Inter-LCC Greater Sage-grouse Research Projects

Results and Applications to Inform Landscape-scale Management

Great Northern Landscape Conservation Cooperative

Southern Rockies Landscape Conservation Cooperative

Great Basin Landscape Conservation Cooperative

Plains & Prairie Potholes Landscape Conservation Cooperative


How Did We Get Here?

Region 6
Inter-LCC Sage-Grouse Collaboration Proposal

Spoke to a paradigm shift in sage-grouse management

Envisioned paradigm:

- Collaboration among management entities at range-wide and LCC scales
- Coordination of planning and implementation to reduce redundancy, target efforts to high priorities and increase efficiency
- Management informed by science-based decision support tools
- Sage-grouse data shared and available to all through a common data portal
- WAFWA as appropriate entity to lead collaborative efforts

Collaboration Started with Oversight Committee

- Developed and distributed RFP & scoring criteria
- OC makeup, 23 individuals with science/sage-grouse expertise or responsibility
  - 6 state Division of Wildlife sage-grouse biologists/researchers
  - 5 LCC Science Coordinators
  - 7 Federal (FWS, BLM, USFS, USGS)
  - 3 University Professors
  - 2 WAFWA (Stiver and Remington)

RFP – called for:

- Meaningful impact to sage-grouse conservation in the short term, completed by 30 Sept. 2015
- Large-scale; at least at scale of single LCC, ideally multi-LCC
- Research to fill data gaps, mapping, decision support tools, adaptive management constructs, evaluate effectiveness of current management, etc. eligible
- Data must be made available to LC MAP portal, appropriate protections allowed

- 42 proposals received requesting $5.13 million, leveraging over $6 million
- Reviewed and ranked by 13 OC members
- Funding awarded to 4 projects

Revisions:

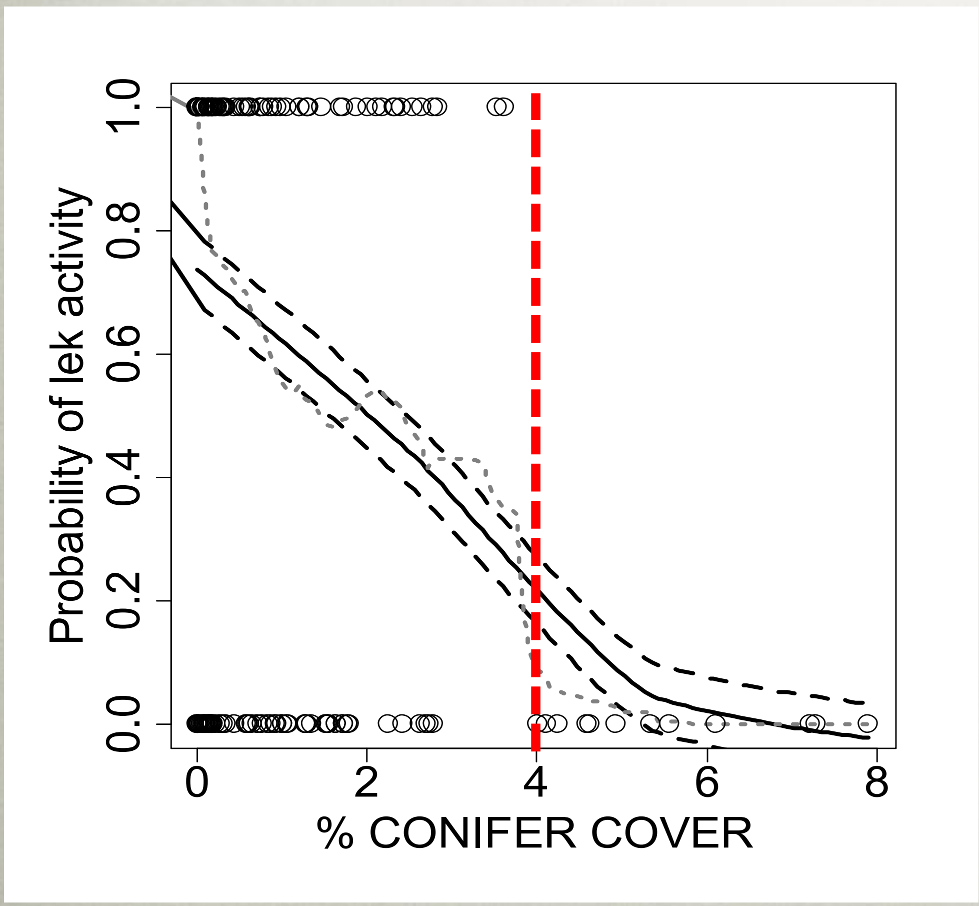
Principal Investigators	Title
Mike Gregg, FWS	Using cheatgrass suppressive soil bacteria to break the fire cycle and proactively maintain greater sage-grouse habitats
Collin Homer, USGS Matt Bobo, BLM	Annual Grass Cover Mapping for Greater Sage-Grouse Conservation
Lyman McDonald Ryan Nielson West, Inc.	Analysis of Greater Sage-Grouse Lek Data: Trends in Peak Male Counts, 1965-2015

Sage Grouse Hate Trees: A Range-Wide Solution for Increasing Bird Benefits Through Accelerated Conifer Removal

Michael J. Falkowski
Colorado State University
Department of Ecosystem Science and Sustainability

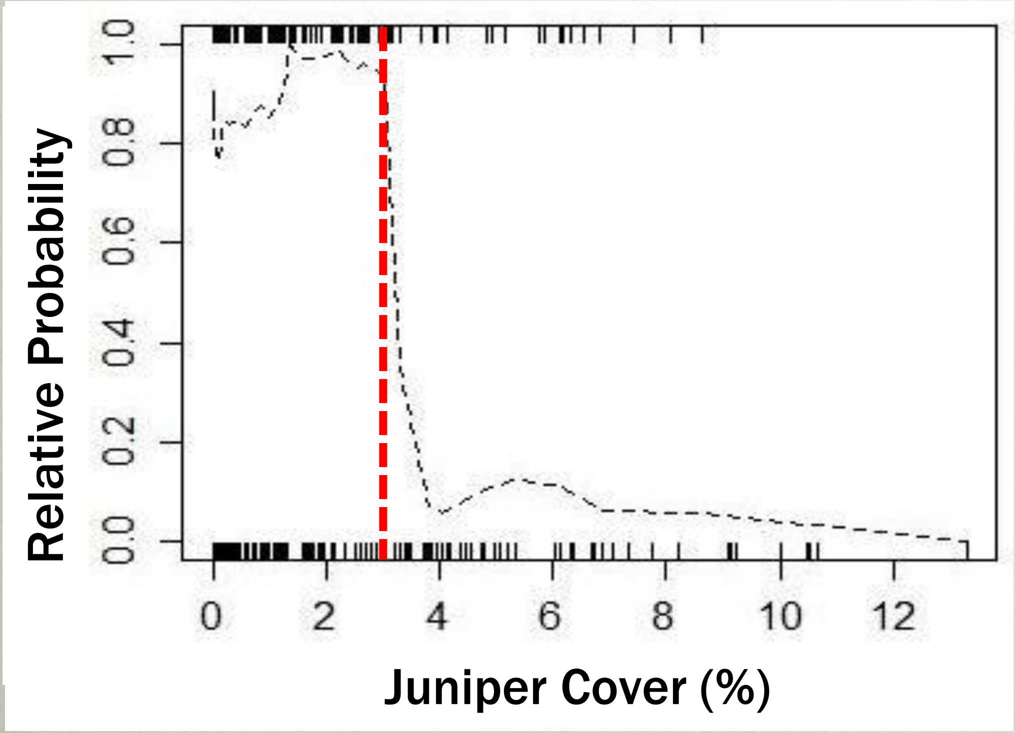
Collaborators: Aaron Poznanovic (UMN), Dave Naugle (UMT/SGI), Jeremy Maestas (NRCS), Christian Hagen (OSU/LPCI), Jeffery Evans (TNC), Brady Allred (UMT)

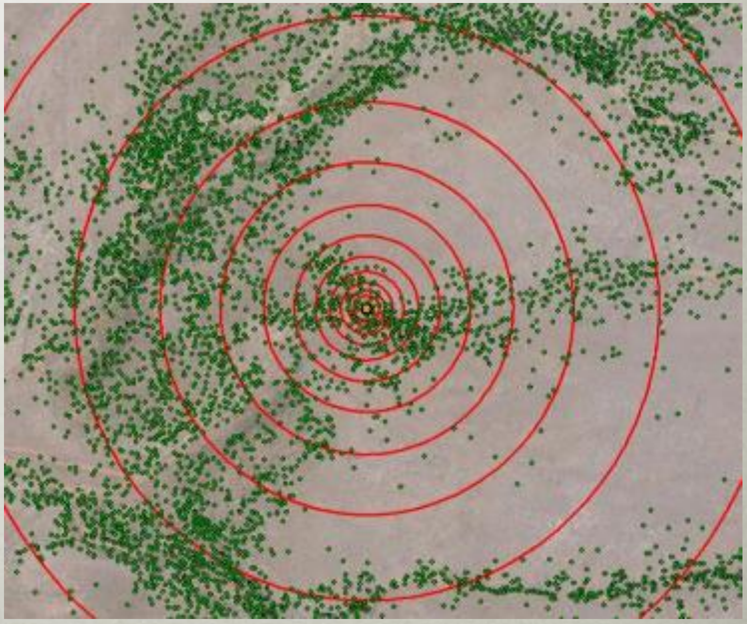
Top down threat with population-level impacts at low levels of tree cover



Baruch-Mordo et al. 2013. Biological Conservation

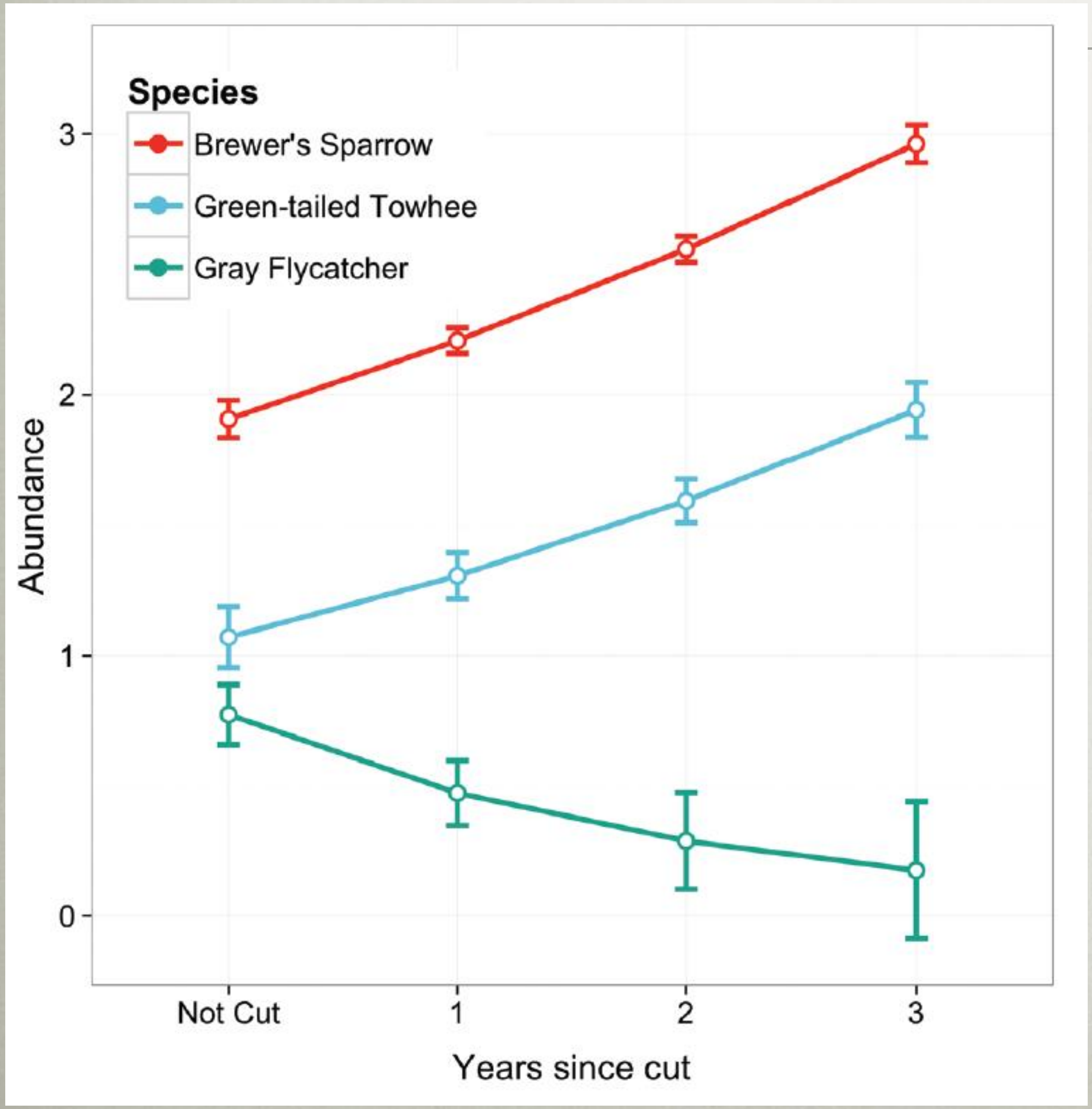
Sage-Grouse
Nesting Impacts





Severson et al., In Review

It's not just about grouse....



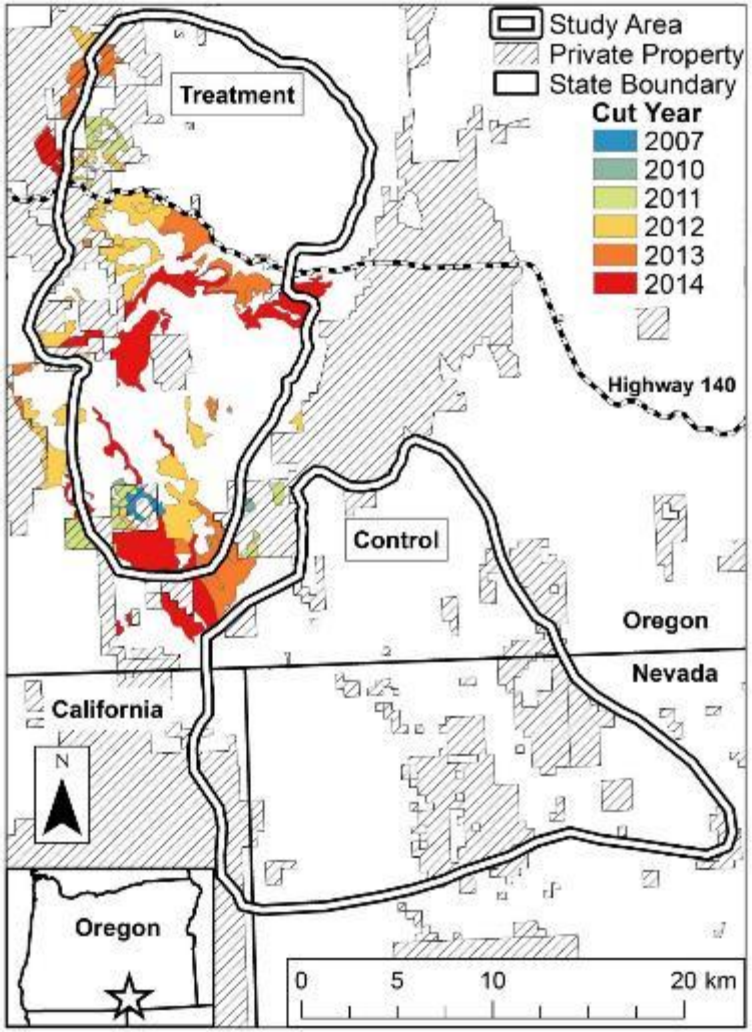
+55%

+85%

Sagebrush Obligates of High Conservatio n Concern

Open Woodland Songbird

Holmes et al., In Review

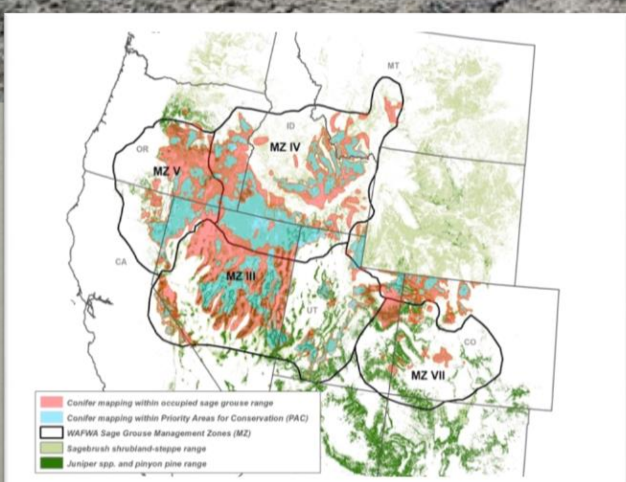


Does conifer removal work?

- Tree removal increased available nesting habitat by 28%
- Probability of use of newly restored sites increased by 22% annually
- Hens were 43% more likely to nest within 1000 m of treatments
- 29% of marked birds shifted nesting into treated habitats

Severson et al., In Review

Where Are the Trees?

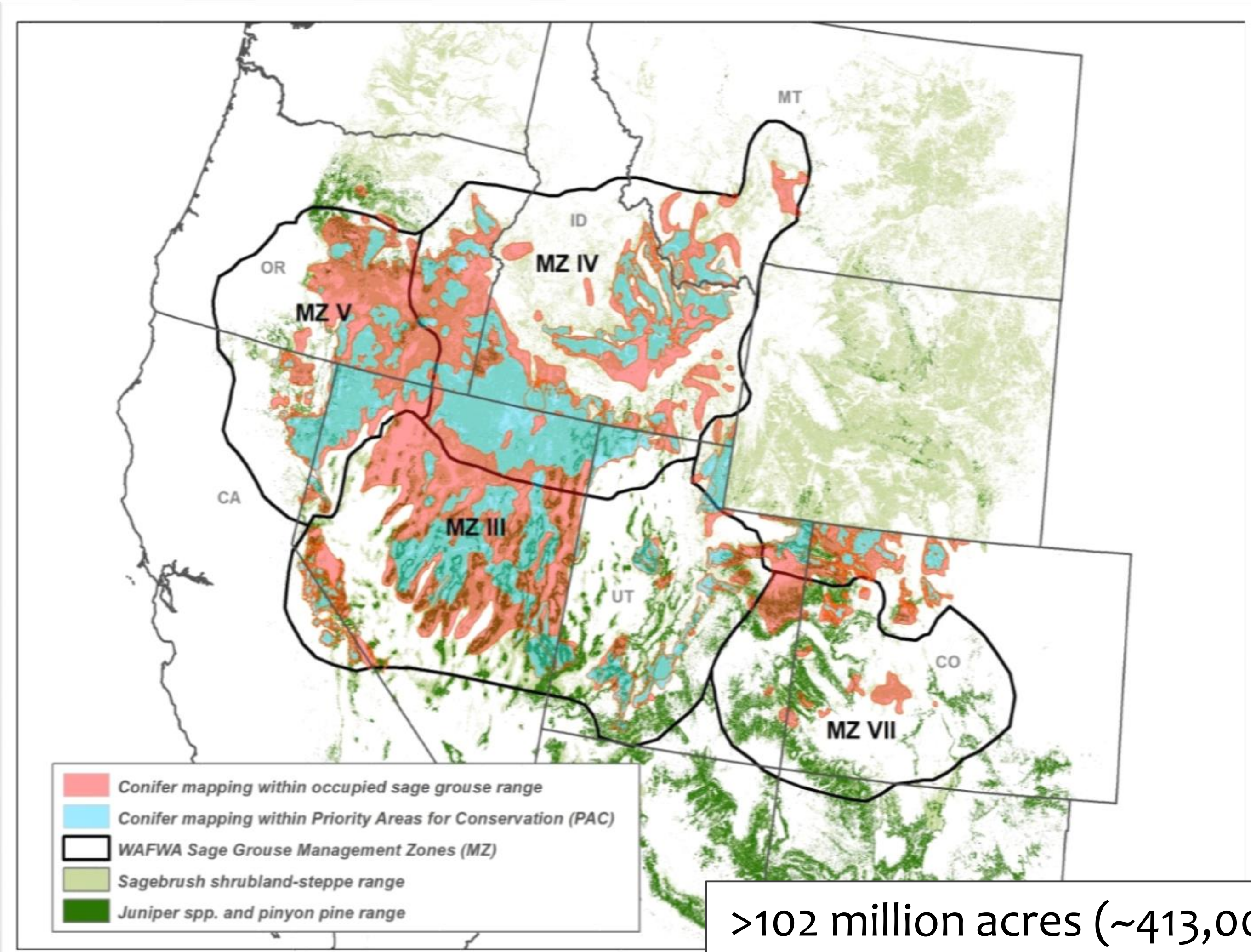


How do we prioritize? Where do we start?

Source: Dave Naugle - Photos by: Andy Gallagher

A rangewide tool for scaling up implementation

How do we prioritize? Where do we start?



State	Status	Acres
CA	PAC	2.1
	Non PAC	1.1
CO	PAC	2.4
	Non PAC	6.3
ID	PAC	9.8
	Non PAC	7.1
MT	PAC	1.4
	Non PAC	2.2
NV	PAC	20.4
	Non PAC	21.4
OR	PAC	6.6
	Non PAC	12.5
UT	PAC	7.5
	Non PAC	4.2

Proposed acres (millions) of conifer mapping by state within PAC and non-PAC areas.

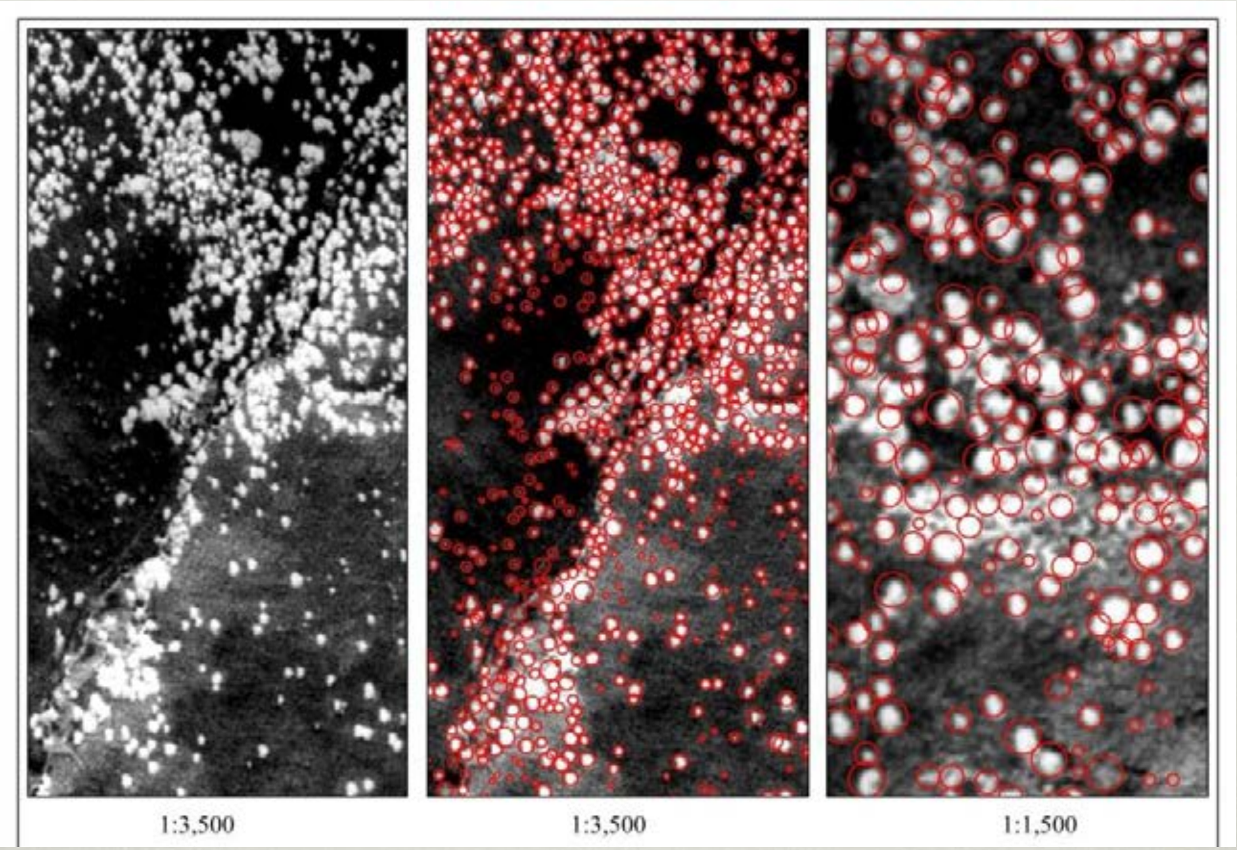
>102 million acres (~413,000 km²) to be mapped

Object Based Juniper Detection

Can We Determine the Size and Location of Every Tree?

Object Oriented Approach: Spatial Wavelet Analysis

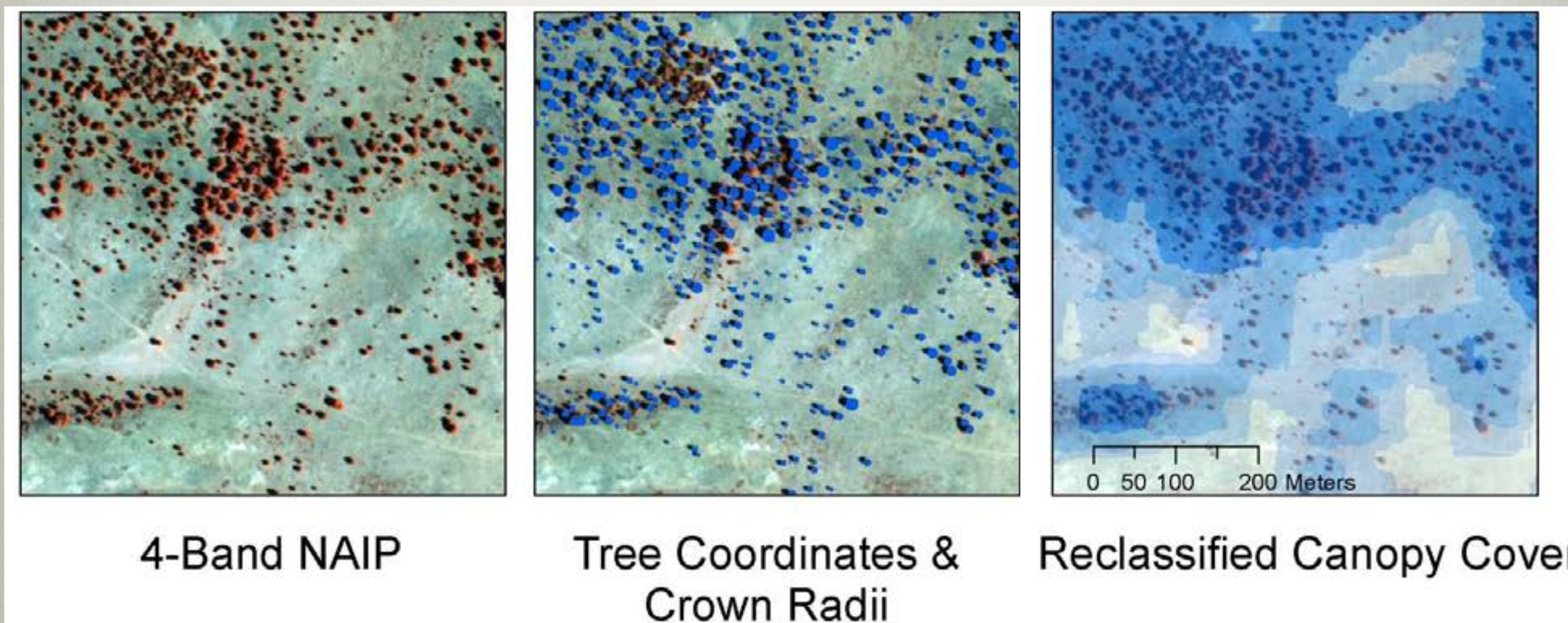
Applied to NAIP NDVI Image

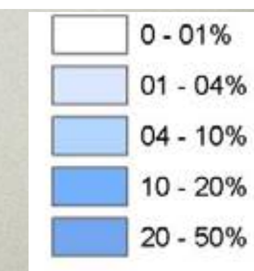


We use an object-based image analysis approach (spatial wavelet analysis) to map the location and crown diameter of individual juniper trees in NAIP images, then calculate canopy cover per acre using a moving window. Can also calculate tree density.

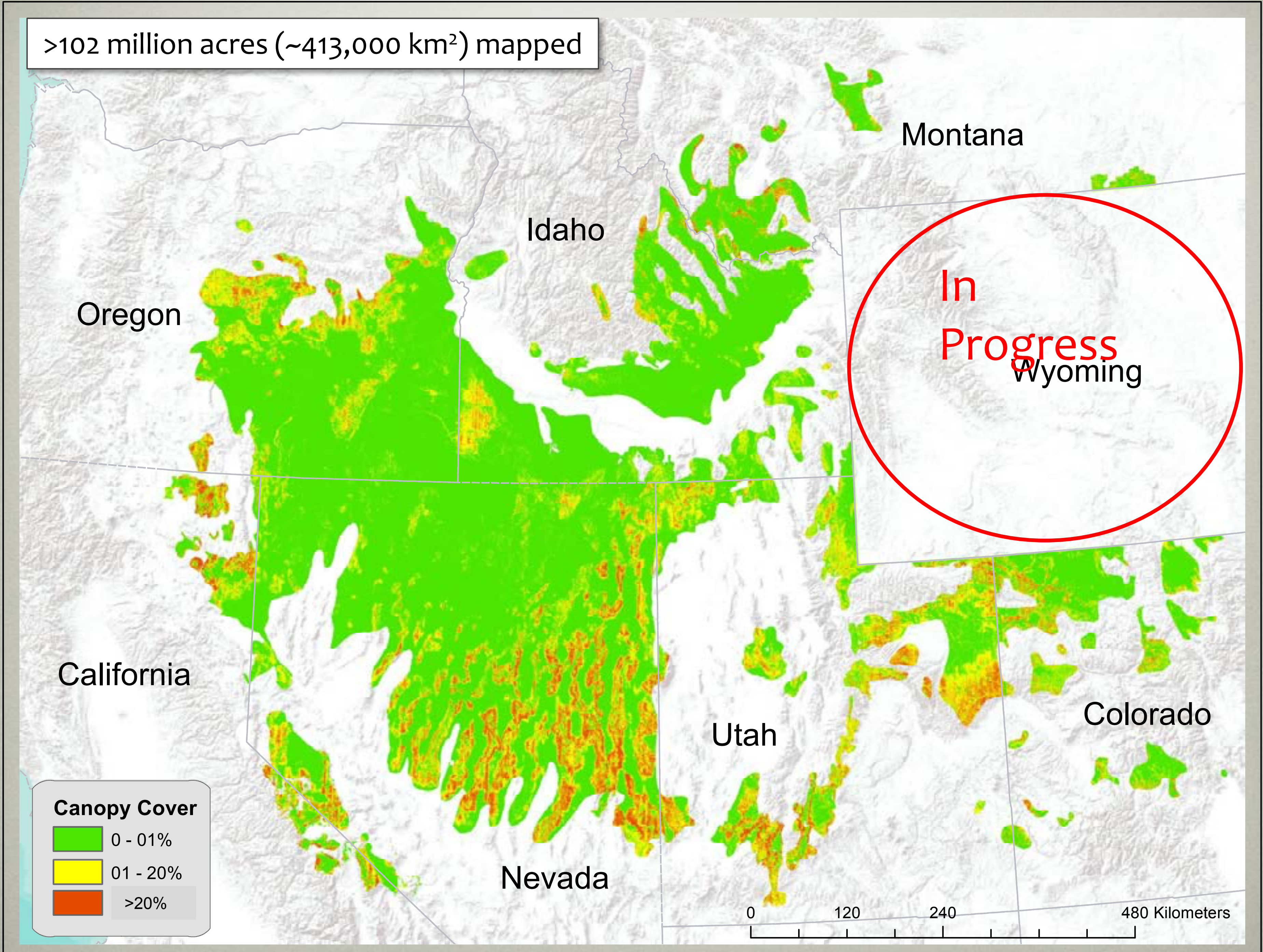
Object Oriented Approach: Spatial Wavelet Analysis

Applied to NAIP NDVI Image

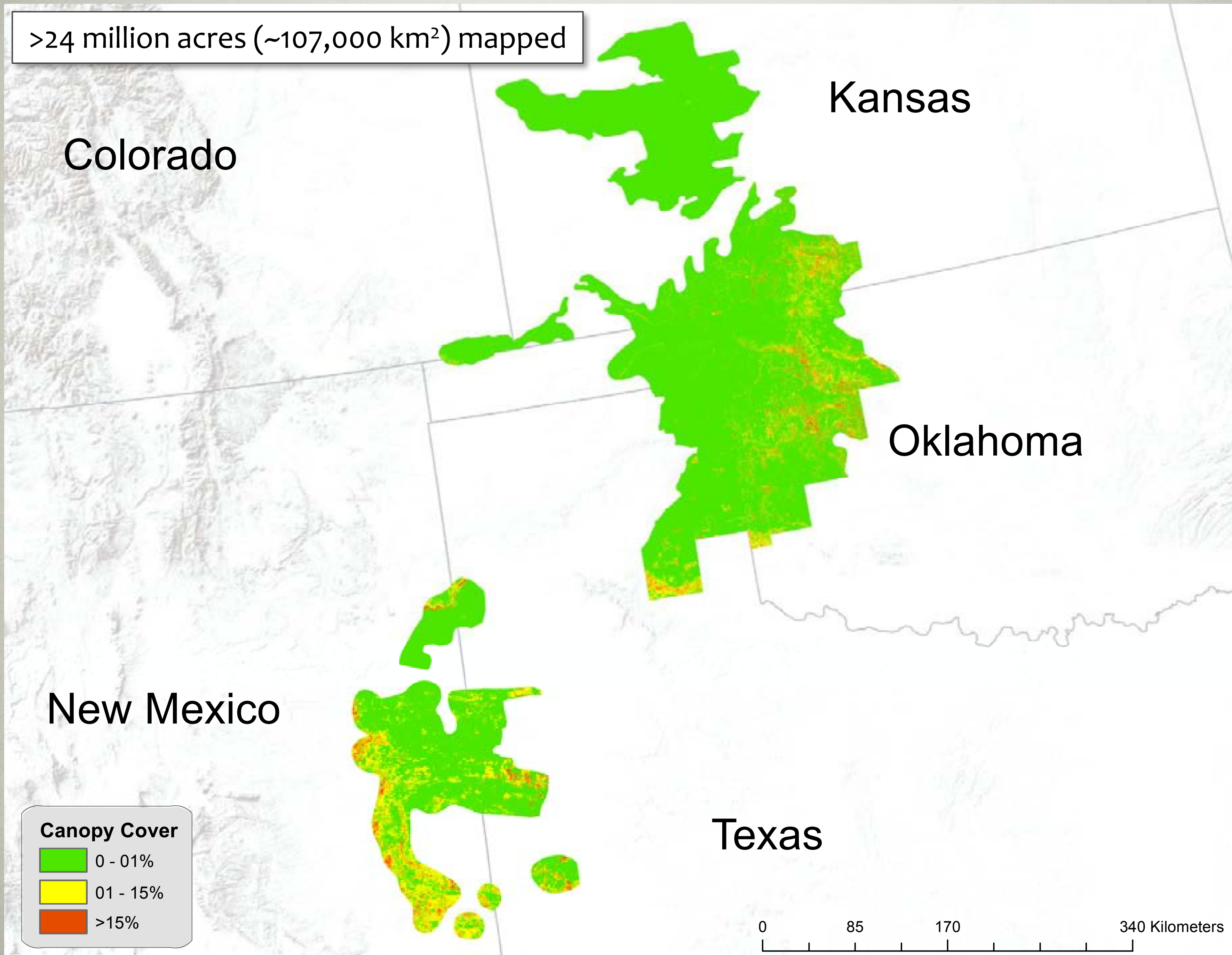




We use an object-based image analysis approach (spatial wavelet analysis) to map the location and crown diameter of individual juniper trees in NAIP images, then calculate canopy cover per acre using a moving window.

