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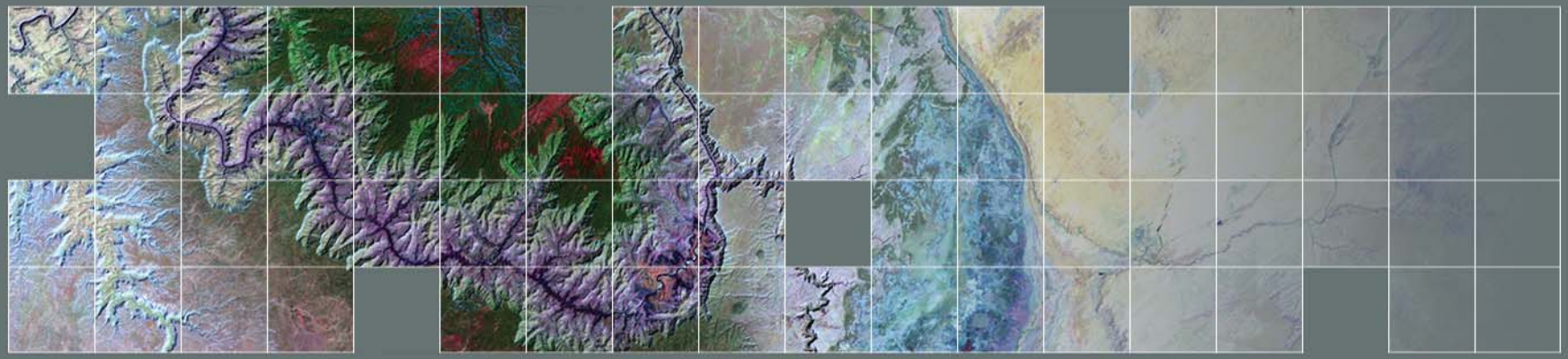
science for a changing world

USGS Land-Cover Trends: A focus on contemporary land-use and land-cover change within the LCCs



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

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The Challenge

- Land use is a pervasive driver of environmental change and has important implications related to climate, biodiversity, natural resources, and ecosystem services
  - There are numerous different landscape changes and consequences affecting LCCs

- We seek to address these critical challenges from a land-use/land-cover perspective – through a systematic analysis of land change dynamics that are occurring across a full range of land-use/cover types and climate and ecological settings.
  - A multi-temporal, multi-scale ecoregion-based analysis

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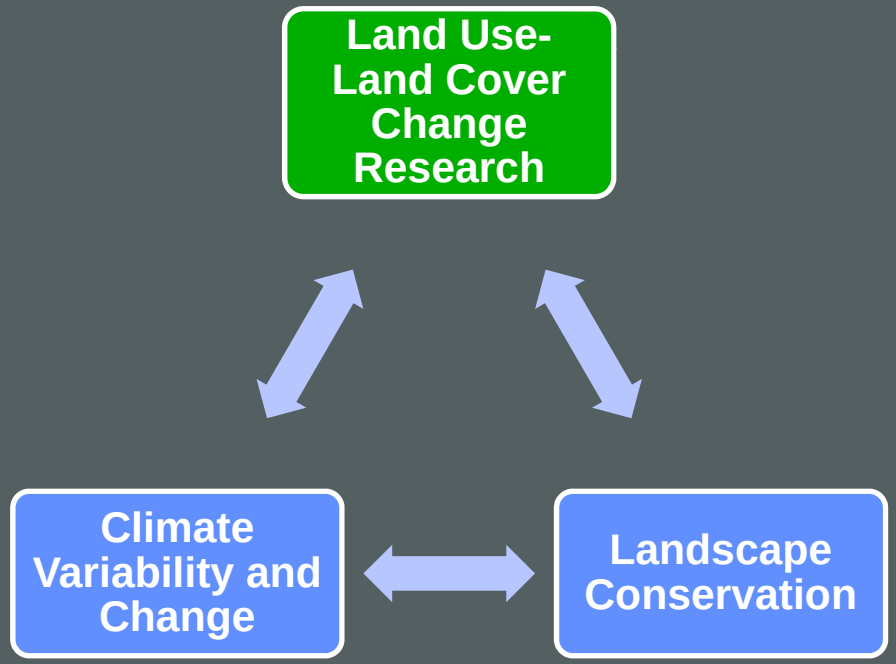
Land Change Science

- **Has a diverse context, we are focused on:**
  - LULC dynamics and landscape conservation
  - LULC and weather/climate interactions



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2010 and beyond: The Land Change Science Initiative

- **National Land Change Assessment:** Analyze the scale, pace, causes, and implications of land-use/cover changes occurring across the national landscape

- **Monitoring:** Establish a comprehensive and integrated land change monitoring system to provide regular land-cover updates needed to continue a wide range of land change research

- **Consequences of Land Change:** Assess the societal significance and environmental impacts of past, present, and future land use and land cover change on earth systems and their associated feedbacks.

- **Scenarios and Modeling:** Develop and model scenarios of land use and land cover change to understand the vulnerability and resilience of coupled human–environment systems and the services they provide.

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General Approach

- **Designed to understand the scale, pace, causes, and consequences of US land change**
  - Innovative multi-scale ecoregion framework
    - *National – biome – regional – landscape*
  - Synthesis of land use information with land cover/ satellite data
  - Develop partnerships to analyze consequences of landscape change

