Planning for Growth and Open Space Conservation

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Rick Pringle, Susan Stein, Sara Comas, Susan Guynn (Clemson University)
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Forest Service National Open Space Conservation Group

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Session #7: Science to Inform Open Space Conservation

Miranda Mockrin
Rocky Mountain Research Station
US Forest Service

Kurt Riitters
Southern Research Station
US Forest Service

Session #7: Science to Inform Open Space Conservation

Dave Wear
Southern Research Station
US Forest Service

Dave Theobald
Inventory and Monitoring Division
National Park Service

Logistics – Q&A

- **Continuing Education Credits**
  - Attend entire presentation
- **Questions for speakers – chat pod**
- **Technical difficulties – chat pod or**

  email Susan Guynn: SGUYNN@clemson.edu

Getting to Know You!

Miranda Mockrin

Rocky Mountain Research Station

US Forest Service

Mapping the Wildland-Urban Interface

Miranda H. Mockrin
Rocky Mountain Research Station
USDA Forest Service
Fort Collins, CO

October 24th 2012

US Forest Service Open Space Webinar

Science to Inform Open Space Conservation: Land use changes, forest fragmentation, and the wildland-urban interface

Presentation Outline

- Meet the team
- Why map the WUI?
- How do we define the WUI?
- Research findings
- Other data products
- References and more

Meet the Team

- Volker Radeloff, University of Wisconsin
- Susan Stewart, Northern Research Station, USDA Forest Service
- Roger Hammer, Oregon State University

Research: Housing and Environment

- Land use and remote sensing
- Housing growth/demographic change
- Biodiversity conservation
- Wildland fire management

Photos: http://www.silvis.forest.wisc.edu/

Why Map the Wildland-Urban Interface?

- Emerged from wildfire management
- But applies to *many* natural resource issues
- Wanted consistent, high-resolution data for national extent

How Do We Define the WUI?

The area where houses meet or intermingle with undeveloped wildland.—Federal Register

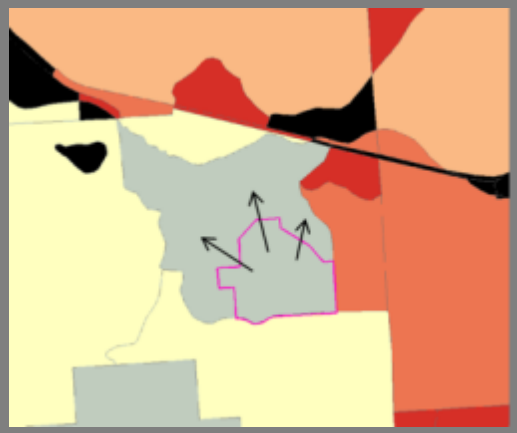
How Do We Define the WUI?

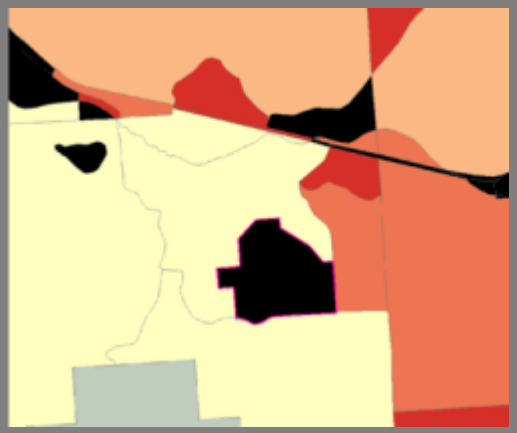
Interface WUI - *"where houses meet"*

Intermix WUI - *"where houses mingle"*

WUI Data: Housing

- Housing data from US Census
- Mapping units are Census blocks
  - blocks are always smaller than counties
  - size varies with housing density
  - bounded by roads, physical features
  - ***Census blocks subdivided into public/private***





WUI Data: Land Cover

- Wildland vegetation identified ***for 1990-2000*** using ***Retrofit*** National Land Cover Data
  - Wildland vegetation includes forests, shrublands, native grasslands, wetlands and transitional
  - *excludes* agriculture, orchards, all urban classes, and non-vegetated areas

WUI = Housing and Vegetation

Interface WUI - *"where houses meet"*

> 6.17 houses/km^2 with less than 50% wildland vegetation

But within 2.4 km^1 of vegetation (> 5km^2 and 75% vegetated)

1. Split block if it was only partially within distance

Intermix WUI - *"where houses mingle"*

> 6.17 houses/km^2 with more than 50% wildland vegetation

Radeloff et al. 2005.

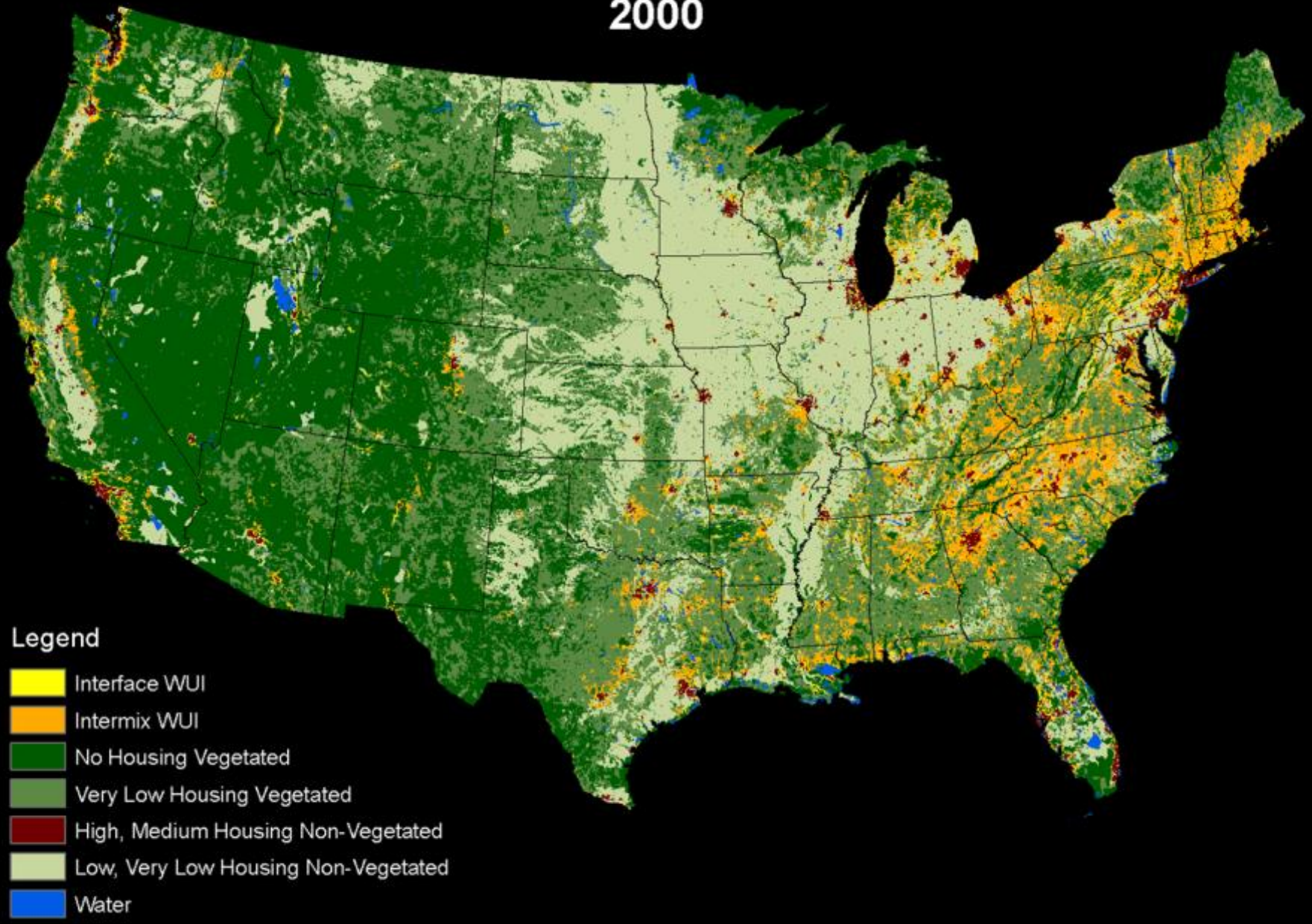
Research Findings

1. Wildland-urban interface in 2000
2. Change from 1990 to 2000
3. *Coming soon*: 2010 WUI;

   2000-2010 change

All data and maps available
http://silvis.forest.wisc.edu//maps/wui/

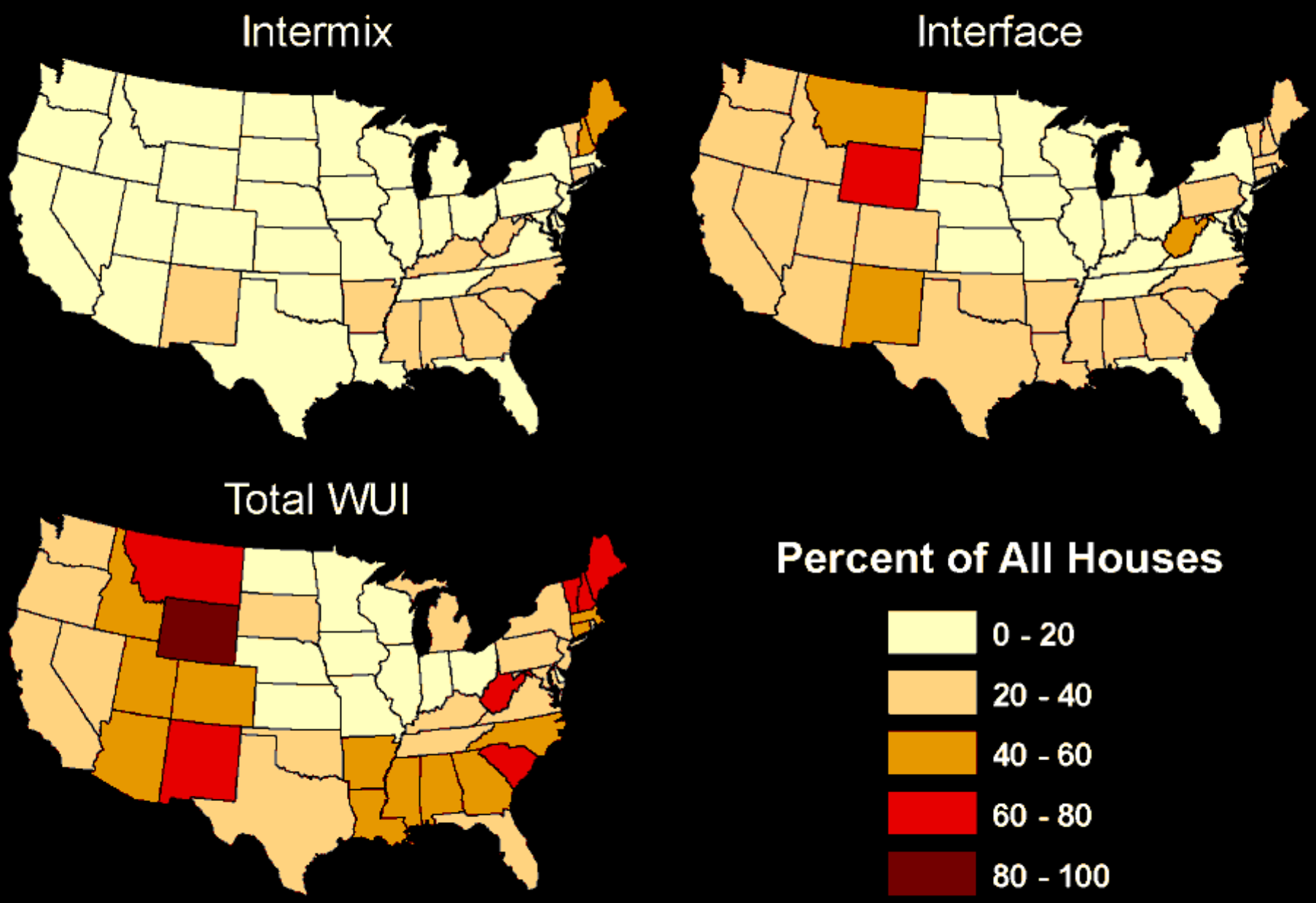
Wildland Urban Interface
Conterminous United States
2000



WUI 2000

- In total, 10% of country's area is WUI
- 33 % of all homes are in the WUI
- 44 million homes in the WUI

Percent of Houses in the WUI, 2000

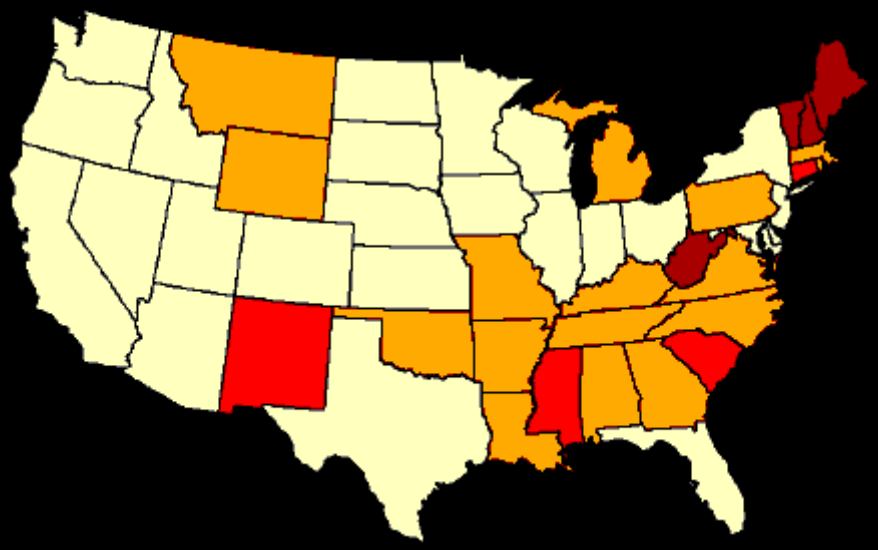


WUI Growth, 1990-2000

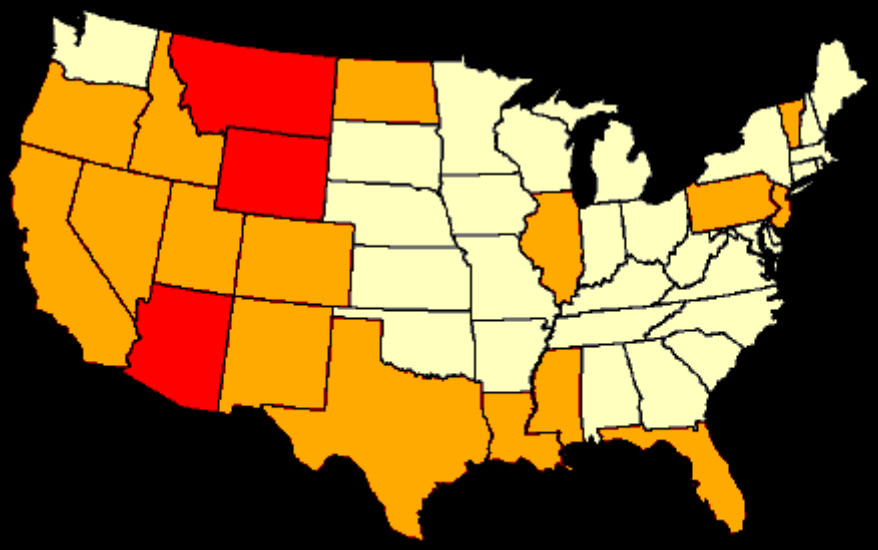
- 40% of new homes are in the WUI
- Intermix WUI is growing the fastest
- In total, 18% growth in WUI area

Percent New Houses in the WUI, 2000

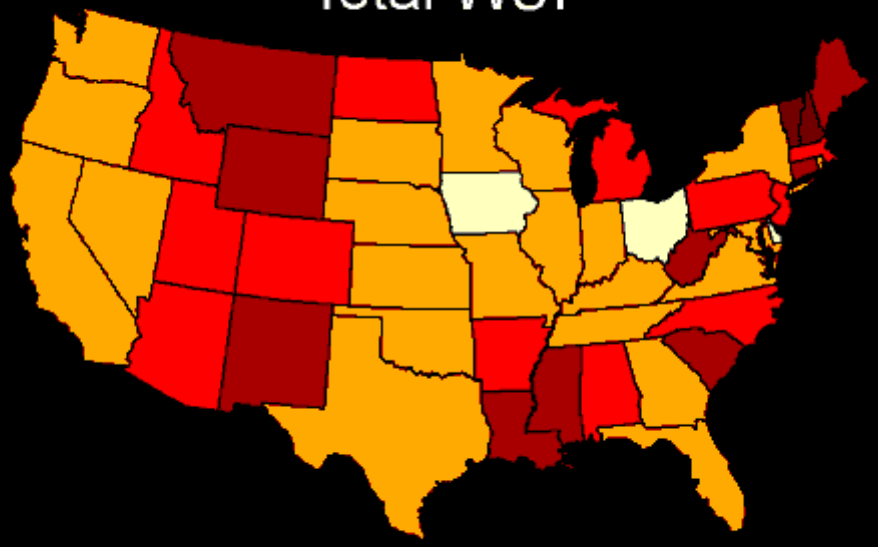
Intermix



Interface



Total WUI



Percent of All New Houses

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100

Remember The Milk - Miranda | The Wildland Urban Interface | The Wildland Urban Interface
silvis.forest.wisc.edu//maps/wui/
Calendar RTM Library Gmail Google Maps Google Reader Online Stopwatch The Write Motivator WW

The Wildland Urban Interface (version 3)

About the WUI

Population deconcentration in the U.S. has resulted in rapid development in the outlying fringe of metropolitan areas and in rural areas with attractive recreational and aesthetic amenities, especially forests. This demographic change is increasing the size of the wildland-urban interface (WUI), defined as the area where structures and other human development meet or intermingle with undeveloped wildland. The expansion of the WUI in recent decades has significant implications for wildfire management and impact. The WUI creates an environment in which fire can move readily between structural and vegetation fuels. Its expansion has increased the likelihood that wildfires will threaten structures and people.

WUI Maps and GIS data

WUI maps are intended to illustrate where the WUI was located in 1990 and 2000. We map two types of WUI: intermix and interface. Intermix WUI are areas where housing and vegetation intermingle; interface WUI are areas with housing in the vicinity of contiguous wildland vegetation.

WUI GIS data were designed to provide a spatially detailed national assessment of the Wildland Urban Interface (WUI) across the coterminous U.S. to support inquiries into the effects of housing growth on the environment, and to inform both national policy and local land management concerning the WUI and associated issues. These data are useful within a GIS for mapping and analysis at national, state, and local levels and are available for download as compressed ESRI Shapefile (.shp) files. Detailed metadata is included with each shapefile.

View/Download WUI3 Maps and GIS Data

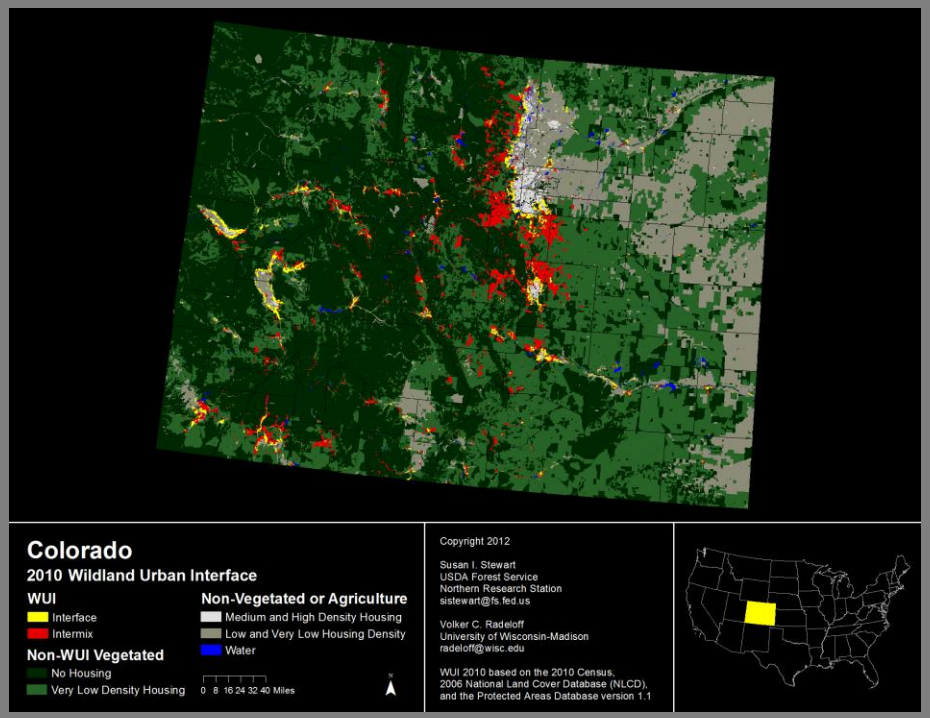
The WUI defined

The definition we used to map the WUI originated in the Federal Register (66:751, 2001) report on WUI communities at risk from fire (USDA & USDI, 2001), and Tie and Weatherford's 2000 report to the Western Governor's Association on WUI fire risk.