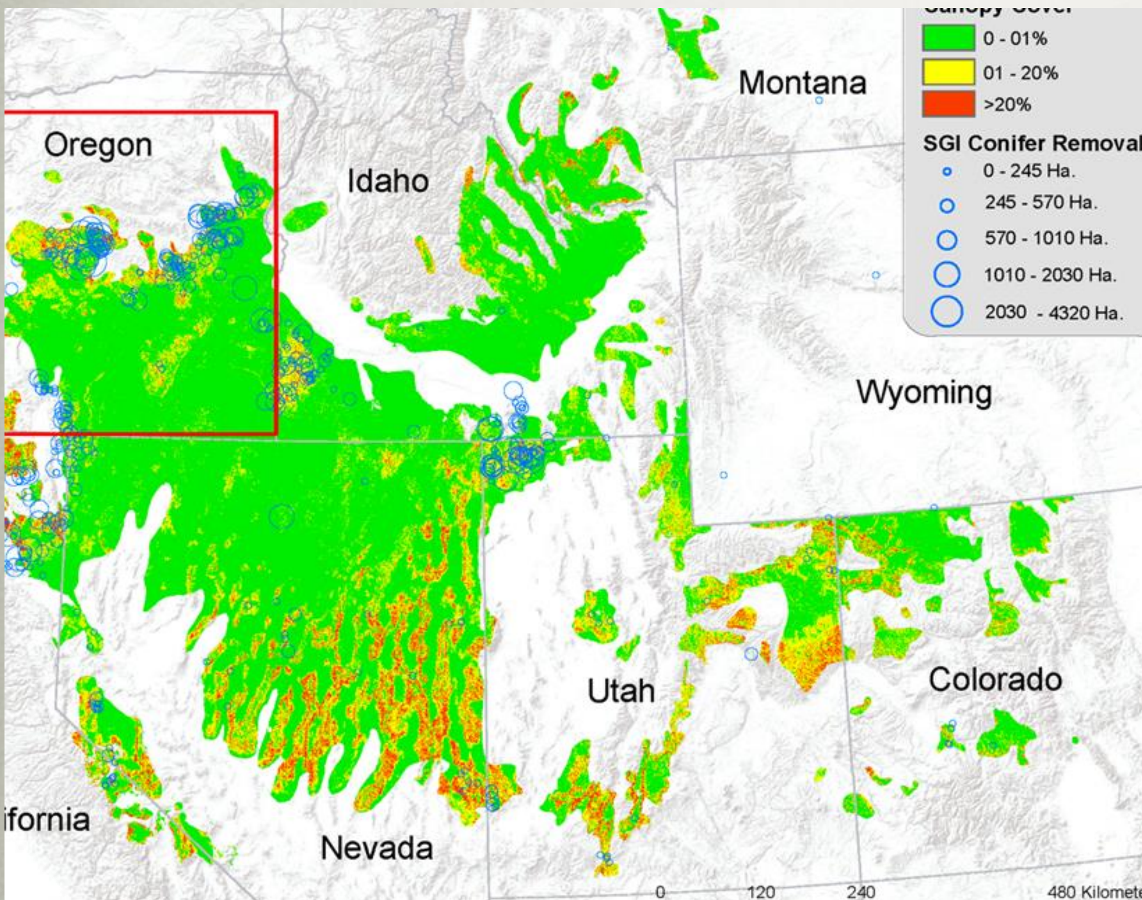


>102 million acres (~413,000 km²) mapped
Montana
Idaho
Oregon
In Progress
Wyoming
California
Utah
Colorado
Nevada
Canopy Cover
0 - 01%
01 - 20%
>20%
0
120
240
480 Kilometers

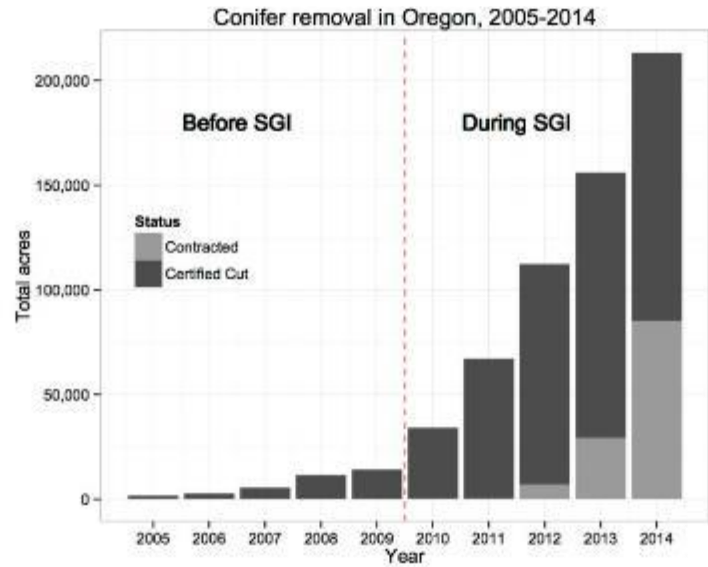


>24 million acres (~107,000 km²) mapped
Kansas
Colorado
Oklahoma
New Mexico
Texas
Canopy Cover
0 - 01%
01 - 15%
>15%
0
85
170
340 Kilometers

Strategic approach to threat alleviation

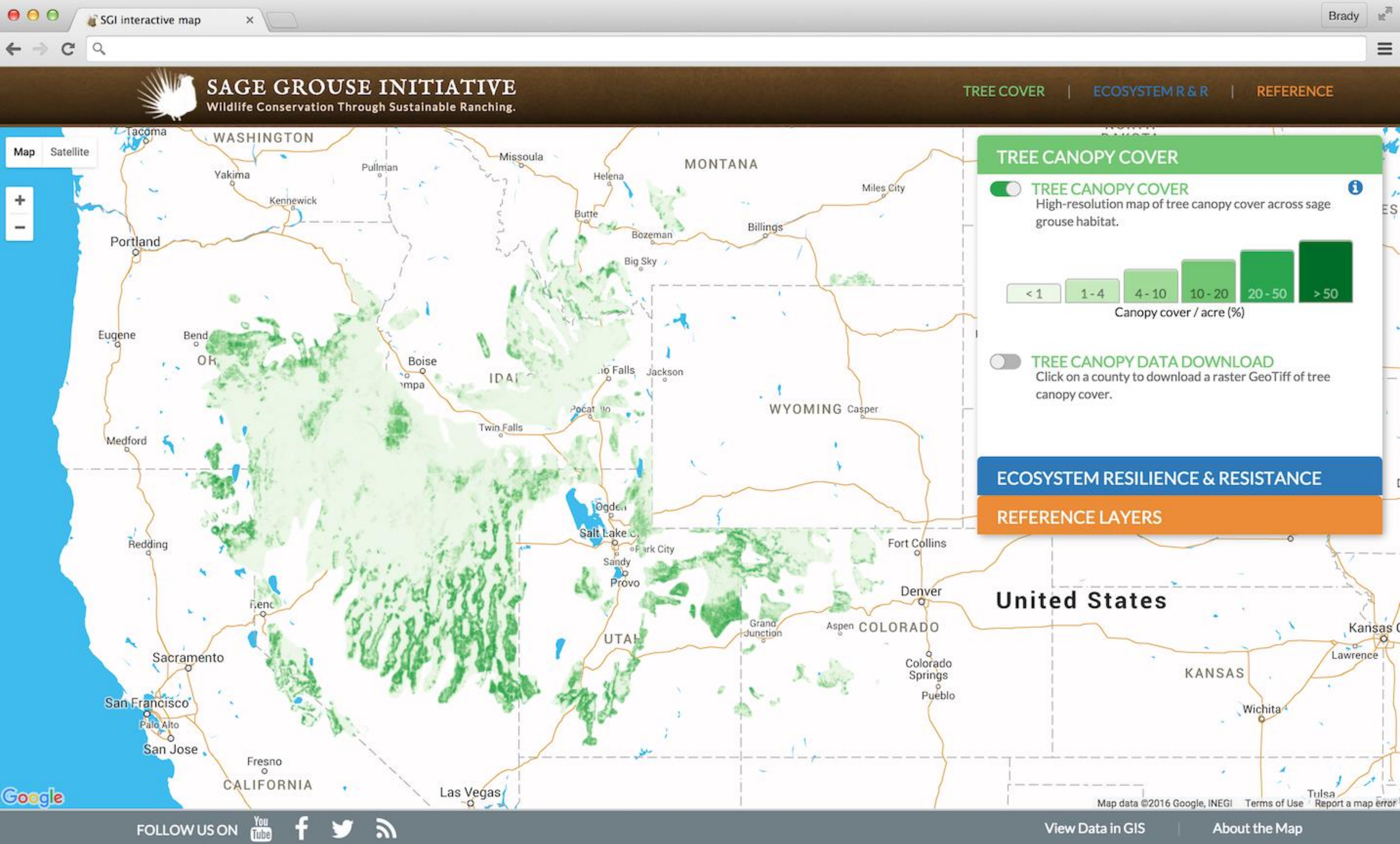


Oregon Example



SGI Conifer Removal inside PACs	
Population	% Threat reduced SGI 1.0
Central Oregon	85%
Northern Great Basin	67%
Western Great Basin	52%
Baker, Oregon	41%
TOTAL	68%

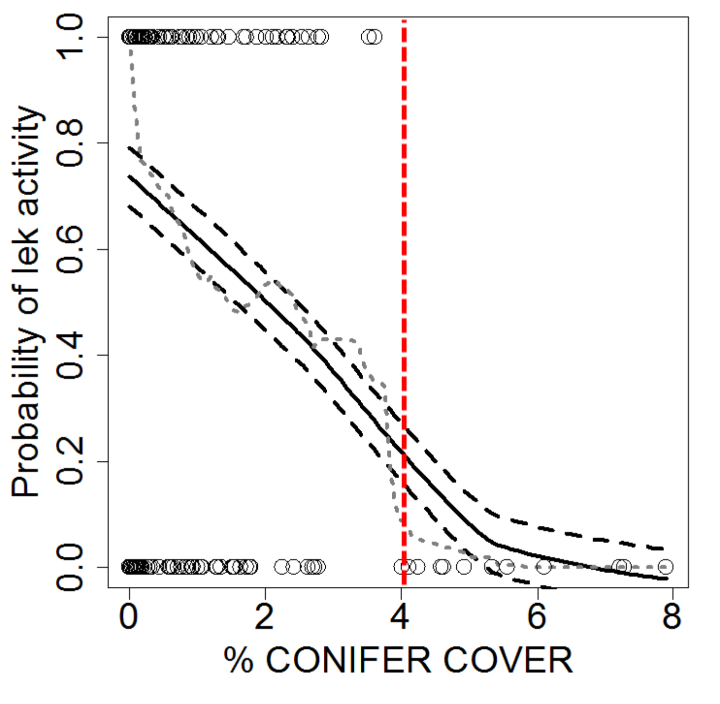
In 5 years - 405,241 Acres Treated
Highly targeted to prioritized populations - 81% in PACs

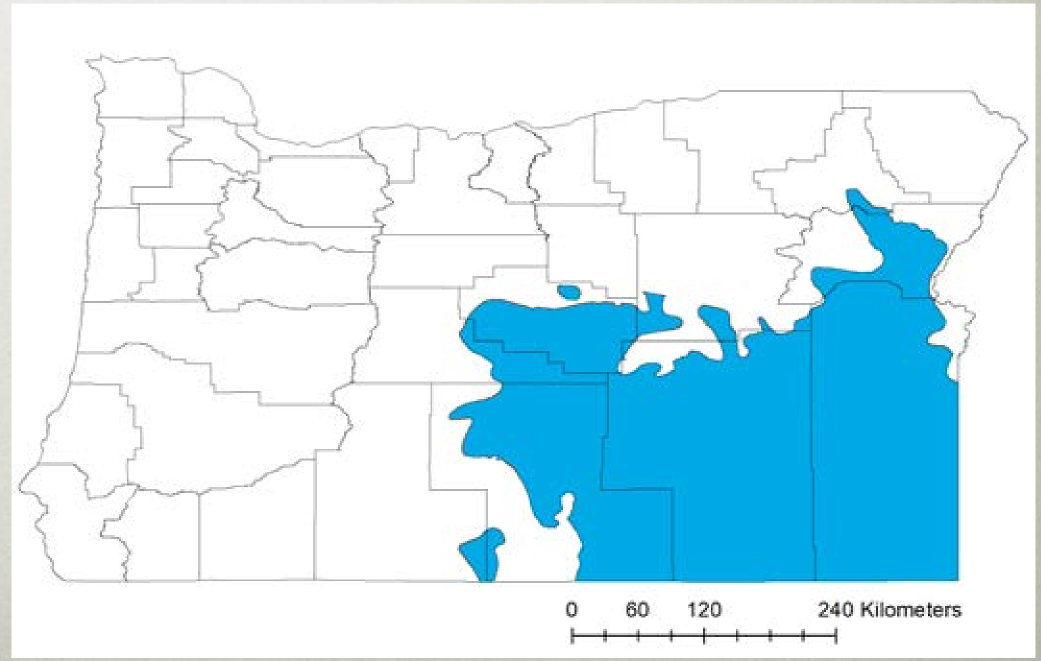


targeting implementation and outcomes
putting data into the right hands

Prioritizing conifer removal for Sage Grouse conservation

Where to target removal?
- Costly
- Limited Resources
- Most beneficial areas?
- Oregon Case Study



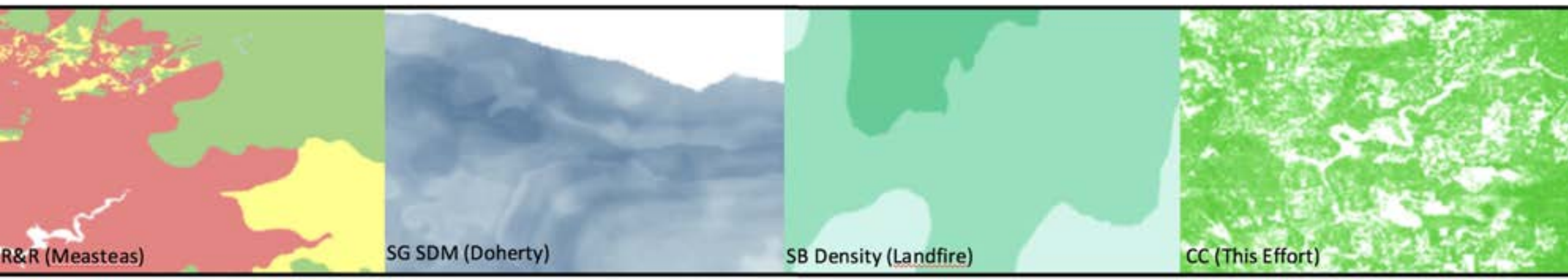


Conservation Features:
Sage Grouse Lek Populations
Sage Grouse Habitat Suitability
Sage Brush Density

Penalty / 'Cost' Terms:
Conifer Cover
Resistance & Resilience

Marxan

Priority Conifer Removal Areas

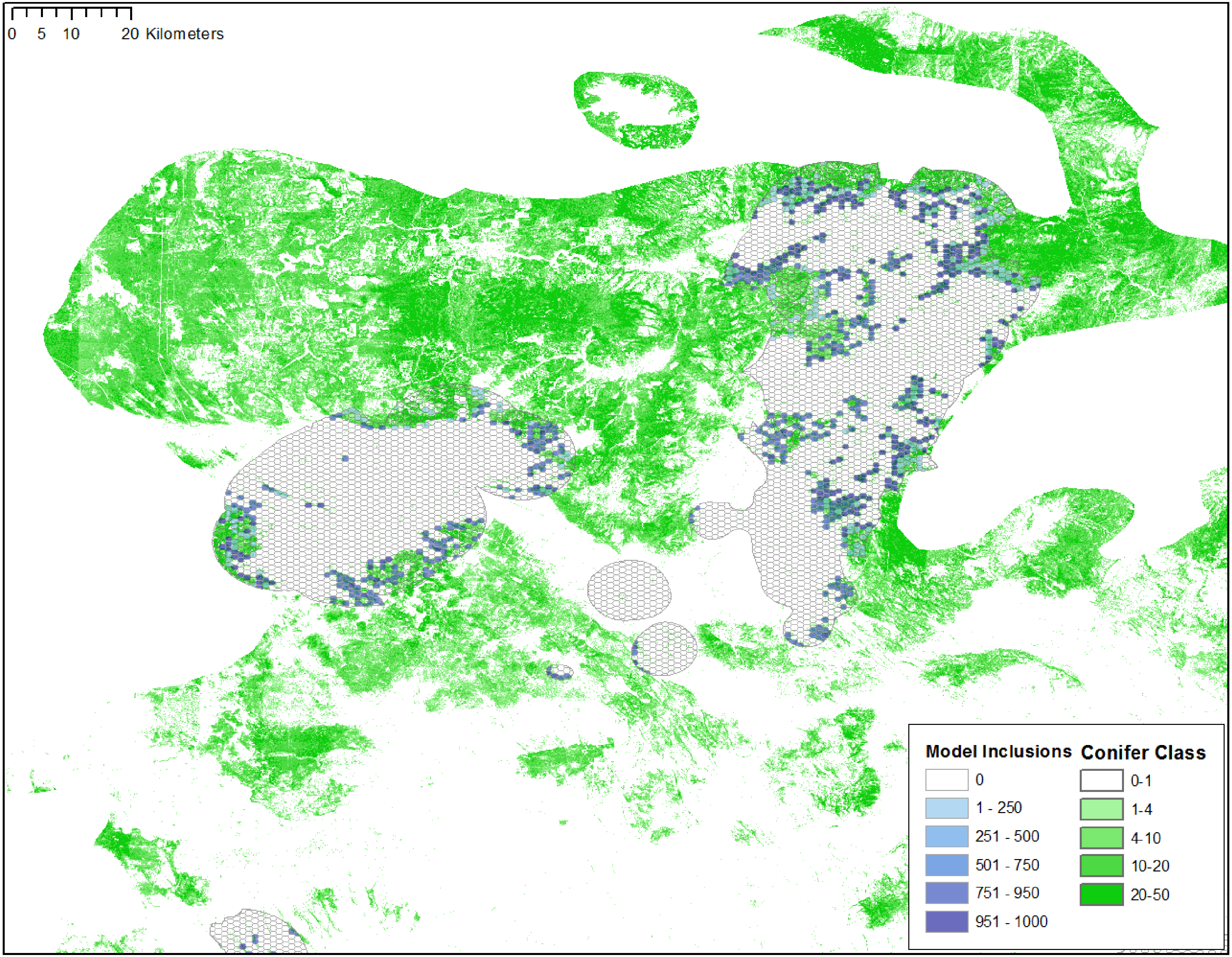


Objectives:

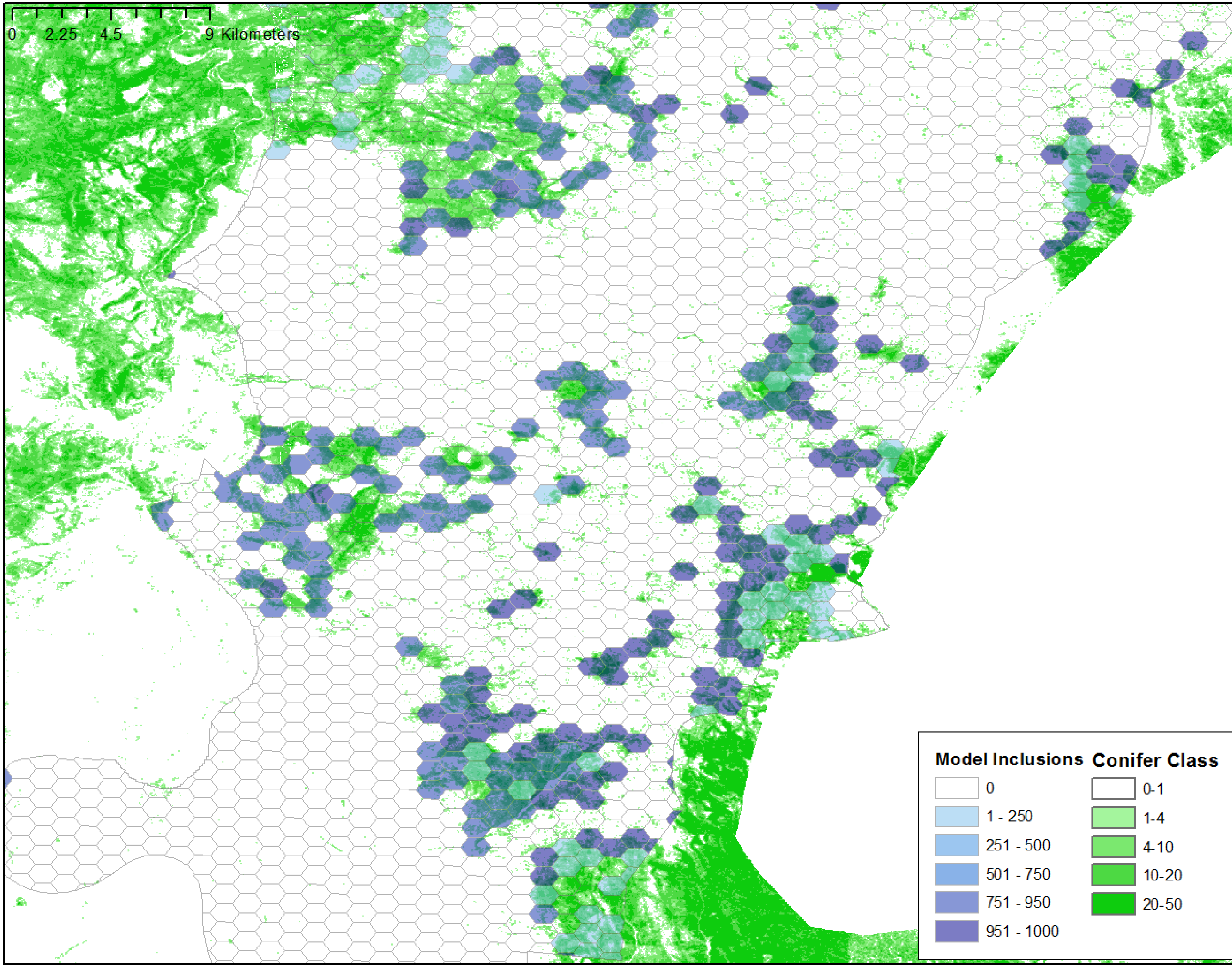
I
Identify priority conifer removal areas within Sage Grouse PACs

II
Identify priority conifer removal areas between breeding and brooding habitat

III
Identify priority conifer removal areas between Sage Grouse PACs



0 5 10 20 Kilometers
Model Inclusions
0
1 - 250
251 - 500
501 - 750
751 - 950
951 - 1000
Conifer Class
0-1
1-4
4-10
10-20
20-50


0 2.25 4.5 9 Kilometers
Model Inclusions
0
1 - 250
251 - 500
501 - 750
751 - 950
951 - 1000
Conifer Class
0-1
1-4
4-10
10-20
20-50

Thanks !! Funding Sources and Cooperators:

Conifer mapping in the sage grouse range was supported by a grant administered by the Western Association of Fish and Wildlife Agencies (WAFWA) with funding partners including the:

U.S. Fish and Wildlife Service

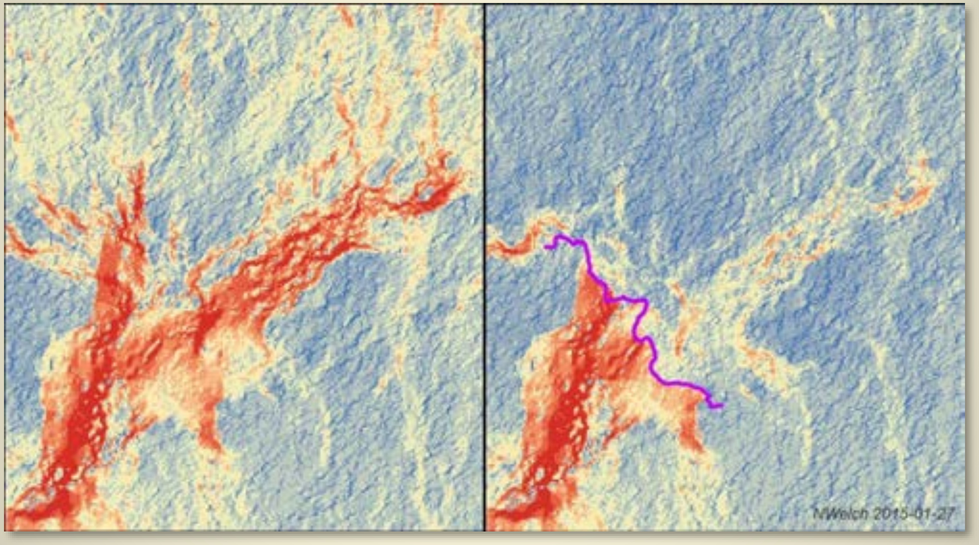
Bureau of Land Management

National Fish and Wildlife Foundation

Utah Department of Natural Resources - Watershed Restoration Initiative

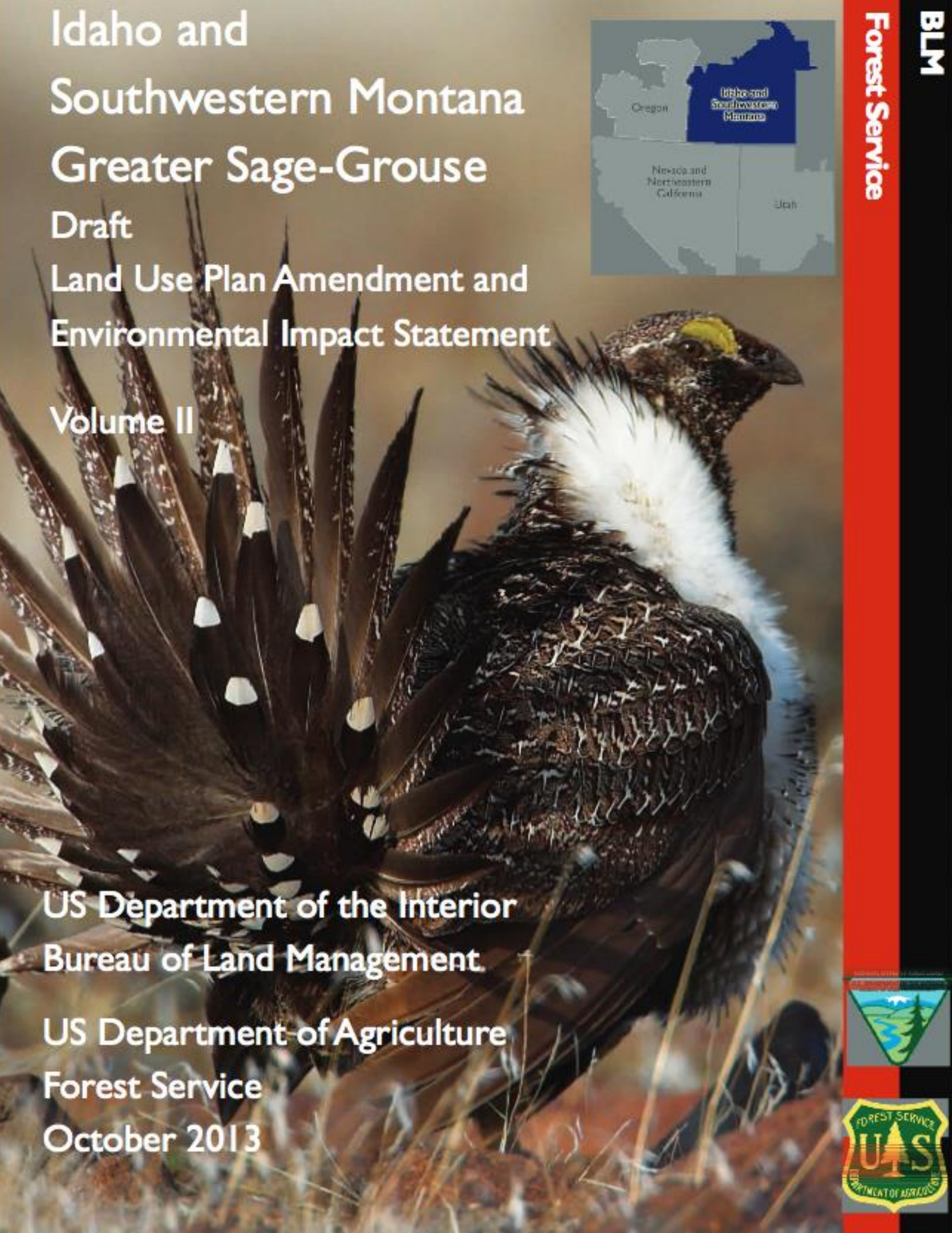
Special Thanks to TNC

Designing a regional network of fuel breaks to protect Greater Sage-Grouse habitat: An experimental approach using Circuitscape



Nathan Welch (ID), Louis Provencher (NV), Bob Unnasch (ID),
Tanya Anderson (NV) & Brad McRae (North America)

The Nature Conservancy



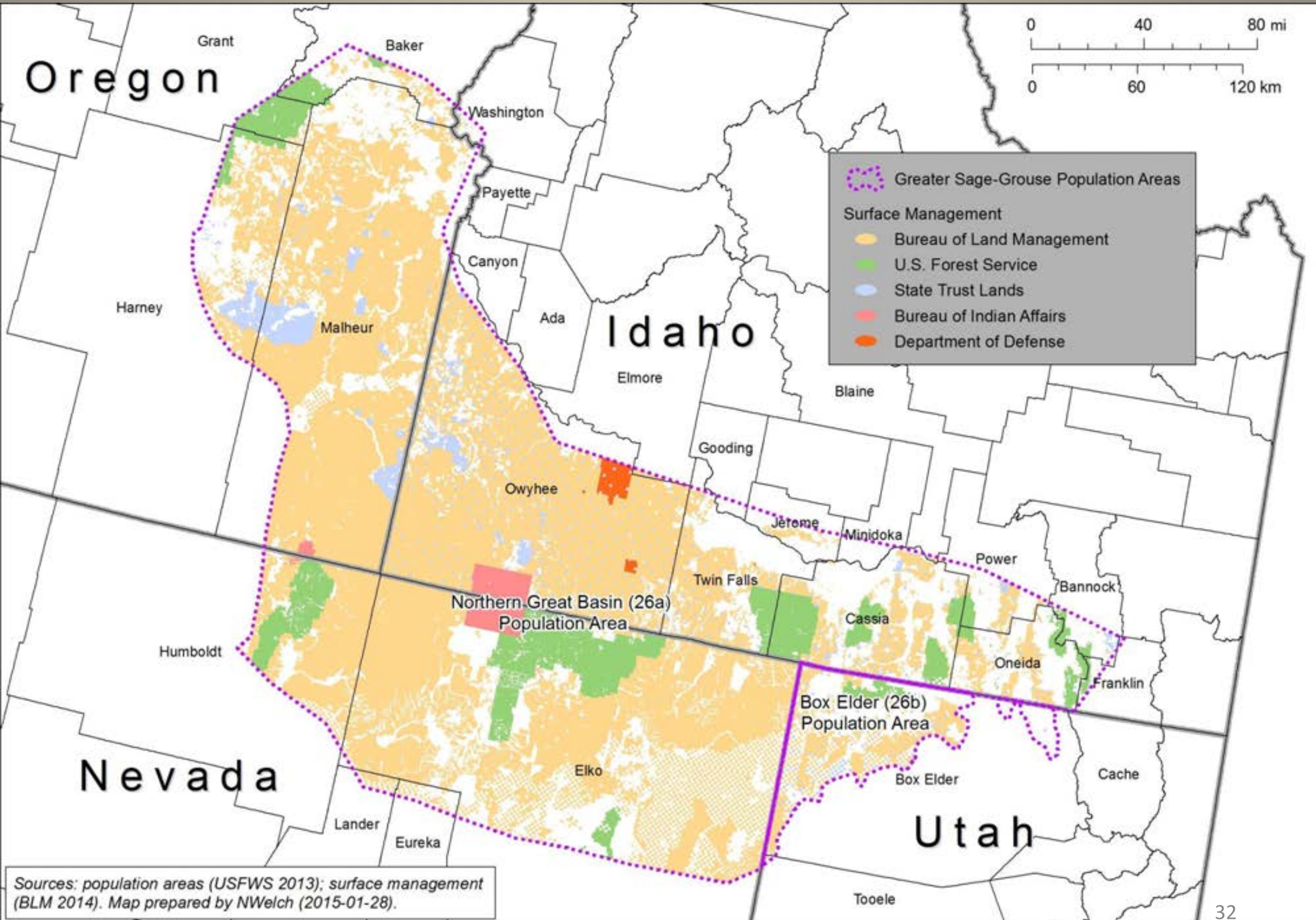
"Create and maintain effective fuel breaks in **strategic** locations that will modify fire behavior and increase fire suppression effectiveness…."

"Federal firefighters shall ensure close coordination with State firefighters, local fire departments and local expertise (i.e., livestock grazing permittees and road maintenance personnel) to **create the best possible network of strategic fuel breaks** and road access to minimize and reduce the size of a wildfire following ignition…"

Response

- Policy documents identify the need for landscape-scale approaches to design and implement fuel treatments to stop or slow fire spread.
  - We developed a GIS protocol for identifying strategic locations for fuel breaks at large spatial extents and simulating potential fuel breaks.
    - We proposed next steps in the refinement of our protocol and devised general recommendations for a regional network of fuel breaks to prevent loss of critical Sage-Grouse habitat.


Ken Miracle


Oregon
Idaho
Nevada
Utah
Grant
Baker
Washington
Payette
Canyon
Ada
Harney
Malheur
Elmore
Blaine
Gooding
Owyhee
Jerome
Minidoka
Power
Twin Falls
Bannock
Cassia
Oneida
Franklin
Humboldt
Northern Great Basin (26a) Population Area
Box Elder (26b) Population Area
Elko
Box Elder
Cache
Lander
Eureka
Tooele
0 40 80 mi
0 60 120 km
Greater Sage-Grouse Population Areas
Surface Management
Bureau of Land Management
U.S. Forest Service
State Trust Lands
Bureau of Indian Affairs
Department of Defense
Sources: population areas (USFWS 2013); surface management (BLM 2014). Map prepared by NWelch (2015-01-28).

Methods

- We simulated *wildfire transmission / fuel break potential* using Circuitscape, which is based on electrical circuit theory.
- The inputs for the model are *sources* where electrical current enters the system (=ignitions), *grounds* where current departs the system (=edge of the landscape), and a resistance surface (=flammability raster) across which the current will flow between sources and grounds.
- We identified “pinch points” that provide connections between areas with high flammability, but where adjacent areas with low flammability could constrict wildfire.
- We installed sample fuel breaks in “pinch point” areas and simulated fuel break behavior by modifying the sources raster to include negative current sources that remove fire from the system.