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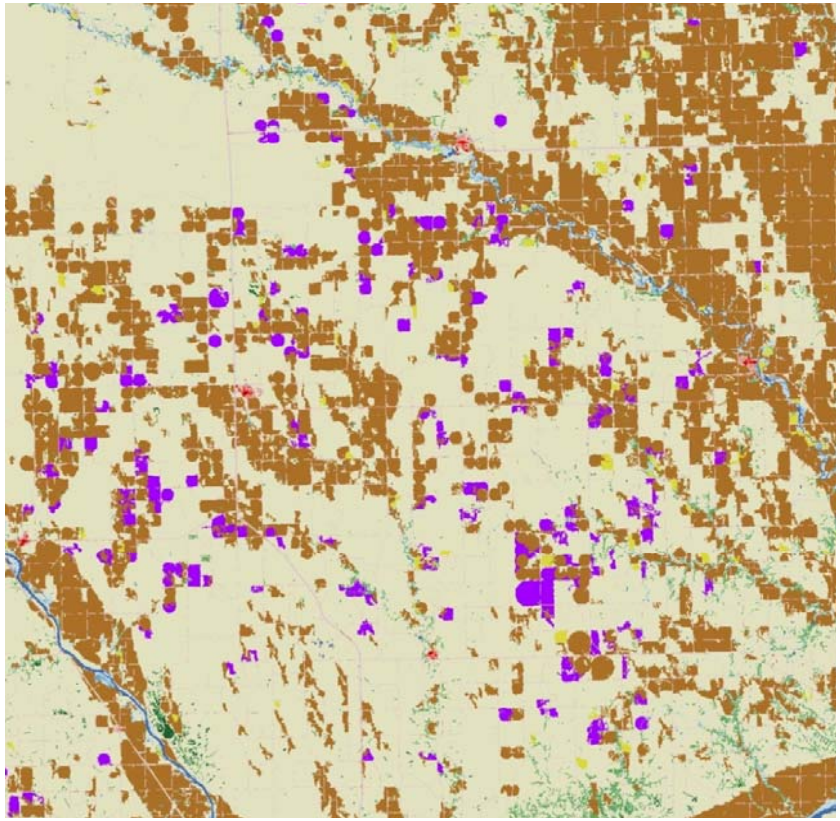
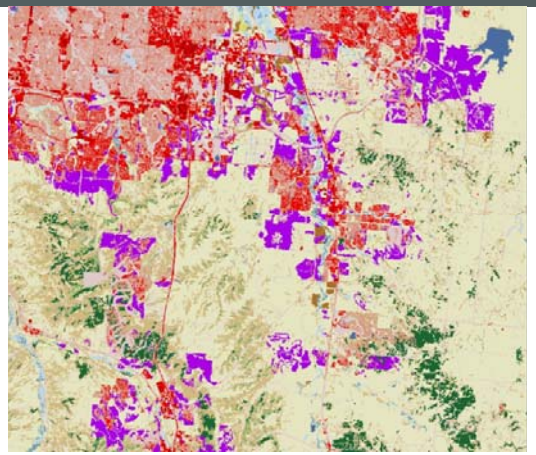
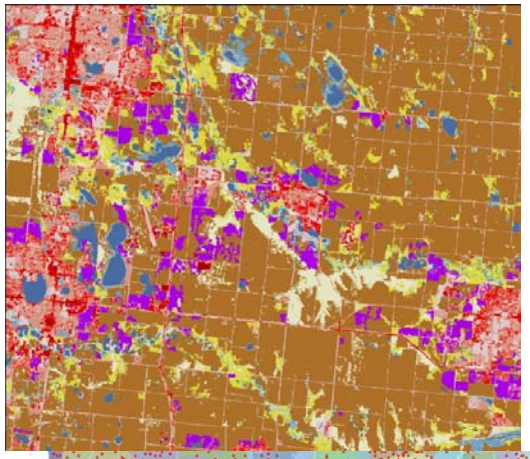
Approach