- *Housing density:* Housing density information was derived from U.S. Census data. Analysis was conducted at the finest demographic spatial scale possible, Census

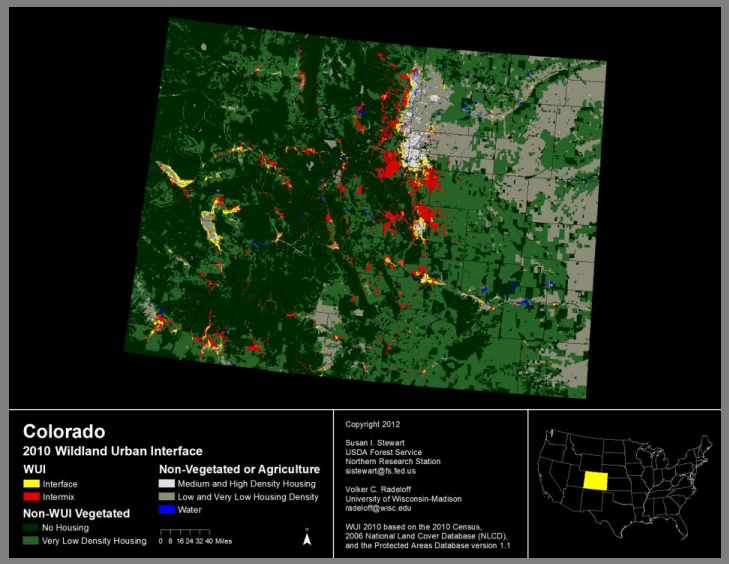
Coming Soon: WUI 2010

- Land Cover—2006 NLCD data
- Housing—2010 US Census Block Housing
- *Will do 2000-2010 change; need land cover*



Benefits of WUI Mapping

- Consistent, repeatable
- Set priorities, see trends over time
- Other WUI mapping:
  - vegetation for treatment (Wilmer and Aplet 2005)
  - wildfire regimes (Theobold and Romme 2007)
  - fine-grained resolution (Platt et al 2011)

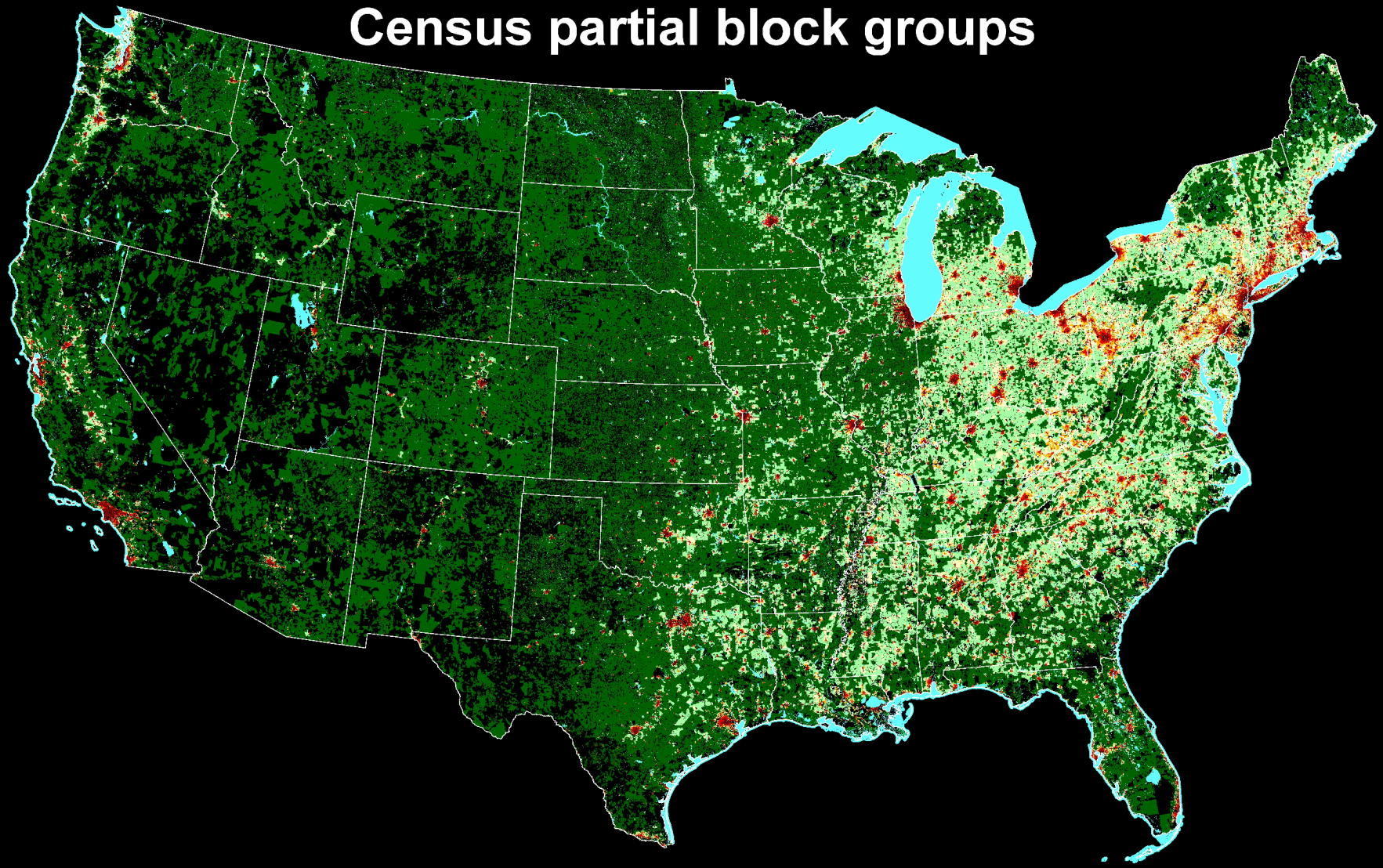


Other Data Products: Housing

- Housing Data
  - 1940 to 2030 data
    - Backcasts, census data (1990, 2000), and forecasts
  - Working on updated methods and forecasts
  - Partial block group scale

http://silvis.forest.wisc.edu/old/maps.php

United States Housing Density - 1940
Census partial block groups



Housing Units per Km^2

- 0
- 0 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 128
- >128
- Water

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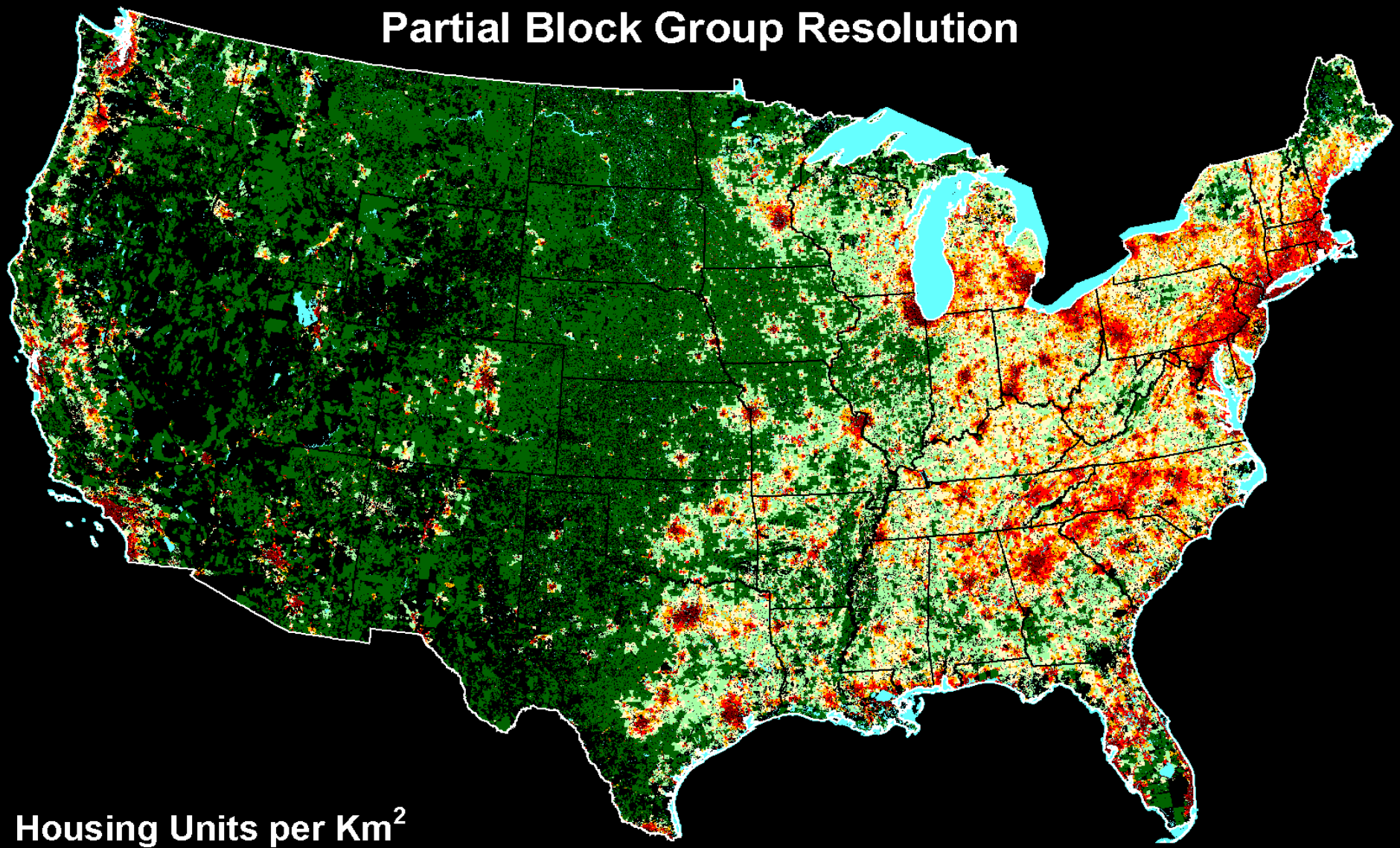
Oregon State University and University of Wisconsin - Madison
rhammer@oregonstate.edu and radeloff@wisc.edu

Housing Density 2000

Partial Block Group Resolution



Housing Units per Km^2

- 0
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- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 128
- >128
- water

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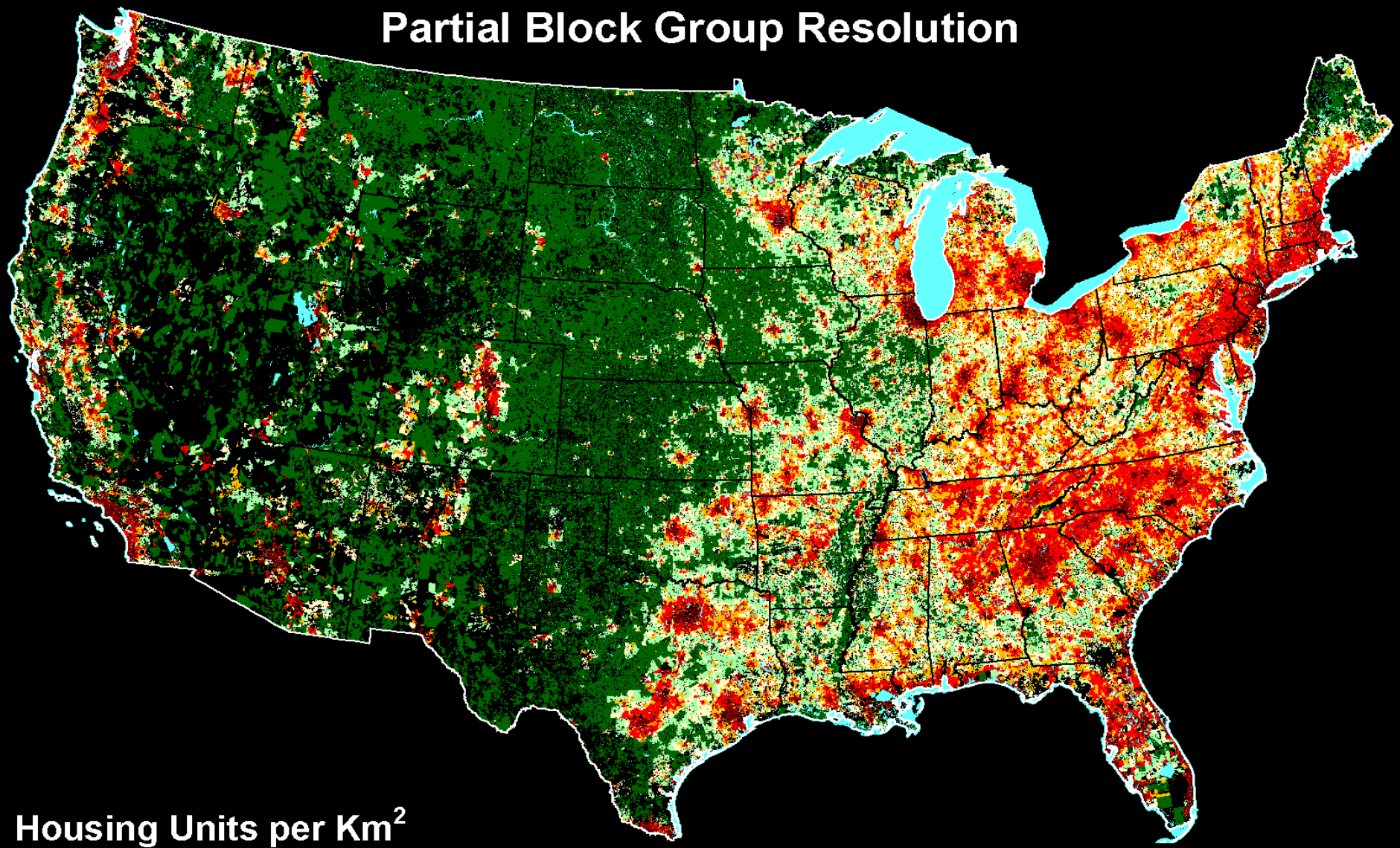
Projected Housing Density 2030

Partial Block Group Resolution



Housing Units per Km^2

- 0
- 0 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 128
- >128
- water

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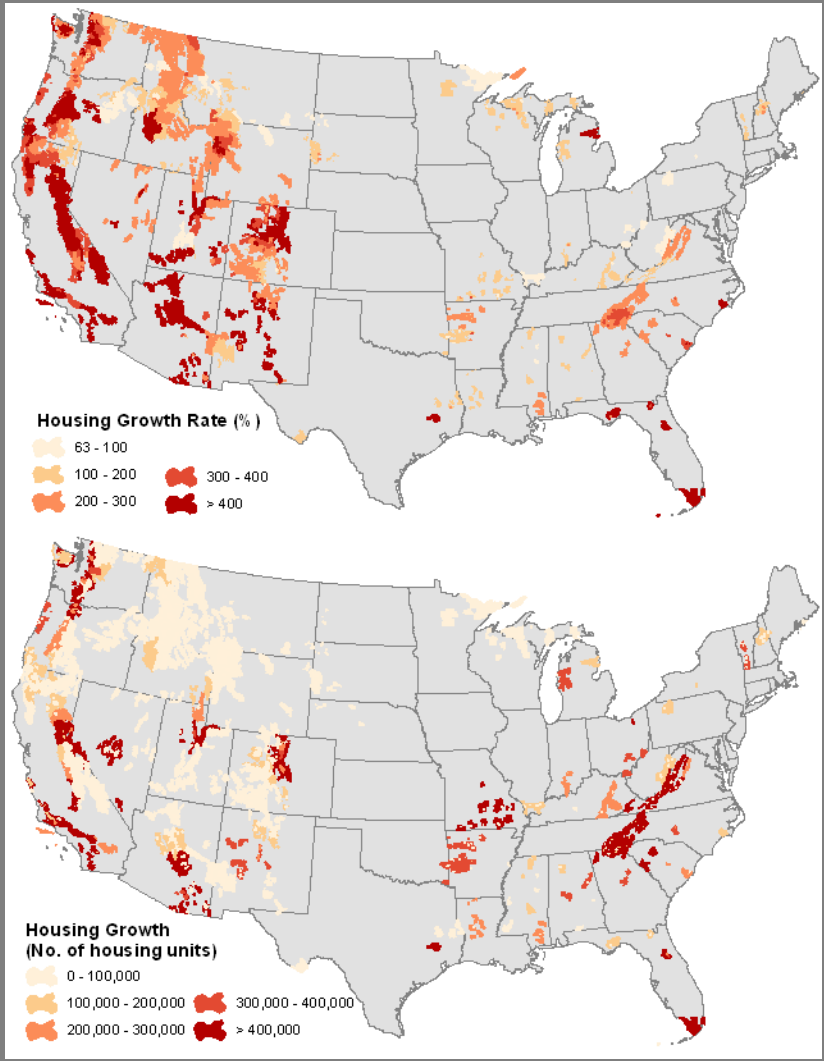
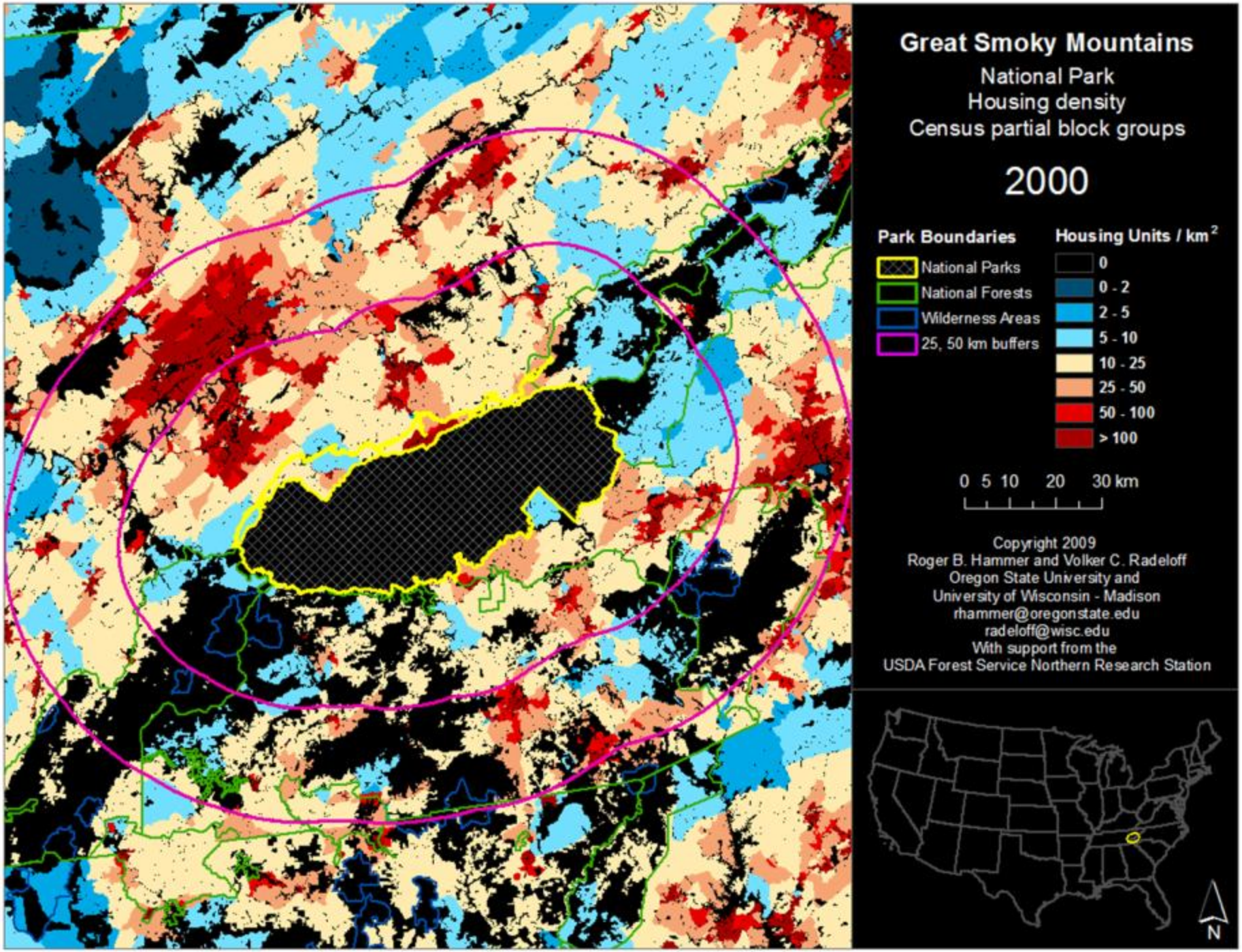
Housing Growth near Protected Areas

PBG housing data also used to map housing growth in and around federally managed protected lands between 1940 and 2030:

1. *National Parks*
2. *National Forests*
3. *Wilderness Areas*



http://silvis.forest.wisc.edu/old/maps.php


Great Smoky Mountains
National Park
Housing density
Census partial block groups
2000
Park Boundaries
National Parks
National Forests
Wilderness Areas
25, 50 km buffers
Housing Units / km²
0
0 - 2
2 - 5
5 - 10
10 - 25
25 - 50
50 - 100
> 100
0 5 10 20 30 km
Copyright 2009
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University of Wisconsin - Madison
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radeloff@wisc.edu
With support from the
USDA Forest Service Northern Research Station
N

References and More

- **Graphics and datasets available online**
  - **http://silvis.forest.wisc.edu/**
- All methods are peer-reviewed in journal articles
  - **WUI**:Radeloff, V. C., R. B. Hammer, S. I. Stewart, J. S. Fried, S. S. Holcomb, and J. F. McKeefry. 2005. The wildland-urban interface in the United States. Ecological Applications 15:799-805.
  - **Housing**: Hammer, R. B., S. I. Stewart, R. L. Winkler, V. C. Radeloff, and P. R. Voss. 2004. Characterizing dynamic spatial and temporal residential density patterns from 1940–1990 across the North Central United States. Landscape and Urban Planning 69:183-199.
  - **Housing and Protected Areas**:Radeloff, V. C., S. I. Stewart, T. J. Hawbaker, U. Gimmi, A. M. Pidgeon, C. H. Flather, R. B. Hammer, and D. P. Helmers. 2010. Housing growth in and near United States protected areas limits their conservation value. Proceedings of the National Academy of Sciences **107**:940.