Ecological Applications, 25(4), 2015, pp. 1099–1113

A new model of landscape-scale fire connectivity applied to resource and fire management in the Sonoran Desert, USA

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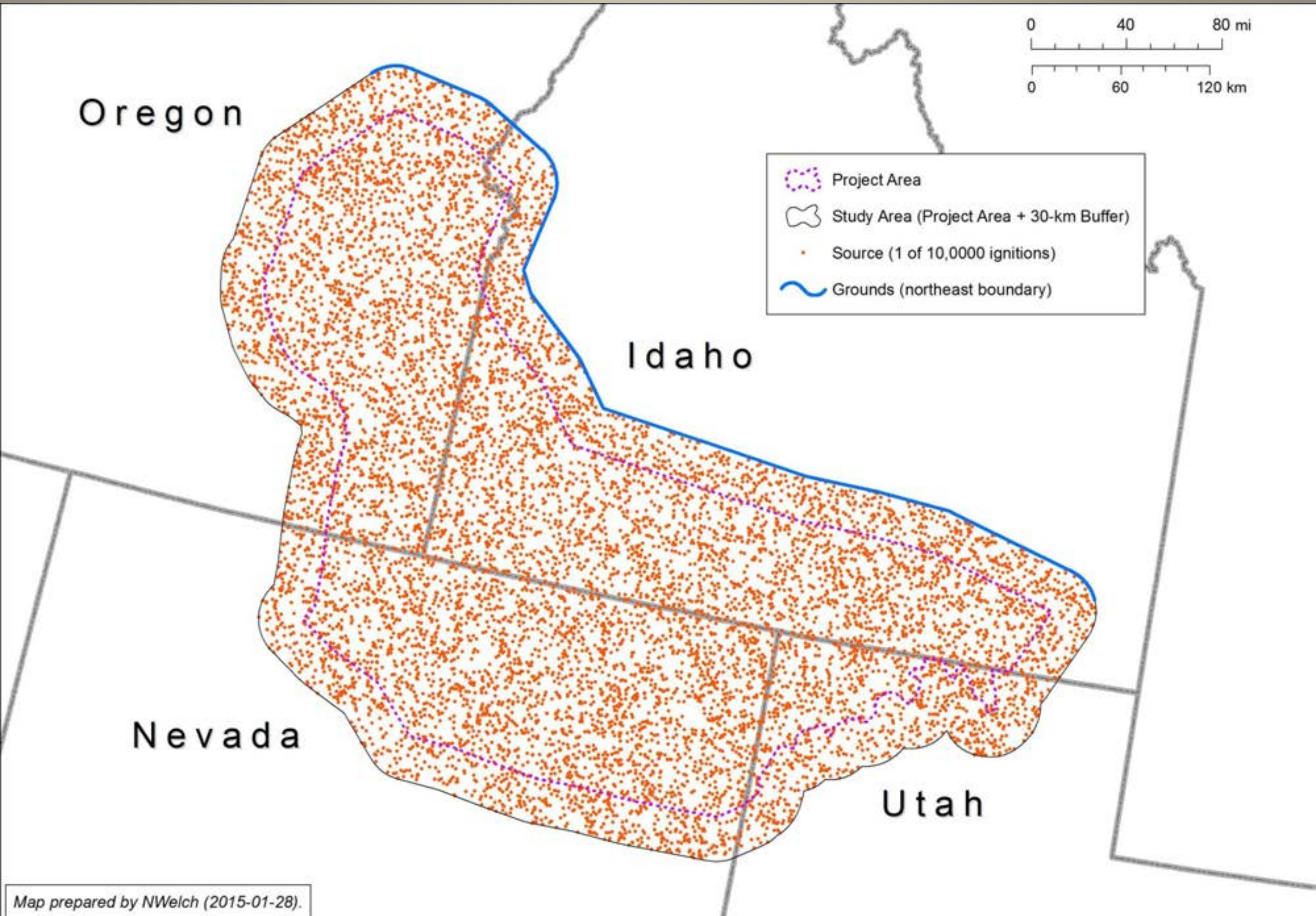
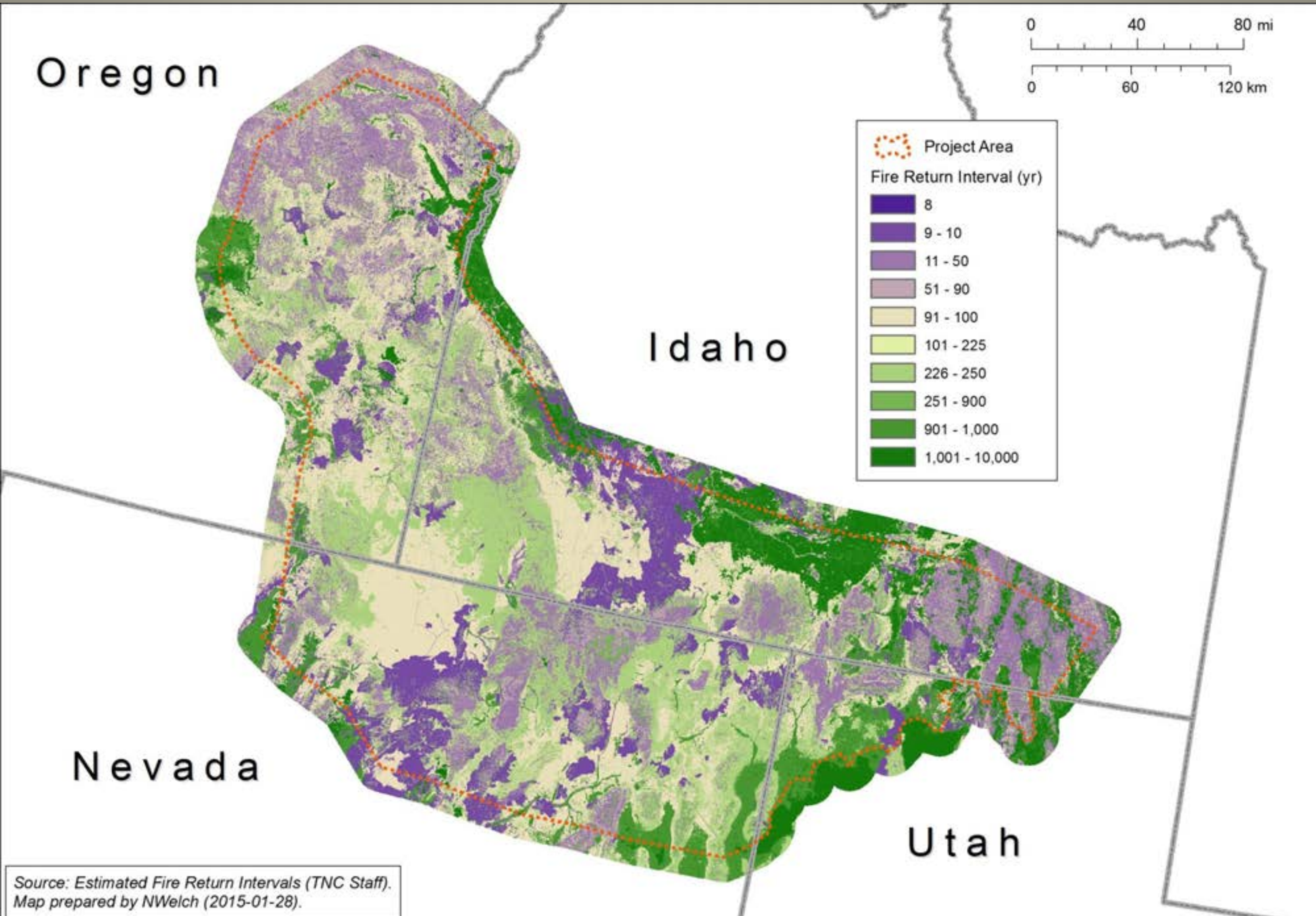
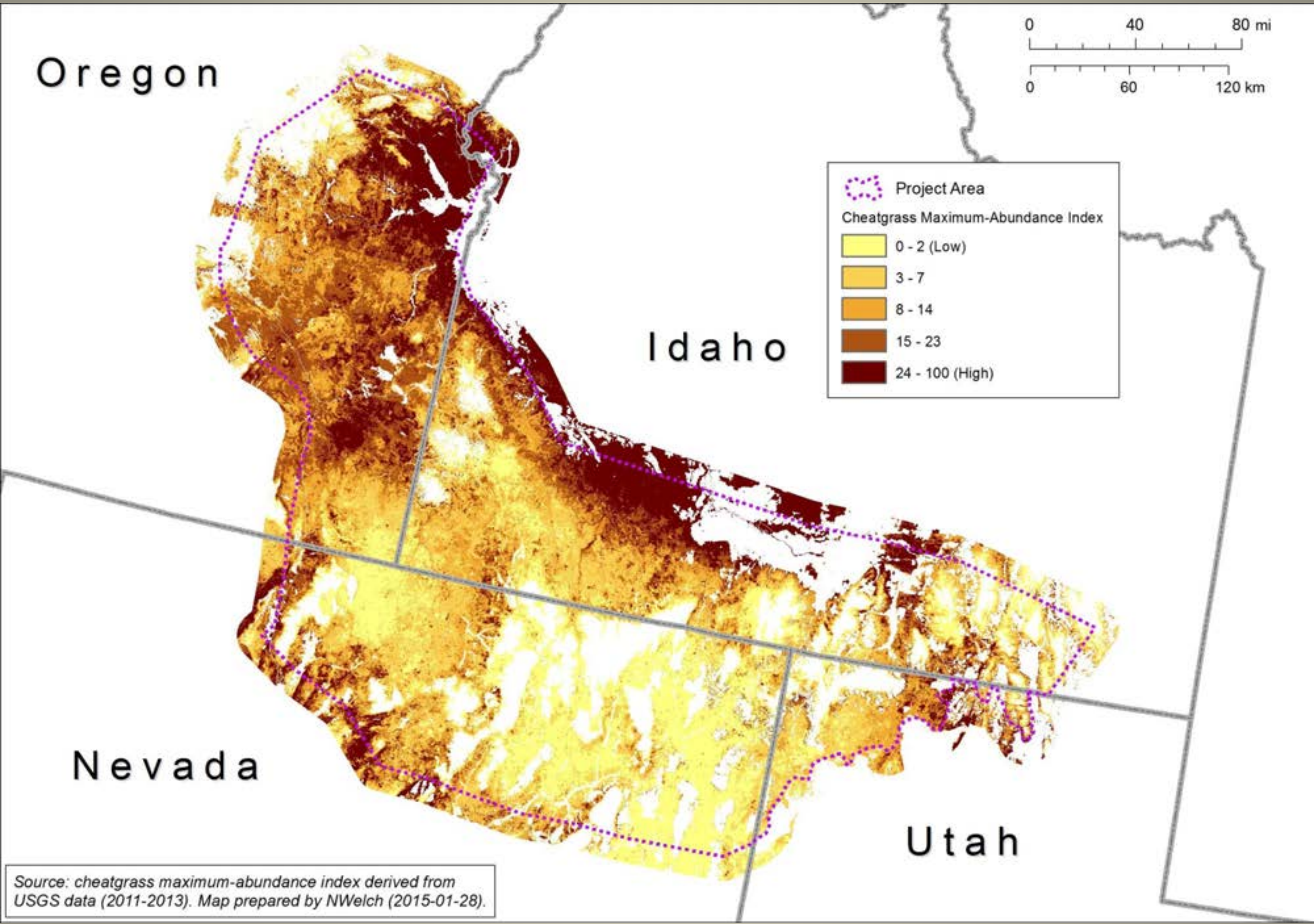
[1]*Lab of Landscape Ecology and Conservation Biology, Landscape Conservation Initiative, Northern Arizona University, Flagstaff, Arizona 86011 USA*
[2]*Conservation Science Partners, Truckee, California 96161 USA*

Abstract. Understanding where and when on the landscape fire is likely to burn (fire likelihood) and the predicted responses of valued resources (fire effects) will lead to more effective management of wildfire risk in multiple ecosystem types. Fire is a contagious and highly unpredictable process, and an analysis of fire connectivity that incorporates stochasticity may help predict fire likelihood across large extents. We developed a model of fire connectivity based on electrical circuit theory, which is a probabilistic approach to modeling ecological flows. We first parameterized our model to reflect the synergistic influences of fuels, landscape properties, and winds on fire spread in the lower Sonoran Desert of southwestern Arizona, and then defined this landscape as an interconnected network through which to model flow (i.e., fire spread). We interpreted the mapped outputs as fire likelihood and used historical burned area data to evaluate our results. Expected fire effects were characterized based on the degree to which future fire exposure might negatively impact native plant community recovery, taking into account the impact of repeated fire and major vegetation associations. We explored fire effects within habitat for the endangered Sonoran pronghorn antelope and designated wilderness. Model results indicated that fire likelihood was higher in lower elevations, and in areas with lower slopes and topographic roughness. Fire likelihood and effects were predicted to be high in 21% of the currently occupied range of the Sonoran pronghorn and 15% of the additional habitat considered suitable. Across 16 designated wilderness areas, highest predicted fire likelihood and effects fell within low elevation wilderness areas that overlapped large fire perimeters that occurred in 2005. As ongoing changes in climate and land cover are poised to alter the fire regime across extensive and ecologically important areas in the lower Sonoran Desert, an analysis of fire likelihood

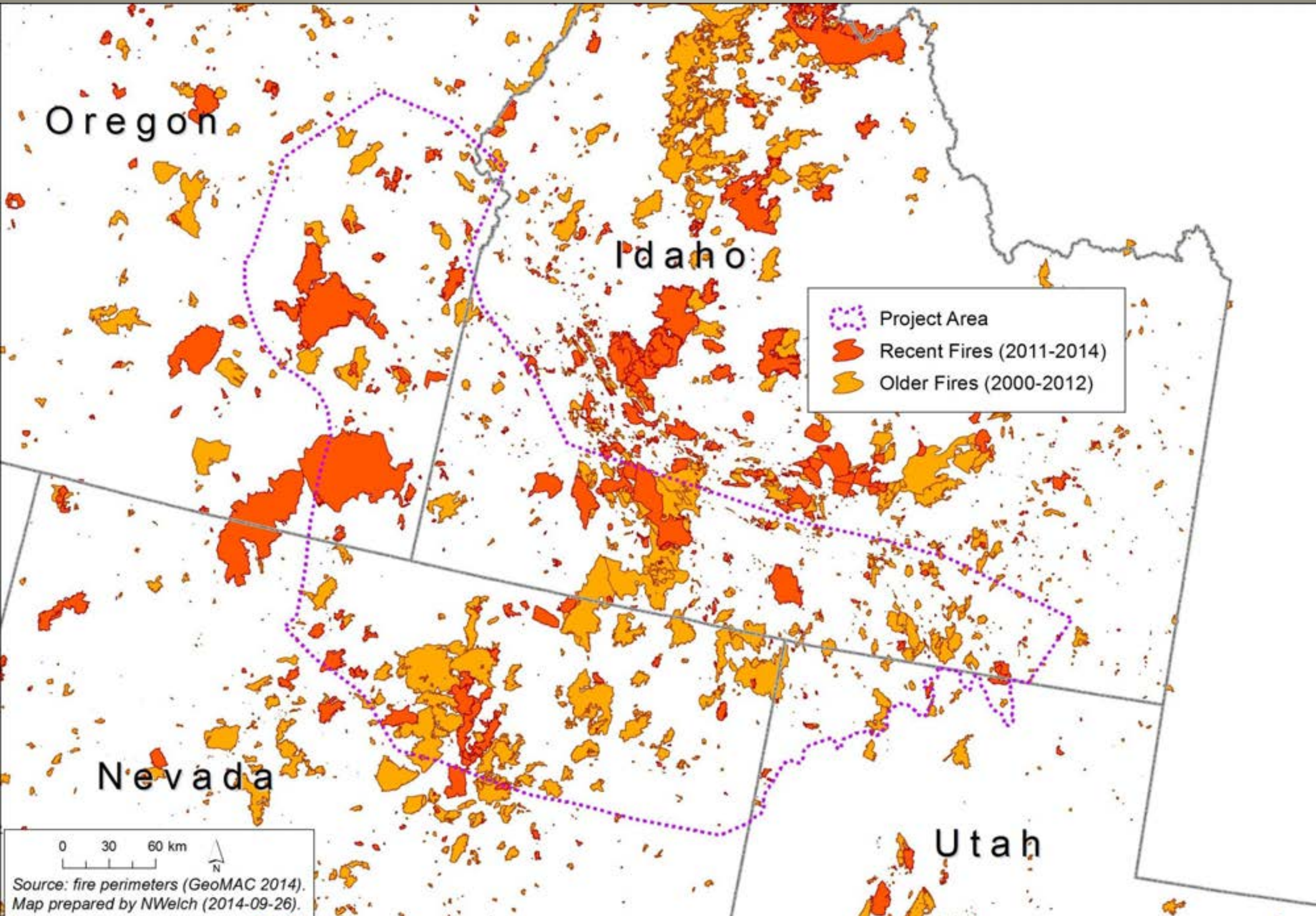

Oregon
Idaho
Nevada
Utah
0 40 80 mi
0 60 120 km
Project Area
Study Area (Project Area + 30-km Buffer)
Source (1 of 10,0000 ignitions)
Grounds (northeast boundary)
Map prepared by NWelch (2015-01-28).

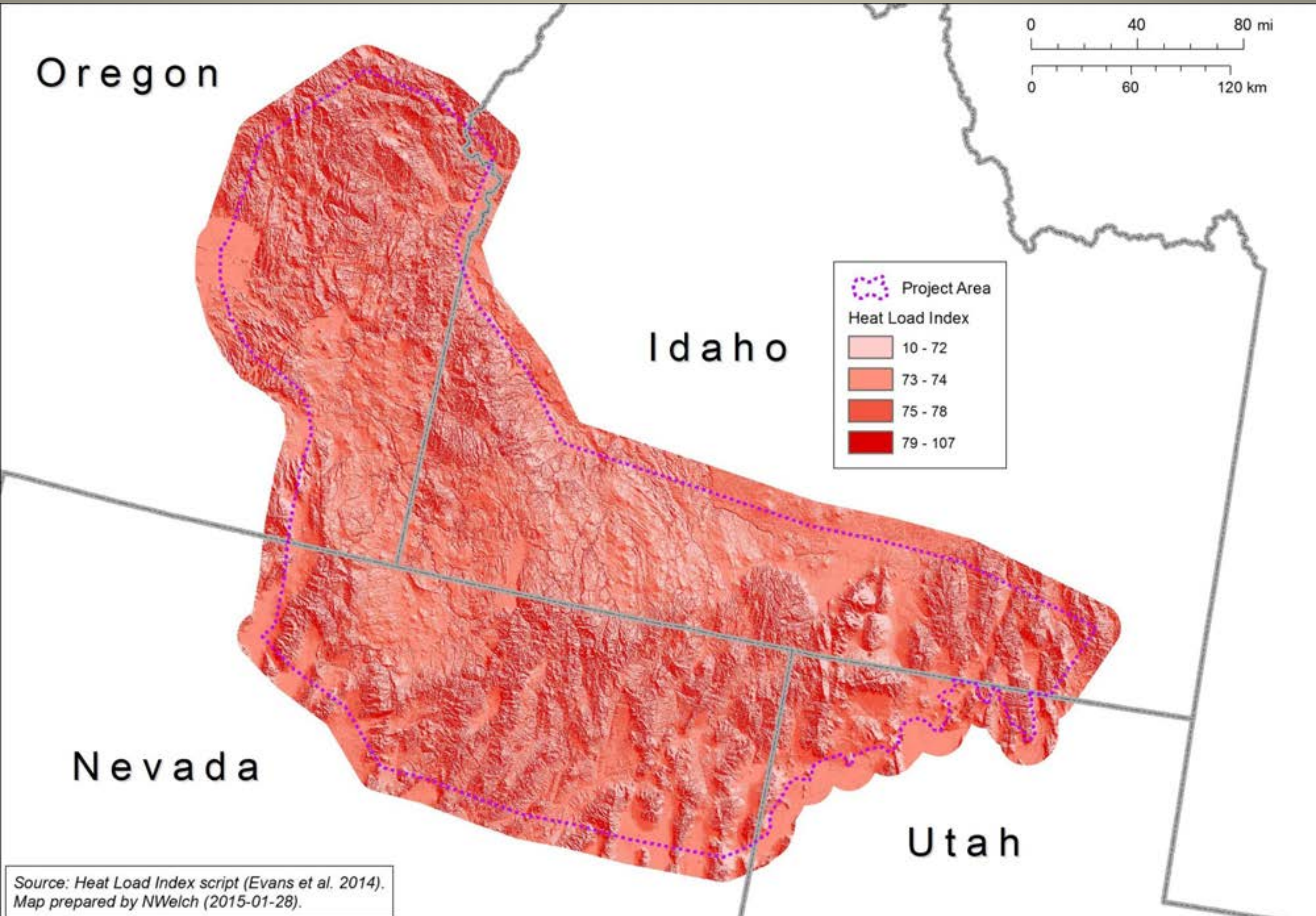
Creating the Resistance Raster

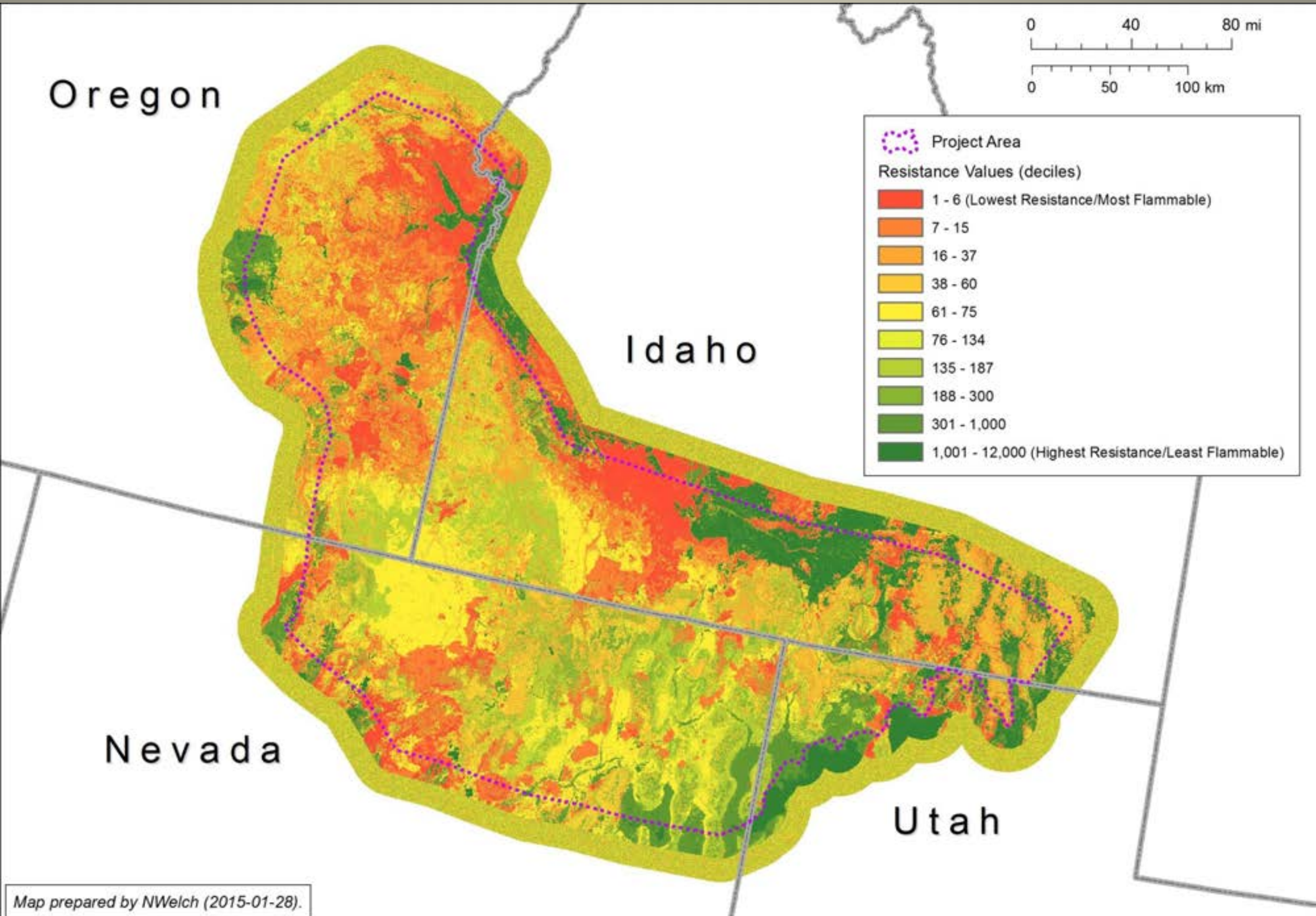

Oregon
Idaho
Nevada
Utah
0
40
80 mi
0
60
120 km
Project Area
Fire Return Interval (yr)
8
9 - 10
11 - 50
51 - 90
91 - 100
101 - 225
226 - 250
251 - 900
901 - 1,000
1,001 - 10,000
Source: Estimated Fire Return Intervals (TNC Staff).
Map prepared by NWelch (2015-01-28).



Oregon
Idaho
Nevada
Utah
0 40 80 mi
0 60 120 km
Project Area
Cheatgrass Maximum-Abundance Index
0 - 2 (Low)
3 - 7
8 - 14
15 - 23
24 - 100 (High)
Source: cheatgrass maximum-abundance index derived from USGS data (2011-2013). Map prepared by NWelch (2015-01-28).

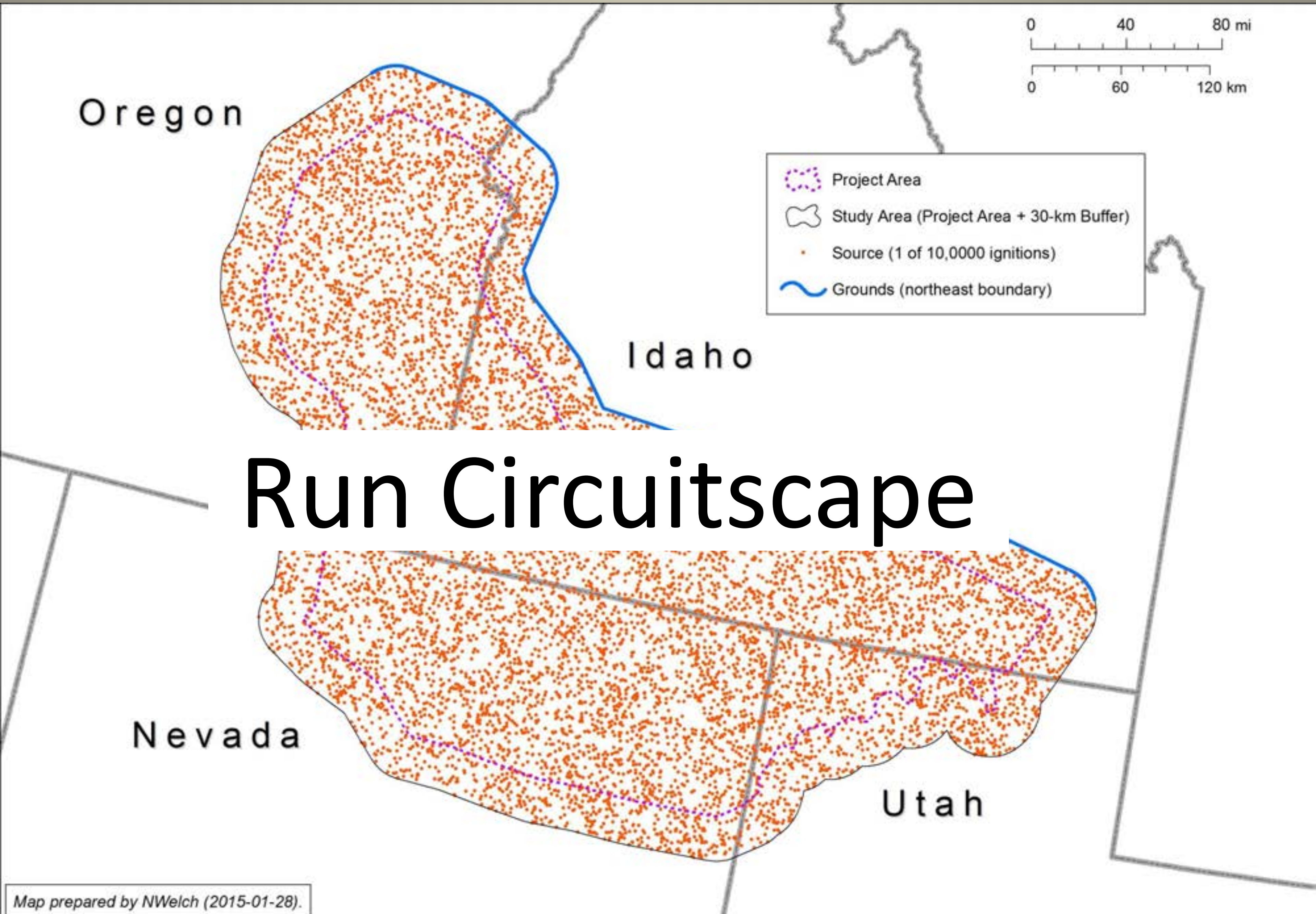

Oregon
Idaho
Nevada
Utah
Project Area
Recent Fires (2011-2014)
Older Fires (2000-2012)
0 30 60 km
N
Source: fire perimeters (GeoMAC 2014).
Map prepared by NWelch (2014-09-26).

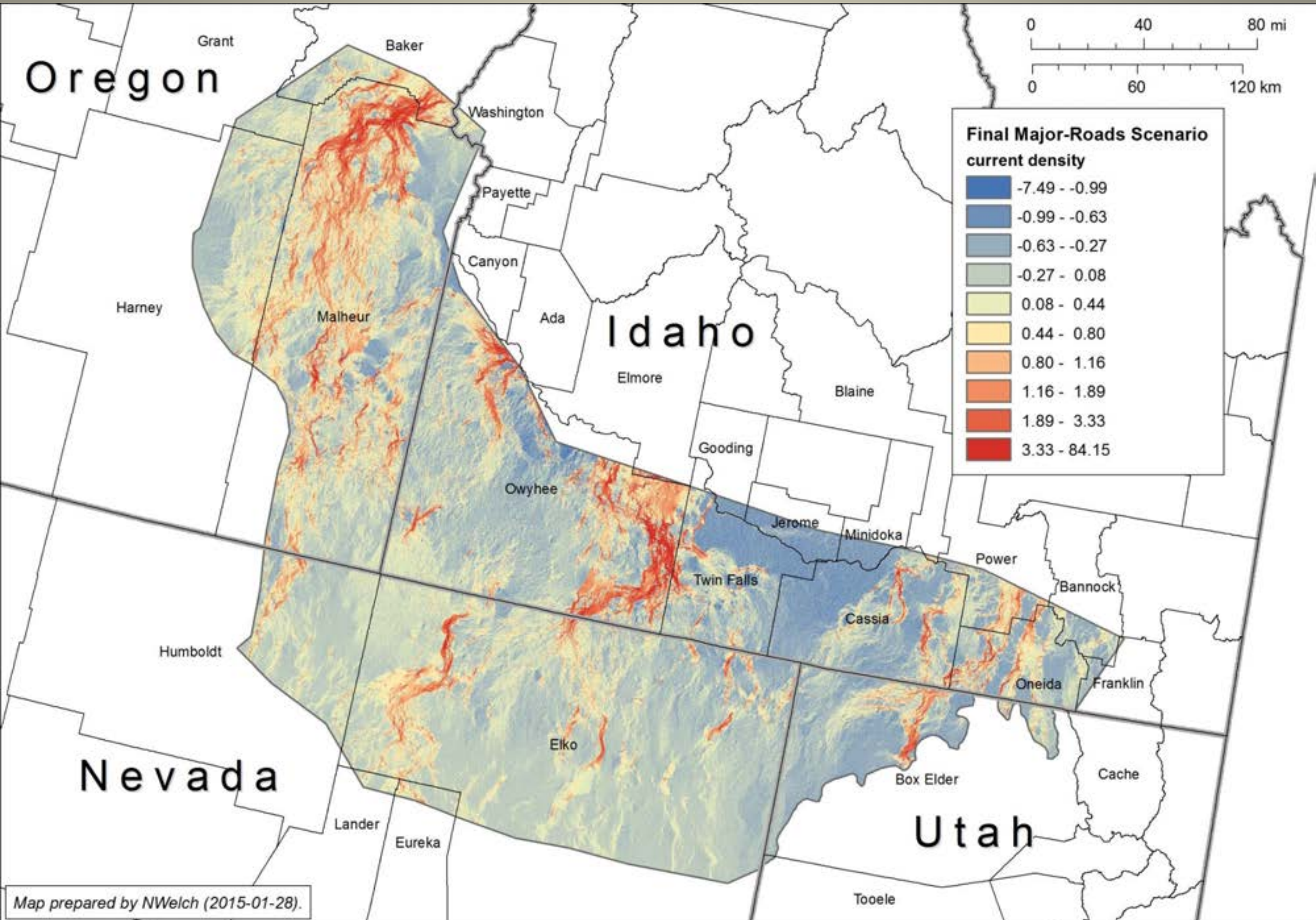

Oregon
Idaho
Nevada
Utah
0 40 80 mi
0 60 120 km
Project Area
Heat Load Index
10 - 72
73 - 74
75 - 78
79 - 107
Source: Heat Load Index script (Evans et al. 2014).
Map prepared by NWelch (2015-01-28).



Oregon
Idaho
Nevada
Utah
0
40
80 mi
0
50
100 km
Project Area
Resistance Values (deciles)
1 - 6 (Lowest Resistance/Most Flammable)
7 - 15
16 - 37
38 - 60
61 - 75
76 - 134
135 - 187
188 - 300
301 - 1,000
1,001 - 12,000 (Highest Resistance/Least Flammable)
Map prepared by NWelch (2015-01-28).

Run Circuitscape

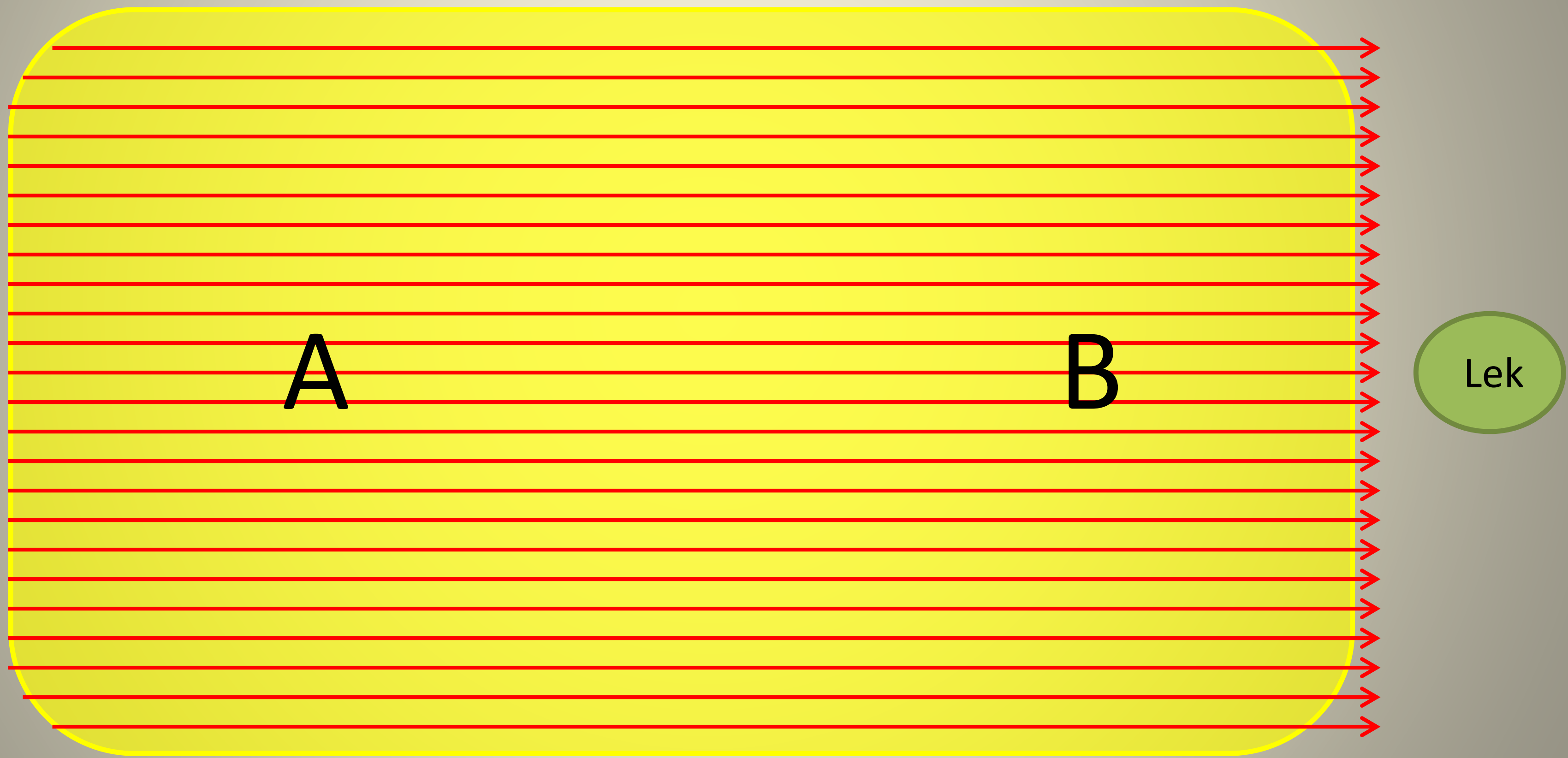



Oregon
Idaho
Nevada
Utah
Grant
Baker
Washington
Payette
Canyon
Ada
Harney
Malheur
Elmore
Blaine
Gooding
Owyhee
Jerome
Minidoka
Power
Bannock
Twin Falls
Cassia
Humboldt
Oneida
Franklin
Elko
Box Elder
Cache
Lander
Eureka
Tooele
0 40 80 mi
0 60 120 km
Final Major-Roads Scenario
current density
-7.49 - -0.99
-0.99 - -0.63
-0.63 - -0.27
-0.27 - 0.08
0.08 - 0.44
0.44 - 0.80
0.80 - 1.16
1.16 - 1.89
1.89 - 3.33
3.33 - 84.15
Map prepared by NWelch (2015-01-28).