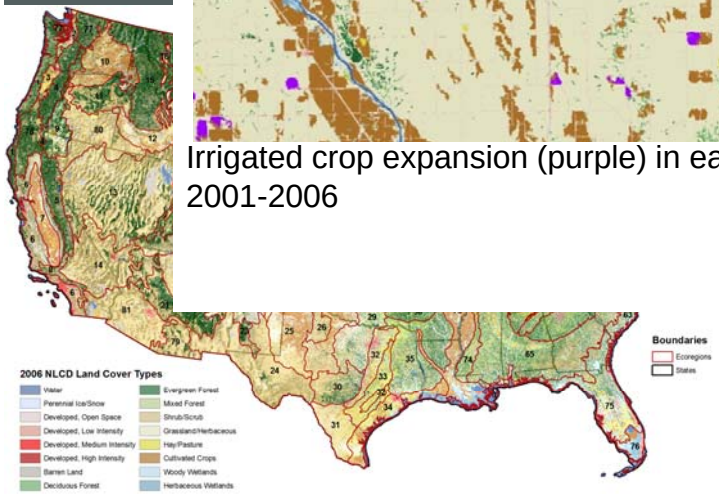


Irrigated crop expansion (purple) in east-central Nebraska, 2001-2006



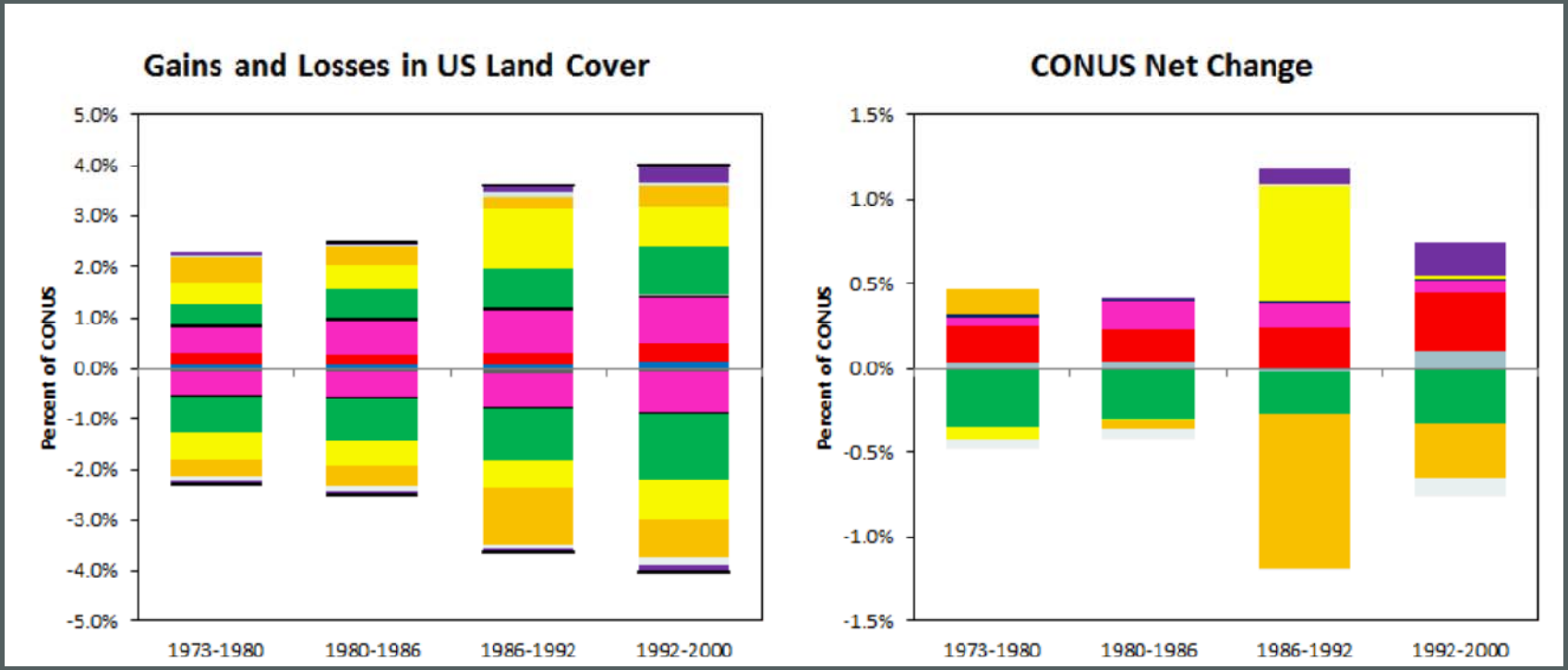
Colorado Front Range urban expansion (purple) onto grassland/woodlands (top) and cropland (below), 2001-2006





Recent Findings

- **National-scale**
  - Sectoral Gains, Losses, and Net Change



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National Scale Ecoregion Trends, 1973-2000