Thank you

- *All of this work was a group effort, funding and resources from home institutions and others*
- *UWisconsin, Dave Helmers – web and GIS*
- *USDA Forest Service and National Fire Plan*

http://silvis.forest.wisc.edu/

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Kurt Riitters

Research Ecologist

Southern Research Station

US Forest Service

Land Cover Patterns

Photos:
Larry Korhnak, www.interfacesouth.org

Primary Audience – National Reports

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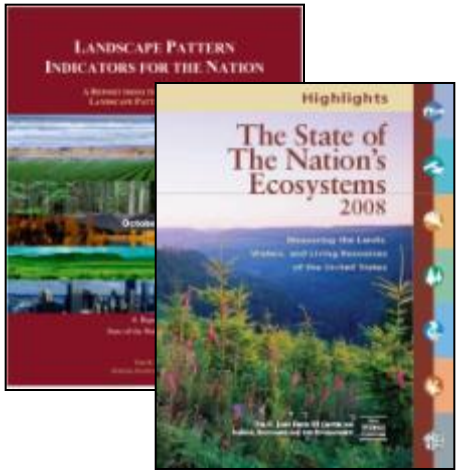
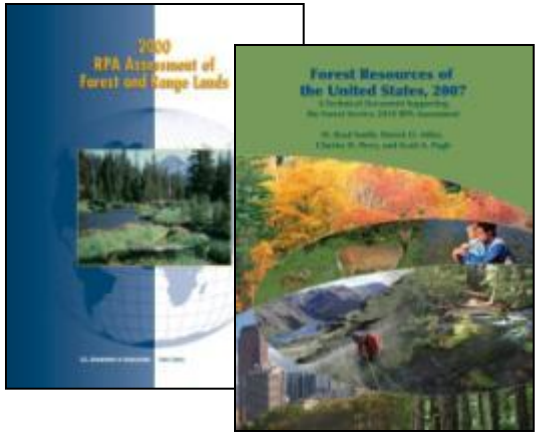
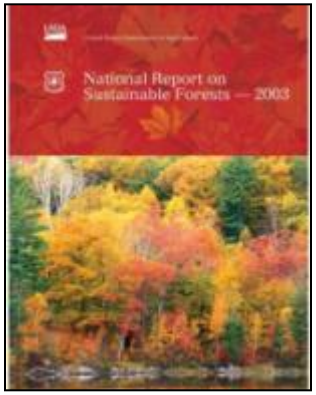
USDA



RPA



Roundtable on Sustainable Forests



National Forest Health Monitoring Program

EPA

Who Cares About Land Cover Patterns?

- **Society and popular science**
  headline indicators (forest fragmentation, urban sprawl…)

- **Spatial ecologists**
  the pattern ↔ process hypothesis (biodiversity, water quality,…)

- **Resource managers**
  ecological goods and services (where to manage what…)

- **Land use planners**
  landscape context (recreation, sense of place …)

- **Epidemiologists**
  human health (Lyme disease…)

- **Assessment scientists**
  environmental risk (ecological security, ecosystem services…)

Approach – A National Census of Patterns

Input data – National Land Cover Database (NLCD)

- Spatial resolution – 0.09 ha per pixel (30m)
- Thematic resolution – 17 land cover types

Notable features

- Complete (wall to wall)
- Consistent (one map legend)
- Comparable (over time)
- Free

Spatial analysis

Three basic questions

1. Which patterns occur where?
→Measure and map three fundamental metrics of pattern.

2. Over what spatial scales does a pattern exist?
→Several measurement scales are used for each metric.

3. How & where are patterns changing over time?
→Land cover maps from several dates are used.

2010 RPA Assessment

Parallel analysis of the patterns of forest, grass, and shrub land cover (using same protocols) using NLCD 2001.

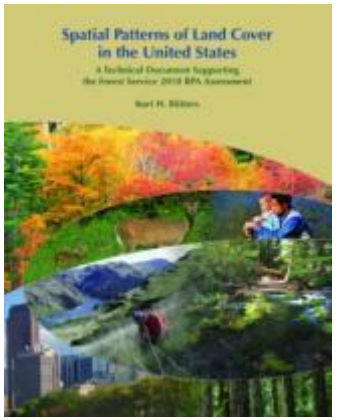
Create national maps of land cover patterns.

Summarize patterns maps by county, by State, etc.

Three fundamental metrics (forest examples)

- "Area density" describes dominance and fragmentation.
  - Essentially, how much forest is surrounded by how much other forest?
- "Landscape mosaic" describes anthropogenic context.
  - e.g. how much forest is surrounded by how much agriculture or developed land cover?
- "Morphology" describes the structural role played by a given location.
  - e.g. how much forest is "core," "connector," "edge," etc.

2010 RPA – Summary of Findings



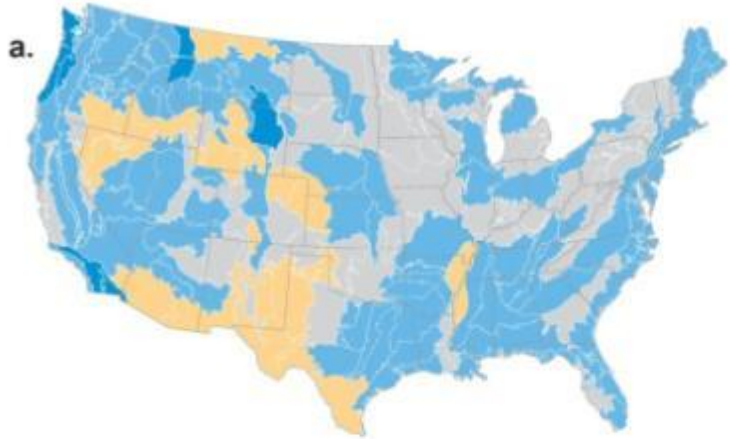
http://www.srs.fs.usda.gov/pubs/37766

- Substantial geographic variation of patterns.
- Forest, grass, and shrub land covers tend to dominate the landscapes where they occur.
- Fragmentation is pervasive: 30-40% of forest, grass, and shrub area is within 100 feet of "edge."
- Anthropogenic risk is common: over half of the forest and grassland area occurs in neighborhoods containing more than 10% agriculture or developed land-cover.
- Grassland is the most fragmented and shrubland is the least fragmented.
- Forest fragmentation is similar to grassland at local scales, and similar to shrubland at broader scales.

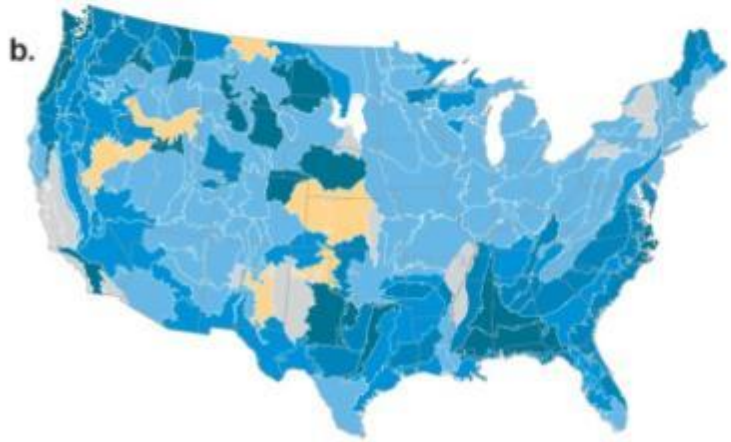
Forest Interior* Change 2001-2006

Bailey's sections shaded according to percentage change.

a) Total forest area (both interior and non-interior)



b) Forest interior area, 65.6-ha scale



Net change
- >1% gain
- <1% change
- 1% to 4% loss
- 5% to 8% loss
- 9% to 12% loss
- >12% loss

Interpretation

There was a widespread shift in the spatial pattern of the extant forest to more fragmented conditions, *including* regions exhibiting relatively small net changes in extant forest area.

***Interior defined:**
Forest pixel at the center of a 65-ha neighborhood that is 90% forested . (*Derived from the Area Density metric*)

Riitters and Wickham. 2012. Decline of forest interior conditions in the conterminous United States. Scientific Reports 2 : 653 | DOI: 10.1038/srep00653

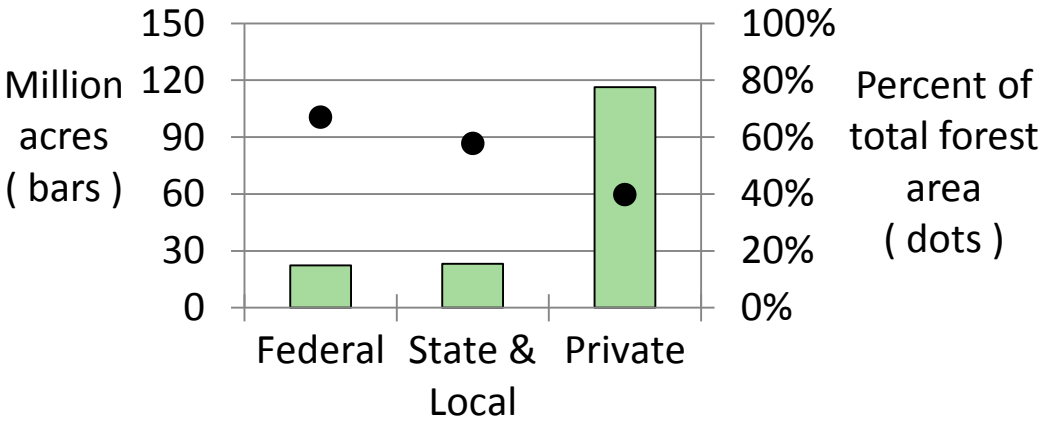
Analysis of Intact* Forest Using FIA Data

Forest types and ownerships evaluated using FIA and NLCD data.

Scope

FIA forestland;
31 eastern States.

Part 1 - Intact forest area by ownership



Part 2 - Comparison of 75 forest types

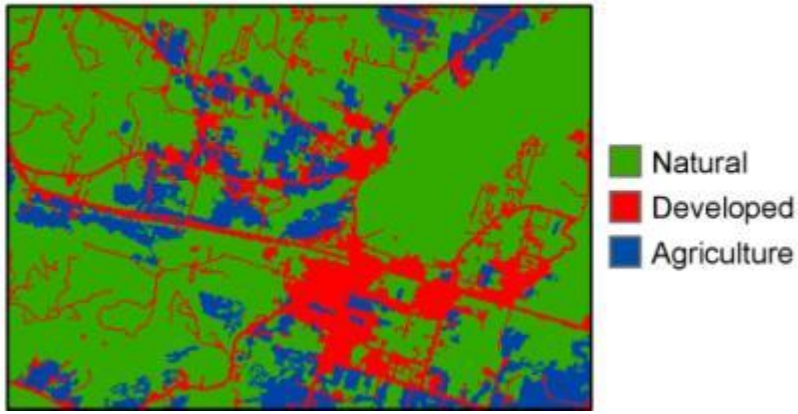
- 13% to 78% of a given total type's area was intact.
- 0.05 to 21.6 million acres of intact type area.
- A few forest types dominate total intact area.

***Intact defined:**
FIA plot at the center of a 10.9-acre neighborhood that is 100% forested on the NLCD map. (*Derived from the Area Density metric*)

Riitters, Coulston, Wickham. 2011. Fragmentation of forest communities in the eastern United States. Forest Ecology and Management 263:85-93

Landscape Mosaic Example

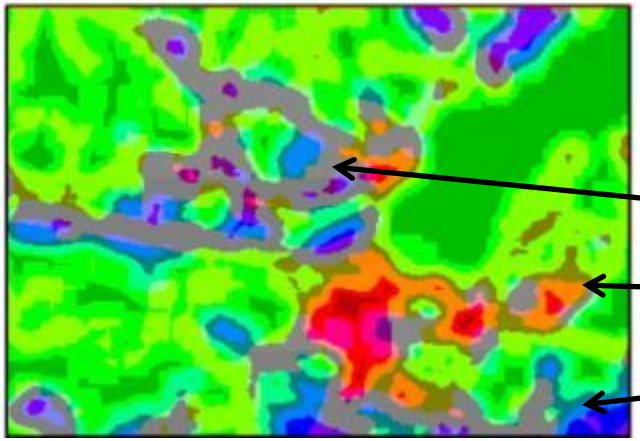
Land-Cover Map



Landscape mosaic classification using tri-polar model

Note: A grid cell on a map of landscape mosaic indicates the anthropogenic composition of the surrounding neighborhood.

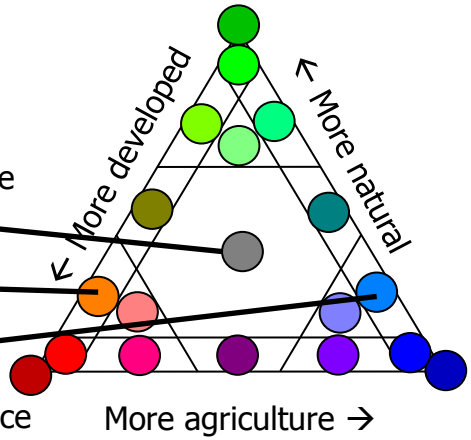
Land-Cover Mosaic Map



Heterogeneous landscape (gray)

Natural-urban interface (orange)

Natural-agriculture interface (cyan)