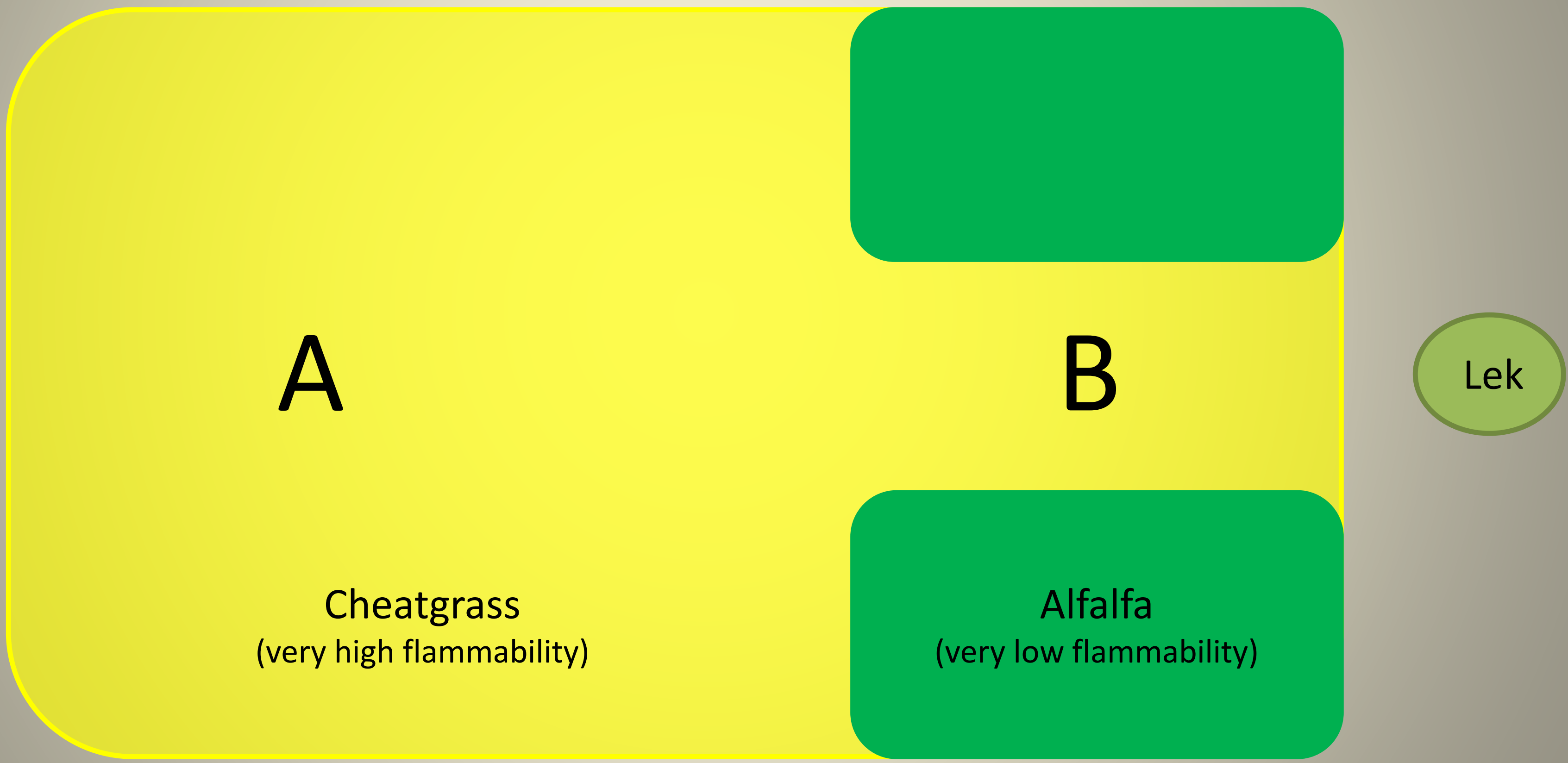
Interpreting Circuitscape Results

In this landscape, locations A and B have the same *wildfire likelihood*.

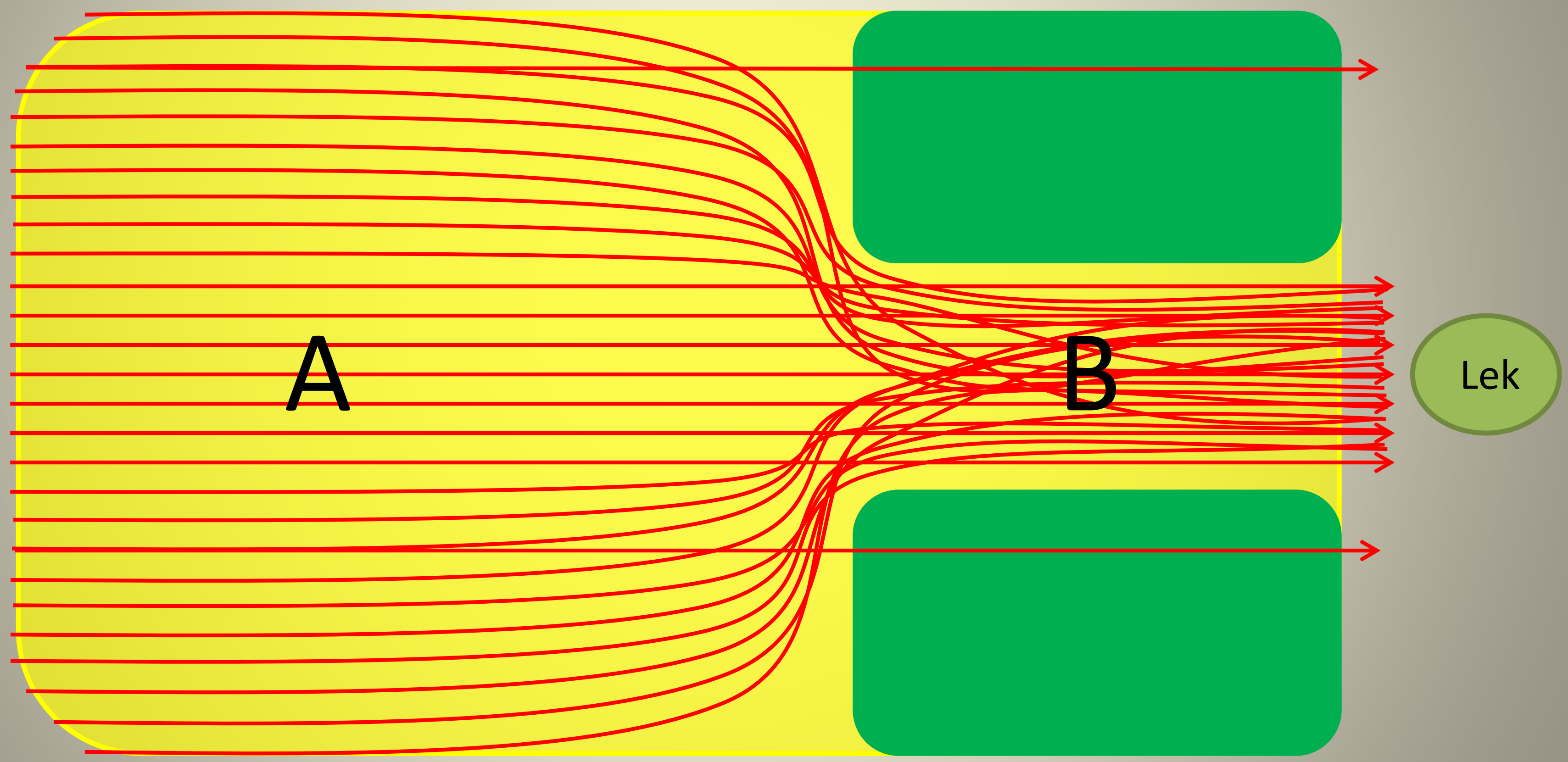
In this landscape, Circuitscape tells us locations A and B have the same current density (= *wildfire transmission* or *fuel break potential*).

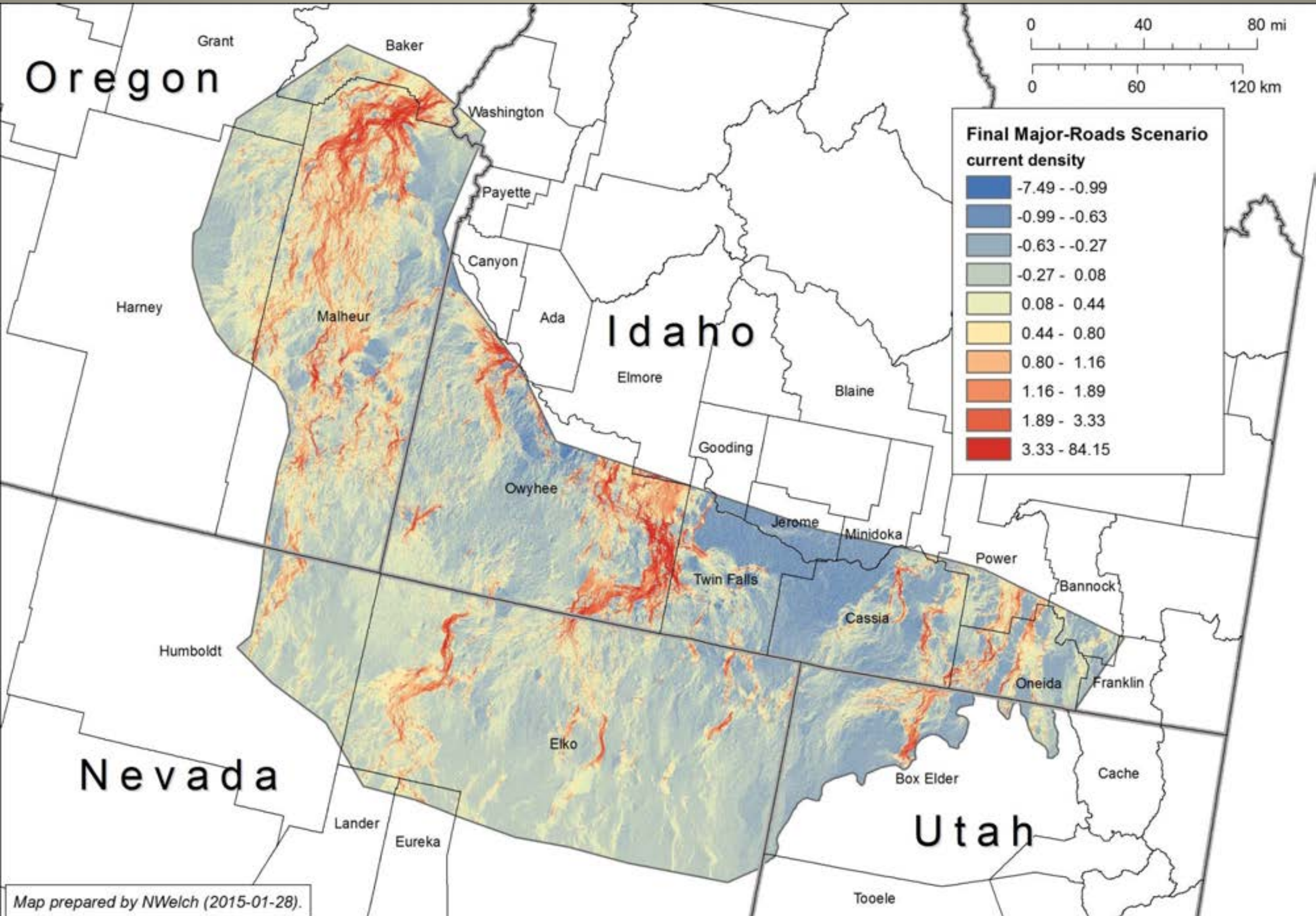


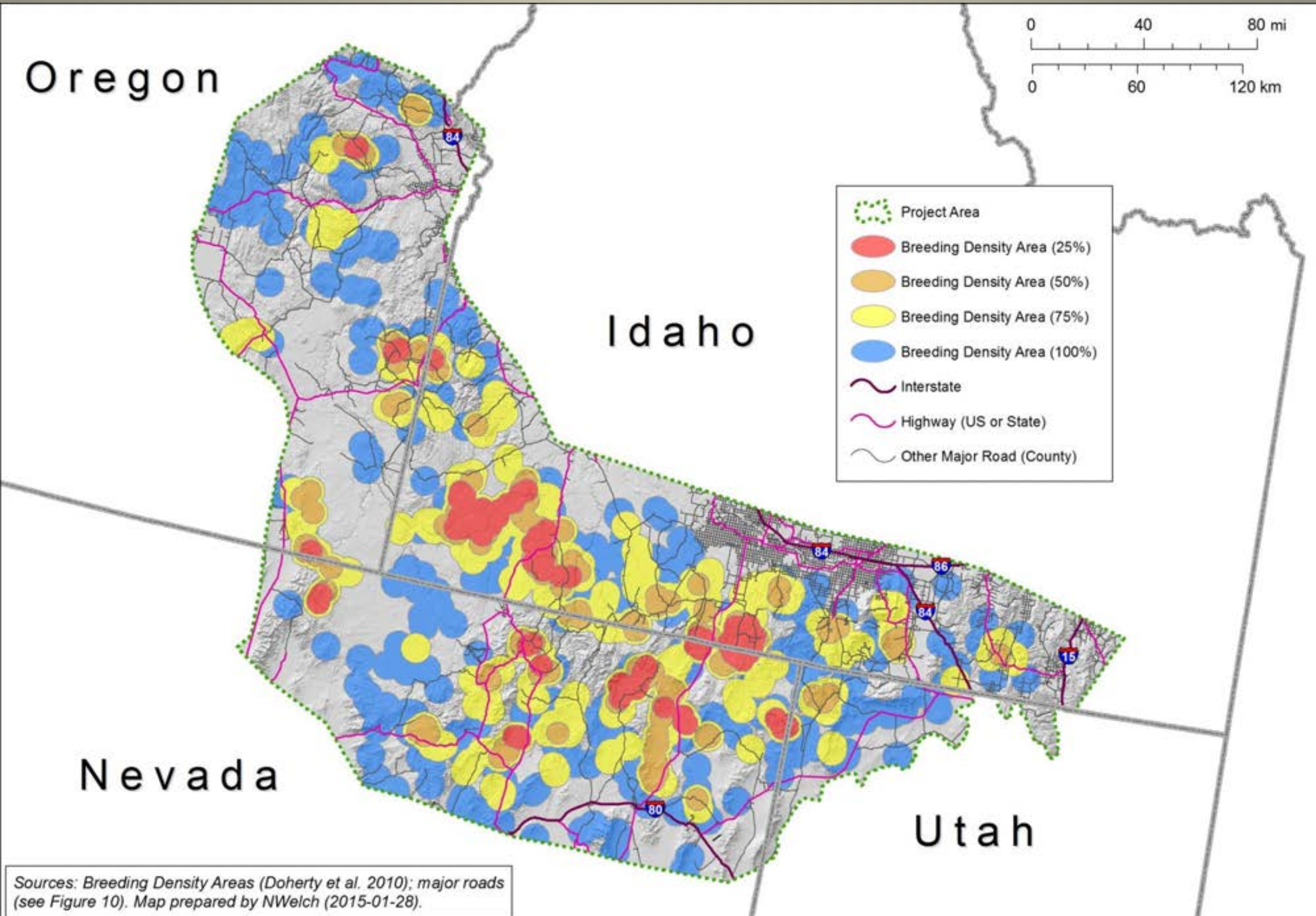
In this new landscape, locations A and B still have roughly the same *wildfire likelihood*.

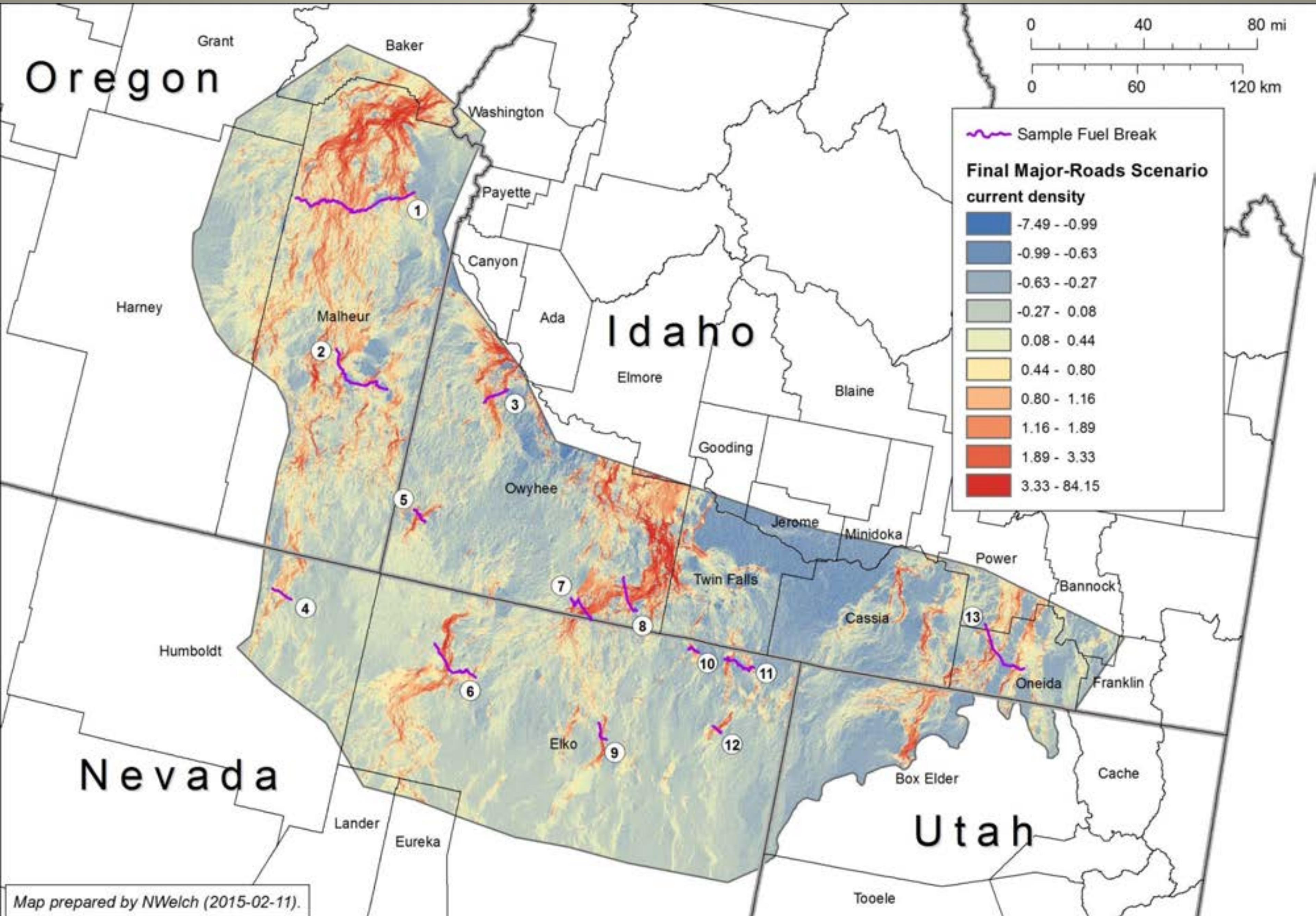


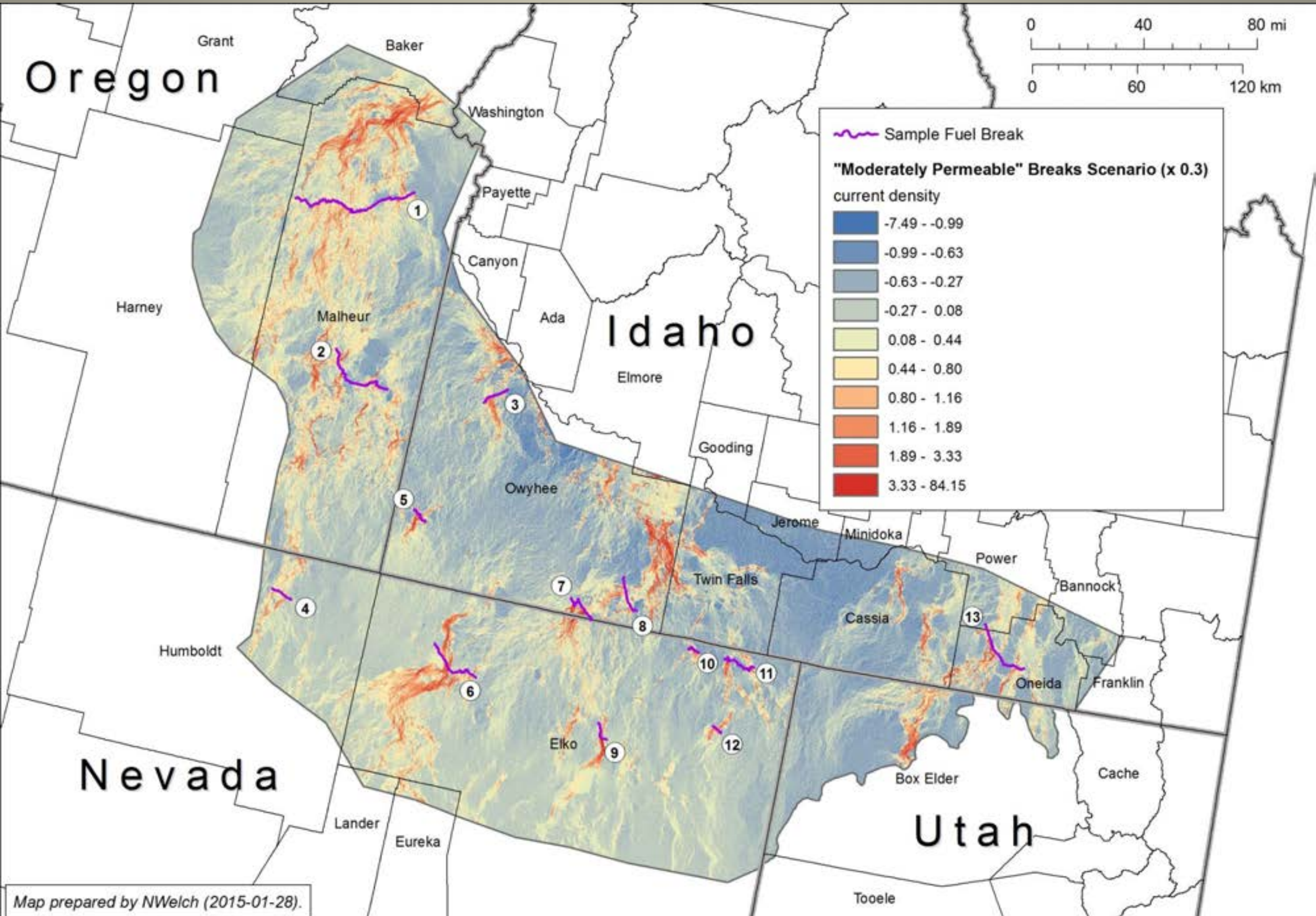
However, now Circuitscape tells us locations A and B have very different current densities (= *wildfire transmission* or *fuel break potential*). The area surrounding B is a “pinch point” and might be a more efficient place for a fuel break.




Oregon
Idaho
Nevada
Utah
Grant
Baker
Washington
Payette
Canyon
Ada
Harney
Malheur
Elmore
Blaine
Gooding
Owyhee
Jerome
Minidoka
Power
Bannock
Twin Falls
Cassia
Humboldt
Oneida
Franklin
Elko
Box Elder
Cache
Lander
Eureka
Tooele
0 40 80 mi
0 60 120 km
Final Major-Roads Scenario
current density
-7.49 - -0.99
-0.99 - -0.63
-0.63 - -0.27
-0.27 - 0.08
0.08 - 0.44
0.44 - 0.80
0.80 - 1.16
1.16 - 1.89
1.89 - 3.33
3.33 - 84.15
Map prepared by NWelch (2015-01-28).


Oregon
Idaho
Nevada
Utah
0 40 80 mi
0 60 120 km
Project Area
Breeding Density Area (25%)
Breeding Density Area (50%)
Breeding Density Area (75%)
Breeding Density Area (100%)
Interstate
Highway (US or State)
Other Major Road (County)
84
86
15
80
Sources: Breeding Density Areas (Doherty et al. 2010); major roads (see Figure 10). Map prepared by NWelch (2015-01-28).


Oregon
Idaho
Nevada
Utah
Grant
Baker
Washington
Payette
Canyon
Ada
Harney
Malheur
Elmore
Blaine
Gooding
Owyhee
Jerome
Minidoka
Power
Bannock
Twin Falls
Cassia
Humboldt
Oneida
Franklin
Elko
Box Elder
Cache
Lander
Eureka
Tooele
0 40 80 mi
0 60 120 km
Sample Fuel Break
Final Major-Roads Scenario
current density
-7.49 - -0.99
-0.99 - -0.63
-0.63 - -0.27
-0.27 - 0.08
0.08 - 0.44
0.44 - 0.80
0.80 - 1.16
1.16 - 1.89
1.89 - 3.33
3.33 - 84.15
1
2
3
4
5
6
7
8
9
10
11
12
13
Map prepared by NWelch (2015-02-11).



Oregon
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Nevada
Utah
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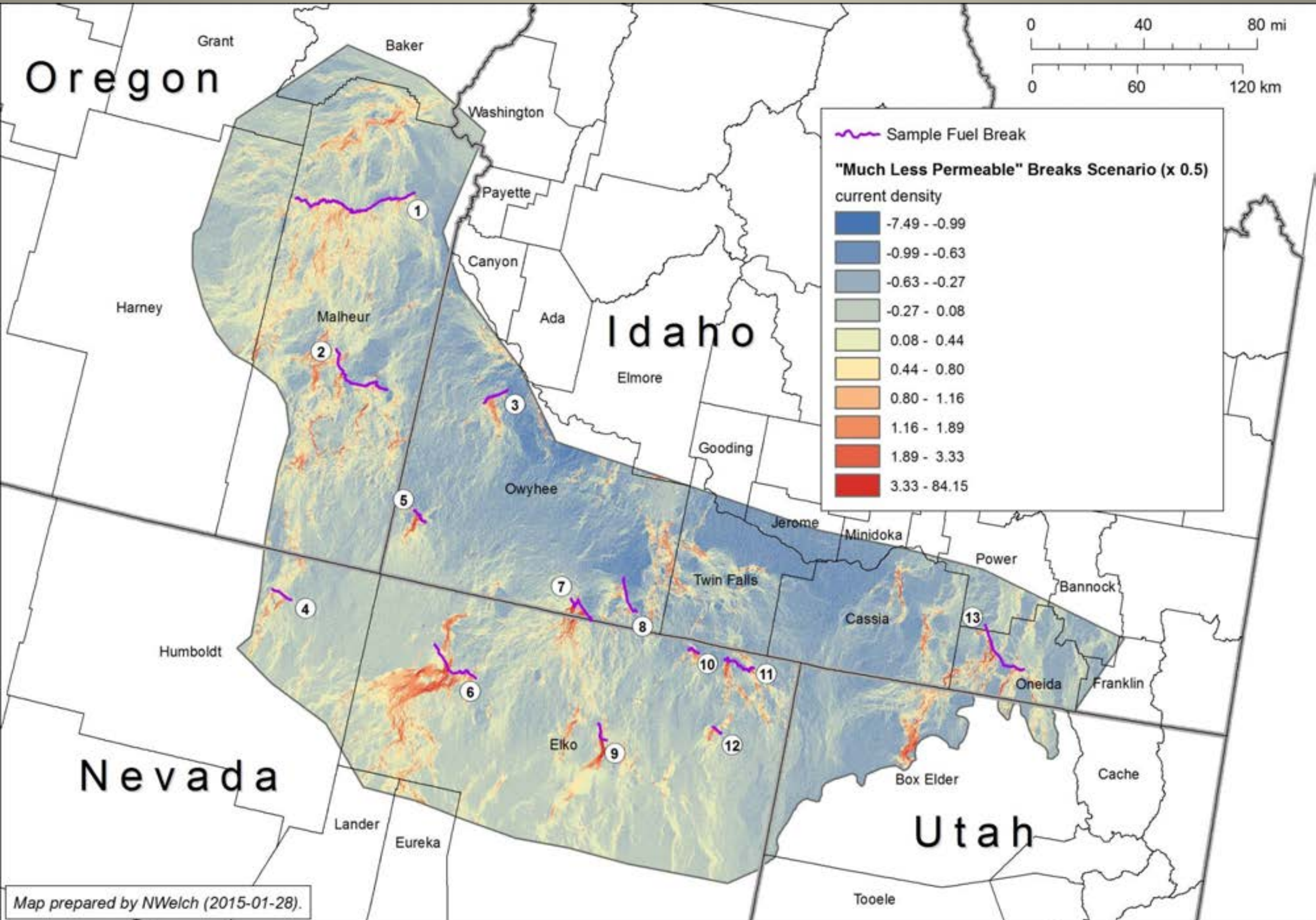
Baker
Washington
Payette
Canyon
Ada
Elmore
Harney
Malheur
Owyhee
Gooding
Jerome
Minidoka
Power
Bannock
Twin Falls
Cassia
Oneida
Franklin
Humboldt
Elko
Box Elder
Cache
Lander
Eureka
Tooele
0 40 80 mi
0 60 120 km
Sample Fuel Break
"Moderately Permeable" Breaks Scenario (x 0.3)
current density
-7.49 - -0.99
-0.99 - -0.63
-0.63 - -0.27
-0.27 - 0.08
0.08 - 0.44
0.44 - 0.80
0.80 - 1.16
1.16 - 1.89
1.89 - 3.33
3.33 - 84.15
1
2
3
4
5
6
7
8
9
10
11
12
13
Map prepared by NWelch (2015-01-28).



Oregon
Idaho
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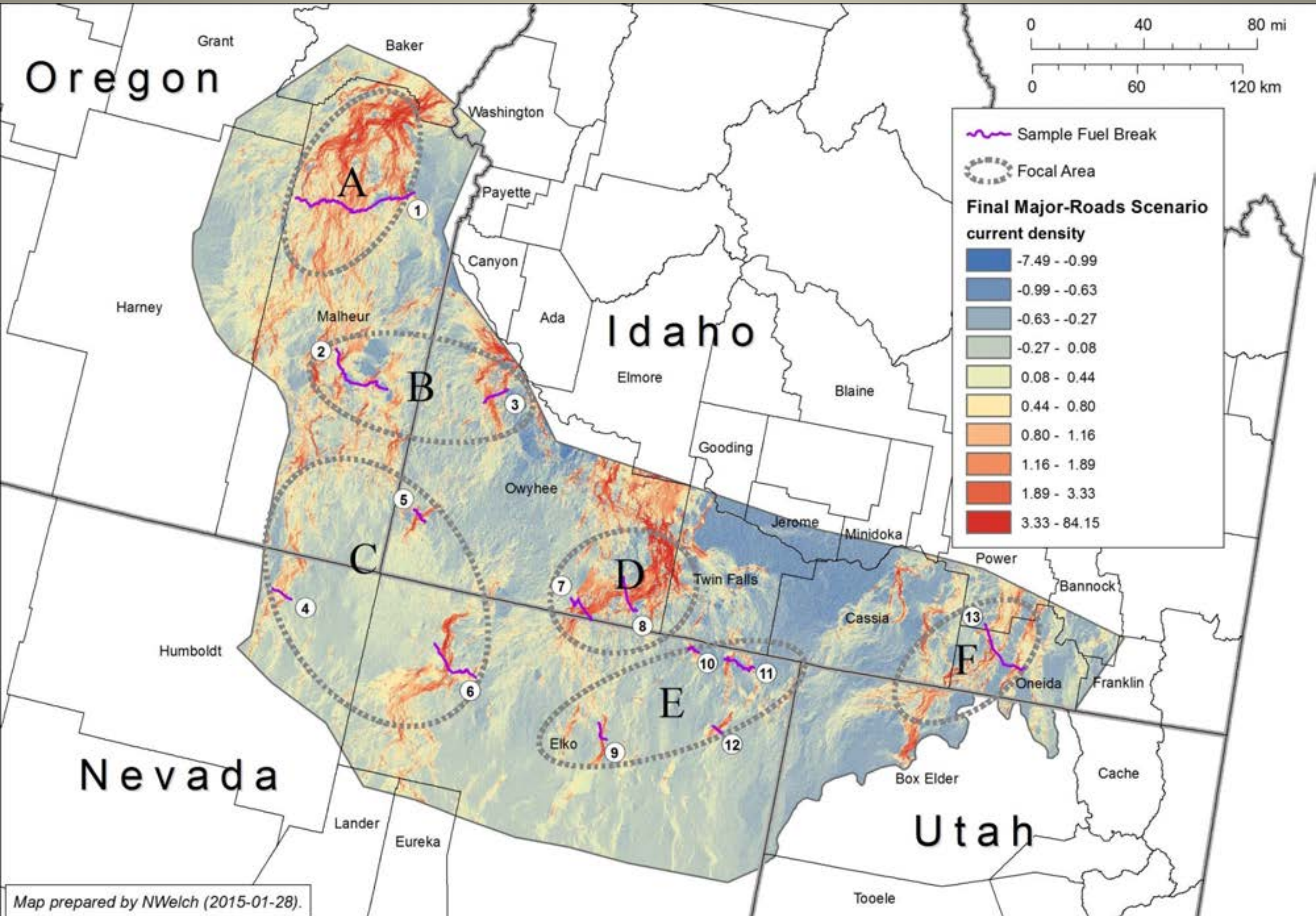
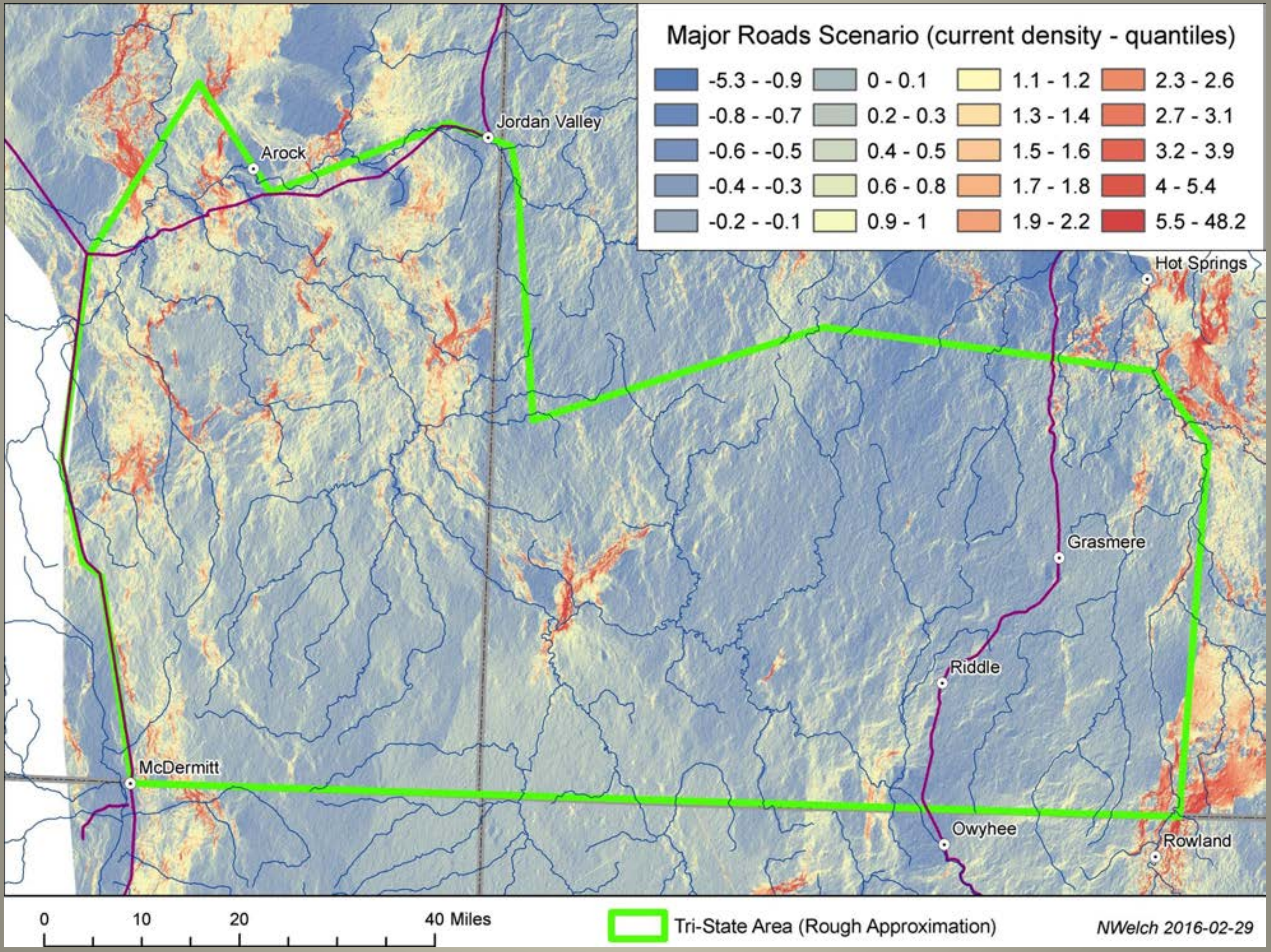
Utah
Grant
Baker
Washington
Payette
Canyon
Ada
Elmore
Gooding
Harney
Malheur
Owyhee
Jerome
Minidoka
Power
Bannock
Twin Falls
Cassia
Oneida
Franklin
Humboldt
Elko
Box Elder
Cache
Lander
Eureka
Tooele
0 40 80 mi
0 60 120 km
Sample Fuel Break
"Much Less Permeable" Breaks Scenario (x 0.5)
current density
-7.49 - -0.99
-0.99 - -0.63
-0.63 - -0.27
-0.27 - 0.08
0.08 - 0.44
0.44 - 0.80
0.80 - 1.16
1.16 - 1.89
1.89 - 3.33
3.33 - 84.15
1
2
3
4
5
6
7
8
9
10
11
12
13
Map prepared by NWelch (2015-01-28).