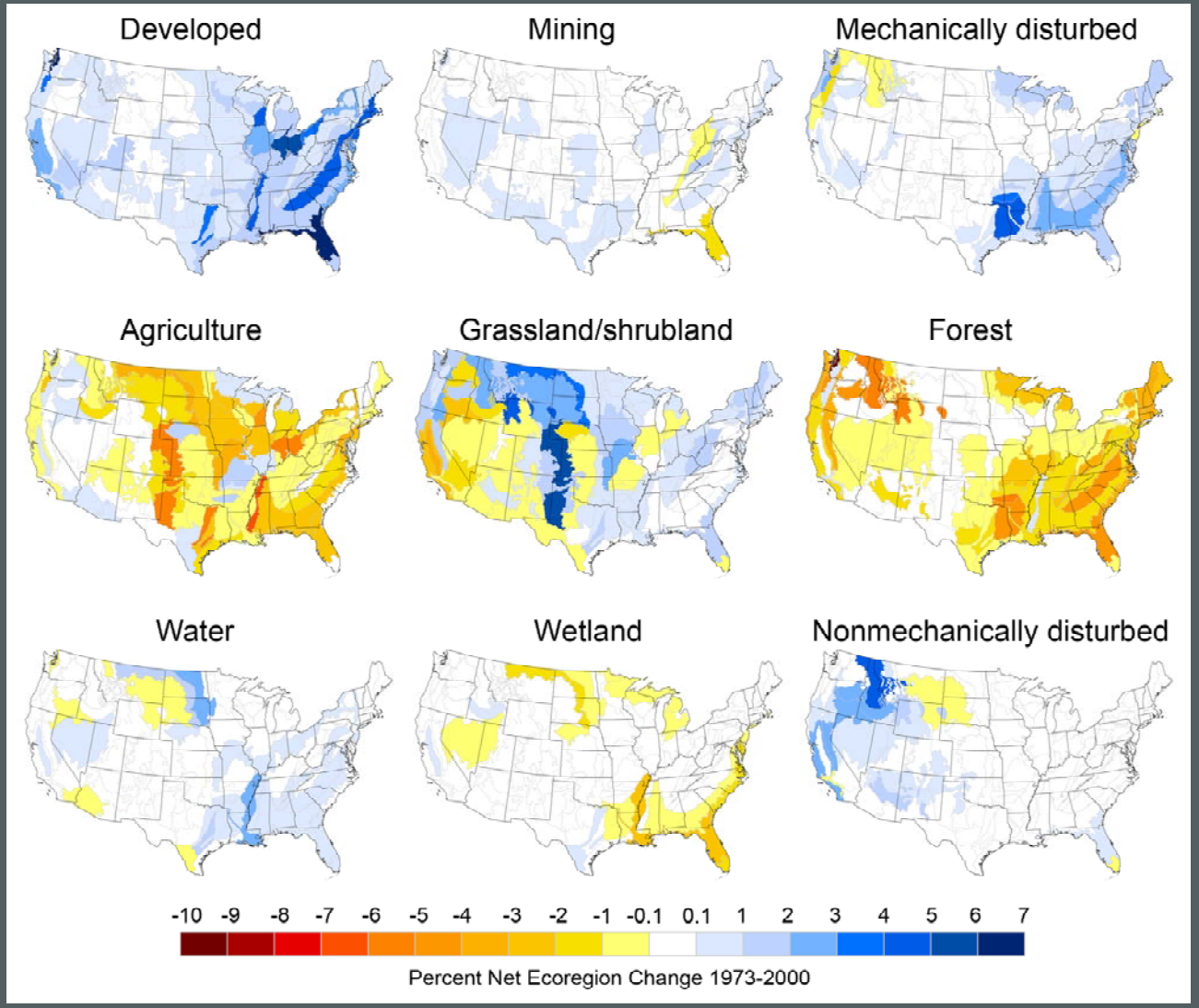

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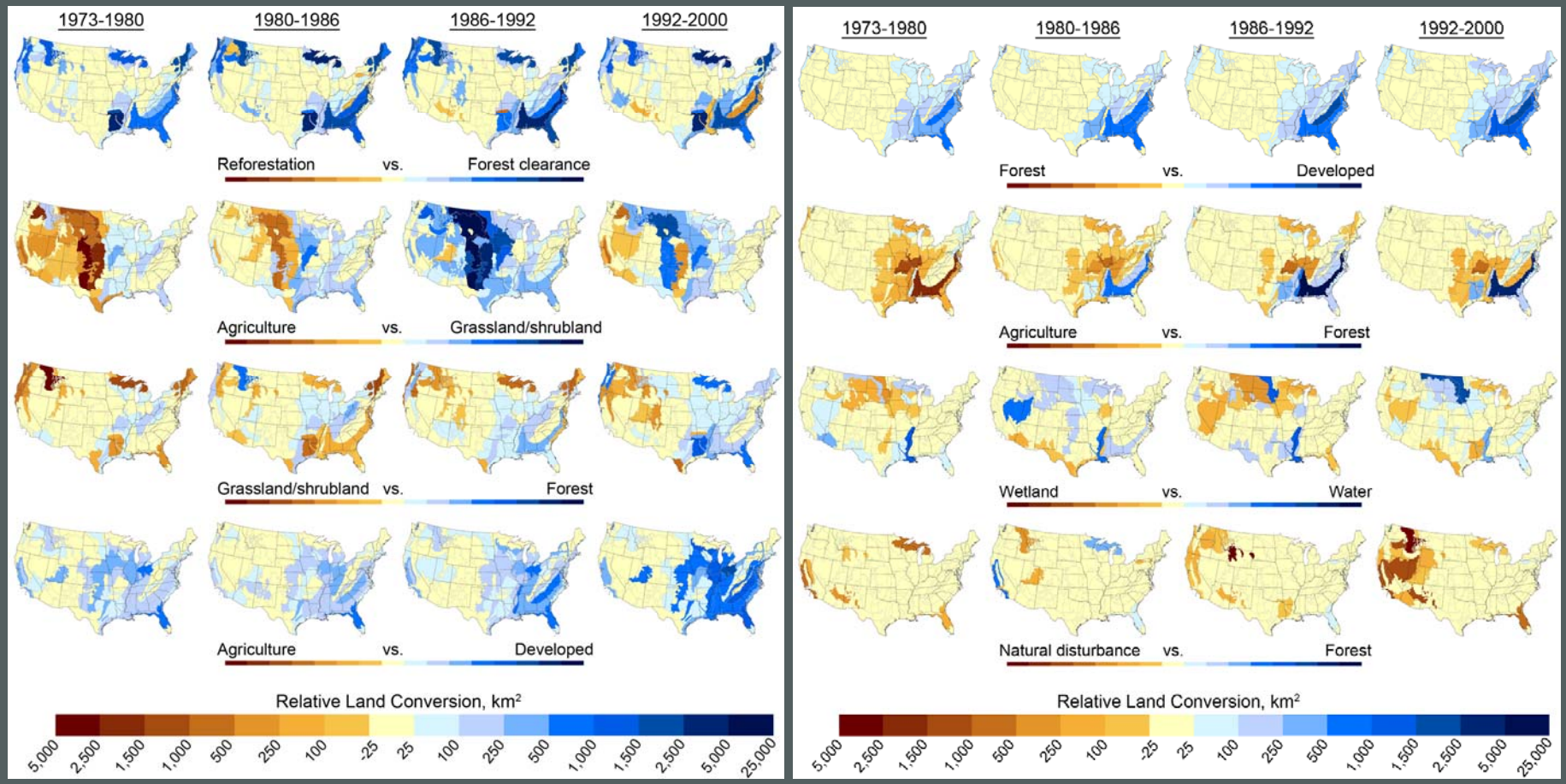
Figure – Substantial gains and losses of land cover occur at the decadal-scale. Level III ecoregions shown.

Trends in US Land Conversion across four time-intervals



Some of the most extensive land conversion dynamics for 4 time intervals between 1973-2000. Level 3 ecoregions are shown.

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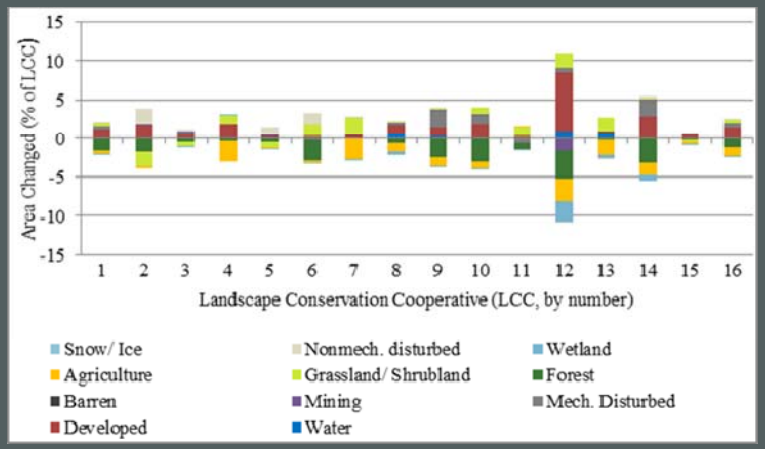
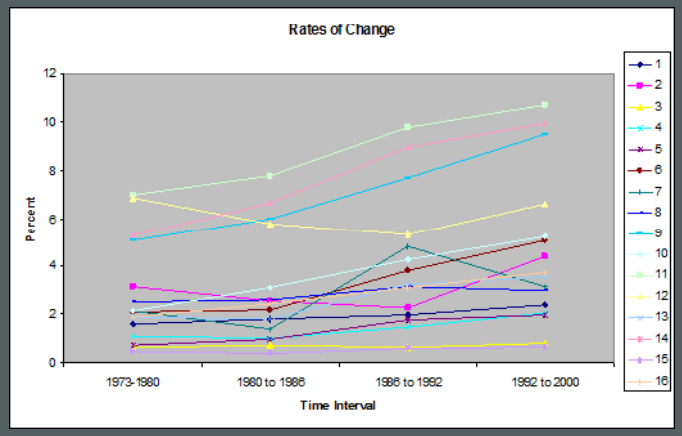
Recent Findings – LCCs