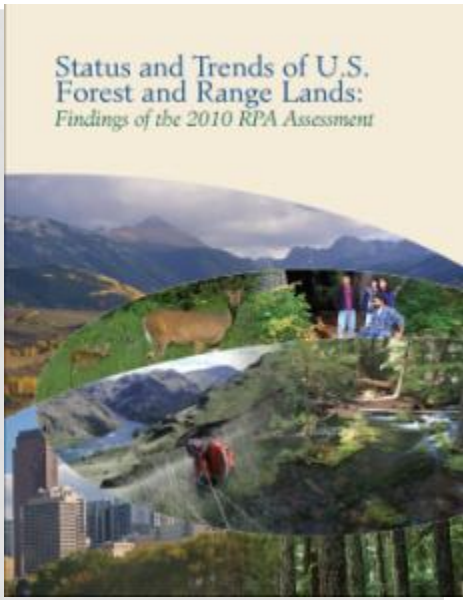
Questions and Answers

Ask questions through the chat pod

Dave Wear

Southern Research Station

US Forest Service



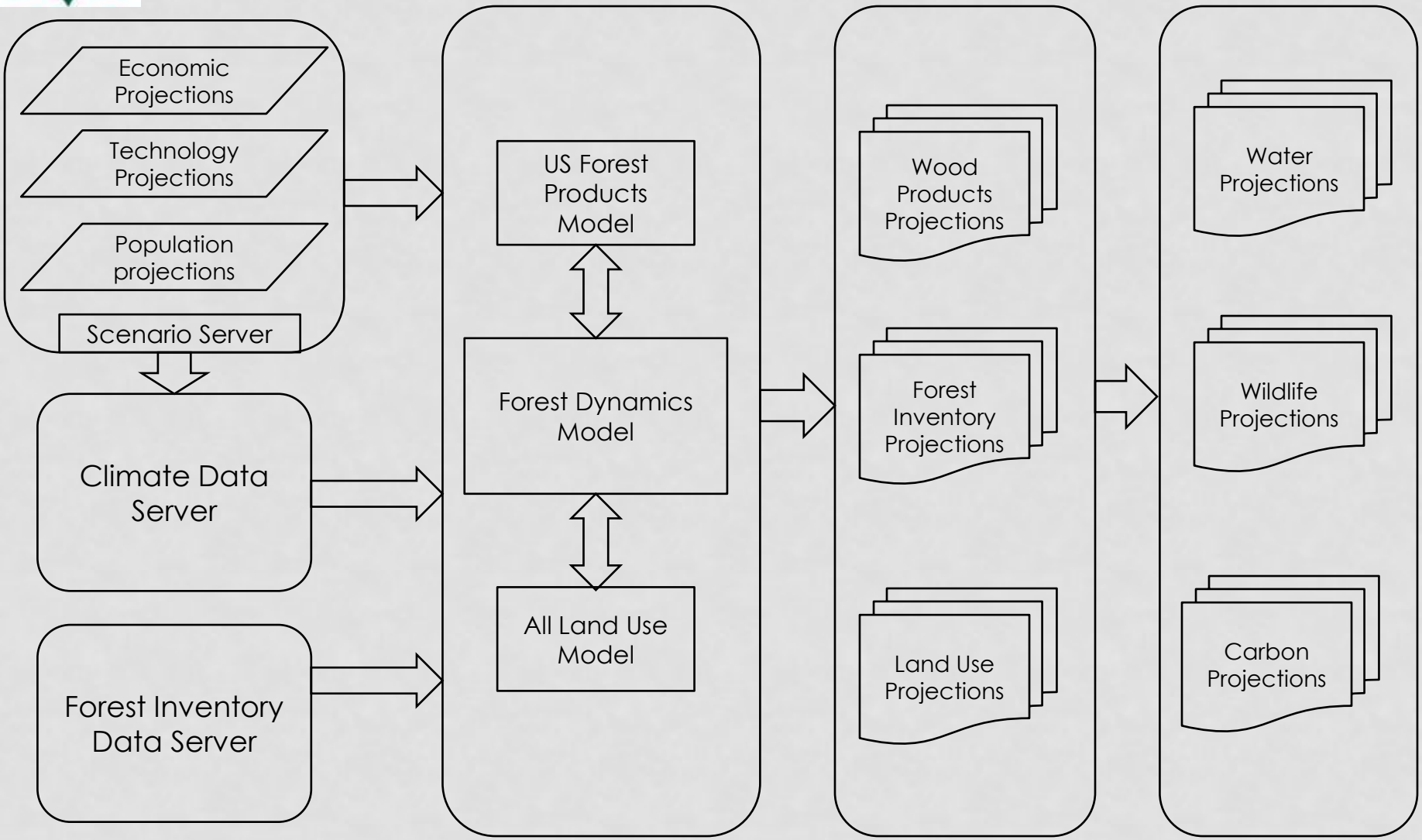
LONG RUN FORECASTS OF U.S. LAND USE AND FOREST CONDITIONS

DAVID WEAR
SOUTHERN RESEARCH STATION

GENERAL OVERVIEW

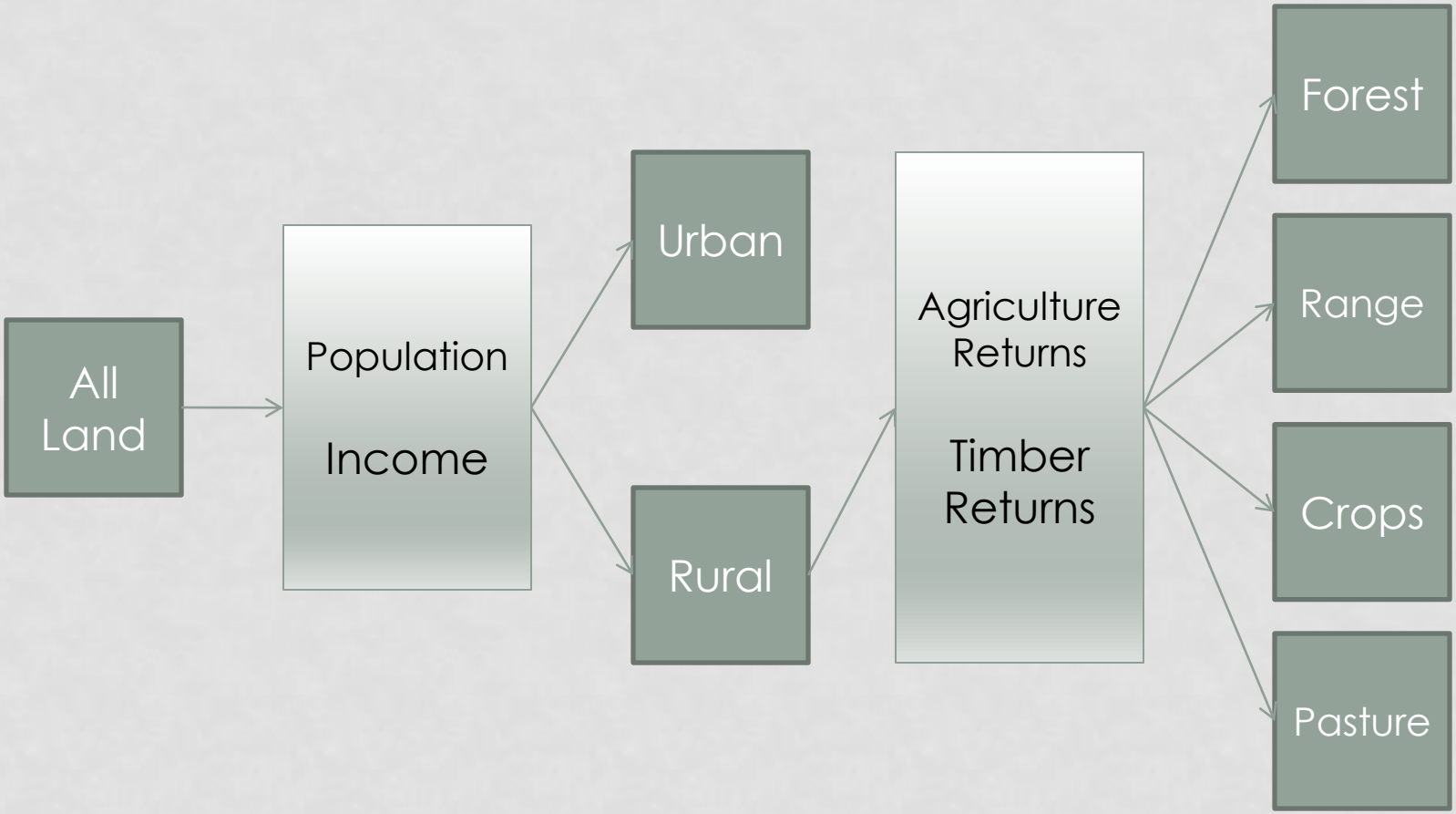
- Objectives: generate forecasts of land use and forest conditions that address:
  - land use choices
  - Forest management choices
  - Disturbance and succession
  - Climate
- Audience
  - RPA Assessment: Congressional mandate to anticipate resource issues
  - Regional Assessments: detailed insights into resource issues: Southern and Northern Forest Futures Projects

US Forest Assessment System

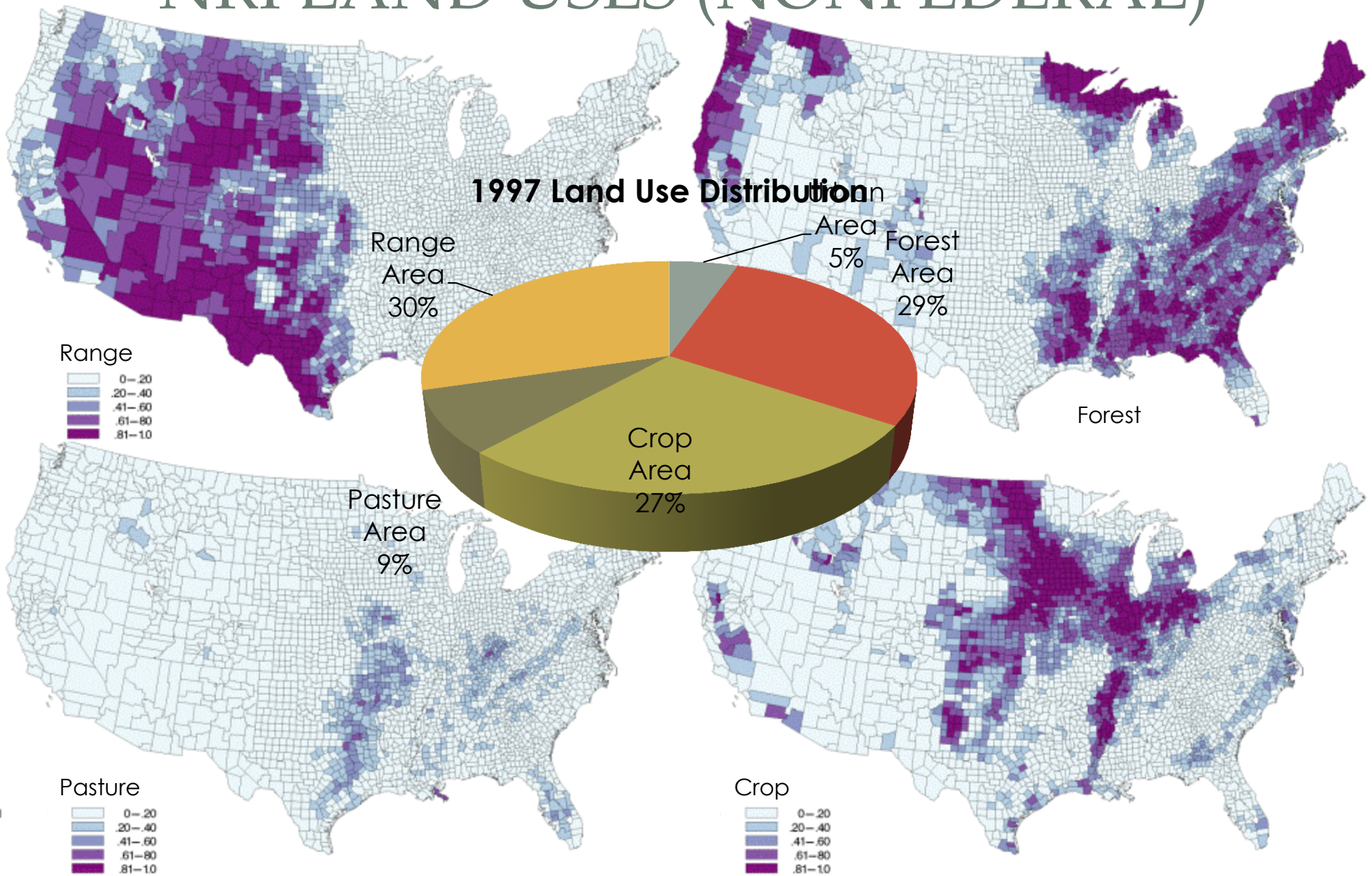


Harmonized models

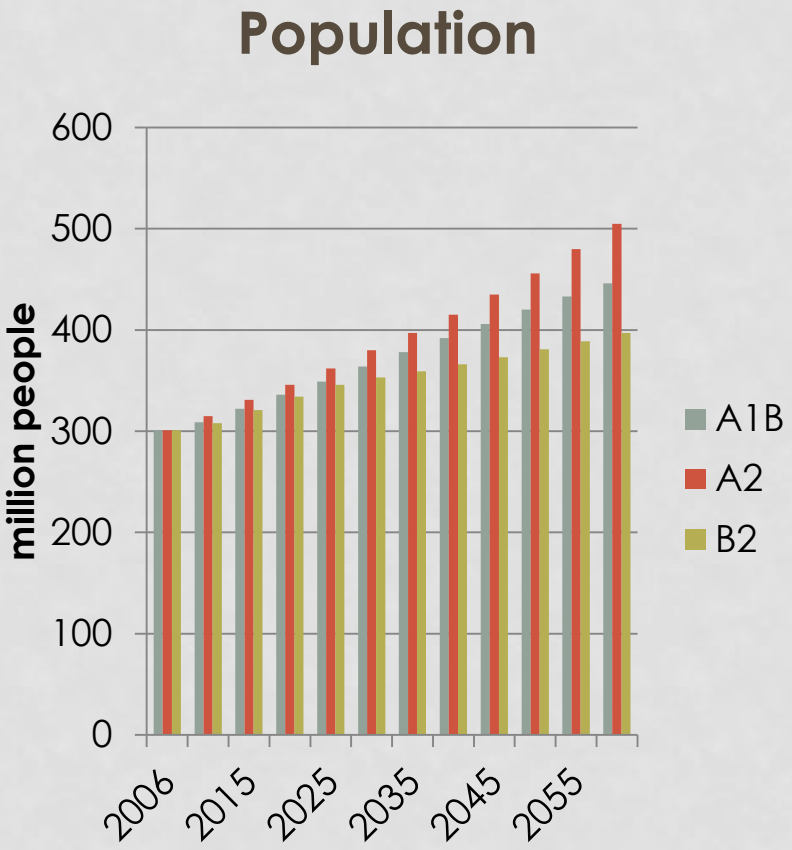
FORECASTING LAND USE

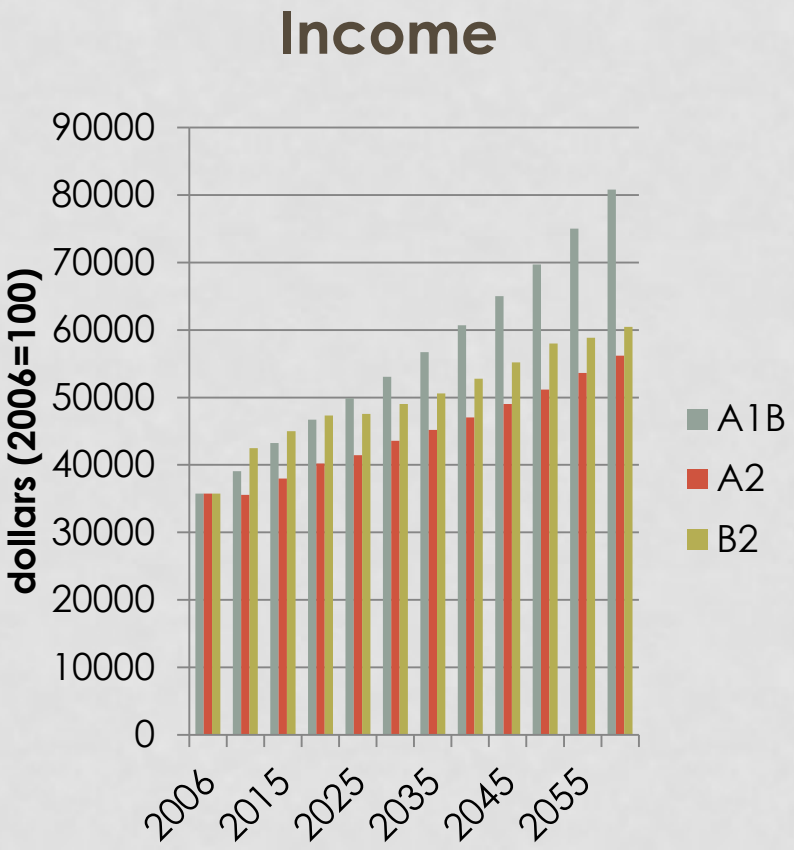


NRI LAND USES (NONFEDERAL)

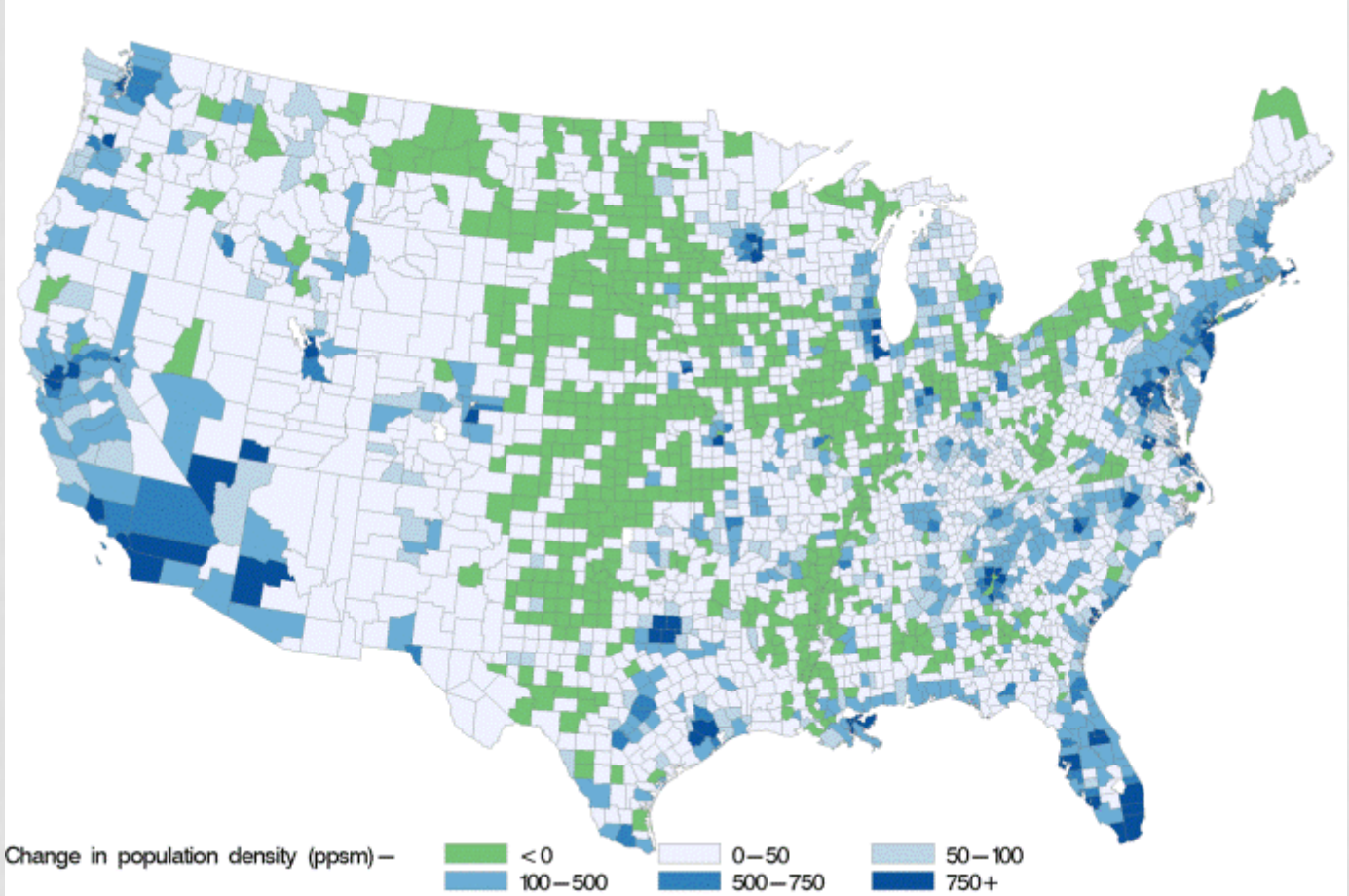


SCENARIOS: POPULATION AND INCOME GROWTH



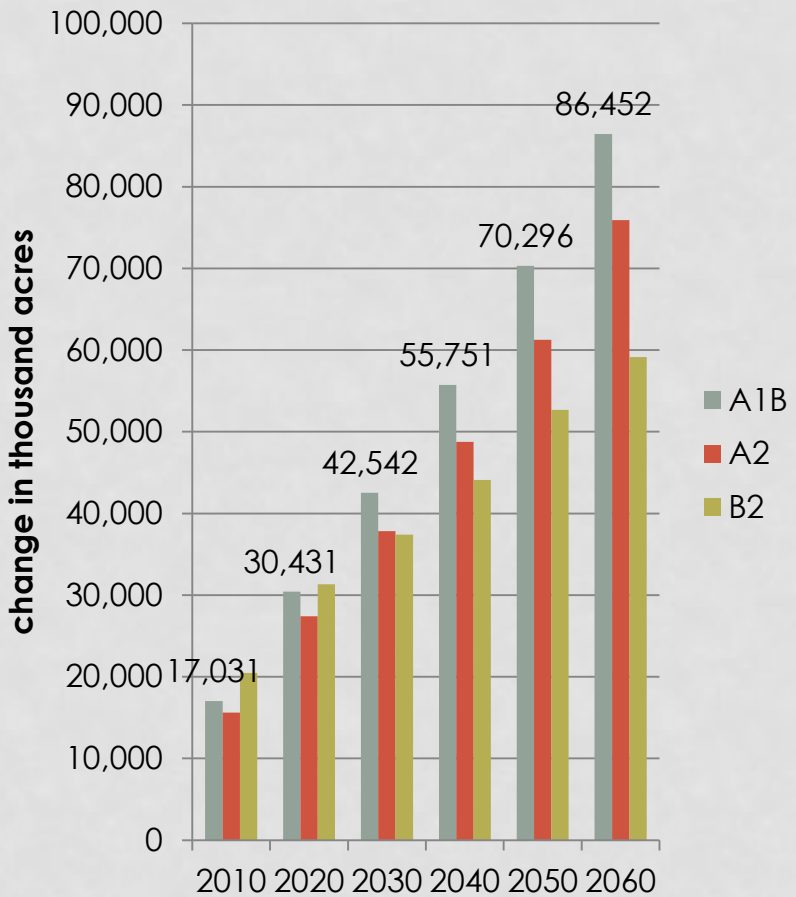


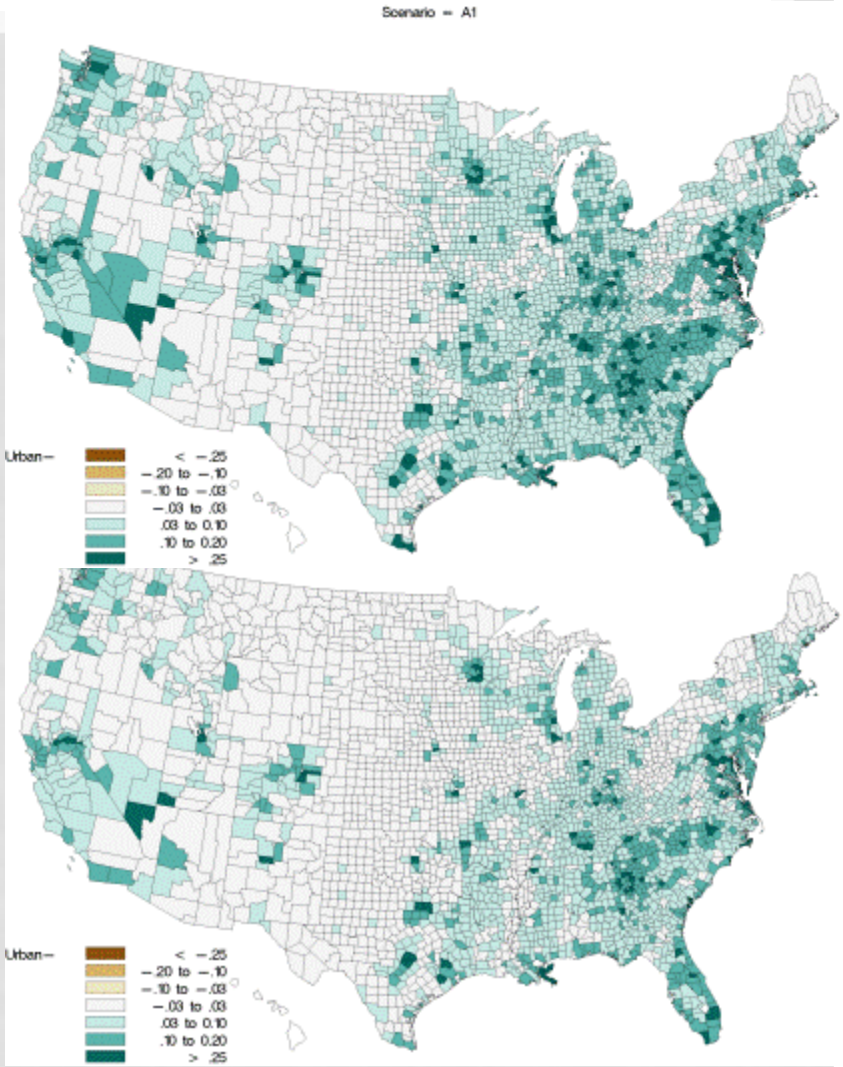
POPULATION GROWTH (A1B)