0
40
80 mi
0
60
120 km
Sample Fuel Break
Focal Area
Final Major-Roads Scenario
current density
-7.49 - -0.99
-0.99 - -0.63
-0.63 - -0.27
-0.27 - 0.08
0.08 - 0.44
0.44 - 0.80
0.80 - 1.16
1.16 - 1.89
1.89 - 3.33
3.33 - 84.15
Oregon
Idaho
Nevada
Utah
Grant
Baker
Washington
Payette
Canyon
Harney
Malheur
Ada
Elmore
Blaine
Gooding
Owyhee
Jerome
Minidoka
Power
Bannock
Twin Falls
Cassia
Humboldt
Oneida
Franklin
Elko
Box Elder
Cache
Lander
Eureka
Tooele
A
B
C
D
E
F
1
2
3
4
5
6
7
8
9
10
11
12
13
Map prepared by NWelch (2015-01-28).


Major Roads Scenario (current density - quantiles)
-5.3 - -0.9
-0.8 - -0.7
-0.6 - -0.5
-0.4 - -0.3
-0.2 - -0.1
0 - 0.1
0.2 - 0.3
0.4 - 0.5
0.6 - 0.8
0.9 - 1
1.1 - 1.2
1.3 - 1.4
1.5 - 1.6
1.7 - 1.8
1.9 - 2.2
2.3 - 2.6
2.7 - 3.1
3.2 - 3.9
4 - 5.4
5.5 - 48.2
Jordan Valley
Arock
Hot Springs
Grasmere
Riddle
McDermitt
Owyhee
Rowland
0
10
20
40 Miles
Tri-State Area (Rough Approximation)
NWelch 2016-02-29

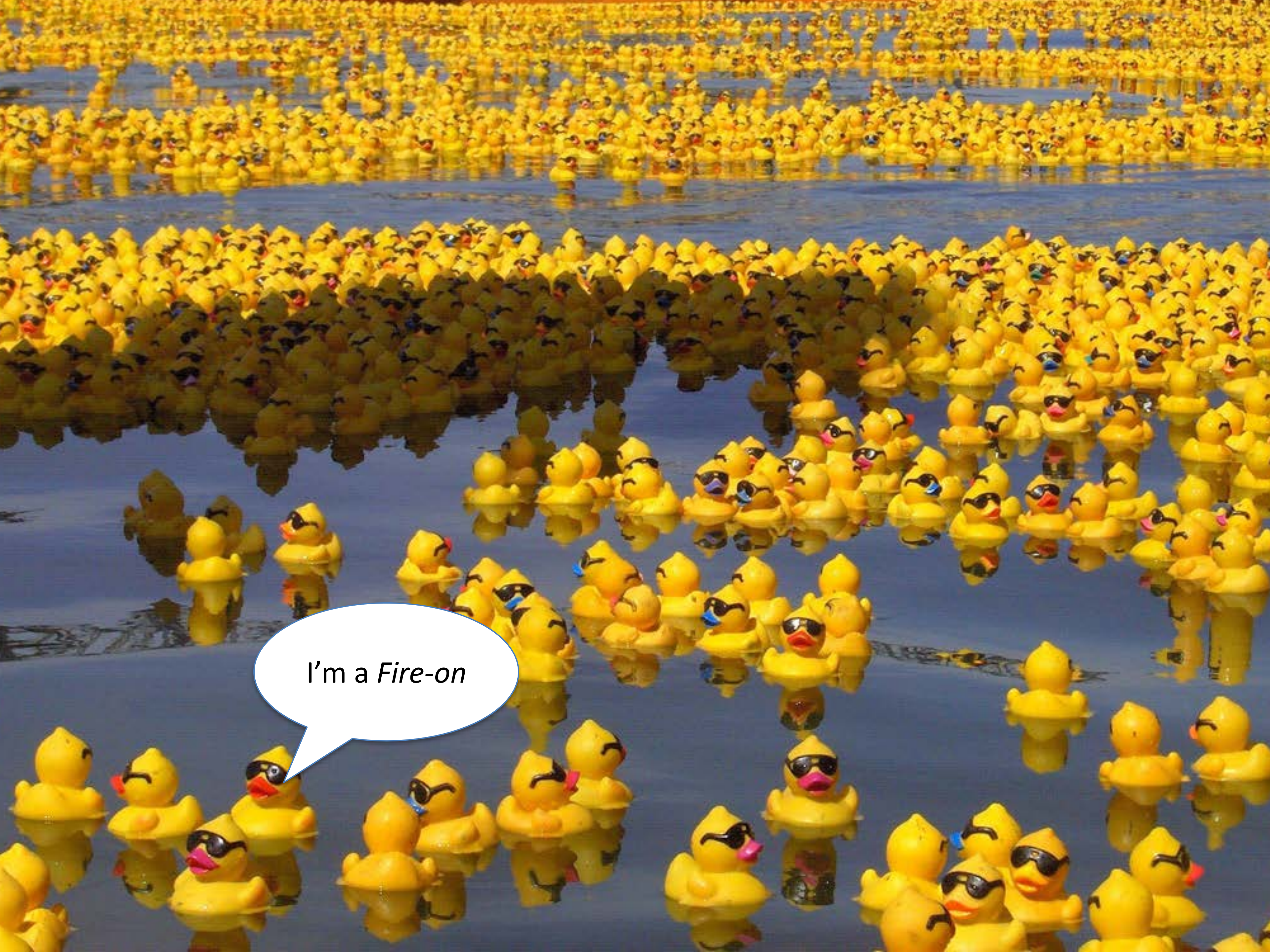
Next Steps

- Using Circuitscape, we have developed a process to identify strategic locations for fuel breaks at regional scales and to simulate potential fuel breaks with different levels of effectiveness (i.e., permeability). It provides a starting place for land managers to consider in planning efforts. It does not indicate whether a fuel break is possible, practical, or desirable from a local perspective.
- Our report is being shared with public and private land managers as another resource to inform decisions about land and fire management. We intend to pursue a collaboration with fire managers in at least one of the focal geographies we identified.
- We are pursuing opportunities to test and improve our modeling approach and to conduct a rigorous comparison with more sophisticated fire models.

Acknowledgments

We are grateful for funding from the Western Association of Fish and Wildlife Agencies and, ultimately, to the U.S. Fish and Wildlife Service.

Elaine York (The Nature Conservancy in Utah) and Jay Kerby (The Nature Conservancy in Oregon) helped with local agency workshop coordination and outreach.

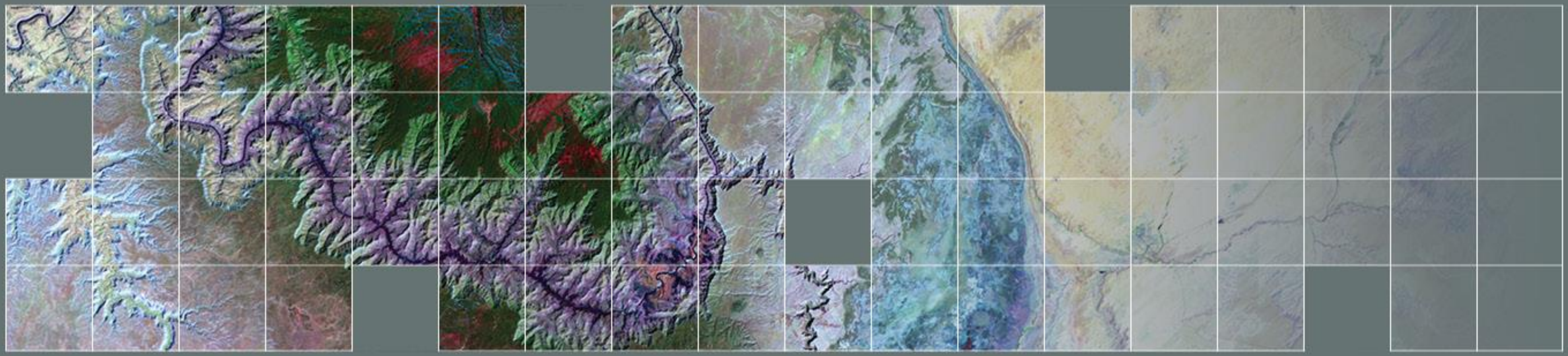

I'm a *Fire-on*

science for a changing world

Climate and Land Use Change

Earth Resources Observation and Science (EROS) Center

Characterization of Shrub/Grass Components Across the West with Remote Sensing, New Opportunities for Habitat and Trend Analysis



U.S. Department of the Interior
U.S. Geological Survey

Collin Homer, April 4th, 2016

Outline and Acknowledgments

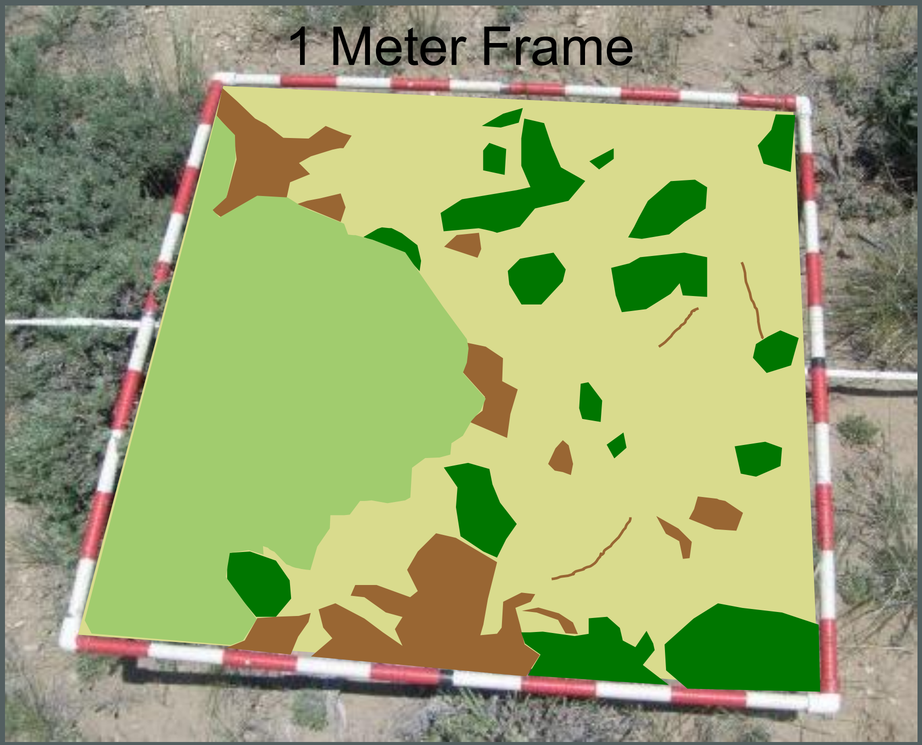
- What are remote sensing components and how are they created?
- What are the current results?
- How can they be used?
- What products are coming?
- Future possibilities?
- How to get them

Acknowledgements:

- Many individuals doing this work at USGS-EROS, USGS-FRESC and USGS-FORT and BLM, USGS and WAFWA/USFWS for providing funding

USGS

What are fractional vegetation components?



Vegetation Components

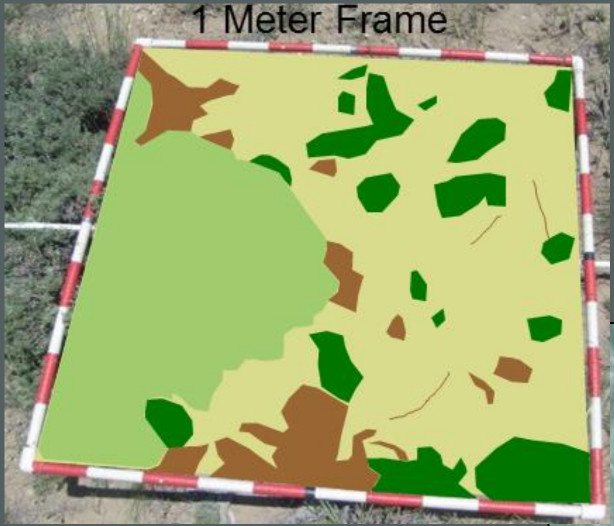
- **Sagebrush/shrub - 30%**
- **Herbaceous - 15%**
- **Litter - 10%**
- **Bare ground - 45%**

Component proportions are field measured and then extrapolated to satellite imagery pixels in the same way

USGS

Fractional components are scaled up from field measurements with 2 scales of satellite imagery using regression tree models

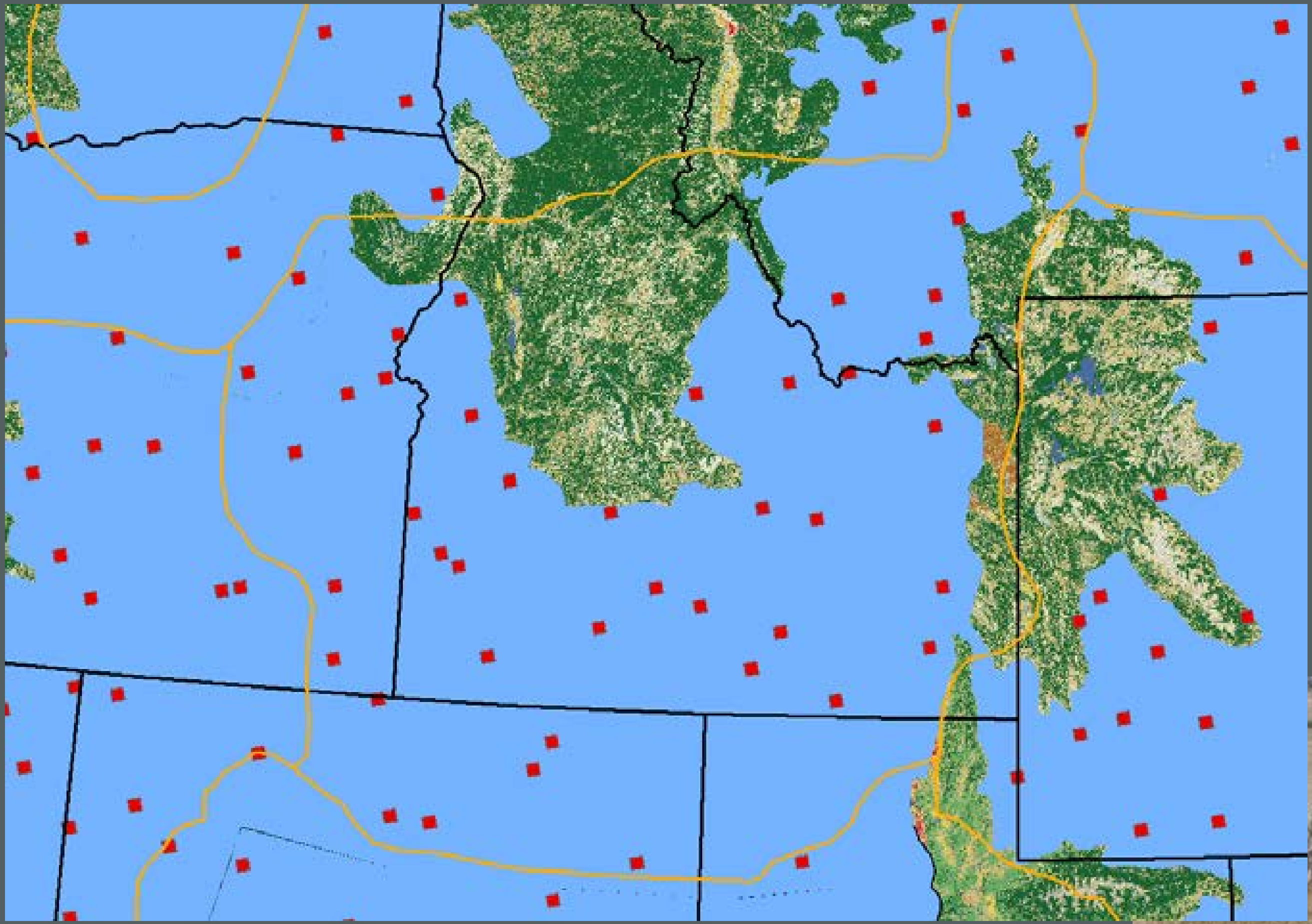
Field Measured Bare Ground



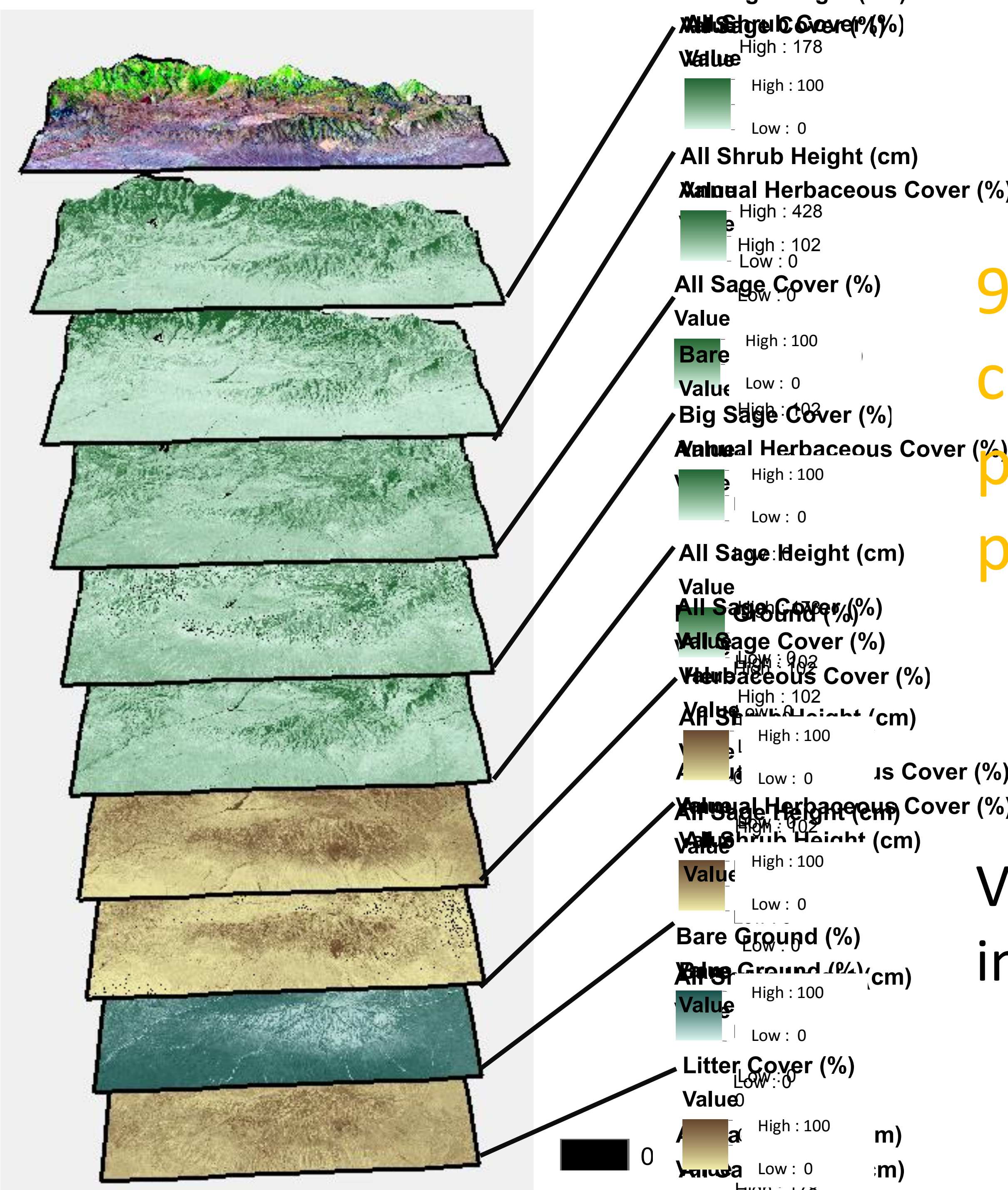
High Resolution Satellite Bare Ground (2.4 meter pixel)

Landsat Bare Ground (30meter pixel)

Products require extensive fieldwork at strategic Worldview 2/3 collects to be successful (about 144 sq. km. each)



USGS

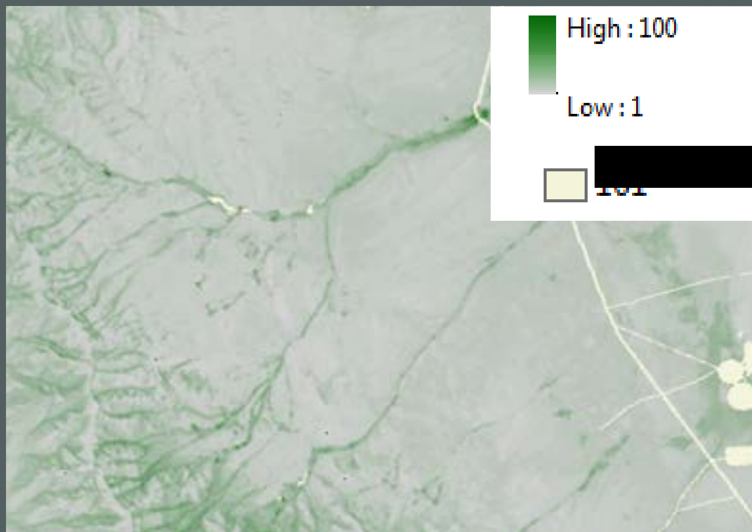


9 Shrub component products are being produced

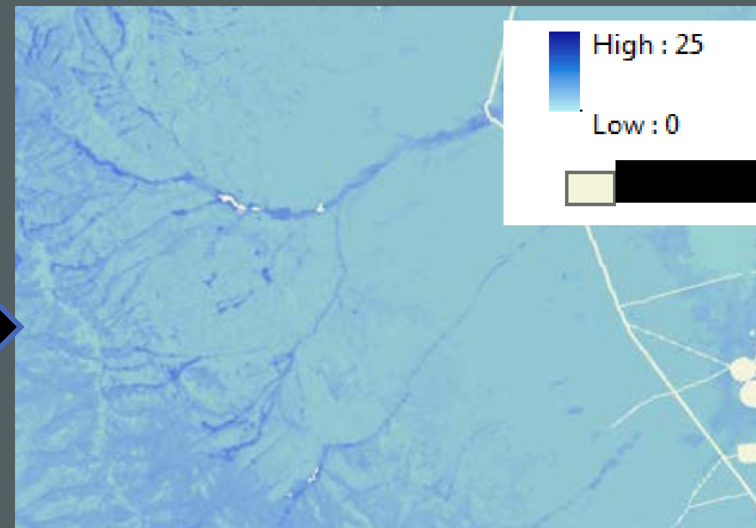
Values in 1% increments

Validation includes independent validation, cross validation and a spatial absolute error model prediction with all products

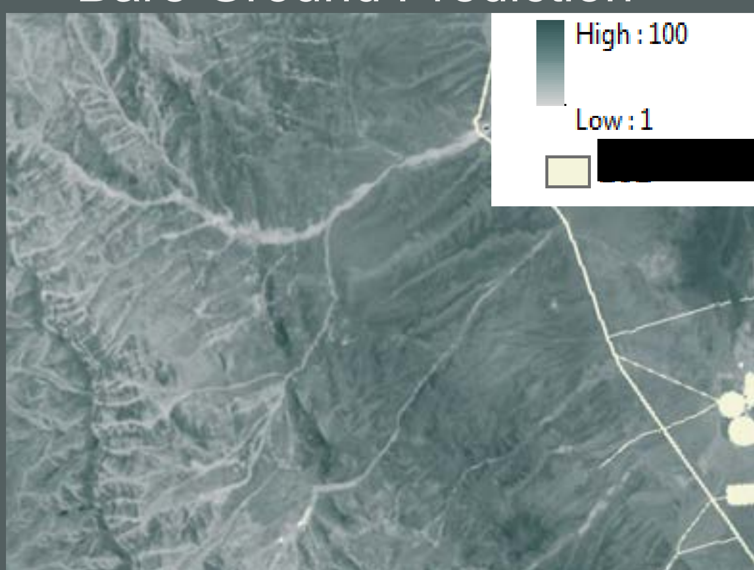
Shrub Prediction



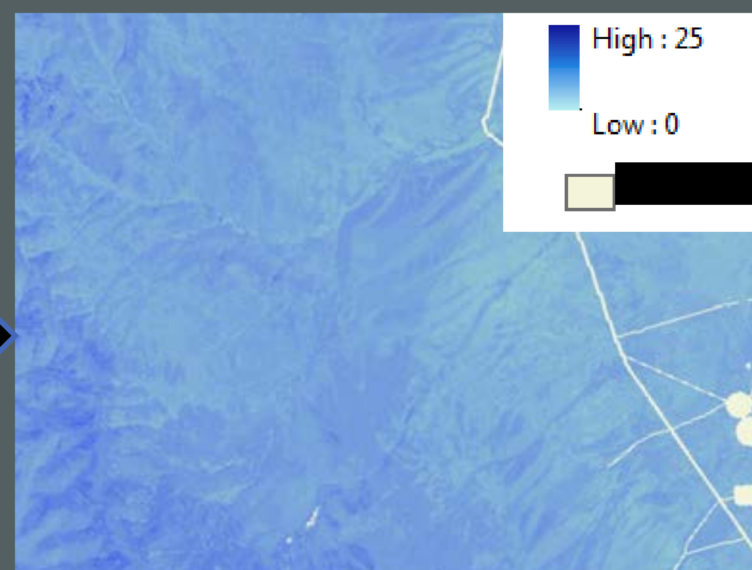
Shrub Absolute Error



Bare Ground Prediction

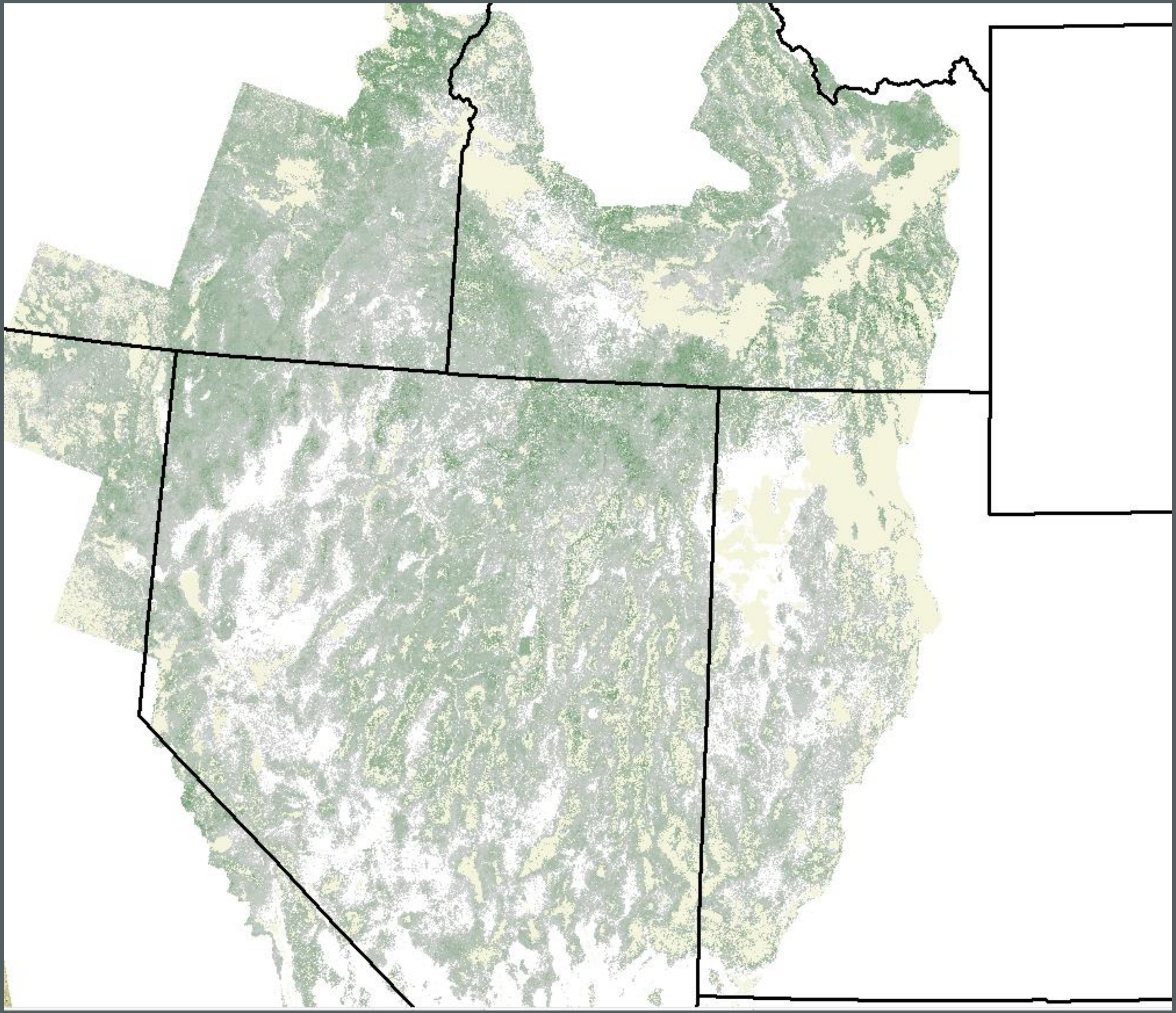


Bare Ground Absolute Error



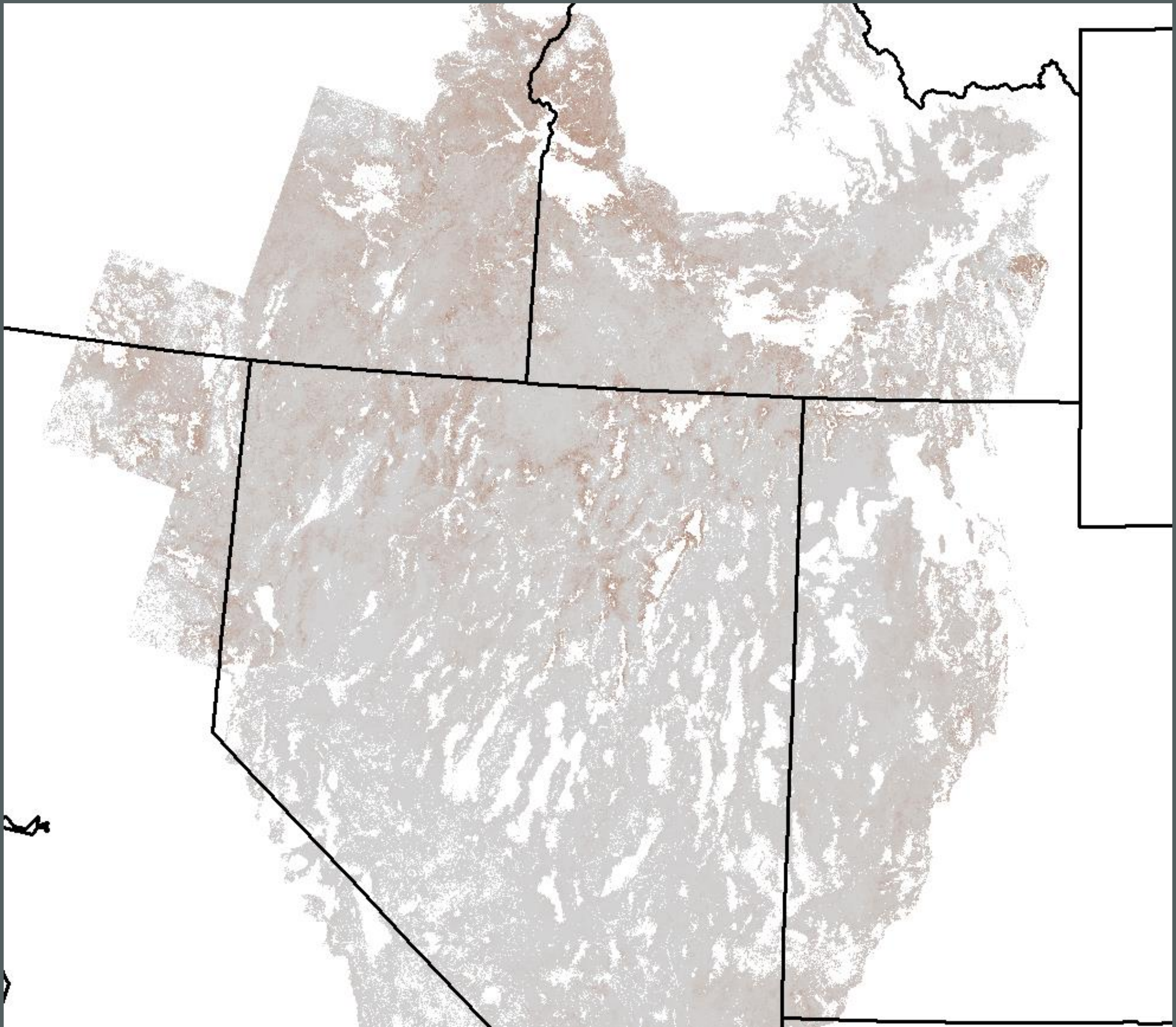
Great Basin Percent Sagebrush Component

RMSE accuracy is about 6%



Great Basin Annual Herbaceous Component

RMSE accuracy is about 7%



The component approach provides maximum flexibility to compile components for endless applications – such as:

- **Sage grouse habitat** (Wyoming state-wide seasonal models (Fedy et al., 2014), and new habitat modeling across Great Basin)
- **Grazing assessment** (Wyoming grazing assessment showing differences in allotments that failed LHS)
- **Invasives** (used for monitoring cheatgrass growth over Twin Falls Idaho and Winnemucca Nevada)
- **Climate change** (used to quantify vegetation change in response to climate in Wyoming and Nevada)
- As well as other applications in **fire fuel analysis, restoration monitoring, other climate impacts**