- **Regional variability**
- **Temporal variability**
  - Accelerating rates
- **However, there is also sectoral variability (LULC categories) as well**
  - Mix of expansion and decline

1	Appalachian	9	Gulf Coastal Plains and Ozarks
2	California	10	North Atlantic
3	Desert	11	North Pacific
4	Eastern Tallgrass Prairie and Big Rivers	12	Peninsular Florida
5	Great Basin	13	Plains and Prairie Potholes
6	Great Northern	14	South Atlantic
7	Great Plains	15	Southern Rockies
8	Gulf Coast Plains	16	Upper Midwest and Great Lakes

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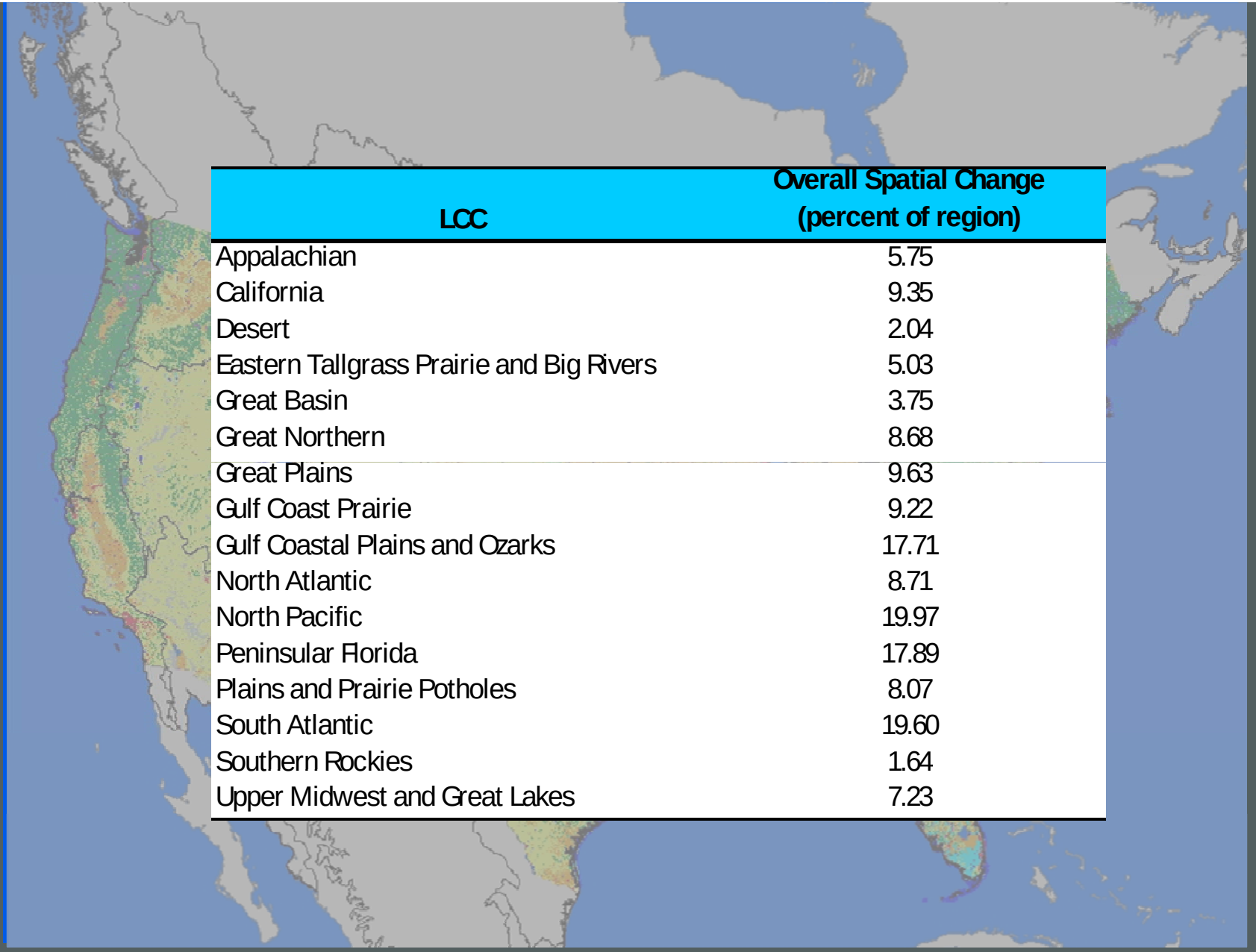

LCC	Overall Spatial Change (percent of region)
Appalachian	5.75
California	9.35
Desert	2.04
Eastern Tallgrass Prairie and Big Rivers	5.03
Great Basin	3.75
Great Northern	8.68
Great Plains	9.63
Gulf Coast Prairie	9.22
Gulf Coastal Plains and Ozarks	17.71
North Atlantic	8.71
North Pacific	19.97
Peninsular Florida	17.89
Plains and Prairie Potholes	8.07
South Atlantic	19.60
Southern Rockies	1.64
Upper Midwest and Great Lakes	7.23