Downscaled population and income projections by Zarnoch and others (2010)

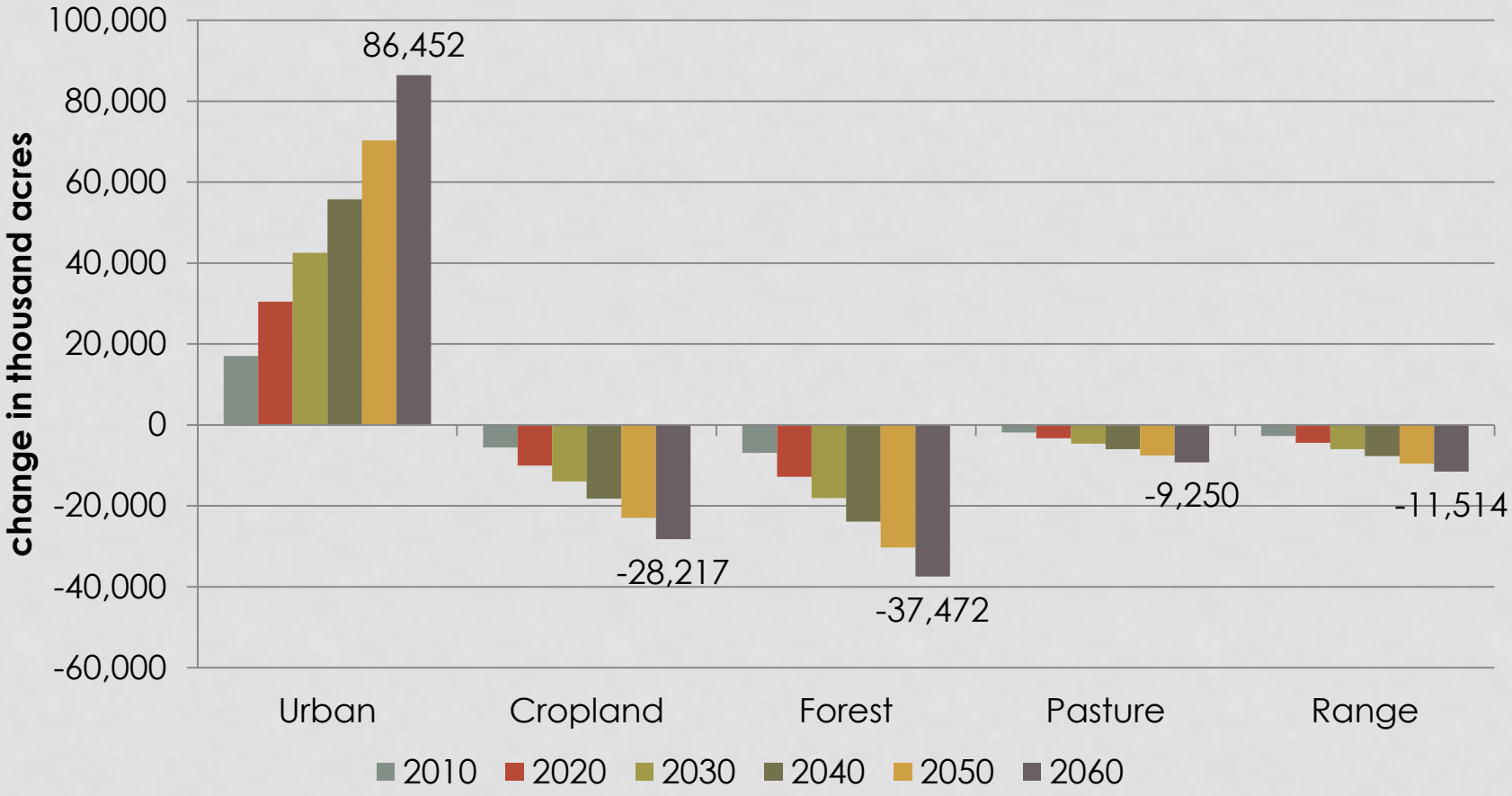
DEVELOPED LAND



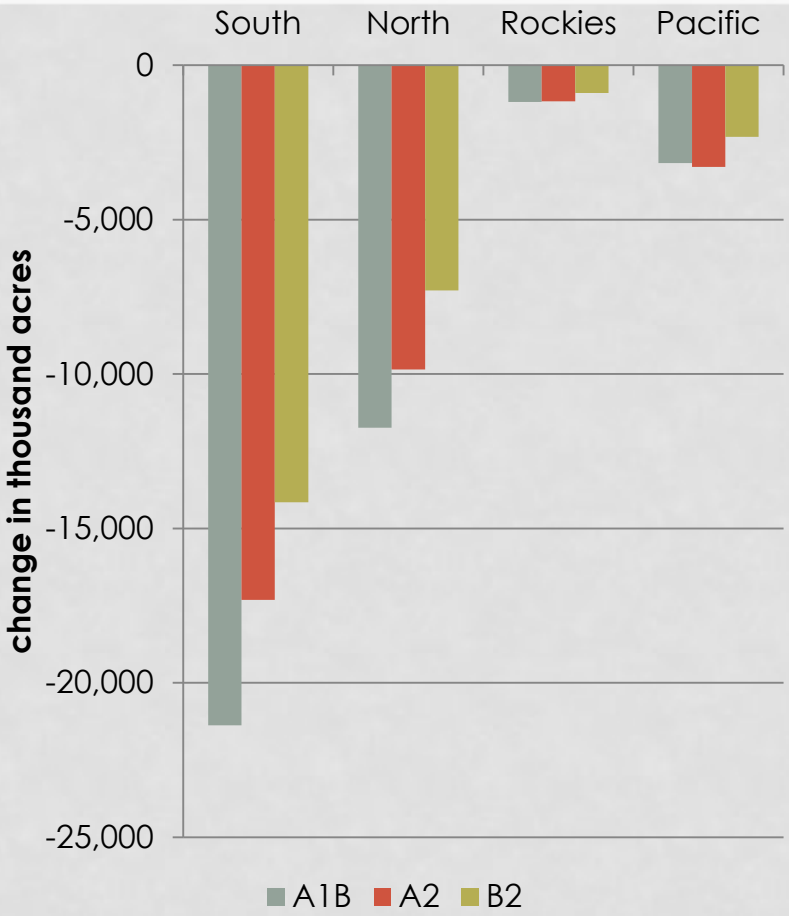


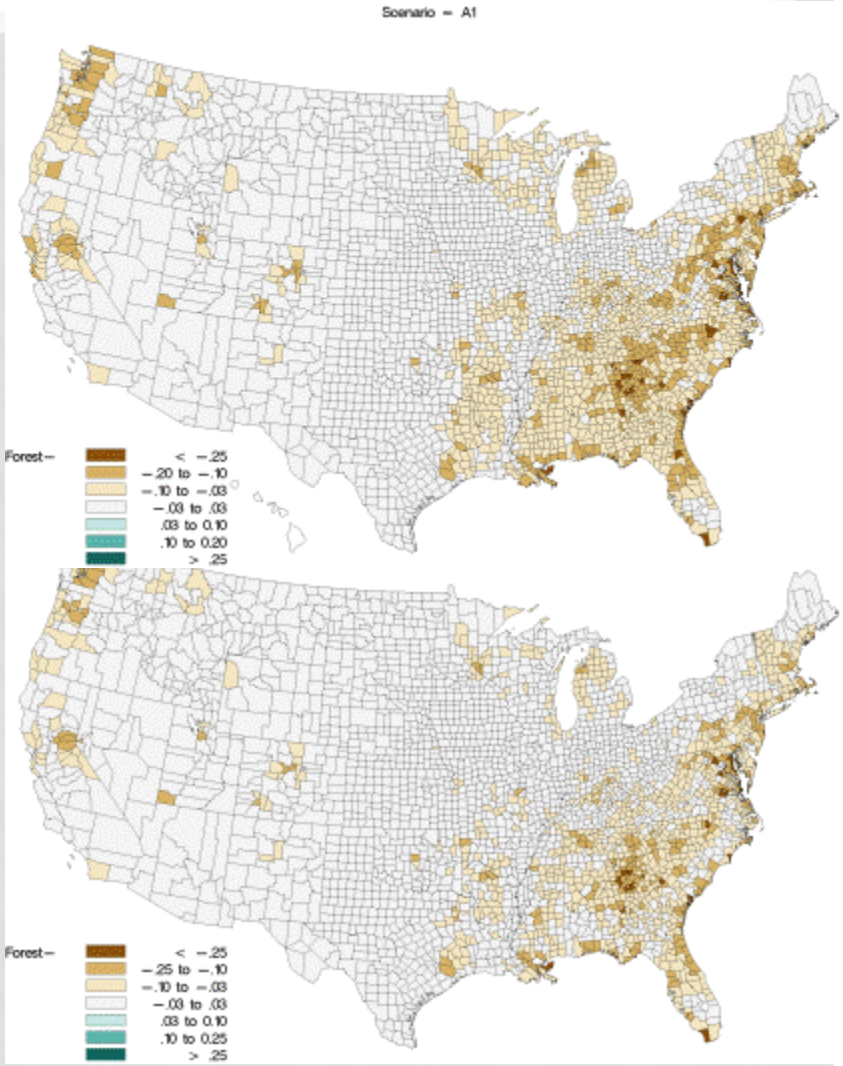
Important interactions between income and population in forecasts of developed.

A1B-IMPLICATIONS ACROSS LAND USES

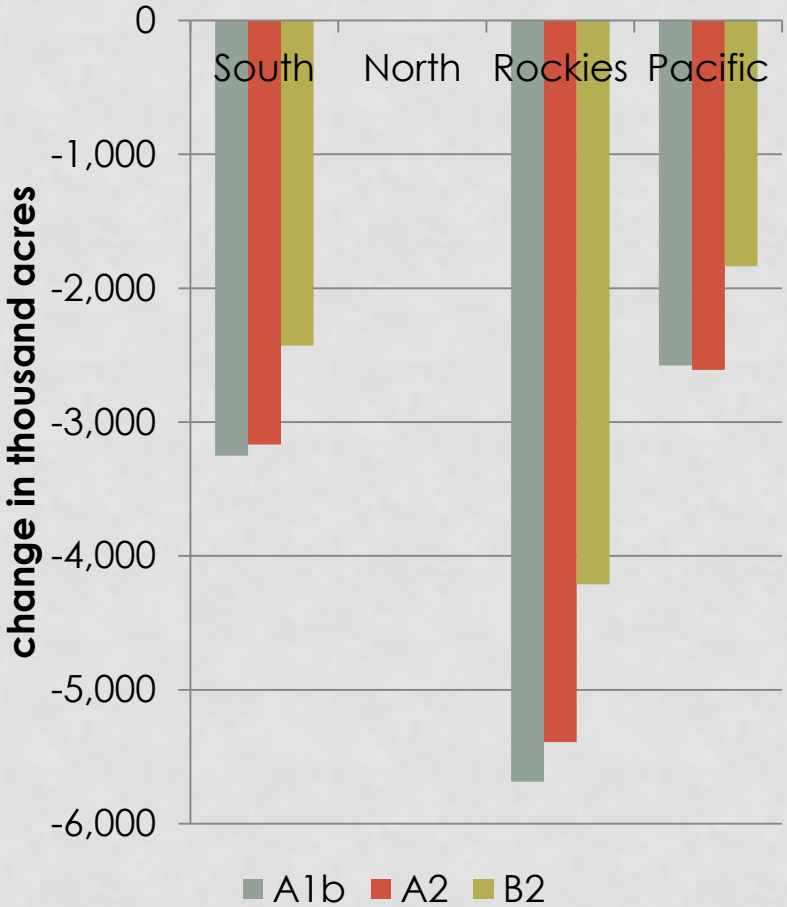


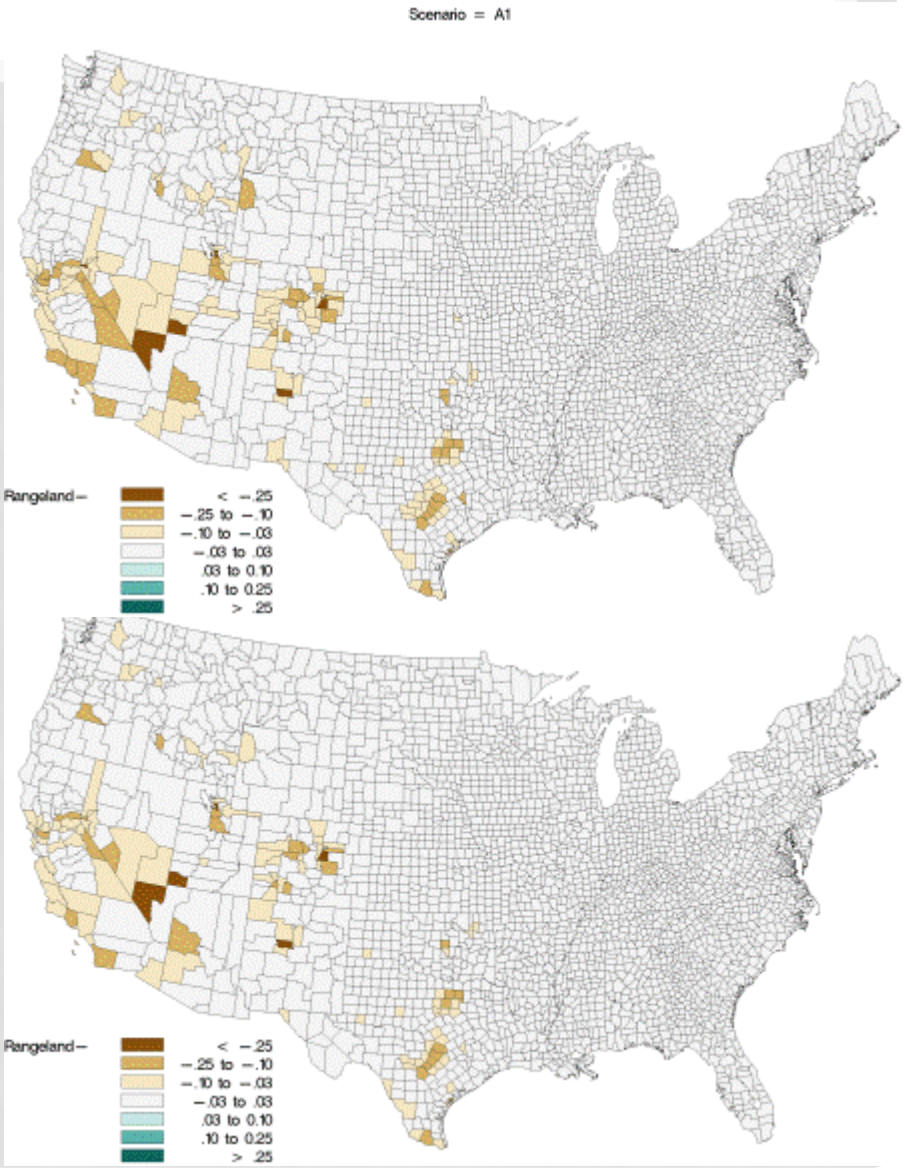
FOREST LAND


South
North
Rockies
Pacific
0
-5,000
-10,000
-15,000
-20,000
-25,000
change in thousand acres
A1B
A2
B2

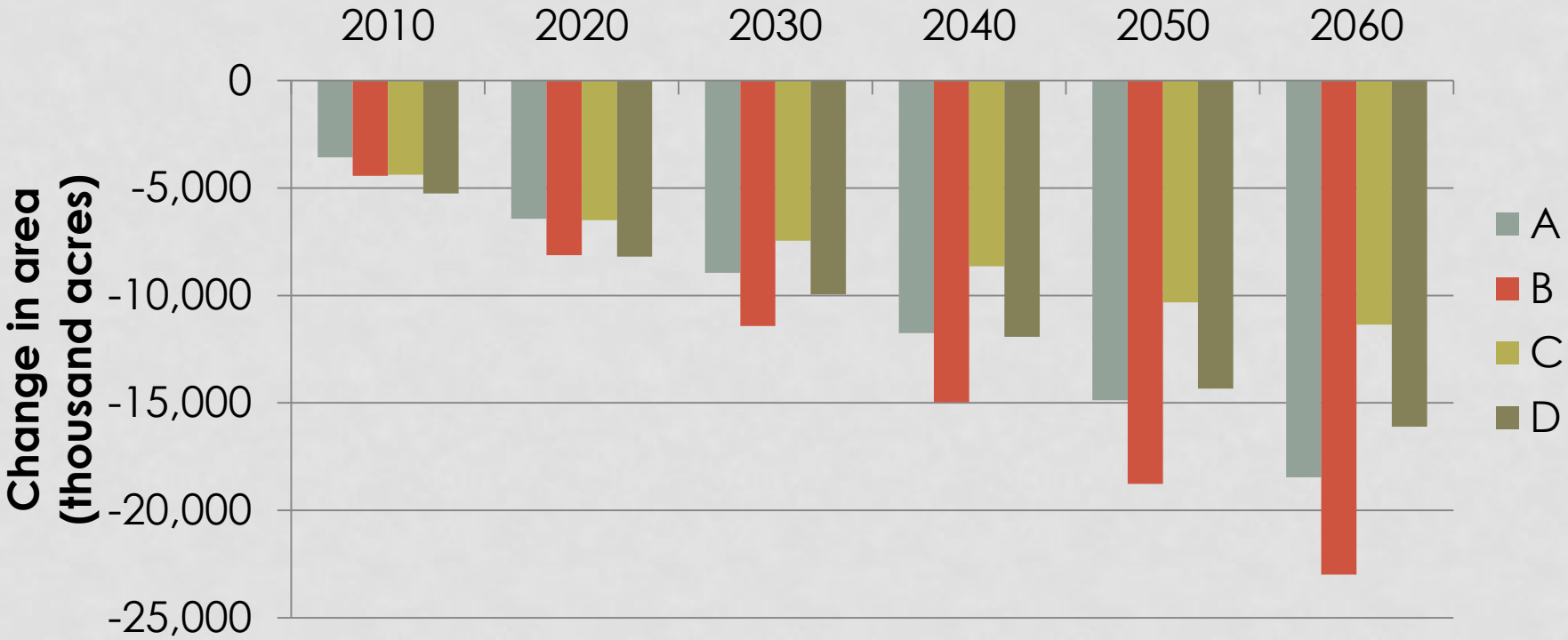

Scenario = A1
Forest–
< –.25
–.20 to –.10
–.10 to –.03
–.03 to .03
.03 to 0.10
.10 to 0.20
> .25
Forest–
< –.25
–.25 to –.10
–.10 to –.03
–.03 to .03
.03 to 0.10
.10 to 0.25
> .25

RANGELAND


0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
change in thousand acres
South
North
Rockies
Pacific
A1b
A2
B2

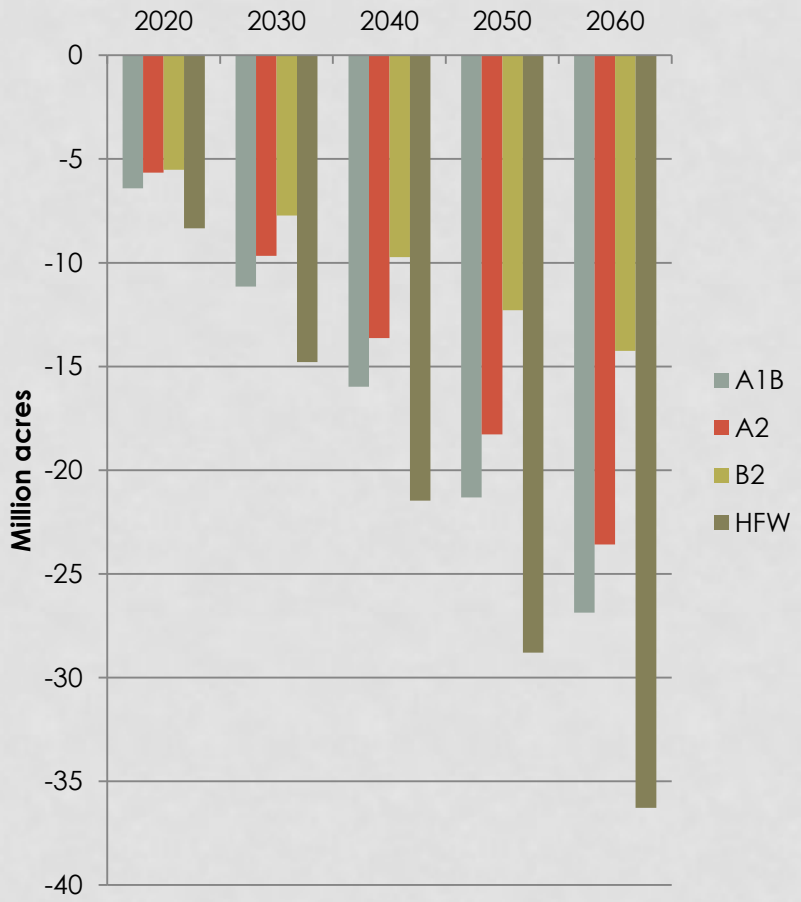

Scenario = A1
Rangeland –
< –.25
–.25 to –.10
–.10 to –.03
–.03 to .03
.03 to 0.10
.10 to 0.25
> .25
Rangeland –
< –.25
–.25 to –.10
–.10 to –.03
–.03 to .03
.03 to 0.10
.10 to 0.25
> .25