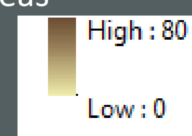
USGS

The component approach allows better quantification and monitoring of change

Nevada example of quantifying cheatgrass increase over time, 1993-2011

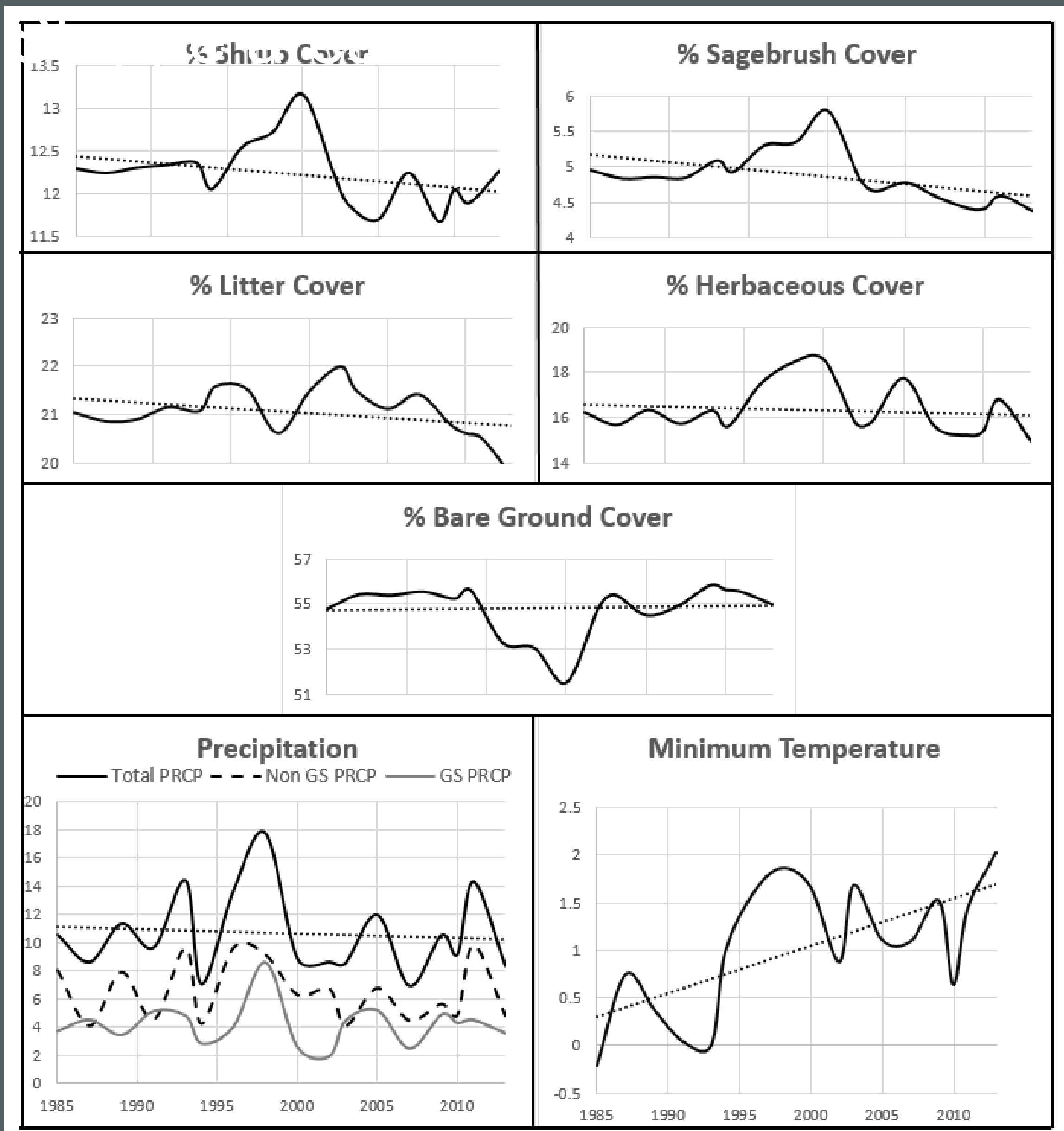
SW of Hot Springs Range

White – masked out areas



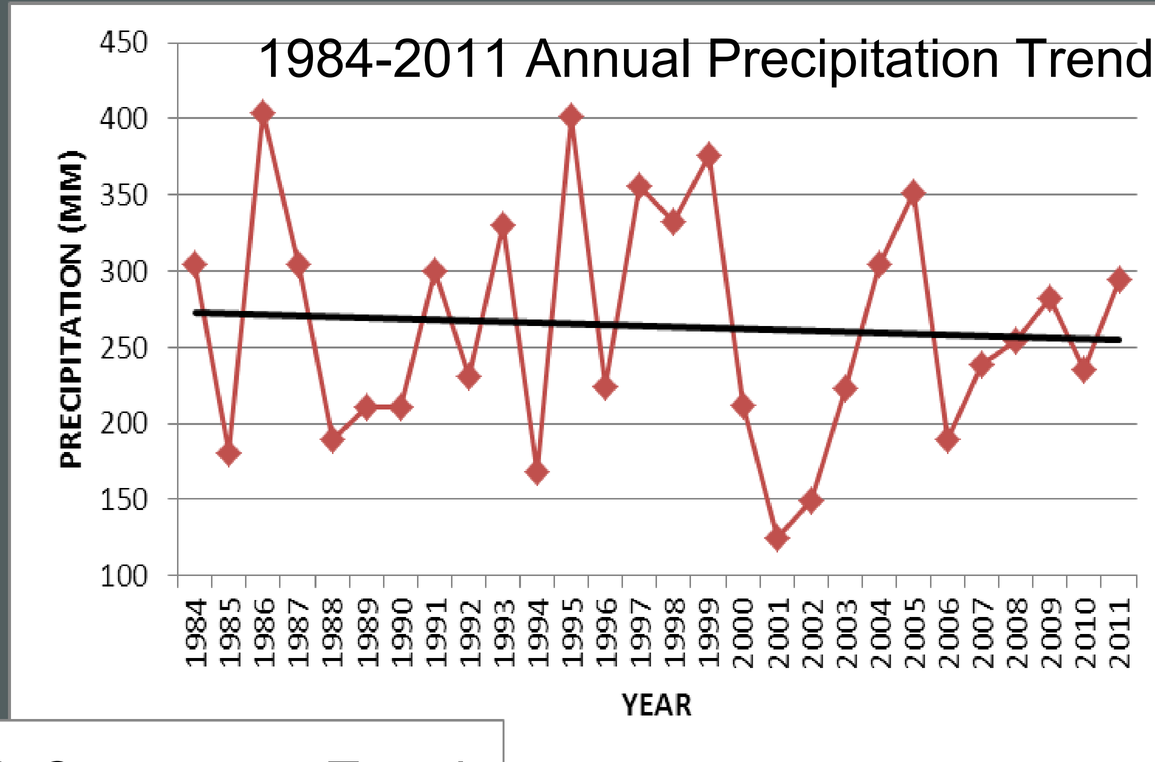
Cheatgrass quantity

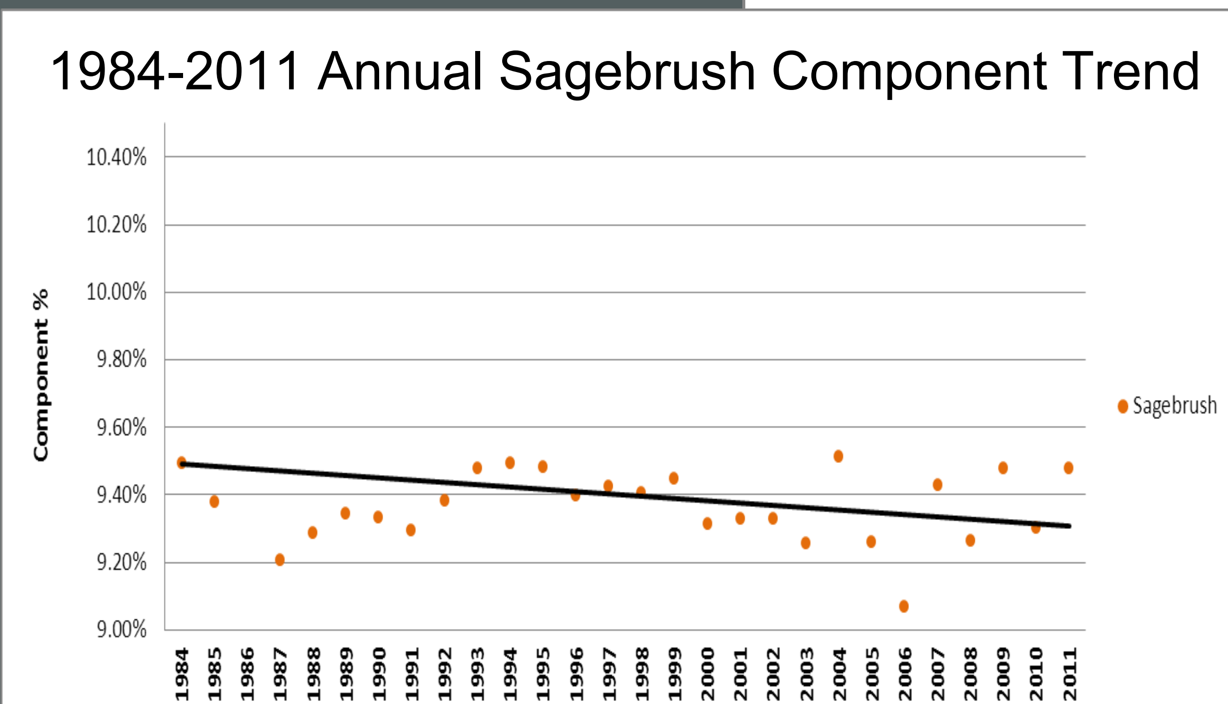
The Landsat archive can be used to see components change over time, such as this climate example…

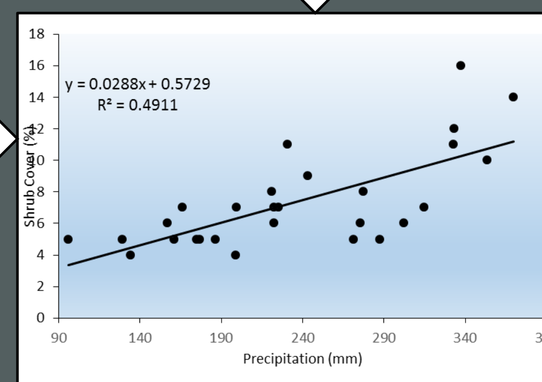


Average yearly value in climate changed pixels for Northwest Nevada/Southeast Oregon, 1985-2014

That historical relationship can then be modeled for each pixel…..

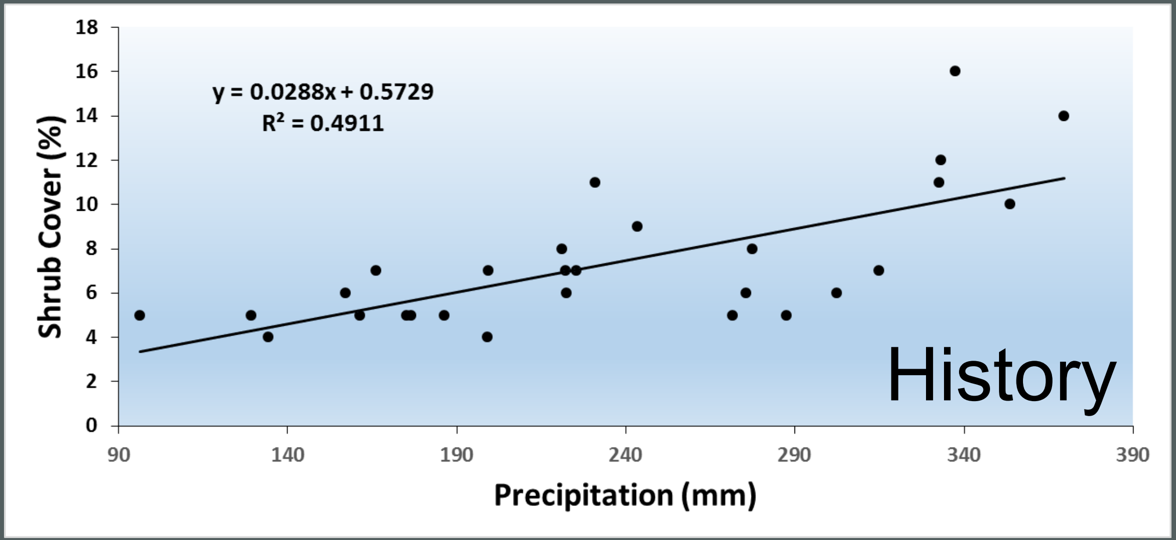






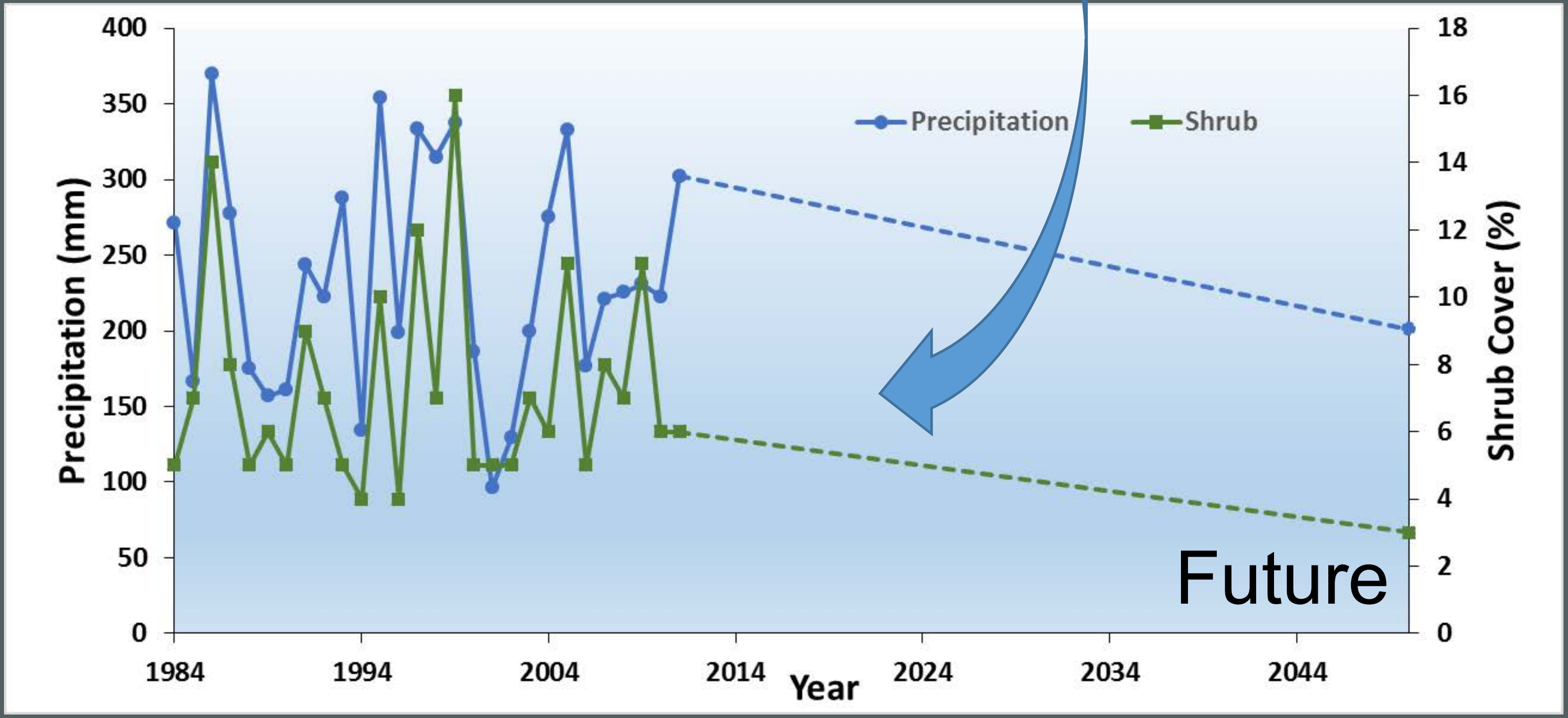
Linear Regression

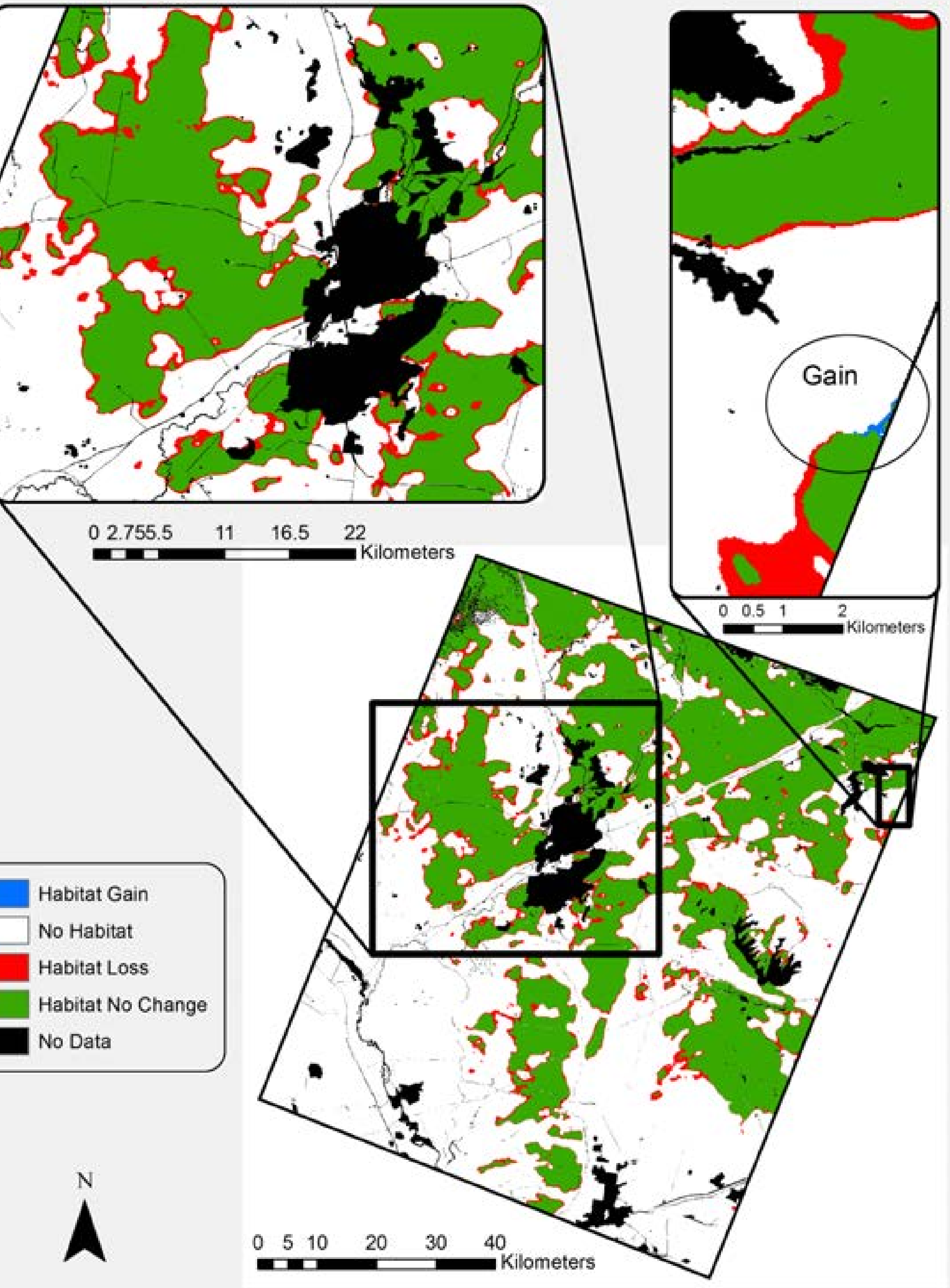
Each pixel model can then forecasted into the future



Regression between sagebrush cover and annual precipitation for a selected pixel

2050 sagebrush projected cover from projected precipitation slope for a selected pixel





This approach was used to predict the impact of climate change on Sage grouse nesting habitat between 2006 and 2050 – results indicate an 11% overall loss…..

Homer, C, Xian, G., Aldridge, C., Meyer, D., Loveland, T. and M. O'Donnell. 2015. Forecasting sagebrush ecosystem components and greater sage-grouse habitat for 2050: Learning from past climate patterns and Landsat imagery to predict the future. *Ecological Indicators*, Vol. 55, 131–145.

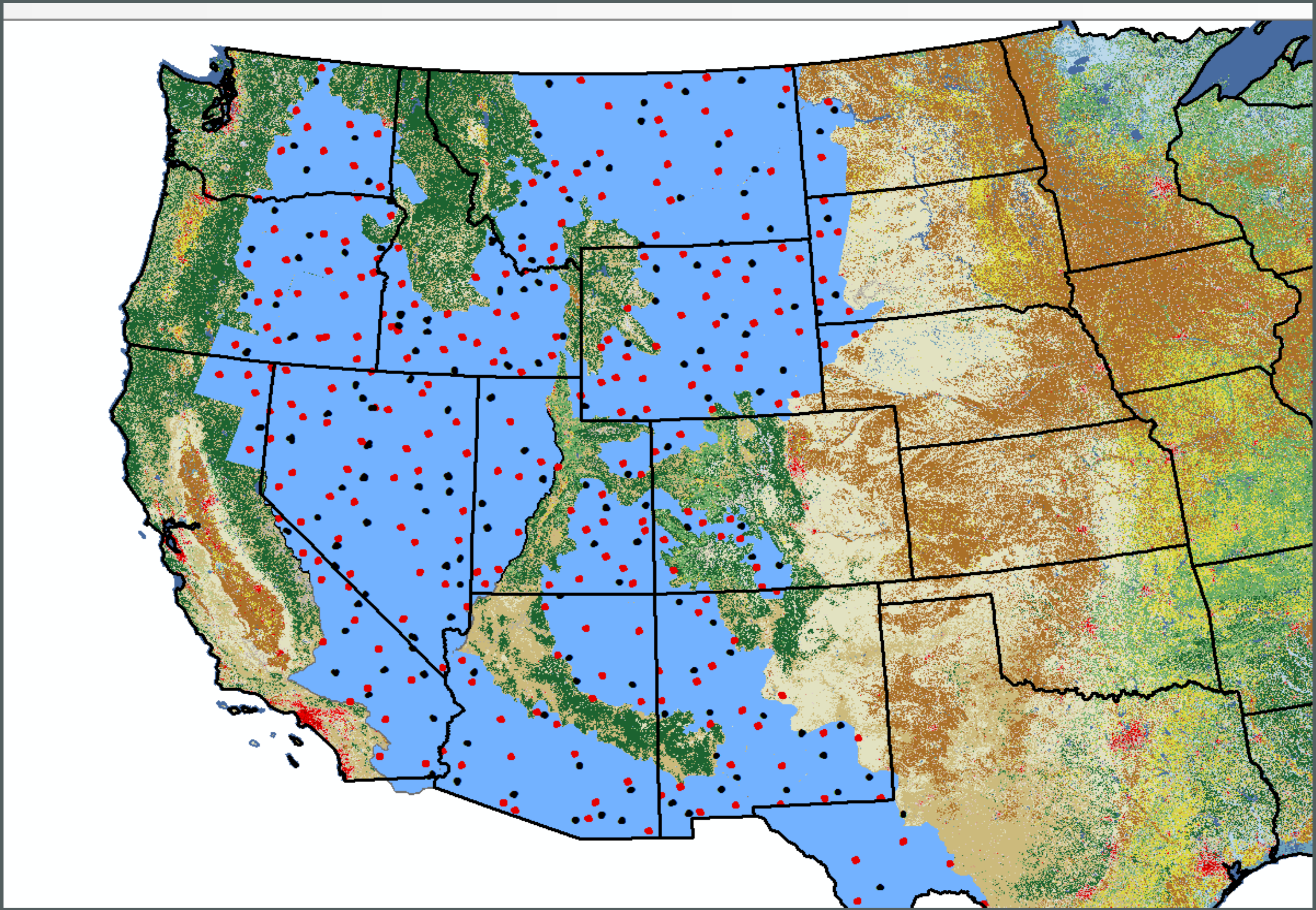
Research Goals – tell this story about every pixel in the West…..

- Characterize it's components
- Score the "intactness" of the pixel against expected site potential
- Determine how much the pixel changed since 1983, and what caused the change?
- How much of that change is climate?
- Knowing the past history, what is the likely future trend for the pixel from climate and other change agents?
- Communicate results with interactive data "maps"

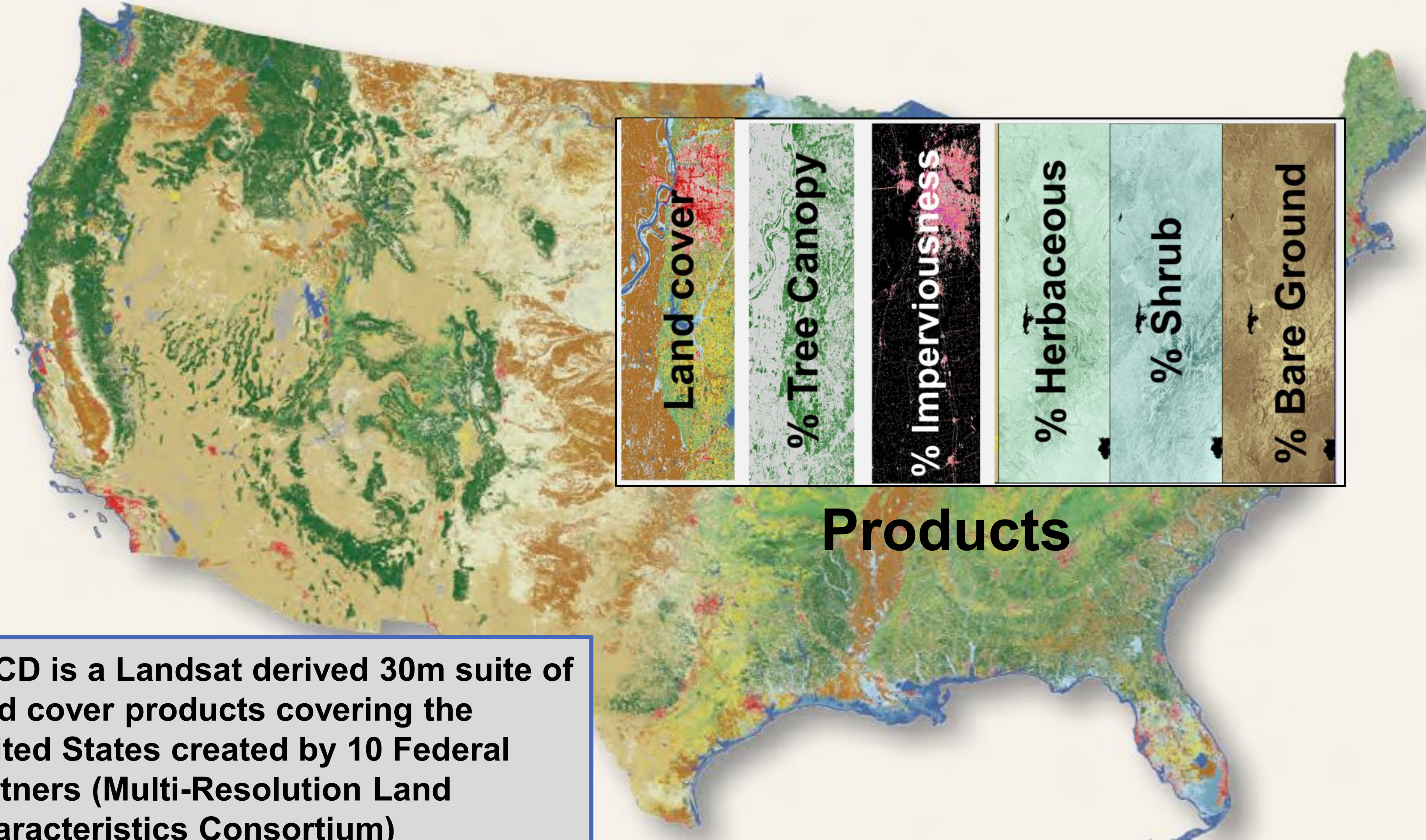
USGS

Total area mapped after 2016 field season

Field sampled high resolution satellite areas in red (189) Independent validation plots in black (1,475)



The National Land Cover Database



NLCD is a Landsat derived 30m suite of land cover products covering the United States created by 10 Federal partners (Multi-Resolution Land Characteristics Consortium)

USGS

Great Basin components available on the MRLC website www.mrlc.gov on April 15th

WEST Inc.

Environmental
& Statistical
Consultants

Trends in Lek Attendance by Male Greater Sage-Grouse

Ryan Nielson
Lyman McDonald
Jason Mitchell
Shay Howlin
Chad LeBeau

4/4/2016

An Independent Look

- Trends in peak (max) lek attendance by males 1965 – 2015.

- There have been other analyses.

An Independent Look

- WEST was asked to
  - Recommend an analysis approach.
  - Provide an example of the analysis using historic data (1965-2015).

An Independent Look

- Our recommendations:
  - Keep analysis assumptions to a minimum.
  - Avoid transformation of the data.
  - Follow individual leks through time.

Analysis Approach

- Lek = 2 or more males in 2 or more years
- Data from larger leks + spatially related satellite leks or activity centers were combined.
  - Clustering analysis combined counts within 1.2-km into lek complexes

Analysis Approach

- Follow standard of not including portions of lek counts with large strings of zeros.

14, 5, 9, 11, 4, 0, 0, 0, 0, 0, 0, 3, 5,…

  - An artifact of the way individual States and biologists treat individual leks and record data.

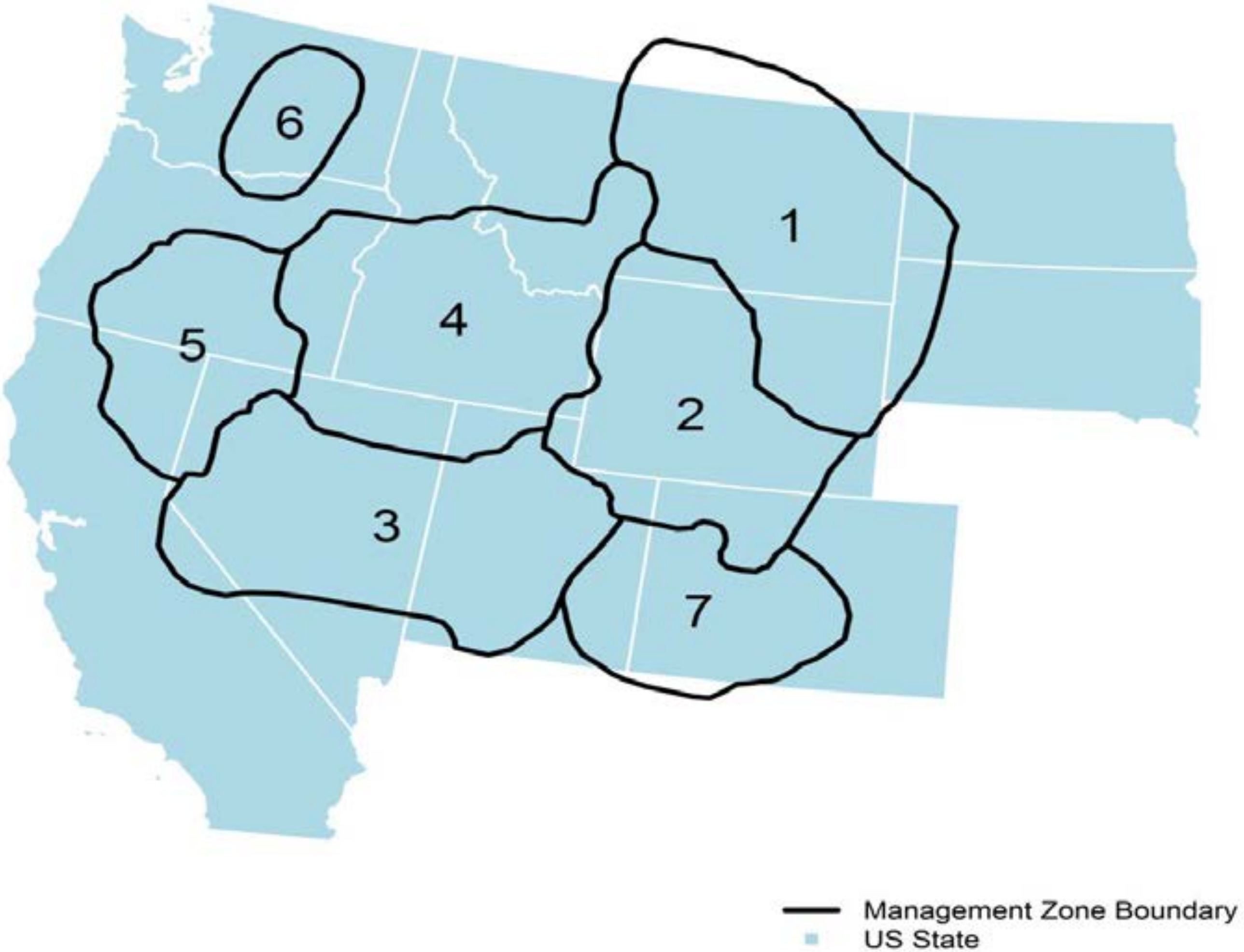
Analysis Approach

- Applied a well-developed model that has been peer-reviewed and published
  - Thogmartin et al. (2006, *Condor*)
  - Nielson et al. (2008, *The Auk*)
  - Sauer and Link (2011, *The Auk*)
  - Millsap et al. (2013, *JWM*)
  - Nielson et al. (2014, *JWM*)

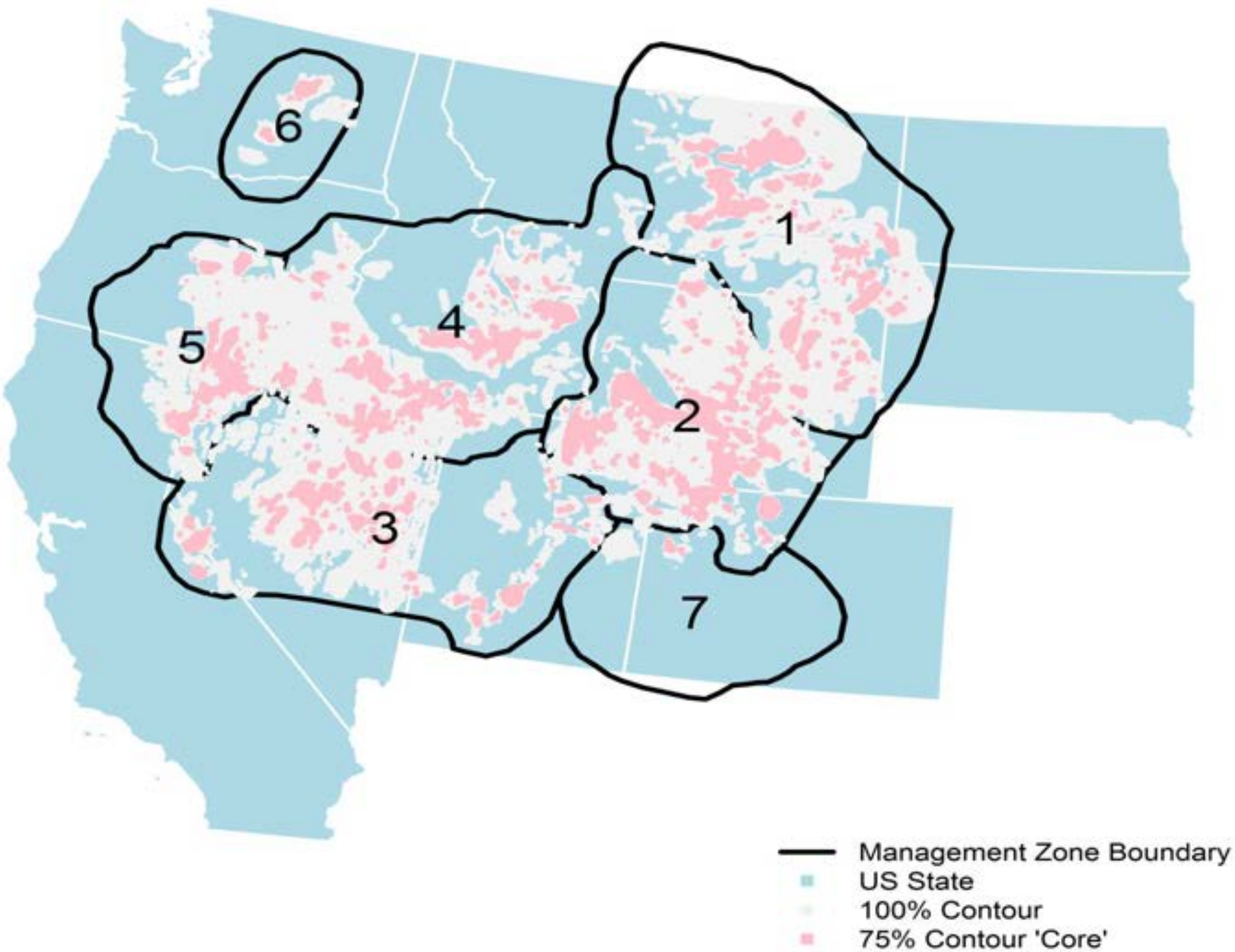
Analysis Approach

- Bayesian Hierarchical Model
  - Follows individual leks through time.
  - Trends for individual management zones.
  - Overall trend.
  - Analyze entire management zone, core area, and periphery.

