennial Forbs & Grasses	Shrubs	Trees	Bare Ground
Mean Absolute Error (%)	7.8%	11.2%	6.9%	4.7%	7.3%



Years with Limited Landsat Data







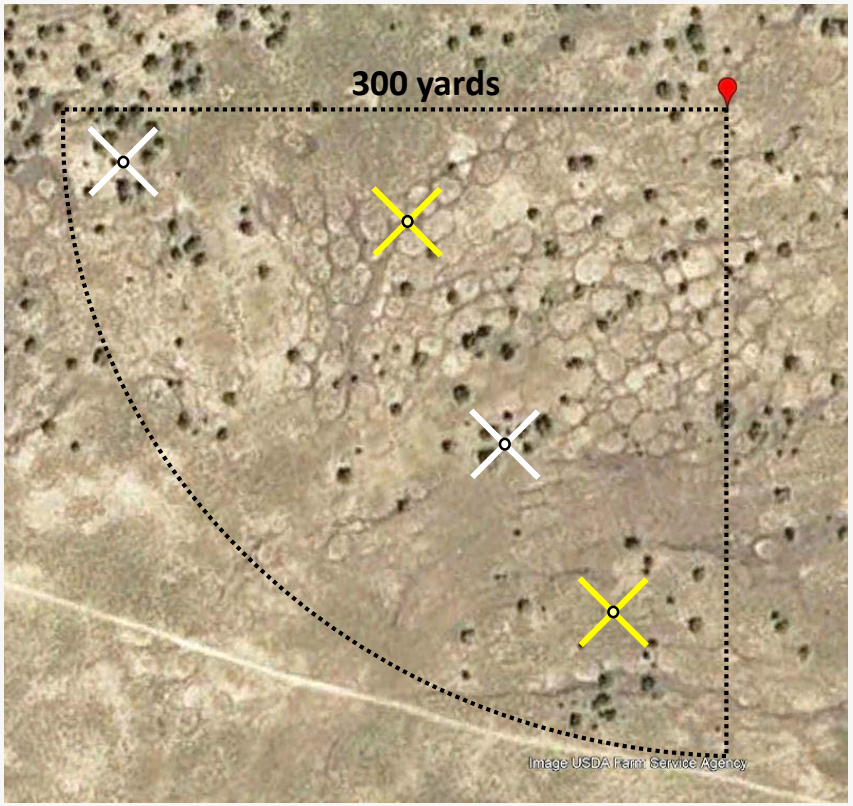
Why doesn't RAP match my expected cover value?

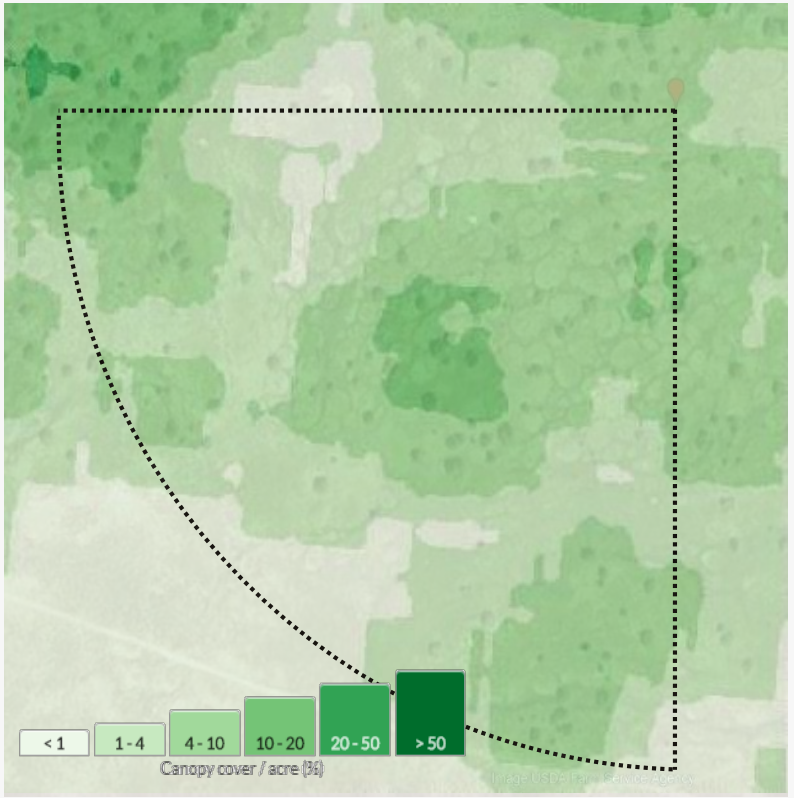
What is your percent tree cover estimate?

Why doesn't RAP match my expected cover value?

Visual estimates may vary significantly from aerial or satellite estimates.

SWA Tree cover mean = 4.5%
RAP Tree cover mean = 4%





RAP is another tool for your toolbox

🚫 **This tool DOES NOT replace boots on the ground.**

The maps and data provided by RAP are intended to be used alongside local knowledge and site-specific data.

🚫 **This tool IS NOT for precision monitoring and management.**

The RAP should *not be used in isolation* to quantify rangeland resources, to define thresholds, or to evaluate the efficacy of management practices or treatments.

✓ **RAP provides a historical and spatially complete view of your area.**

✓ **Use RAP to examine land cover trends through time.**

✓ **Use RAP to assess land cover variability in your area of interest.**

✓ **Use RAP alongside local knowledge and data to inform conservation and management action plans.**

RAP is your tool for monitoring rangelands across space and time as never before.

rangelands.app