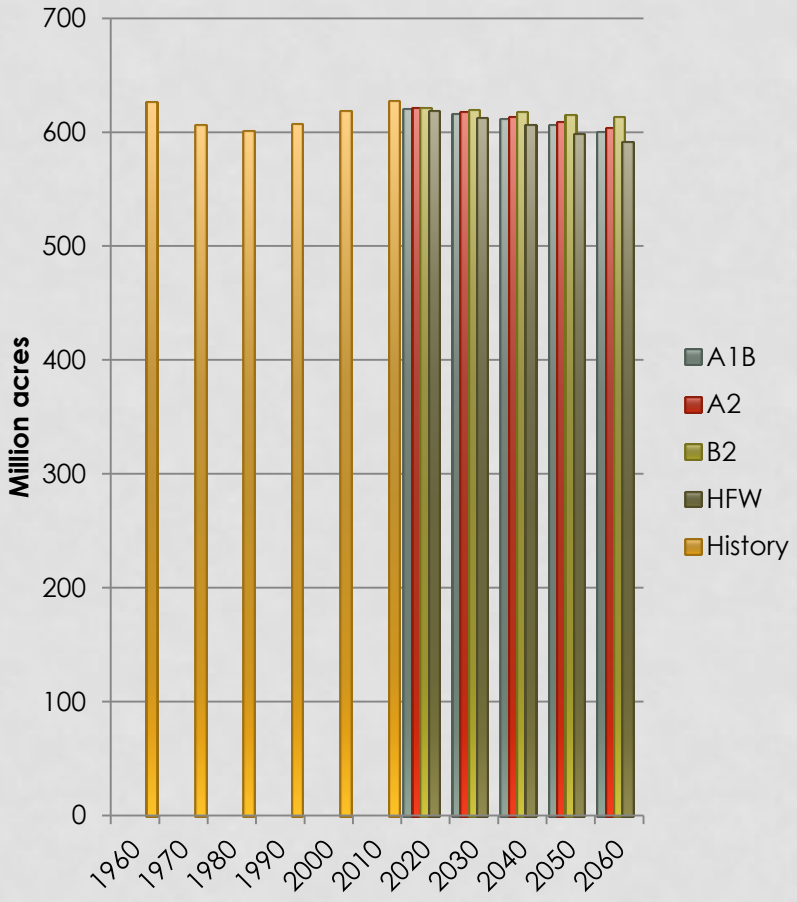
INTERACTION OF URBANIZATION AND TIMBER MARKETS



Change in forest land uses for the South, 1997 to 2060, under four Scenarios: (A) A1B with increasing timber prices, (B) A1B with decreasing timber prices, (C) B2 with increasing timber prices, and (D) B2 with decreasing timber prices.

US FOREST AREA CHANGES (FIA BASIS, 2010-2060)





OVERVIEW OF FINDINGS

- **Urbanization**: between 60 and 86 million acres of rural land are forecasted to be developed between 1997 and 2060, at a rate of 1 to 1.4 million acres per year. Forest losses: Forest land is expected to be the greatest source of newly developed land between 1997 and 2060.
- **Forest losses**: between 24 and 38 million acres of forests are forecasted to be converted to other uses between 1997 and 2060. More than half of the forecasted forest losses occur in the South and more than 90 percent occur in the eastern US.
- **Cropland losses**: Cropland losses are forecasted to range between 19 and 28 million acres and would be focused primarily in the Midwest and Mid Atlantic States.
- **Rangeland losses**: Rangeland losses are forecast to range between 8 and 11 million acres and would be focused in Colorado, Nevada, southern California, and central Texas.

KEY POINTS

- Peak forest area in 2010?
  - All scenarios indicate different degrees of forest decline to 2060
  - Reverses 1980-2010 trend (role of CRP?)
  - Urbanization dominates without offsets from agriculture
- Forest area losses are strongly focused in the East
  - Urban losses mitigated in the South by response to timber market signals (not so much in the North) with a shift toward planted pine
- Also, inventory and forest carbon are forecast to peak in the next 30 years

KEY POINTS

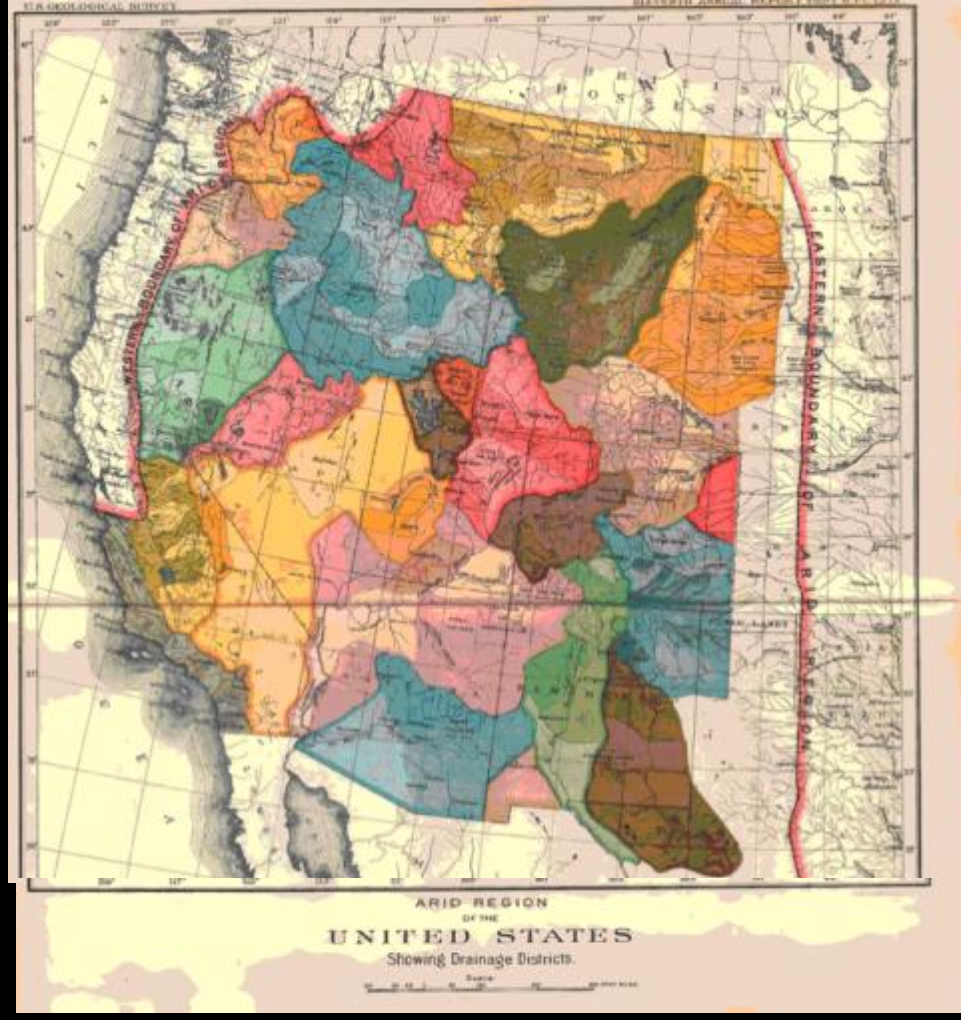
- Broad range of forest loss forecasts
  - Over a fairly narrow range of population forecasts
  - Implication is that planning can guide growth to a smaller land base
- The landscape (and ecosystem service) context of public lands will change over the next 50 years
  - Especially eastern public lands but also in parts of the Southwest

Dave Theobald

Inventory & Monitoring Division

National Park Service

Science to inform Open Space Conservation: Land use, forest fragmentation, and the WUI



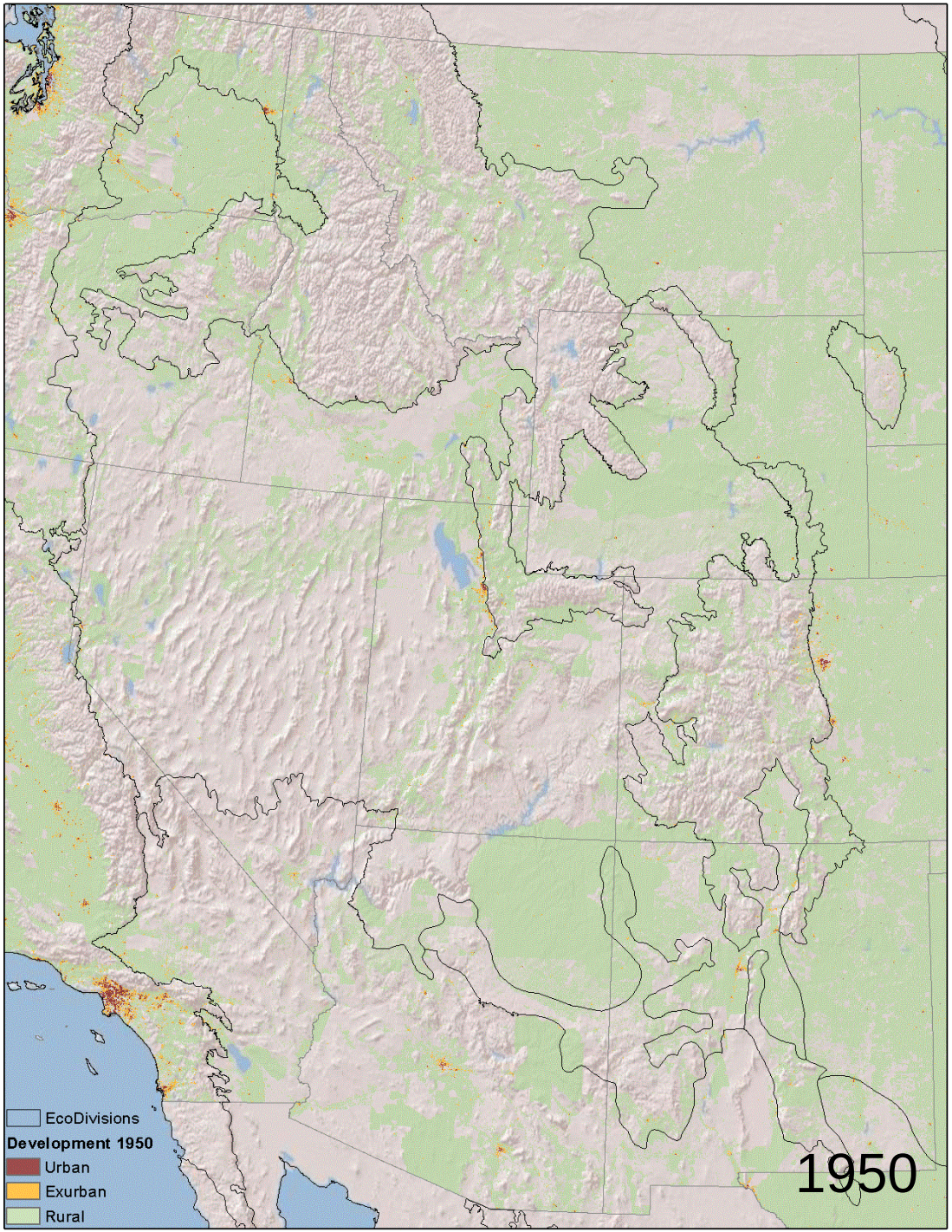
David M. Theobald, PhD
Department of Fish, Wildlife, and Conservation Biology, Colorado State University
now with
Inventory & Monitoring Division, National Park Service

Starting line

- Current patterns
- Likely changes
- Working together

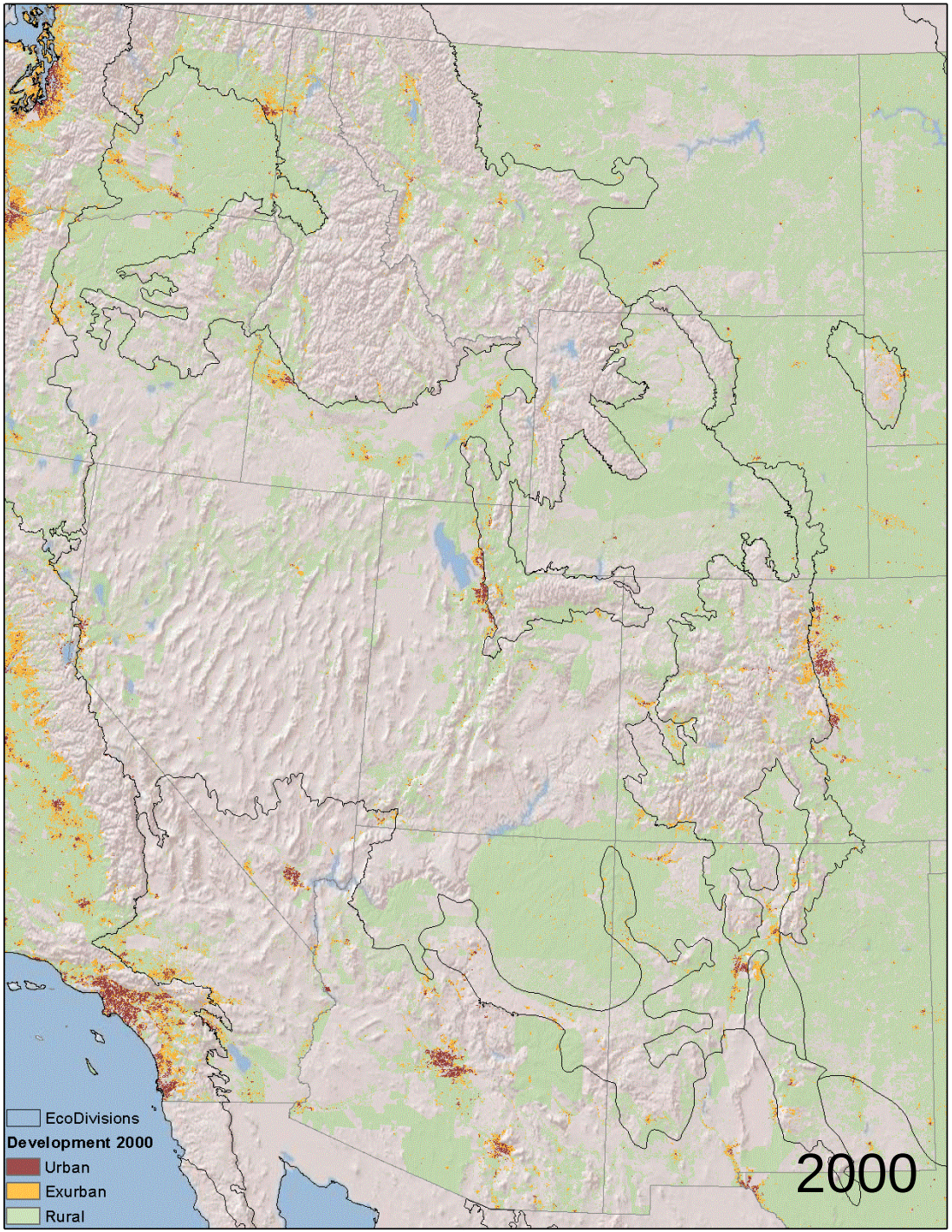
Current patterns

Housing density: urban, exurban, and rural



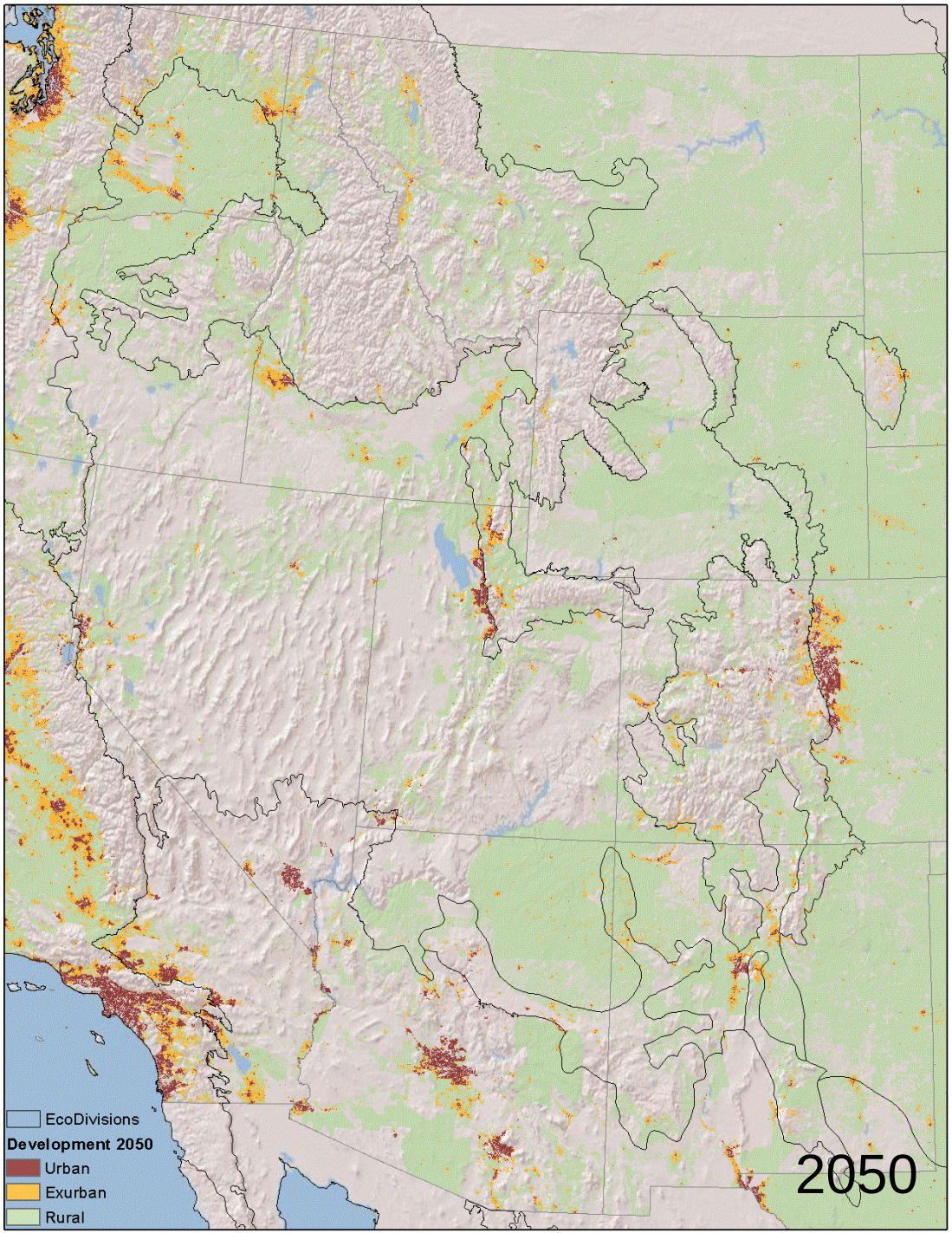
Current patterns

Housing density: urban, exurban, and rural



Current patterns

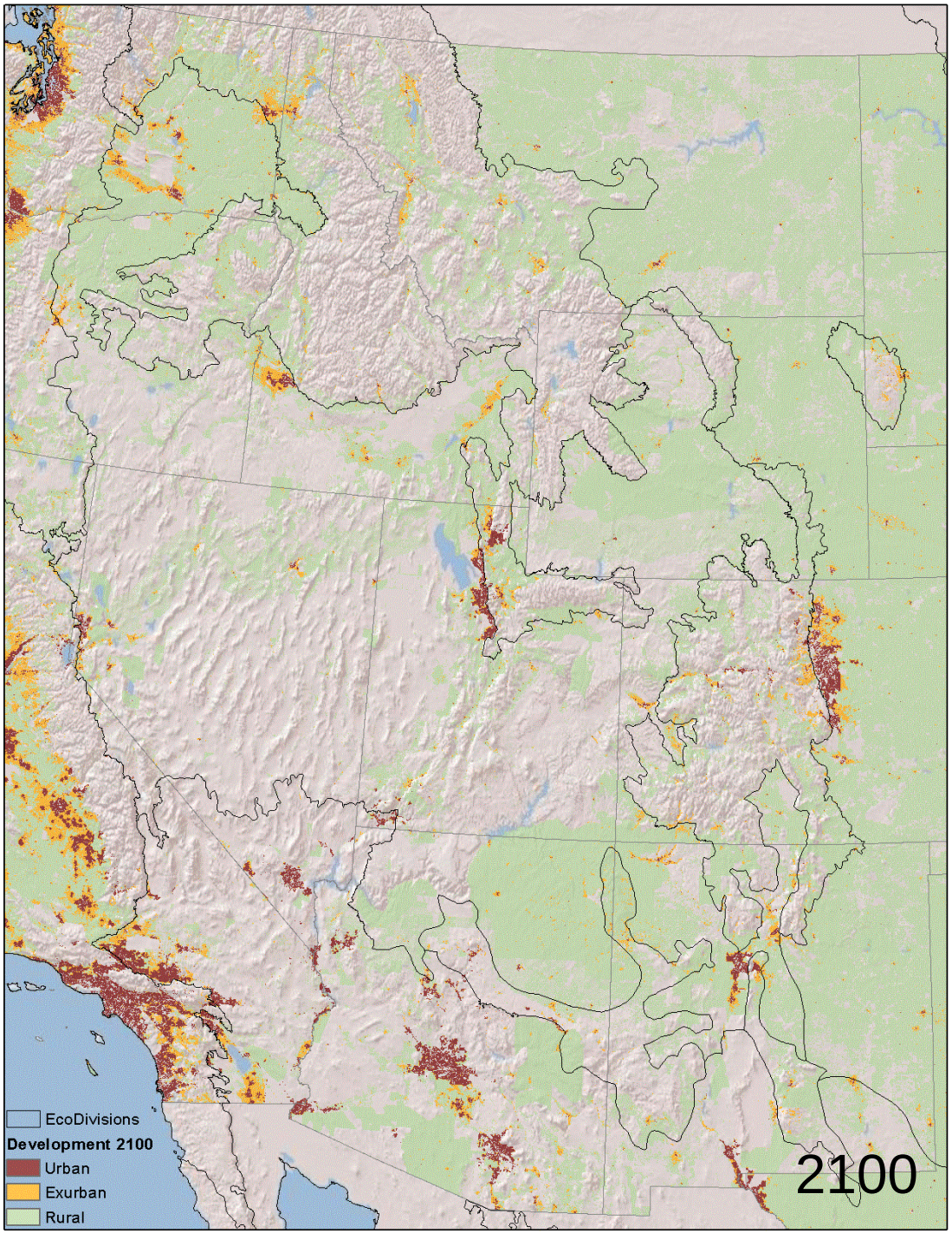
Housing density: urban, exurban, and rural