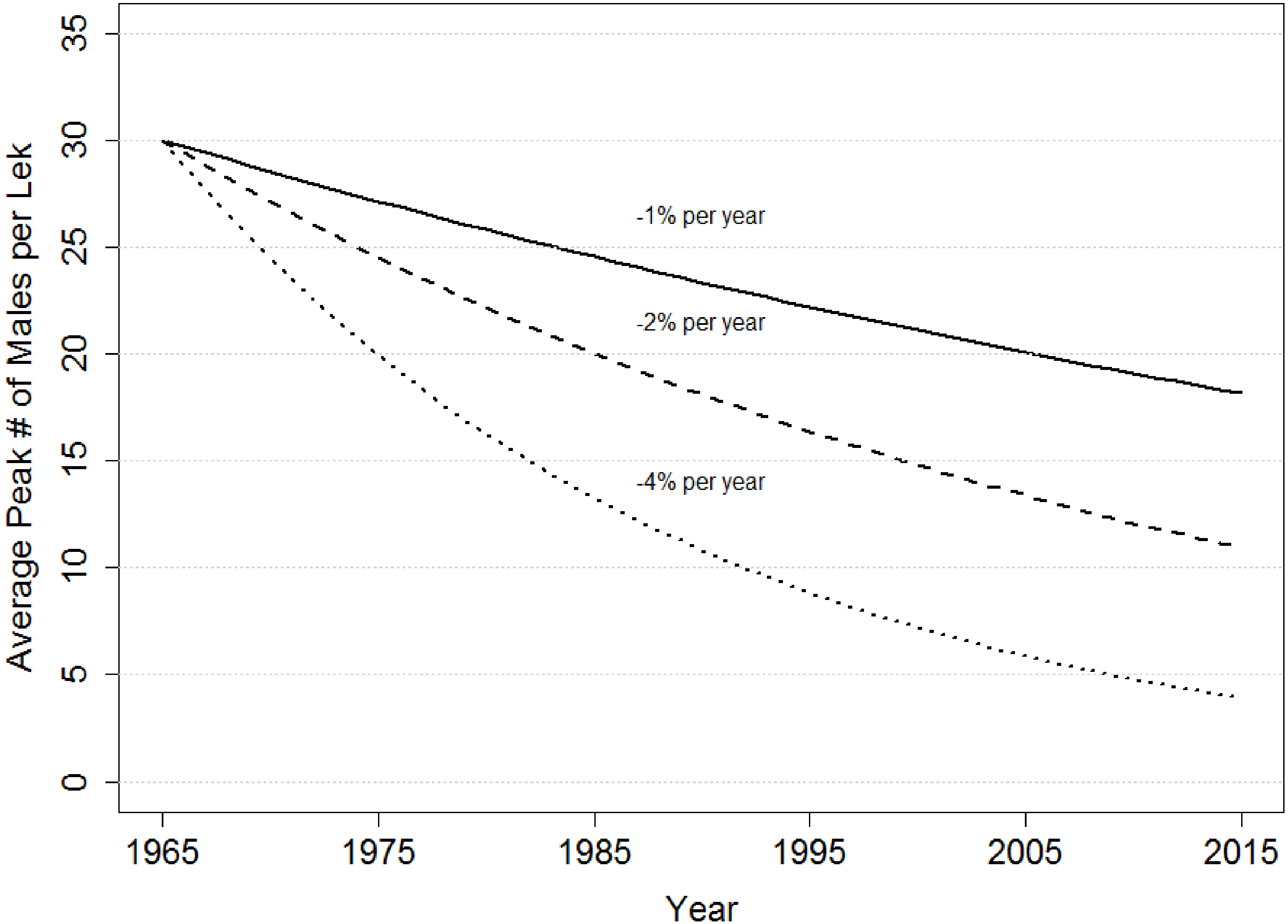
Management Zones



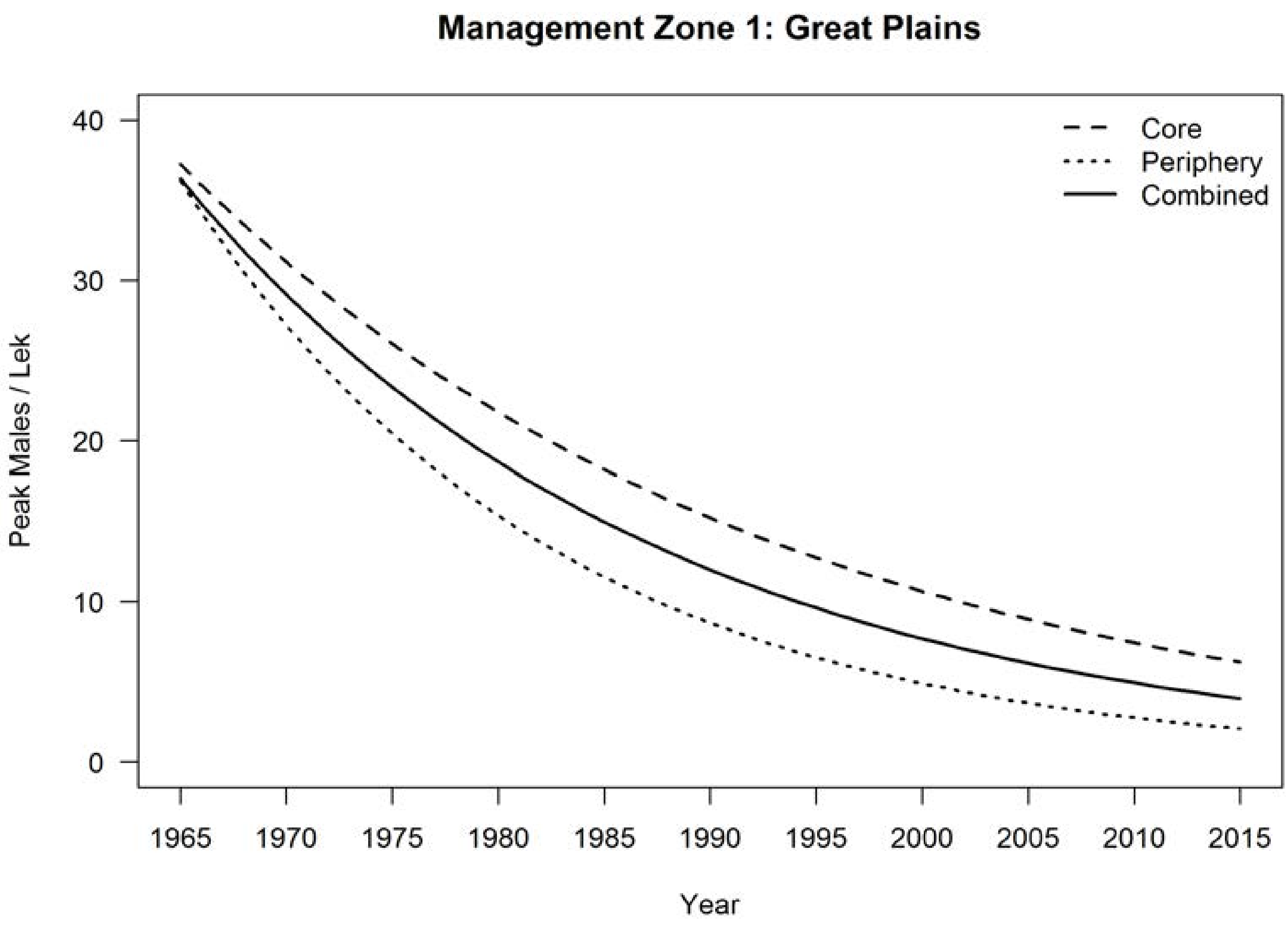
75% Core Area


6
1
4
5
2
3
7
Management Zone Boundary
US State
100% Contour
75% Contour 'Core'

What is a Trend?

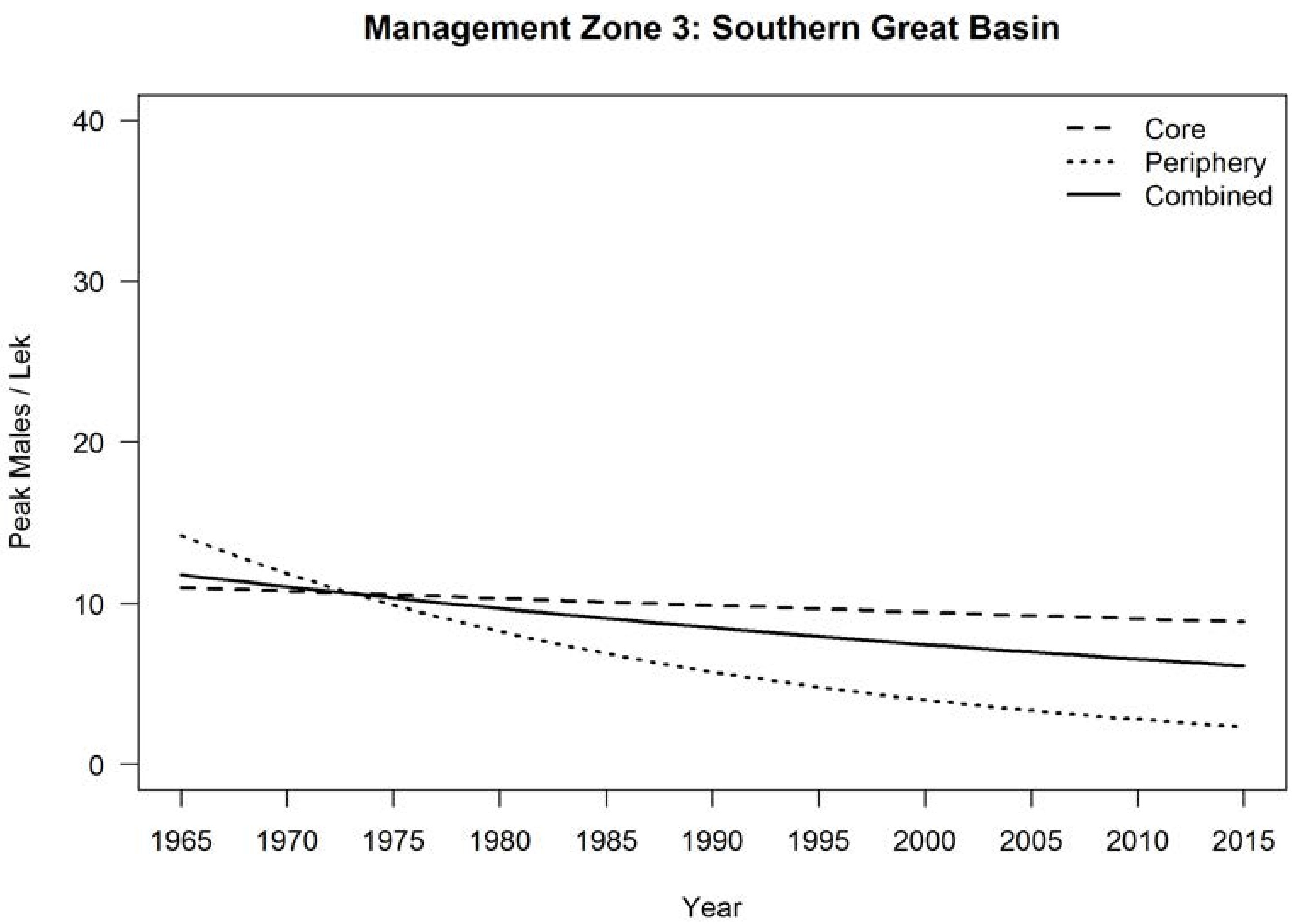


Results

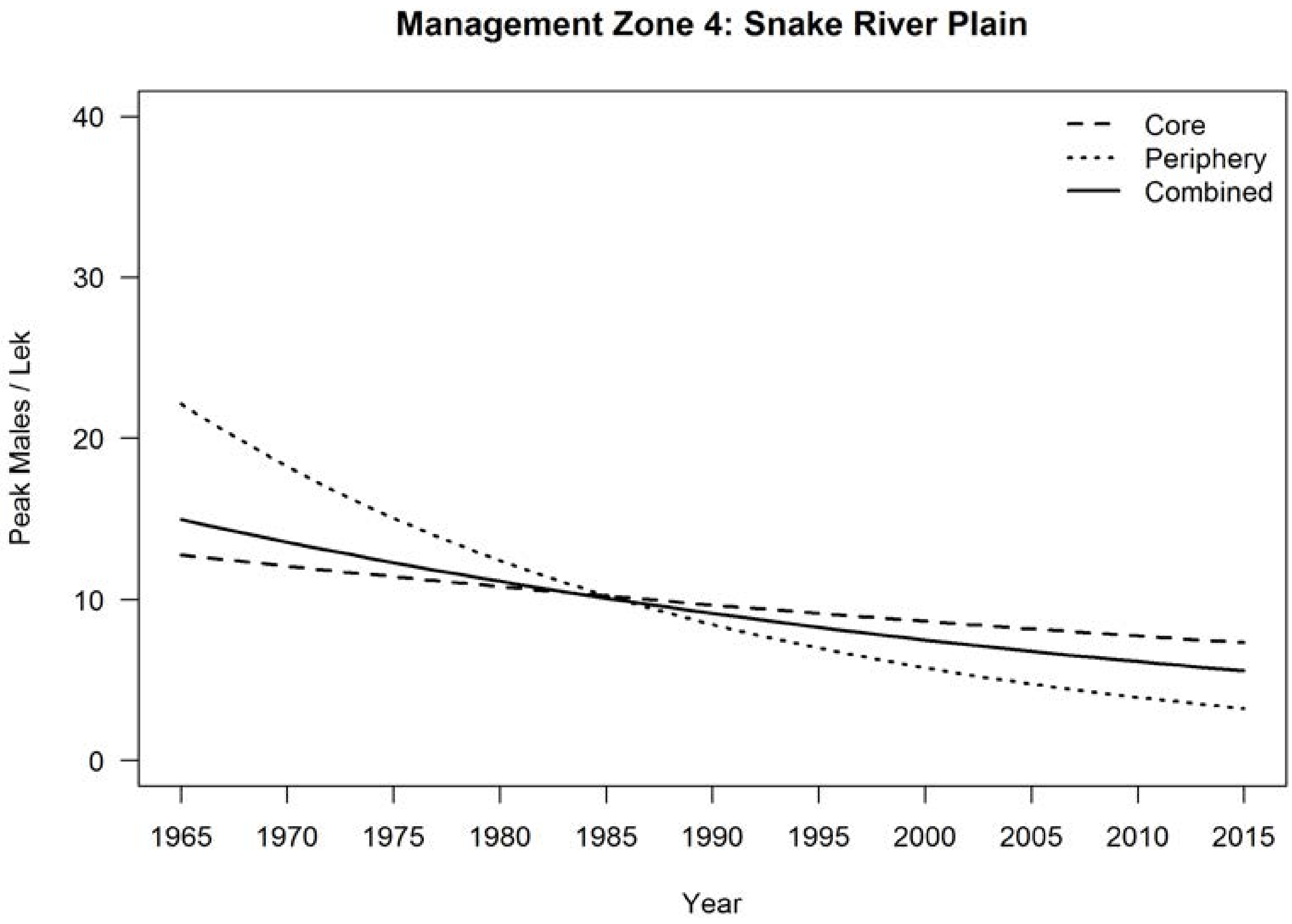


Management Zone 1: Great Plains
Core
Periphery
Combined
Peak Males / Lek
Year
0
10
20
30
40
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

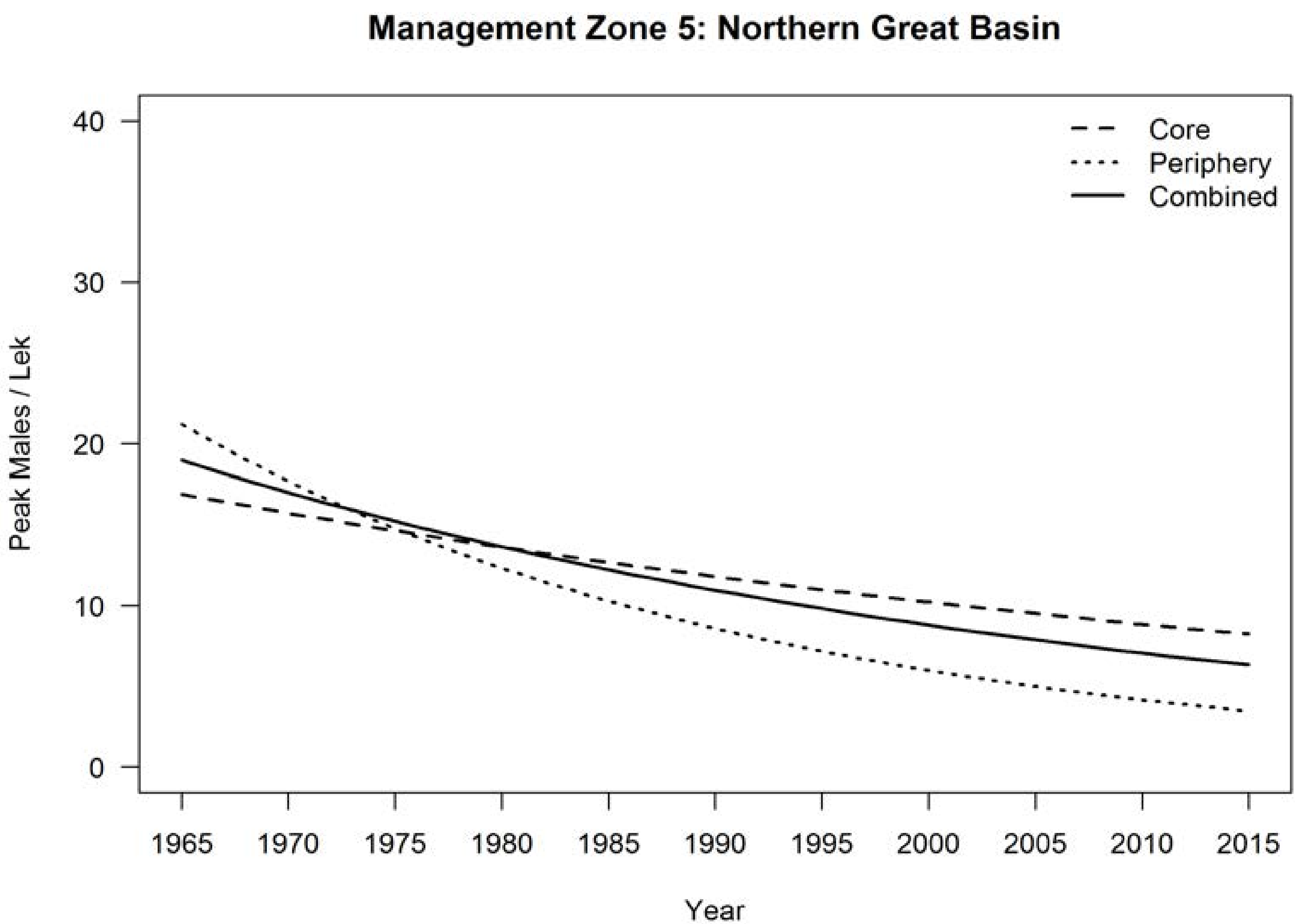
Results


Management Zone 3: Southern Great Basin
Core
Periphery
Combined
Peak Males / Lek
0
10
20
30
40
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year

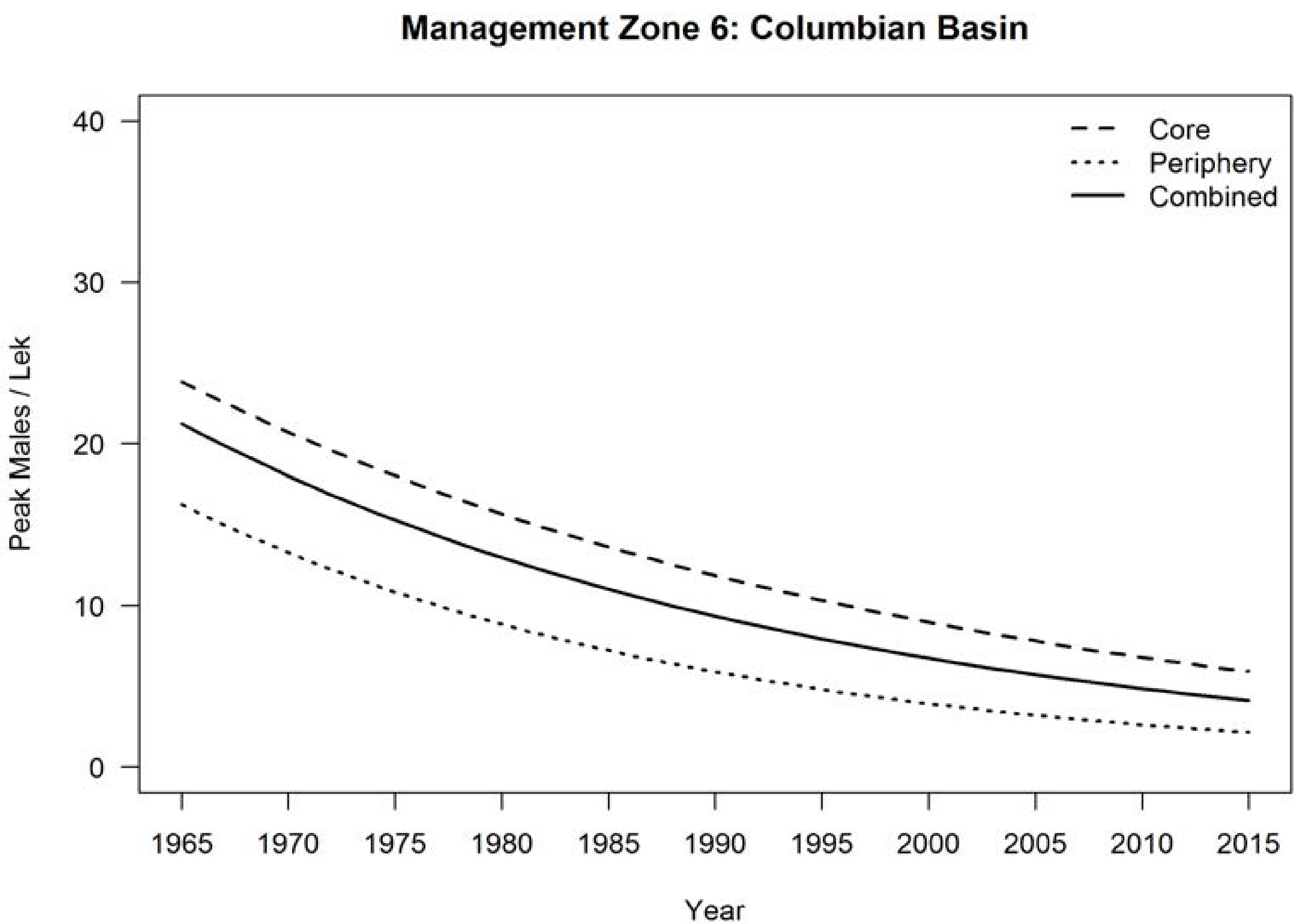
Results


Management Zone 4: Snake River Plain
Core
Periphery
Combined
Peak Males / Lek
40
30
20
10
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year

Results

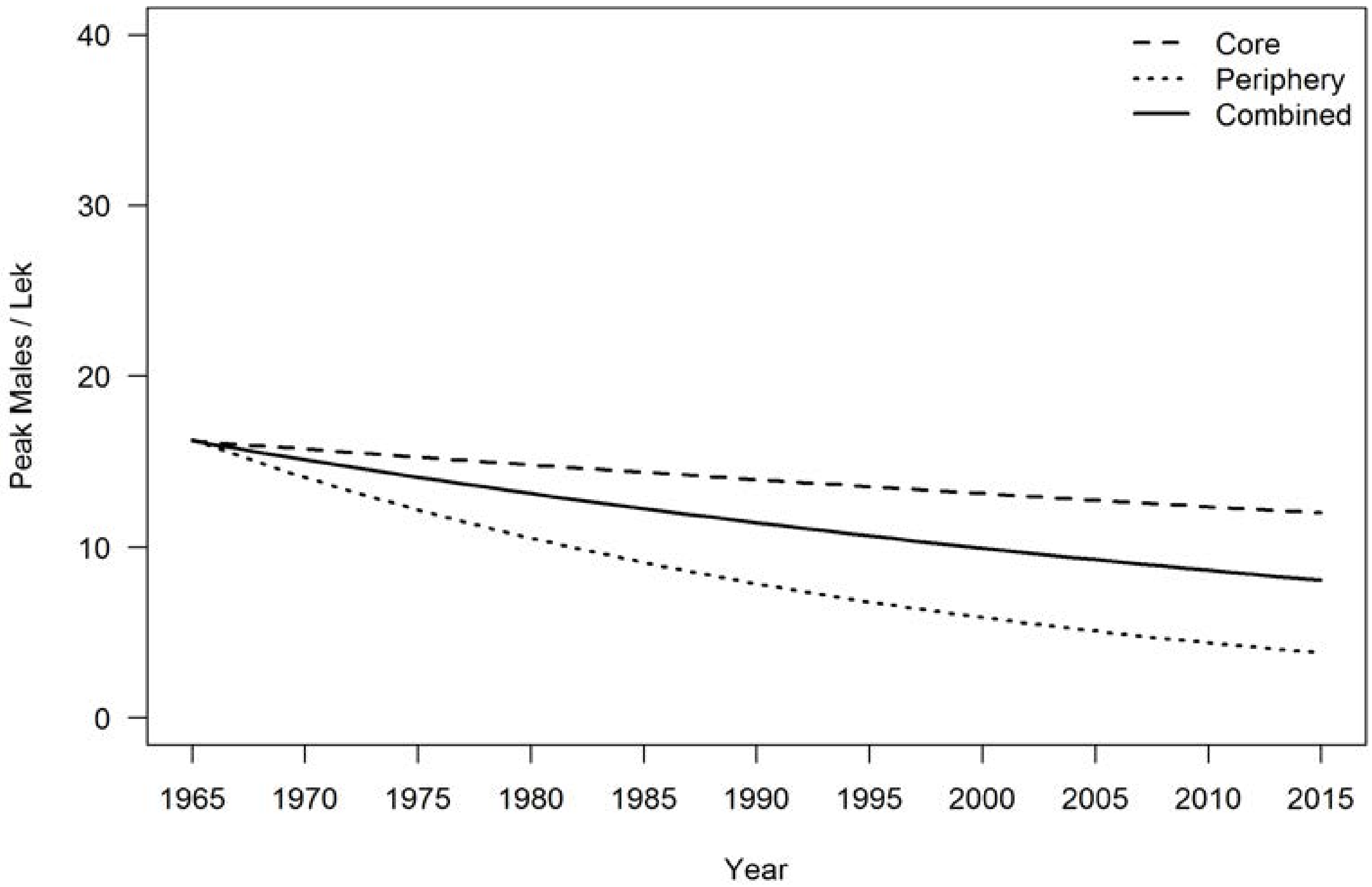

Management Zone 5: Northern Great Basin
Core
Periphery
Combined
Peak Males / Lek
40
30
20
10
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year

Results

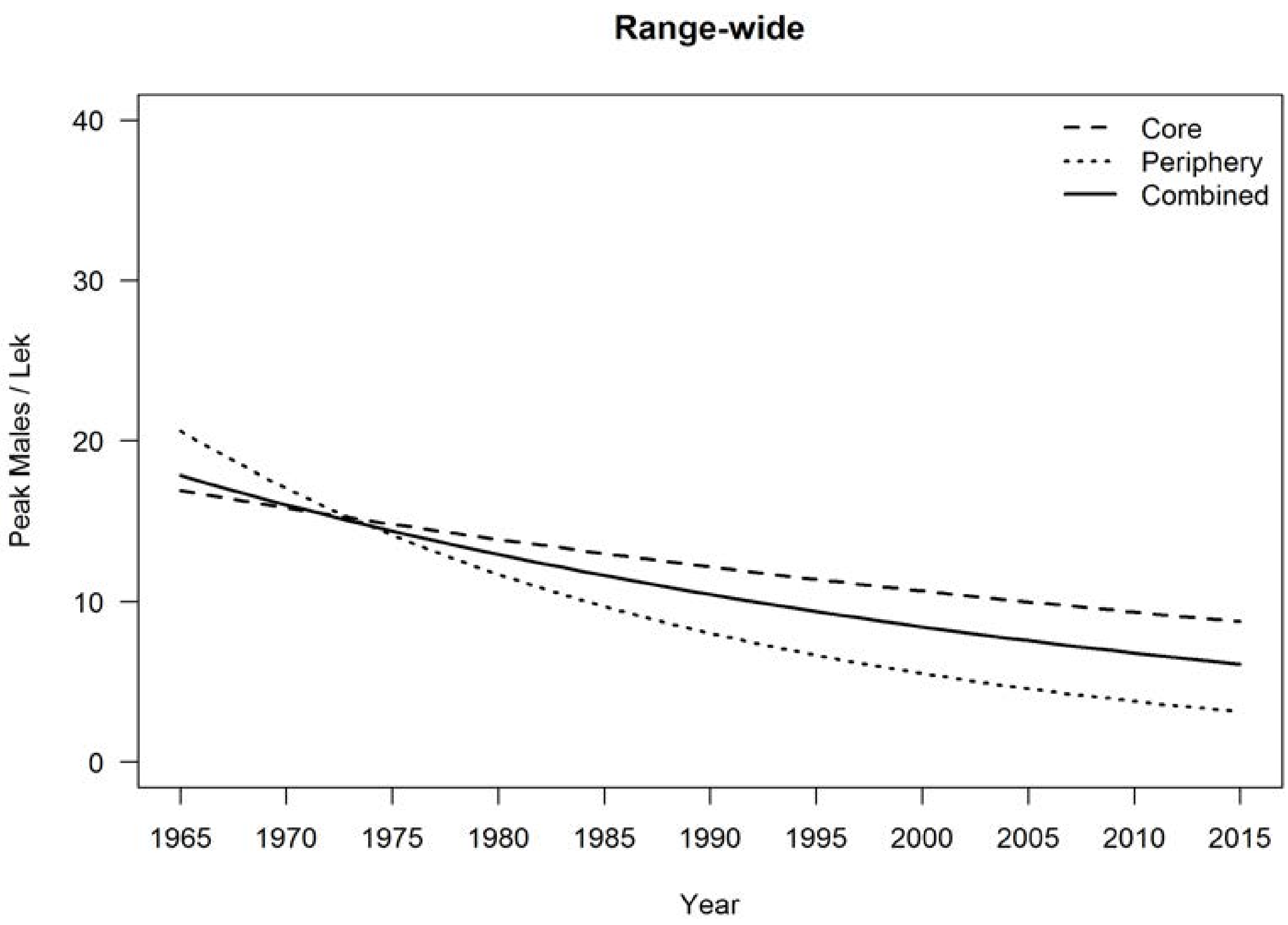

Management Zone 6: Columbian Basin
Core
Periphery
Combined
Peak Males / Lek
40
30
20
10
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year

Results

Management Zone 2 & 7: Wyoming Basin & Colorado Plateau



Results



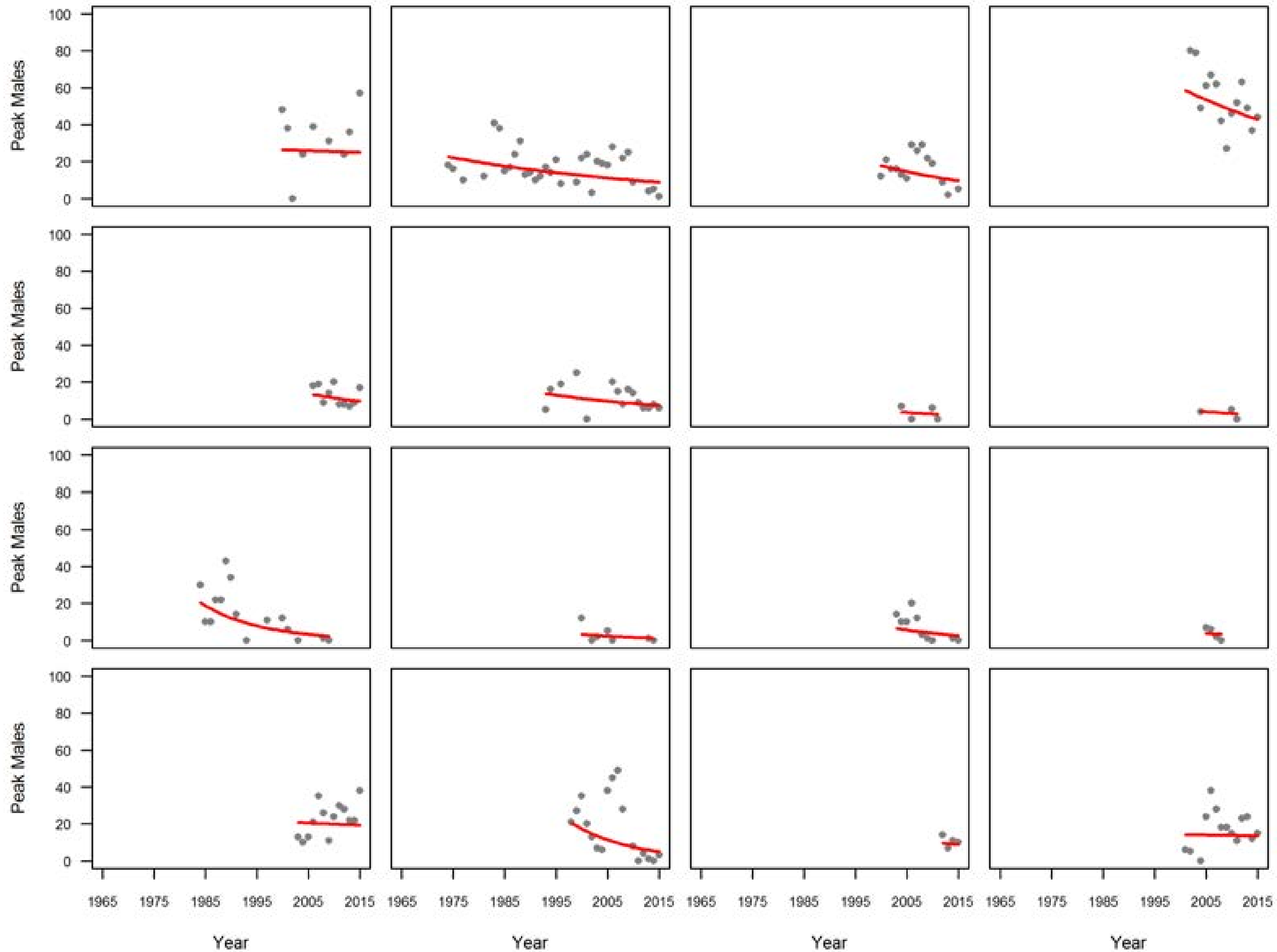
Range-wide
Core
Periphery
Combined
Peak Males / Lek
40
30
20
10
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year

Results

- Average of a 1.3% decline per year (core area) across the 7 management zones.

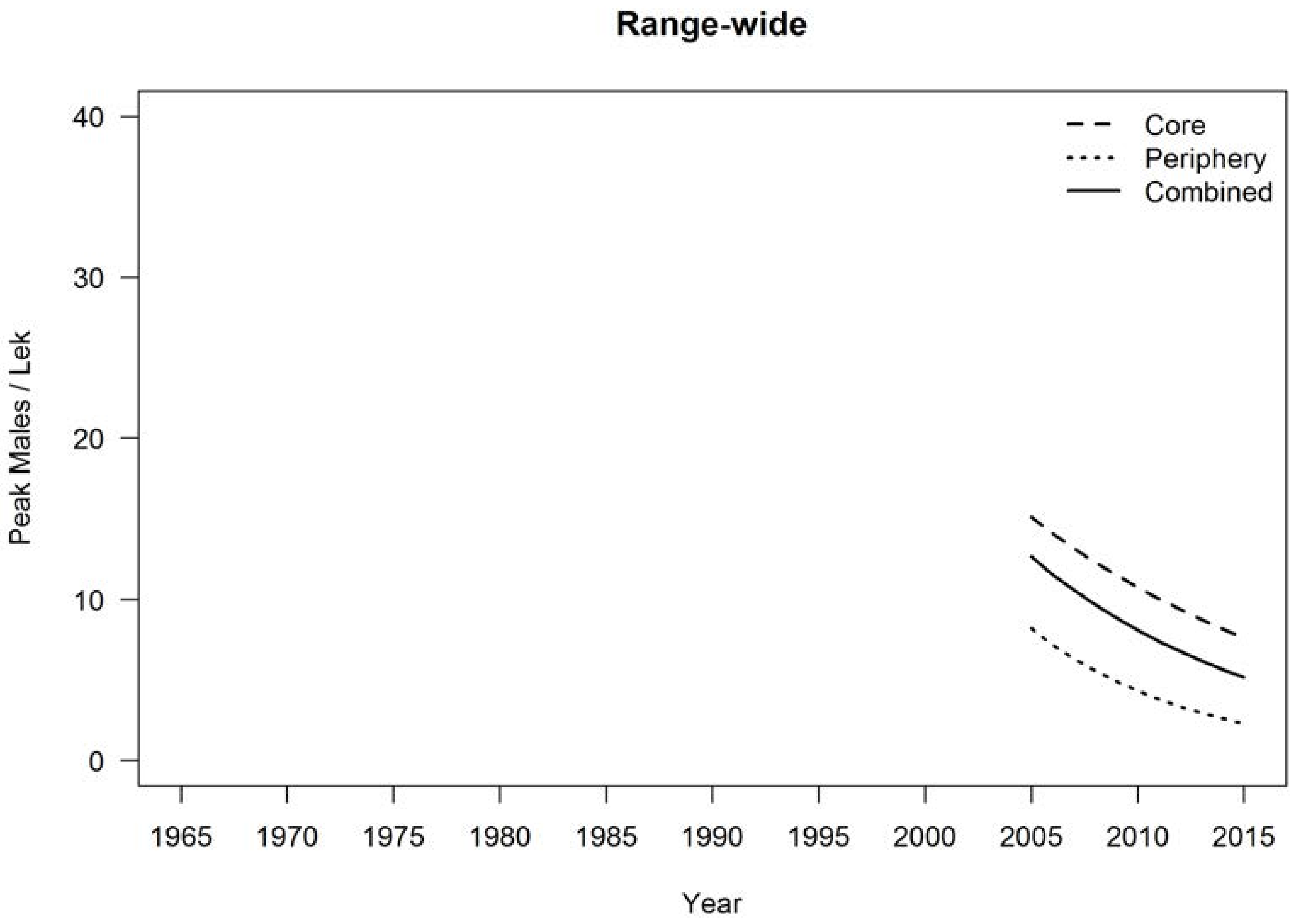
- Ignore zones 1 and 6 … <0.9% decline per year

Results



Peak Males
Peak Males
Peak Males
Peak Males
100
80
60
40
20
0
1965
1975
1985
1995
2005
2015
Year
Year
Year
Year

Results



Range-wide
Peak Males / Lek
Year
Core
Periphery
Combined
0
10
20
30
40
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

Analysis Limitations

- Varying survey effort within management zones / states and between years.
  - More consistency 2007 – present.
- Somewhat opportunistic sampling, especially in the early years.
- Early years focused more on larger leks?
- Handling of zeros

14, 5, 9, 11, 4, 0, 0, 0, 0, 0, 0, 0, 0,…

OR

14, 5, 9, 11, 4, 0, 0, 0, 0, 0, 0, 2, 6,…

Analysis Limitations

- Probability of detection.
- Not part of a probability-based sample of leks.
- Rate of change in males on leks may not be the best metric for rate of change on population size.
  - Maybe OK for estimating direction of trends.
  - LPC surveys have seen increases in abundance with decreases in lek size.