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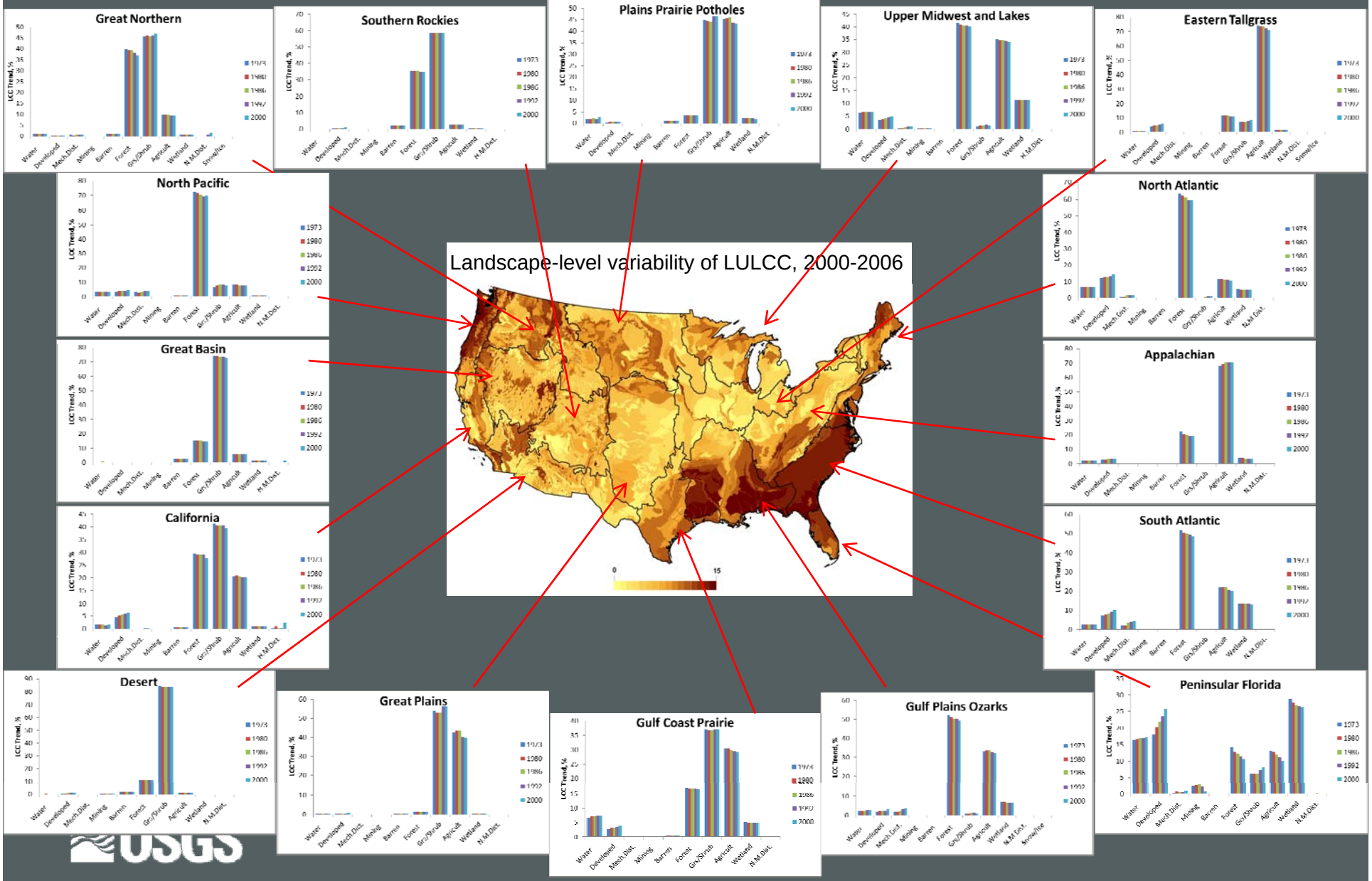
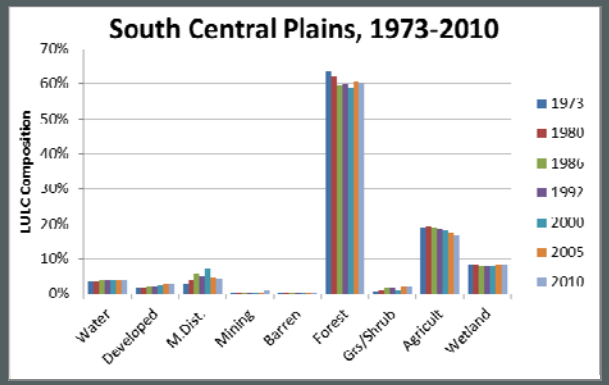
Trends of land cover change, 1973-2000

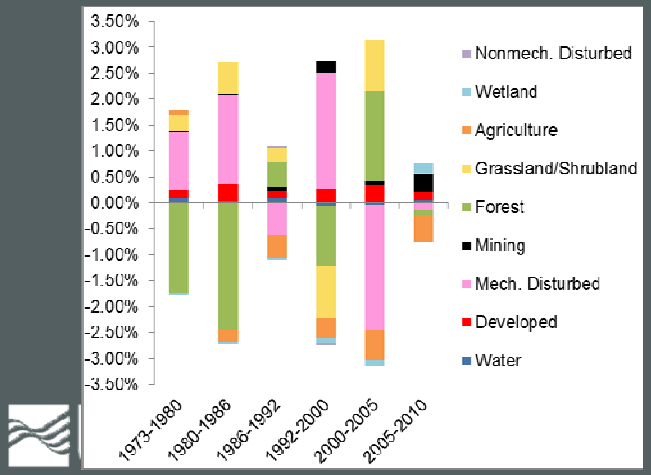


Investigating a long-term & current record of land change

- Example from the South Central Plains, 1973 to 2010

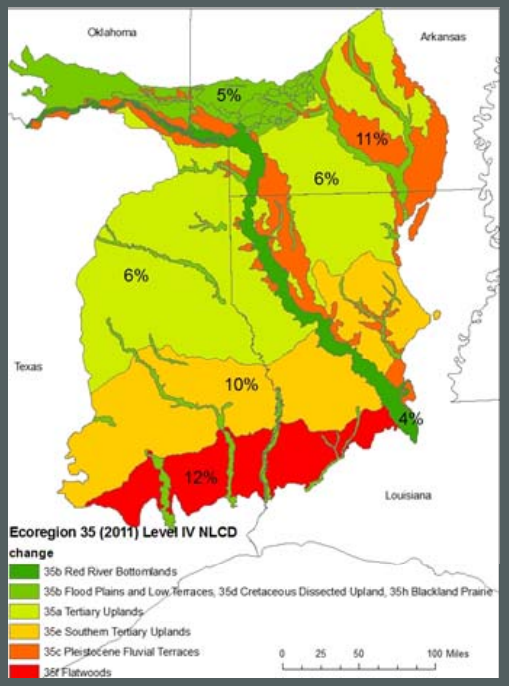
- **We are extending the analysis to 'present'**