Current patterns

Housing density: urban, exurban, and rural

From Integrated Climate & Land Use (ICLUS), Bierwagen et al. 2010



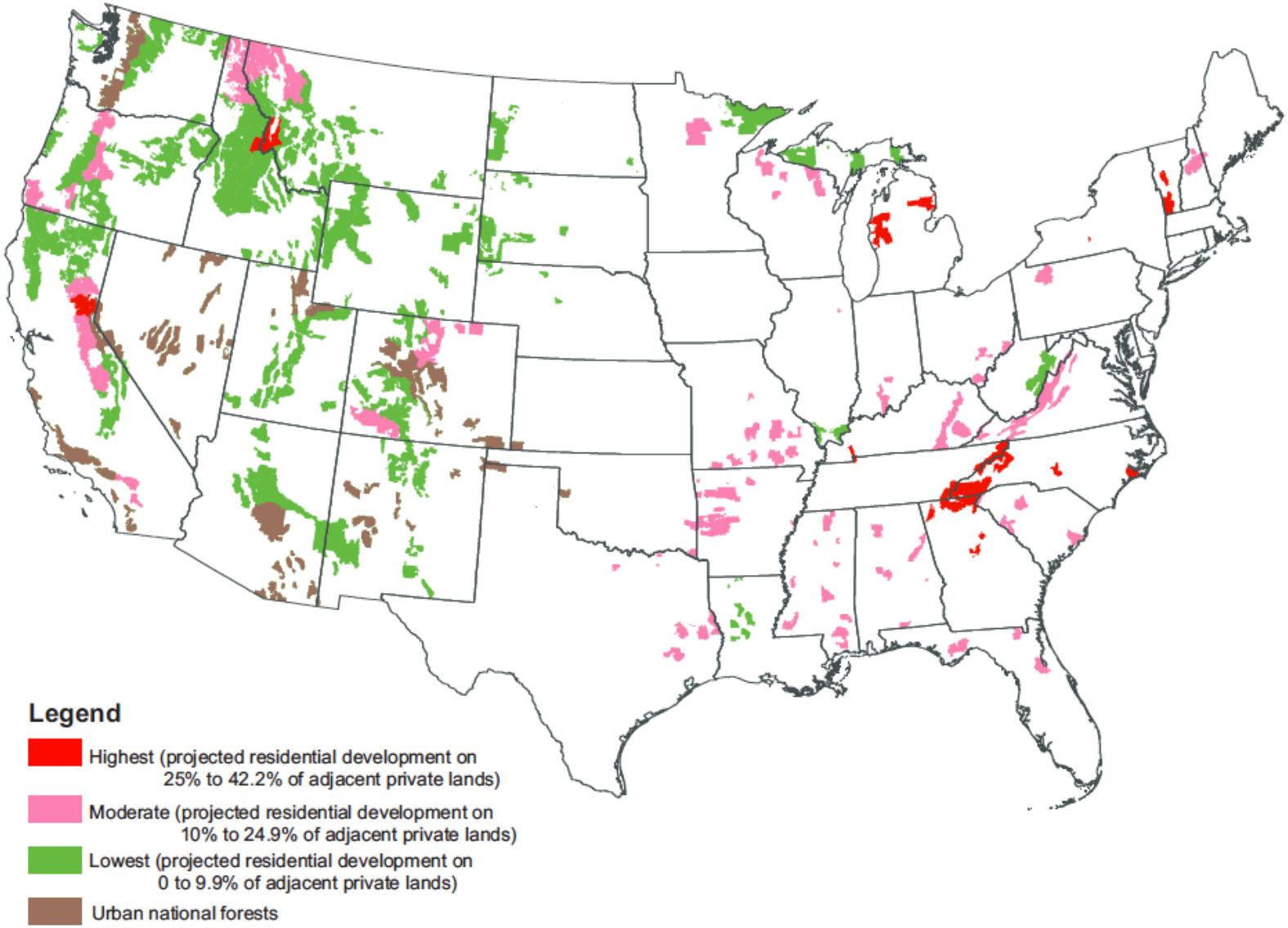
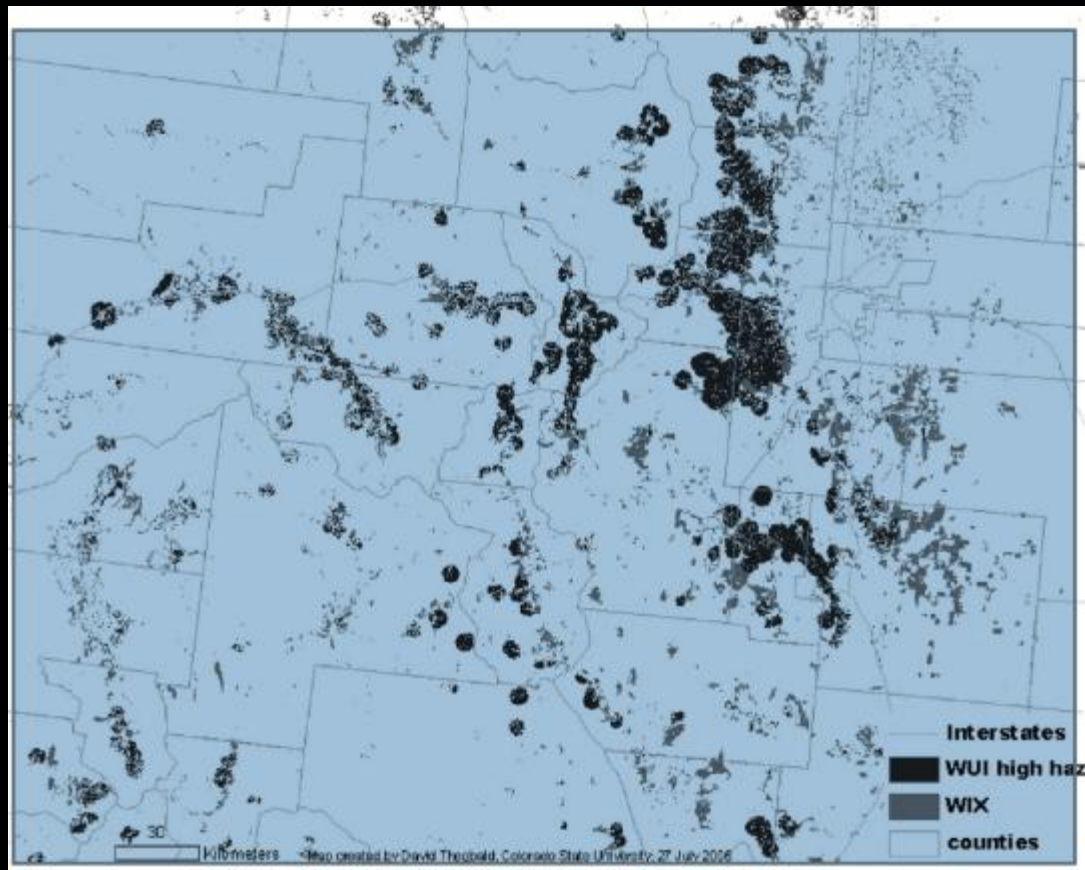


Figure 3—National Forest System lands with private lands within 10 miles projected to experience increased housing density, 2000–2030. Areas shown in brown are designated "urban national forests" (USDA Forest Service 2003b) that were not identified in this study as likely to experience significant increases in rural residential development.

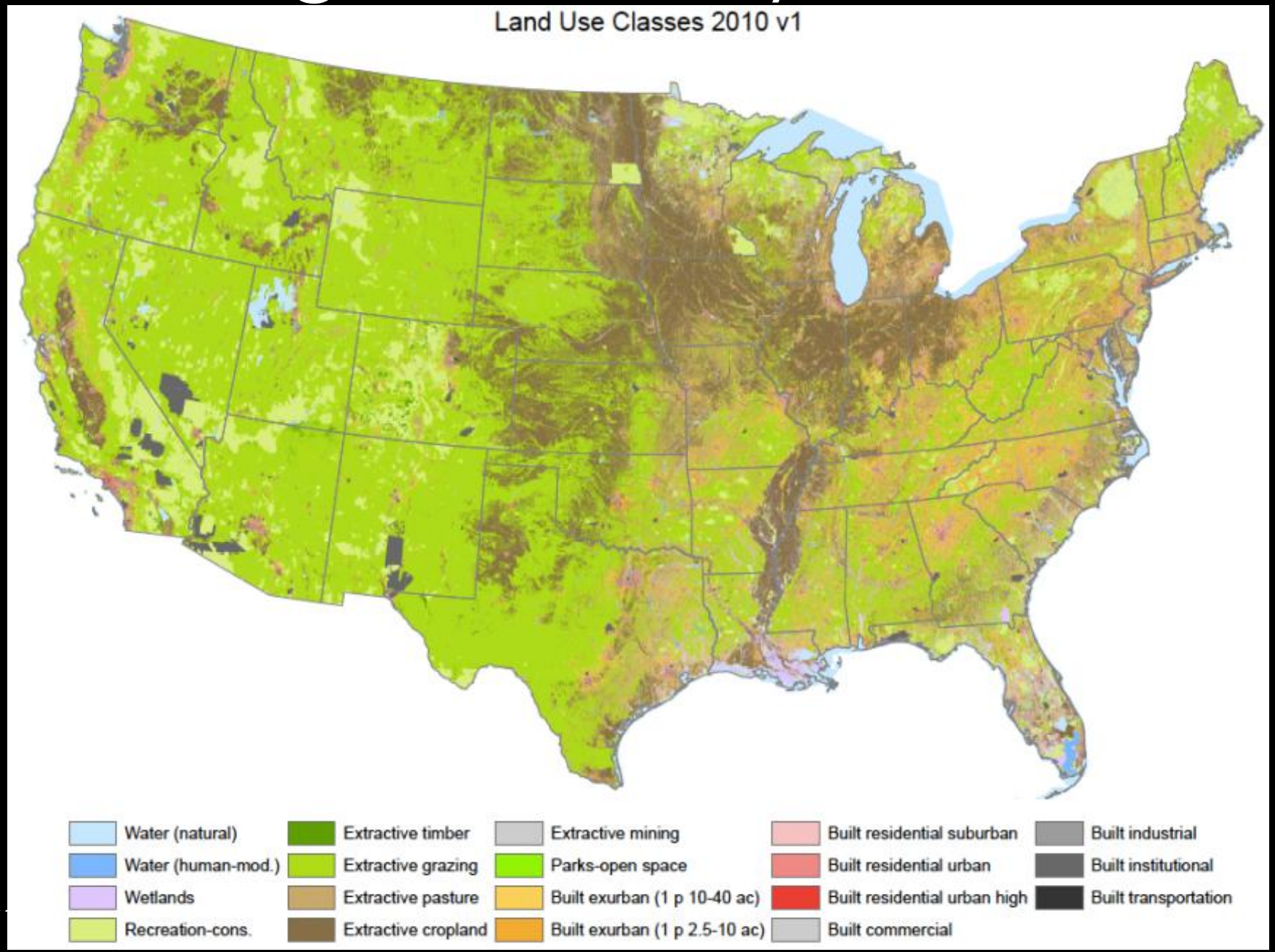
WUI analysis

- In 2000, WUI=465,614 km^2, 12.5 M units, expand to 513,670 km^2 by 2030
- ~89% of WUI is privately owned
- ~65% of WUI occurs in high or high severity fire regime

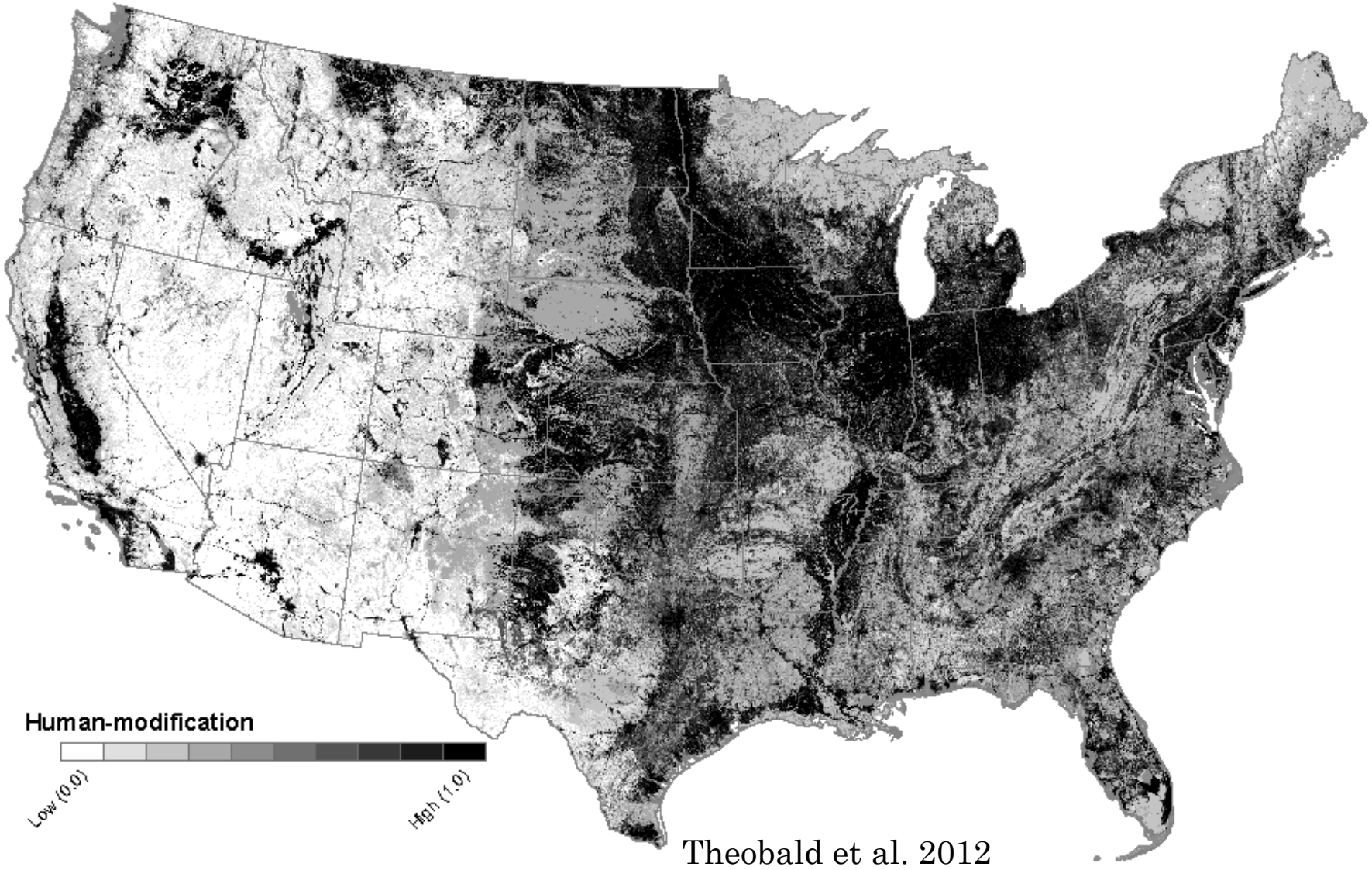
Source: Theobald & Romme 2007
Expansion of the US
Wildland-urban interface