Recommendations

- Use the Bayesian Hierarchical Model described above for retrospective looks.
- Report can be found on the WEST and WAFWA websites.
- Develop a user-friendly analysis tool with a simple dashboard.
  - Requires common storage and filtering of data.

Future Analyses

- Range-wide population abundance survey during winter/breeding.
- Monitoring efforts and data storage consistent over time and space.
- Develop regional RSFs to identify key landscape characteristics.
- Keep assumptions to a minimum.

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307.634.1756

IMPROVING POPULATION SIZE AND TREND ESTIMATION IN GREATER SAGE-GROUSE

Paul M. Lukacs

Rebecca McCaffery

J. Josh Nowak

Objectives:

- Improve sampling design
- Develop an integrated population model
- Design user-friendly software for to implement analyses

Our approach

- Lek counts
  - Can we re-think the use of lek data to improve abundance estimation?
- Population models
  - Combine multiple sources of information
- Software
  - Capitalize on the power of shared computing and ease of web platforms

N-Mixture Models

- Male grouse per lek (biological process)
  - $N_{ik} \sim \mathrm{Poisson}(\lambda_{ik})$
- Variation in lek size
  - $\log(\lambda_{ik}) = \alpha_i + r_i(k-1) + \varepsilon_i$

N-Mixture Models

- Lek counts (observed data)
  - $(y_{ijk} | N_{ik}) \sim \text{Bin}(N_{ik}, p_{ijk})$
- Variation in detection probability
  - $\text{logit}(p_{ijk}) = \alpha_{ijk} + \beta_w \times x_{ijkw} + \delta_{ijk}$

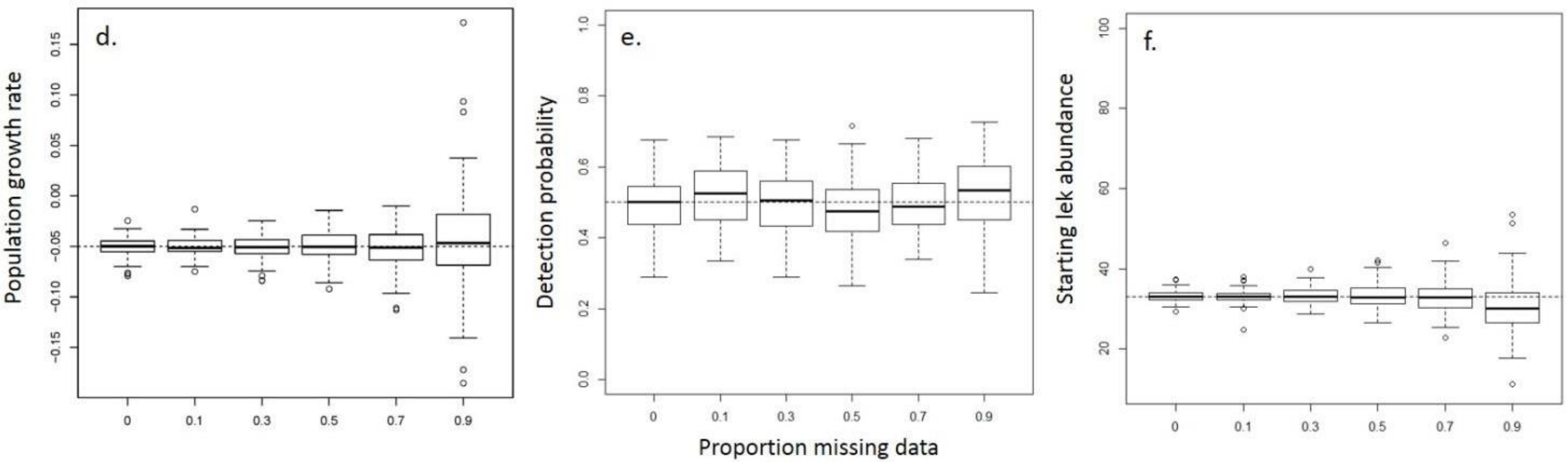
N-Mixture Models

- Key features
  - Allows variation in lek size as a function of environmental features
  - Allows variation in detection as a function of observer or lek-specific characteristics

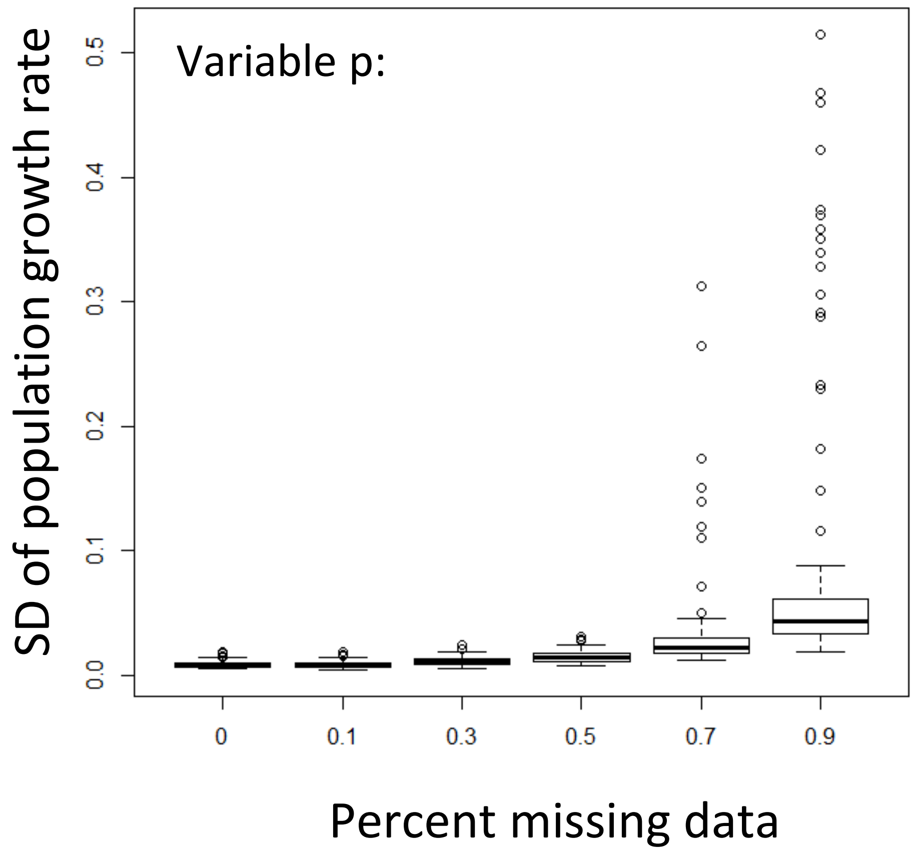
N-Mixture Models

- Do *N*-mixture models adequately estimate abundance from lek count data?
- If they work, how frequently do we have to sample leks?

Results-simulation



Precision:



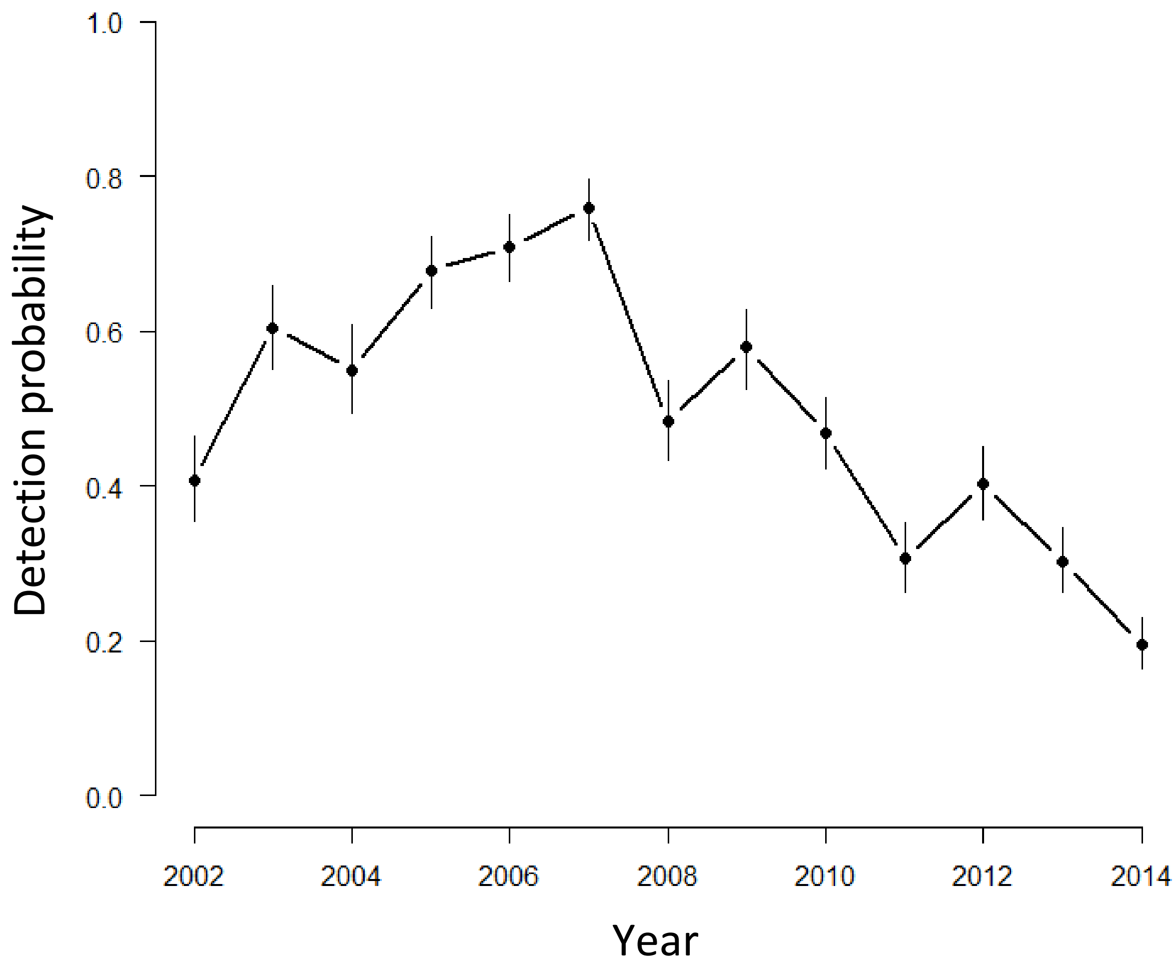
Variable p:
SD of population growth rate
0.0
0.1
0.2
0.3
0.4
0.5
0
0.1
0.3
0.5
0.7
0.9
Percent missing data

Case Study - Montana

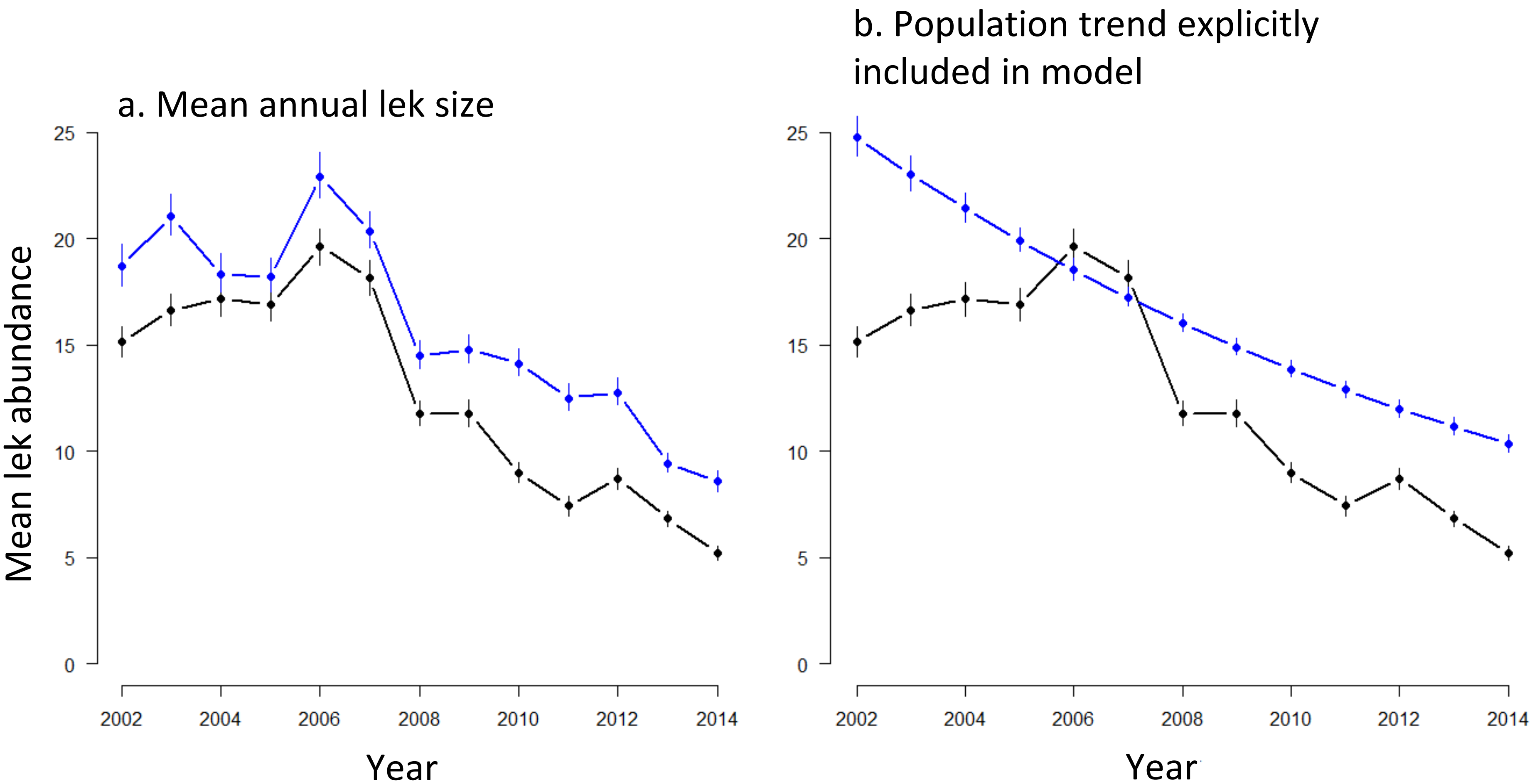
- Lek counts from 2002-2014
- Multiple counts per lek (at some leks)
- Not all leks surveyed in all years

Variation in detection probability over time

Where population growth rate is explicitly included in the model



Case study: State of Montana 2002-2014:



N-mixture model estimate — High male count

N-mixture model

- Summary
  - Useful for improving estimation from lek counts
  - Includes the detection probability
  - Guides sampling design

Integrated Population model

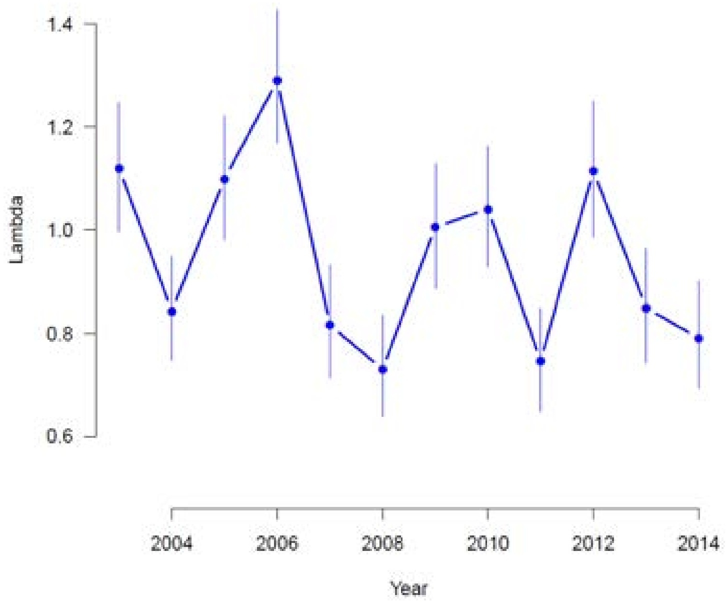
- Combine multiple sources of information
  - Lek counts
  - Survival
  - Recruitment
  - Sex ratio

IPM insights

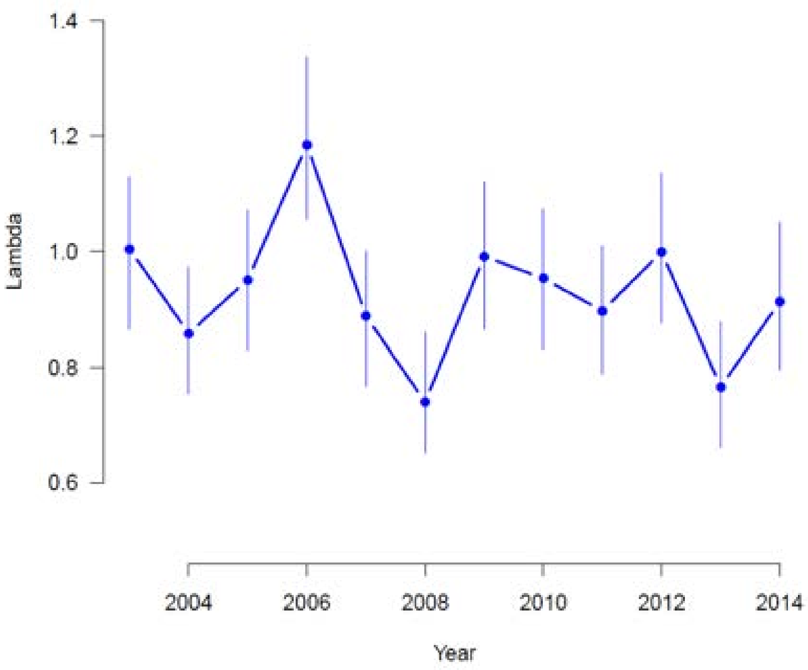
- Lek counts may overstate variation in abundance
- Absence of sex ratio estimates is limiting inference

Population Growth Rate (λ)

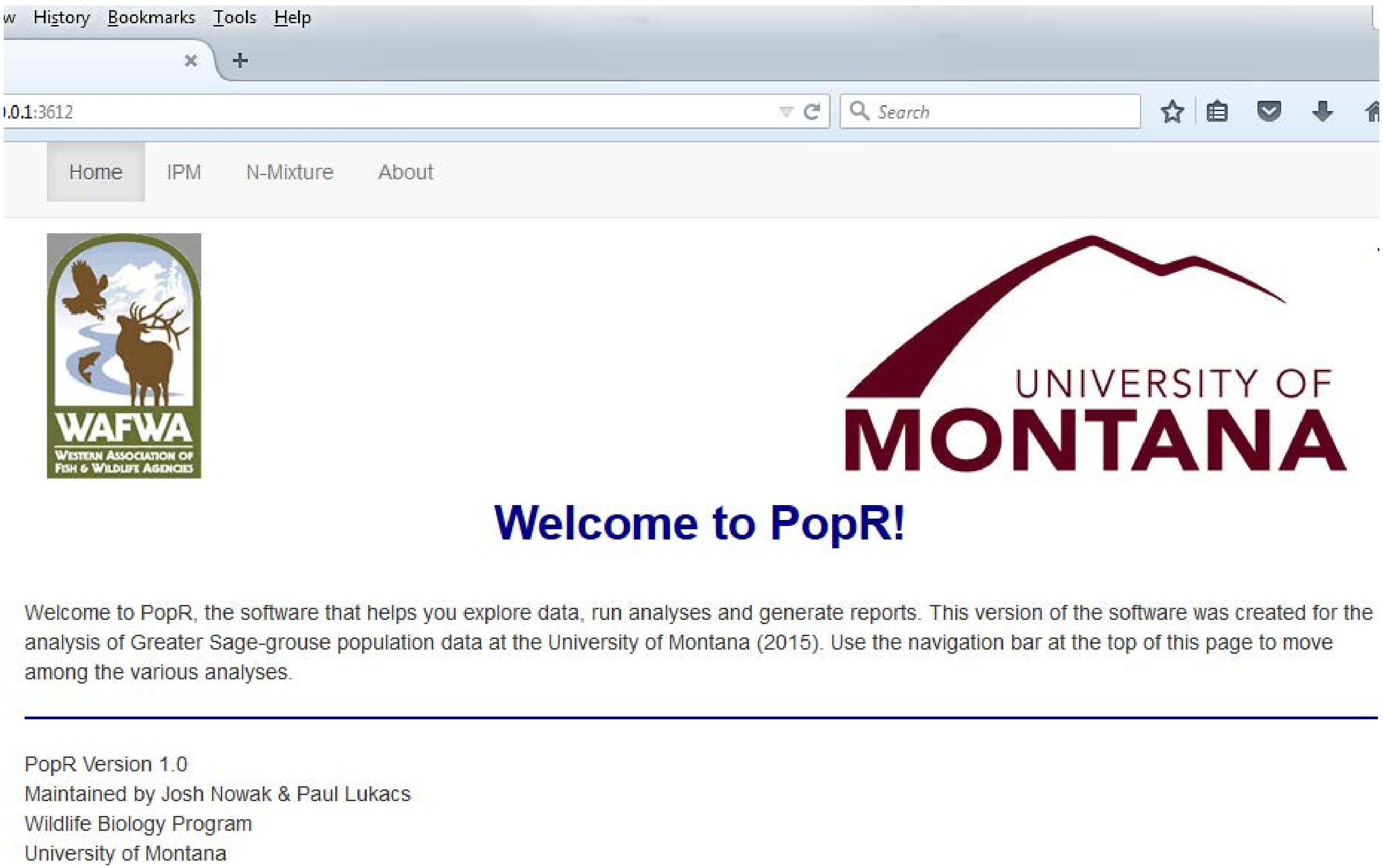
Raw Lek Counts



N-mixture Estimates



Software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).0.1:3612
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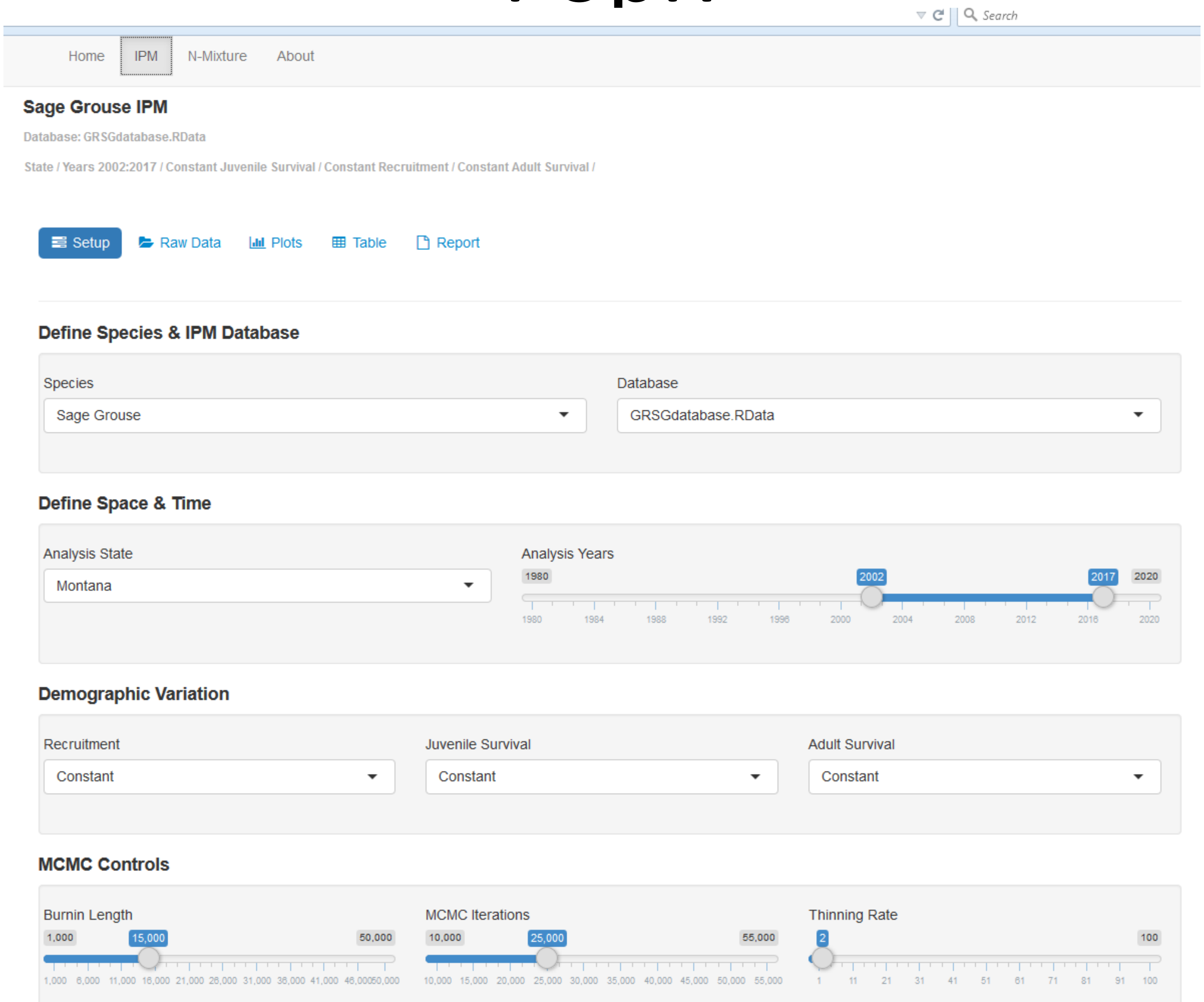
WAFWA
Western Association of Fish & Wildlife Agencies
UNIVERSITY OF
MONTANA
Welcome to PopR!
Welcome to PopR, the software that helps you explore data, run analyses and generate reports. This version of the software was created for the analysis of Greater Sage-grouse population data at the University of Montana (2015). Use the navigation bar at the top of this page to move among the various analyses.
PopR Version 1.0
Maintained by Josh Nowak & Paul Lukacs
Wildlife Biology Program
University of Montana

PopR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Sage Grouse IPM
Database: GRSGdatabase.RData
State / Years 2002:2017 / Constant Juvenile Survival / Constant Recruitment / Constant Adult Survival /
Setup
Raw Data
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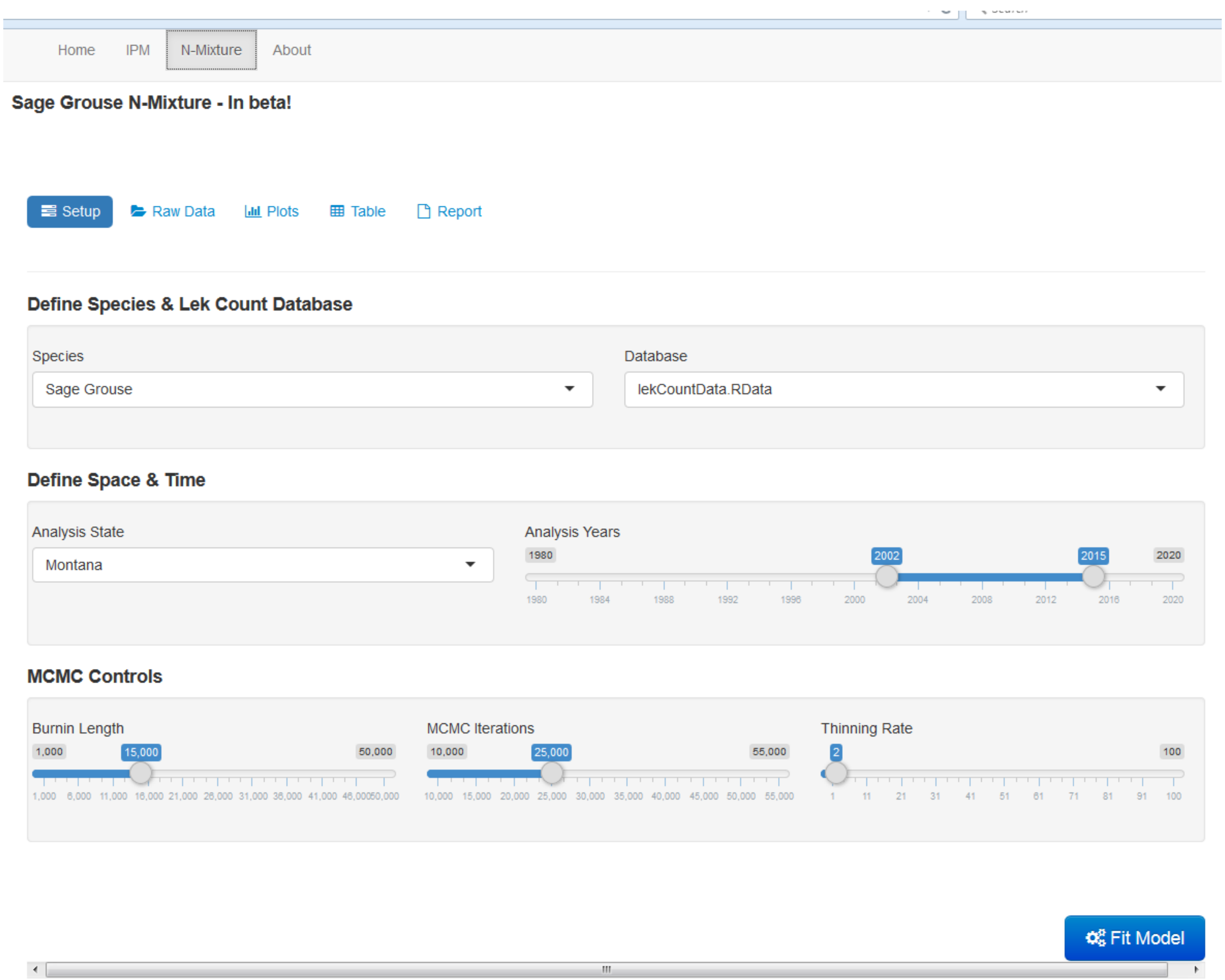
Report
Define Species & IPM Database
Species
Sage Grouse
Database
GRSGdatabase.RData
Define Space & Time
Analysis State
Montana
Analysis Years
1980
2002
2017
2020
Demographic Variation
Recruitment
Constant
Juvenile Survival
Constant
Adult Survival
Constant
MCMC Controls
Burnin Length
1,000
15,000
50,000
MCMC Iterations
10,000
25,000
55,000
Thinning Rate
2
100

PopR


Home
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Sage Grouse N-Mixture - In beta!
Setup
Raw Data
Plots
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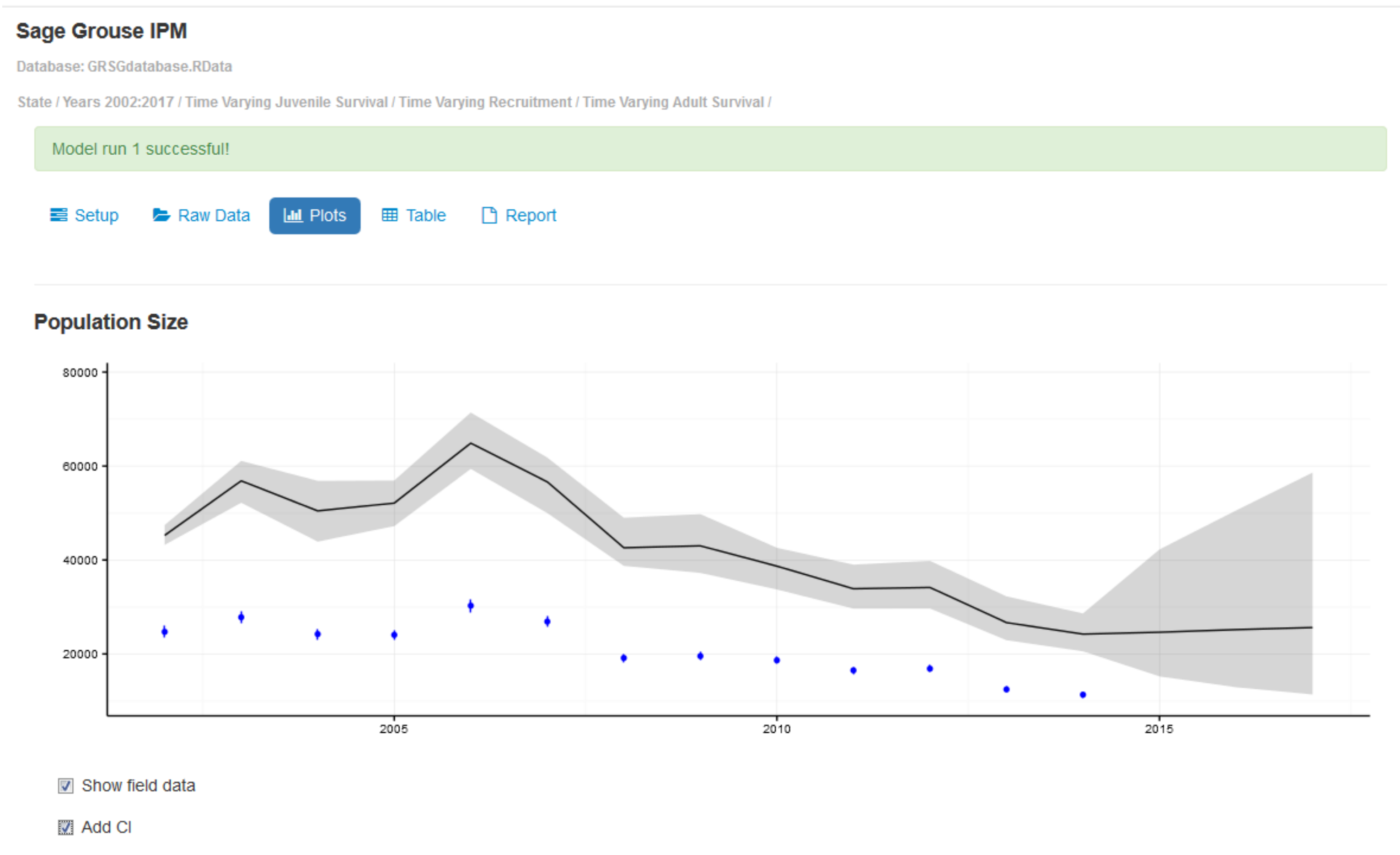
Report
Define Species & Lek Count Database
Species
Sage Grouse
Database
lekCountData.RData
Define Space & Time
Analysis State
Montana
Analysis Years
1980
2002
2015
2020
1980 1984 1988 1992 1996 2000 2004 2008 2012 2016 2020
MCMC Controls
Burnin Length
1,000
15,000
50,000
MCMC Iterations
10,000
25,000
55,000
10,000 15,000 20,000 25,000 30,000 35,000 40,000 45,000 50,000 55,000
Thinning Rate
2
100
1 11 21 31 41 51 61 71 81 91 100
Fit Model

PopR


Sage Grouse IPM
Database: GRSGdatabase.RData
State / Years 2002:2017 / Time Varying Juvenile Survival / Time Varying Recruitment / Time Varying Adult Survival /
Model run 1 successful!
Setup
Raw Data
Plots
Table
Report
Population Size
80000
60000
40000
20000
2005
2010
2015
Show field data
Add CI

IPM

- Summary
  - Model provides framework to consider data collection
  - Guides synthesis of multiple sources of data
  - PopR provides a workflow to simplify the modelling process

Summary

- Sampling Design
  - Better to survey more leks less frequently
  - Visit leks you do survey more than once per year and record the data in a database
- Population Models
  - Reduce sampling variation in population trajectory
  - Demonstrate need for sex ratio estimates
- PopR
  - Easy to use, web-based software

Questions?

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