Net change for 6 time intervals, 1973-2010

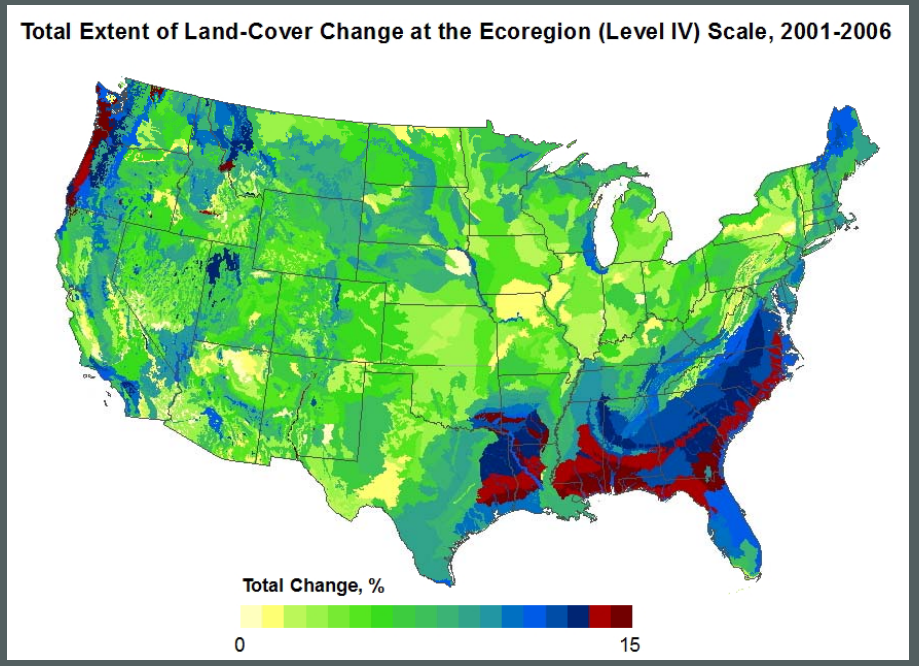
- **Analyzing the causes, trends, and implications of recent land change occurring across the diversity of US ecoregions**
- **Systematically-collected**
- **Comparable across the U.S.**



Extent of change in Level IV ecoregions, 2000-2006

The National Landscape

- **Variable rates of change**
  - In some cases, highest rates are due to one-type of land use (e.g. pine plantation)
  - Areas of low rates may have diverse changes or intensive land use practices, e.g. fertilization, irrigation, etc
- **Finer-level changes relate to the land use potential determined by biophysical setting and socioeconomic drivers**
- **Connection between assessment and consequence**



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Emerging Direction

- Consequences of land change
  - Support DOI research needs within the LCC and CSC networks through regional consequences assessments that examine land use effects on earth systems and processes.
    - Communicating land use effects on land conservation and management
      - Land use effects conservation lands
      - Land use impacts on hydrology and climate
      - Land use impacts on habitat and species
      - Effects of energy development

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Conclusions

- An understanding of land management options for landscape conservation is anchored by an understanding of the regional variability of human-environmental interactions across the United States.

- These interactions include but are not limited to the rates, types of land conversion, driving forces, and consequences of land change.

- We address the issues of landscape change by:
  - A systematic analysis of change across multiple scales
  - Integration of land use information with land cover
  - Identification of patterns and drivers of landscape change
  - Targeted analyses of consequences to the national landscape

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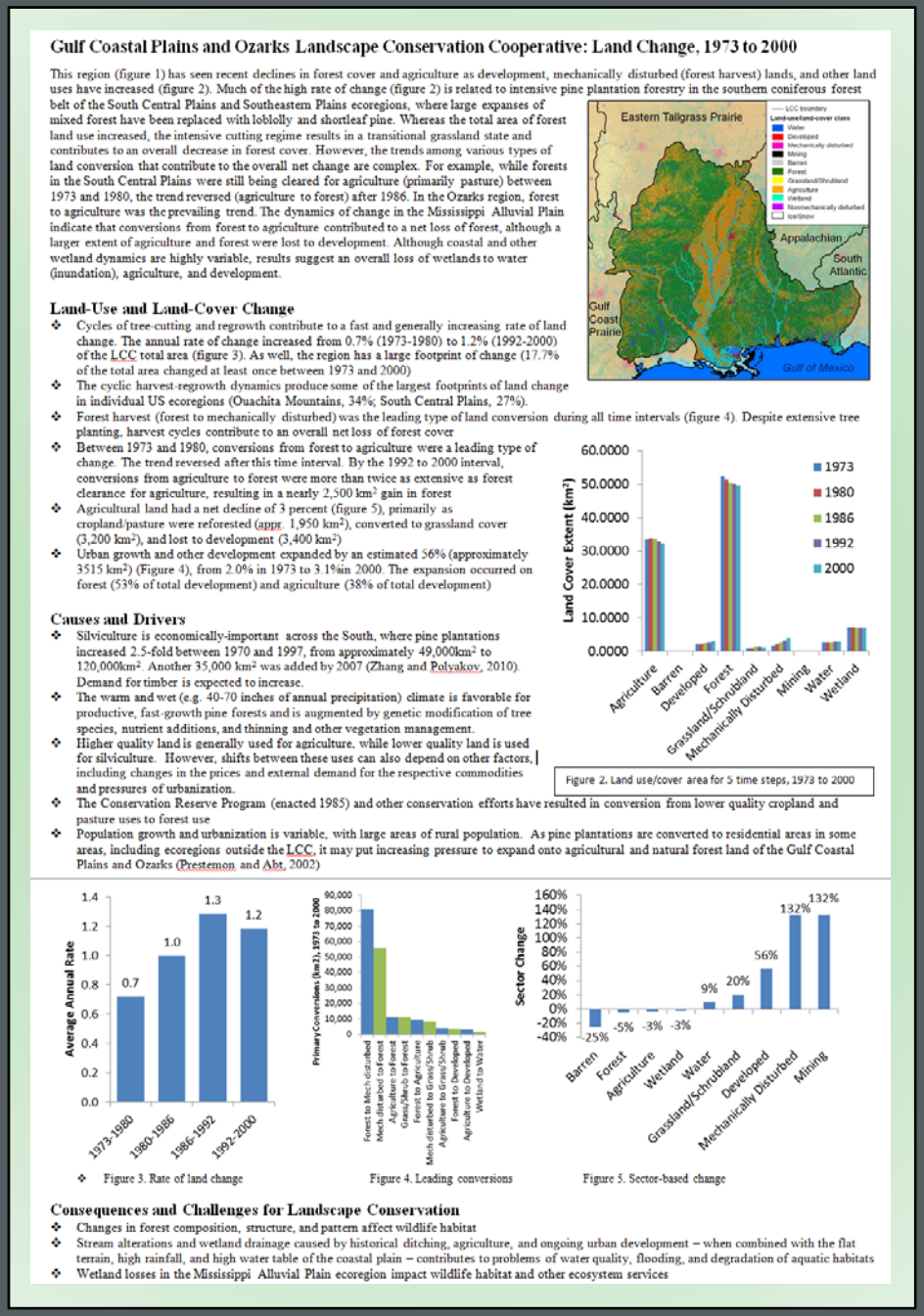

Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative: Land Change, 1973 to 2000

This region (figure 1) has seen recent declines in forest cover and agriculture as development, mechanically disturbed (forest harvest) lands, and other land uses have increased (figure 2). Much of the high rate of change (figure 2) is related to intensive pine plantation forestry in the southern coniferous forest belt of the South Central Plains and Southeastern Plains ecoregions, where large expanses of mixed forest have been replaced with loblolly and shortleaf pine. Whereas the total area of forest land use increased, the intensive cutting regime results in a transitional grassland state and contributes to an overall decrease in forest cover. However, the trends among various types of land conversion that contribute to the overall net change are complex. For example, while forests in the South Central Plains were still being cleared for agriculture (primarily pasture) between 1973 and 1980, the trend reversed (agriculture to forest) after 1986. In the Ozarks region, forest to agriculture was the prevailing trend. The dynamics of change in the Mississippi Alluvial Plain indicate that conversions from forest to agriculture contributed to a net loss of forest, although a larger extent of agriculture and forest were lost to development. Although coastal and other wetland dynamics are highly variable, results suggest an overall loss of wetlands to water (inundation), agriculture, and development.

Land-Use and Land-Cover Change

- Cycles of tree-cutting and regrowth contribute to a fast and generally increasing rate of land change. The annual rate of change increased from 0.7% (1973-1980) to 1.2% (1992-2000) of the LCC total area (figure 3). As well, the region has a large footprint of change (17.7% of the total area changed at least once between 1973 and 2000)
- The cyclic harvest-regrowth dynamics produce some of the largest footprints of land change in individual US ecoregions (Ouachita Mountains, 34%; South Central Plains, 27%).
- Forest harvest (forest to mechanically disturbed) was the leading type of land conversion during all time intervals (figure 4). Despite extensive tree planting, harvest cycles contribute to an overall net loss of forest cover
- Between 1973 and 1980, conversions from forest to agriculture were a leading type of change. The trend reversed after this time interval. By the 1992 to 2000 interval, conversions from agriculture to forest were more than twice as extensive as forest clearance for agriculture, resulting in a nearly 2,500 km² gain in forest
- Agricultural land had a net decline of 3 percent (figure 5), primarily as cropland/pasture were reforested (appr. 1,950 km²), converted to grassland cover (3,200 km²), and lost to development (3,400 km²)
- Urban growth and other development expanded by an estimated 56% (approximately 3515 km²) (Figure 4), from 2.0% in 1973 to 3.1%in 2000. The expansion occurred on forest (53% of total development) and agriculture (38% of total development)

Figure 2. Land use/cover area for 5 time steps, 1973 to 2000

Causes and Drivers

- Silviculture is economically-important across the South, where pine plantations increased 2.5-fold between 1970 and 1997, from approximately 49,000km² to 120,000km². Another 35,000 km² was added by 2007 (Zhang and Polyakov, 2010). Demand for timber is expected to increase.
- The warm and wet (e.g. 40-70 inches of annual precipitation) climate is favorable for productive, fast-growth pine forests and is augmented by genetic modification of tree species, nutrient additions, and thinning and other vegetation management.
- Higher quality land is generally used for agriculture, while lower quality land is used for silviculture. However, shifts between these uses can also depend on other factors, including changes in the prices and external demand for the respective commodities and pressures of urbanization.
- The Conservation Reserve Program (enacted 1985) and other conservation efforts have resulted in conversion from lower quality cropland and pasture uses to forest use
- Population growth and urbanization is variable, with large areas of rural population. As pine plantations are converted to residential areas in some areas, including ecoregions outside the LCC, it may put increasing pressure to expand onto agricultural and natural forest land of the Gulf Coastal Plains and Ozarks (Prestemon and Abt, 2002)

Figure 3. Rate of land change

Figure 4. Leading conversions

Figure 5. Sector-based change

Consequences and Challenges for Landscape Conservation

- Changes in forest composition, structure, and pattern affect wildlife habitat
- Stream alterations and wetland drainage caused by historical ditching, agriculture, and ongoing urban development – when combined with the flat terrain, high rainfall, and high water table of the coastal plain – contributes to problems of water quality, flooding, and degradation of aquatic habitats
- Wetland losses in the Mississippi Alluvial Plain ecoregion impact wildlife habitat and other ecosystem services

Summaries of Land Change in LCCs

- Publication in progress
- Summaries of LULC change results for each of the 16 CONUS LCCs

THANK YOU!

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