Recognize variety of threats

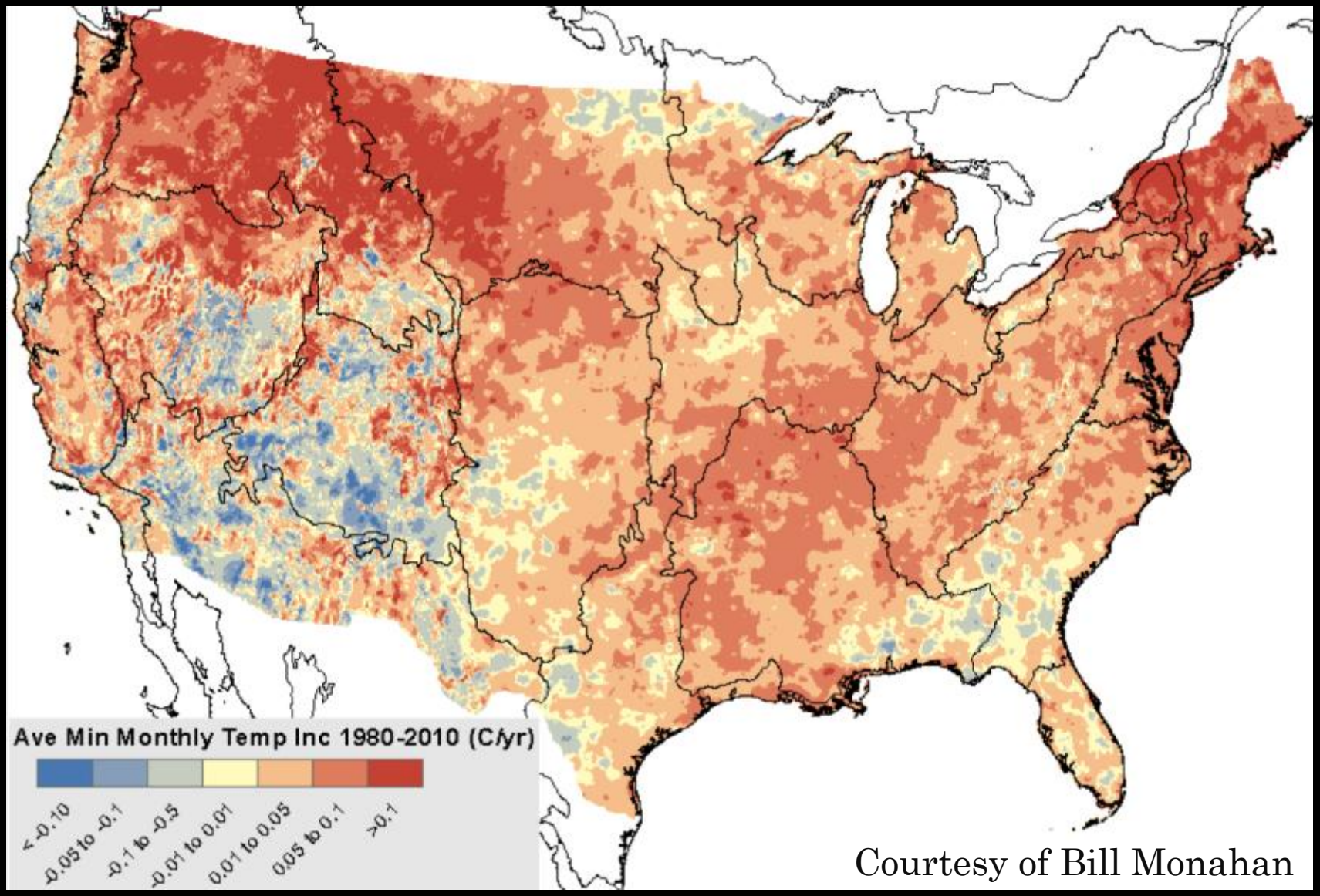


Landscape integrity



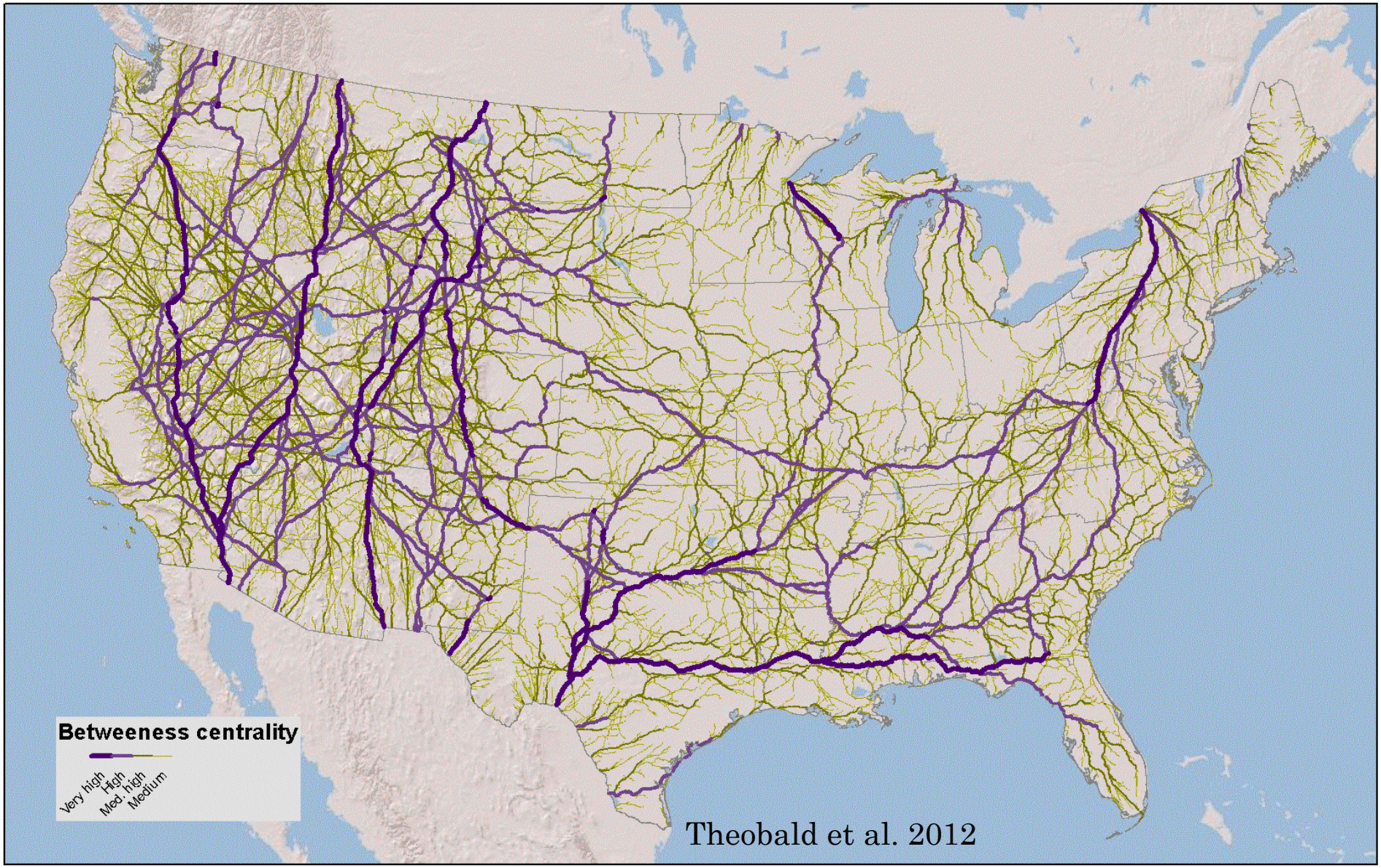
Theobald et al. 2012

Likely changes: climate



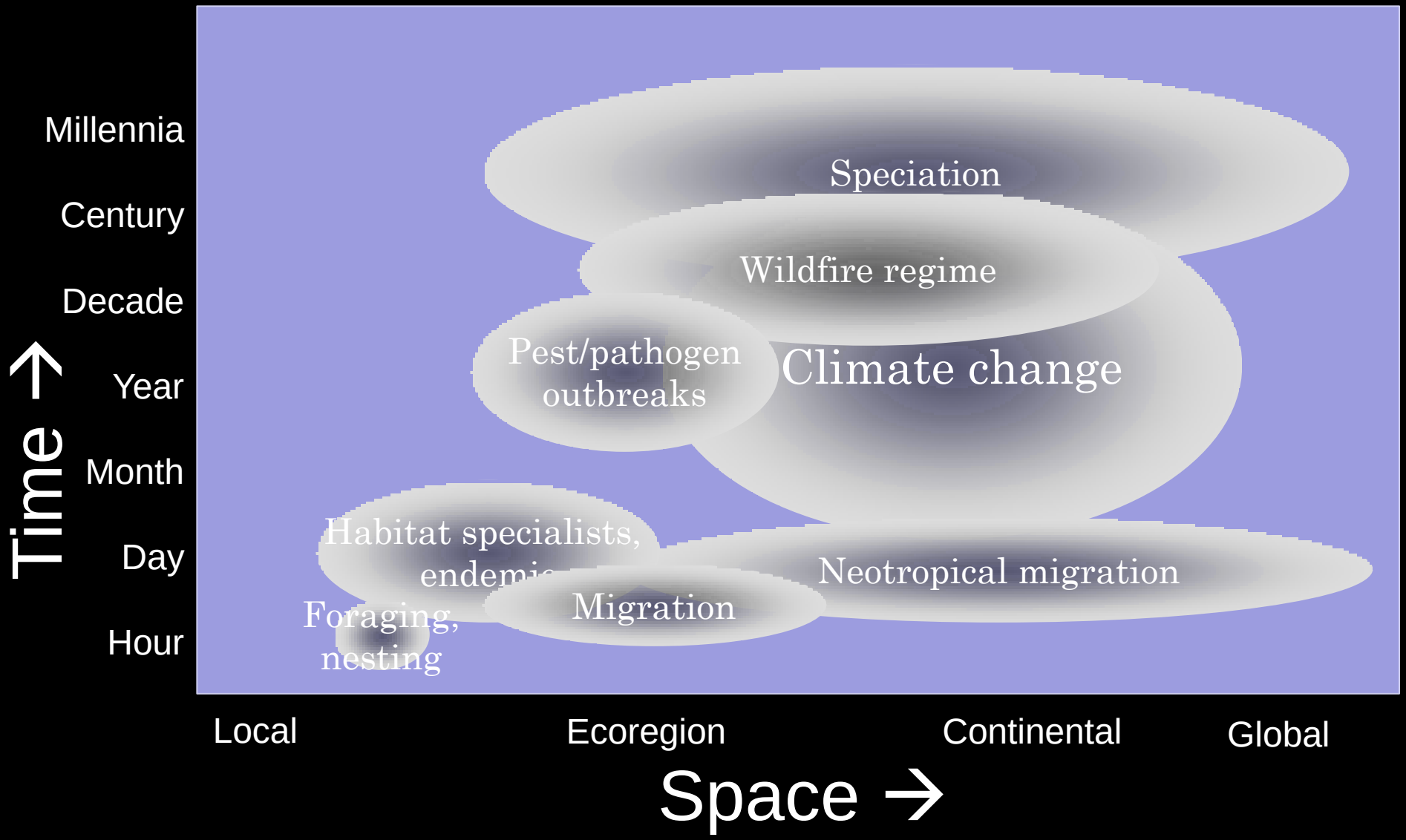
Courtesy of Bill Monahan

Landscape Connectivity

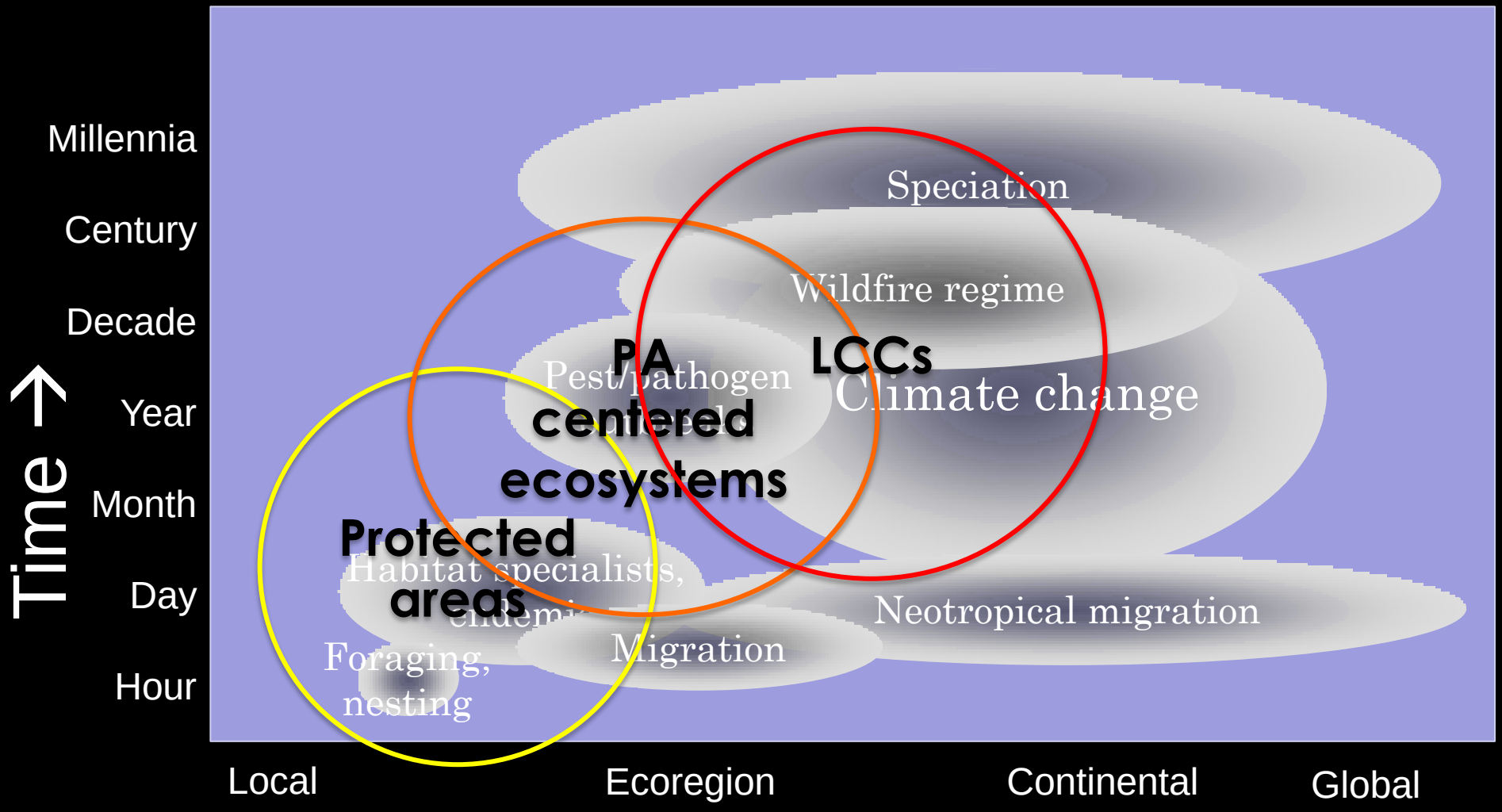


Theobald et al. 2012

Ecological scales



Decision-making scales



Supporting landscape analyses

NPScape – Monitoring Landscape Dynamics of Parks

http://science.nature.nps.gov/im/monitor/npscape/

State of Flux | Google Scholar | Apple | Yahoo! | Google Maps | YouTube | Wikipedia | News (1,244) | Popular | CSU

National Park Service

National Park Service
U.S. Department of the Interior

Find a Park | Discover History | Explore Nature | Working with Communities | Get Involved | Teachers | Kids | About Us

INVENTORY & MONITORING (I&M)

NPS » Explore Nature » I&M » Monitoring » NPScape

- About the I&M Program
- Inventory
- Monitoring
- Data Management
- IRMA Data System
- NPScape
  - Overview
  - Metrics
  - Methods
  - GIS Data
  - Maps
  - Guidance
  - Case Studies
  - How to Cite
- I&M GIS
- Reports
- National I&M Office Contacts & Mailing Address
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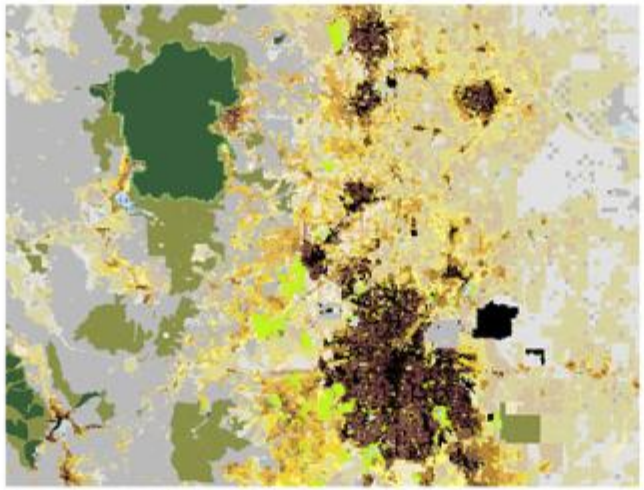
NPScape



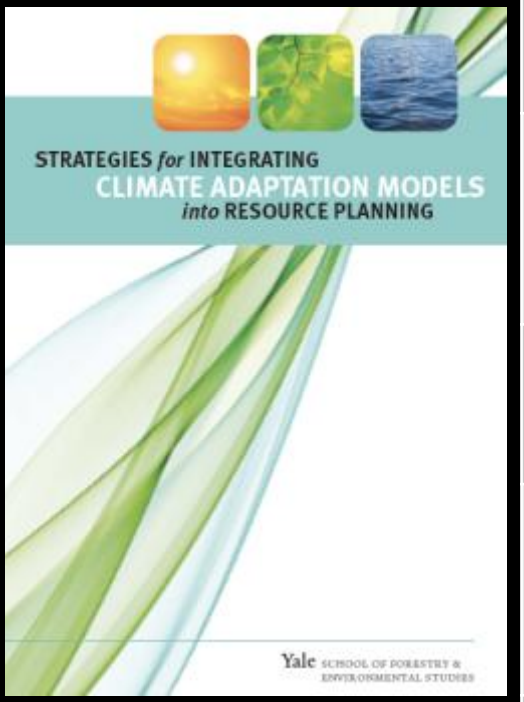
Protected areas surrounded by housing density along the front range of Colorado

Quick Links

- NPScape Resource Brief
- Acknowledgments
- Questions or Comments?
- Related Information
- NPScape Landscape Dynamics Metric Viewer
- NPScape Map Services
- NPScape Map Movies

About NPScape

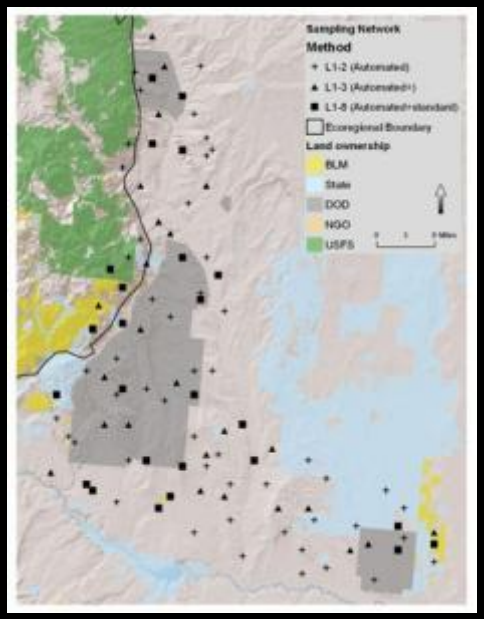
NPScape is a landscape dynamics monitoring project that provides landscape-level data, tools, and evaluations for natural resource management, planning, and interpretation. The target audience for NPScape spans the range from GIS specialists who will benefit from the geospatial products, to ecologists and natural resource specialists who will be interested in the landscape metrics presented in a local and regional context, to park superintendents and other land managers who can incorporate the maps and graphics into reports or briefings.



Adaptation strategies	Species & populations	Ecological systems	Land-scapes
Protect current patterns of biodiversity (baseline)			
Project future patterns of biodiversity			
Maintain ecological processes			
Maintain and restore ecological connectivity			
Protect climate refugia			
Protect the ecological stage (enduring features)			

www.databasin.org/yale

From inventorying resources to monitoring landscapes



Traditionally we have inventoried resources separately:

- Forests , soils, wetlands, land cover, water quality, parks

Need to move toward monitoring landscapes:

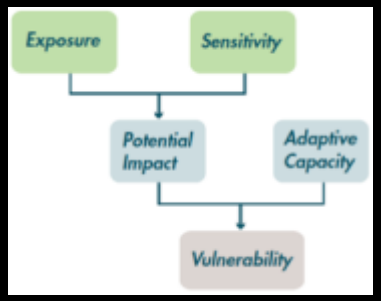
1. Dynamics
2. Leveraging
3. Open source, collaborative science

Thanks!

Strategies	S & P	ES	LS
Protect current			
Project future			
Maintain processes			
Maintain connectivity			
Protect refugia			
Protect stage			

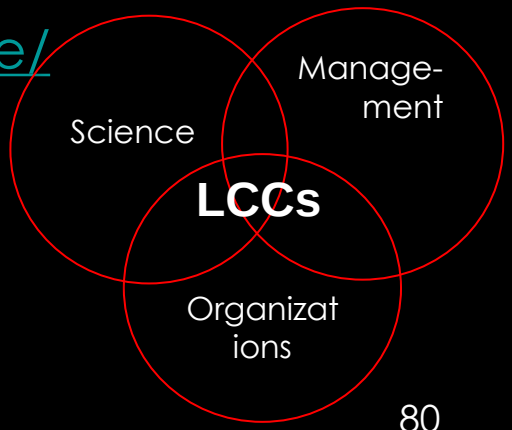
David_Theobald@nps.gov
Google Scholar: David Theobald

Yale Science Panel: www.databasin.org/yale



Landscape Climate Change Vulnerability Project
www.montana.edu/lccvp/

NPScape:
http://science.nature.nps.gov/im/monitor/npscape/



80

Questions and Answers

Ask questions through the chat pod

Session #8

Federal Landscape Conservation Initiatives:

US Fish and Wildlife, Bureau of Land Management, Natural Resources Conservation Service, Department of Defense.

Wednesday, November 7 at 2:00 pm Eastern

Doug Austen/Ben Thatcher – *USFWS: Landscape Conservation Cooperatives*

Kit Muller – *BLM: Eco-Regional Assessments*

Bruce Wight – *NRCS: Landscape Initiatives*

Nancy Natoli *– DoD: Sustainable Ranges*

IN 2 WEEKS!

CLEMSON
School of AGRICULTURAL, FOREST, AND ENVIRONMENTAL SCIENCES

Future Webinar Topics

- Private land conservation programs from the Farm Bill (Last one for 2012!)

- Many new topics being planned for 2013
  - Ecosystem Services and Markets
  - City and County Open Space Programs
  - Land Use and Conservation Planning Tools
  - All Lands and Open Space in Forest Plan Revisions
  - And many more!

Give us your feedback!

www.fs.fed.us/openspace/webinars

Or Contact

Susan Stein – sstein@fs.fed.us
Sara Comas - scomas@fs.fed.us
Rick Pringle – rpringle@fs.fed.us