The Role of Scenario Planning in Risk Assessment of Biodiversity Loss Following Disturbance: Linking Models to Species

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What is Scenario Planning?

An iterative modelling process that projects future conditions based on alternative priorities derived from stakeholder input

- Need a historical record (at least 10 years)
- Models use change rates for land use categories based on record
- Identify drivers of change
- Use of stakeholder groups
- Use change rates to project future landscapes based on alternative scenarios for drivers

The Maps are not predictions – they are reasonable alternatives based on the strength of the drivers and the identified change relationships between landscape elements

Use and Application

Forbes

The Secret Of Successful Scenario Planning

Today almost no business operates without some kind of scenario planning.

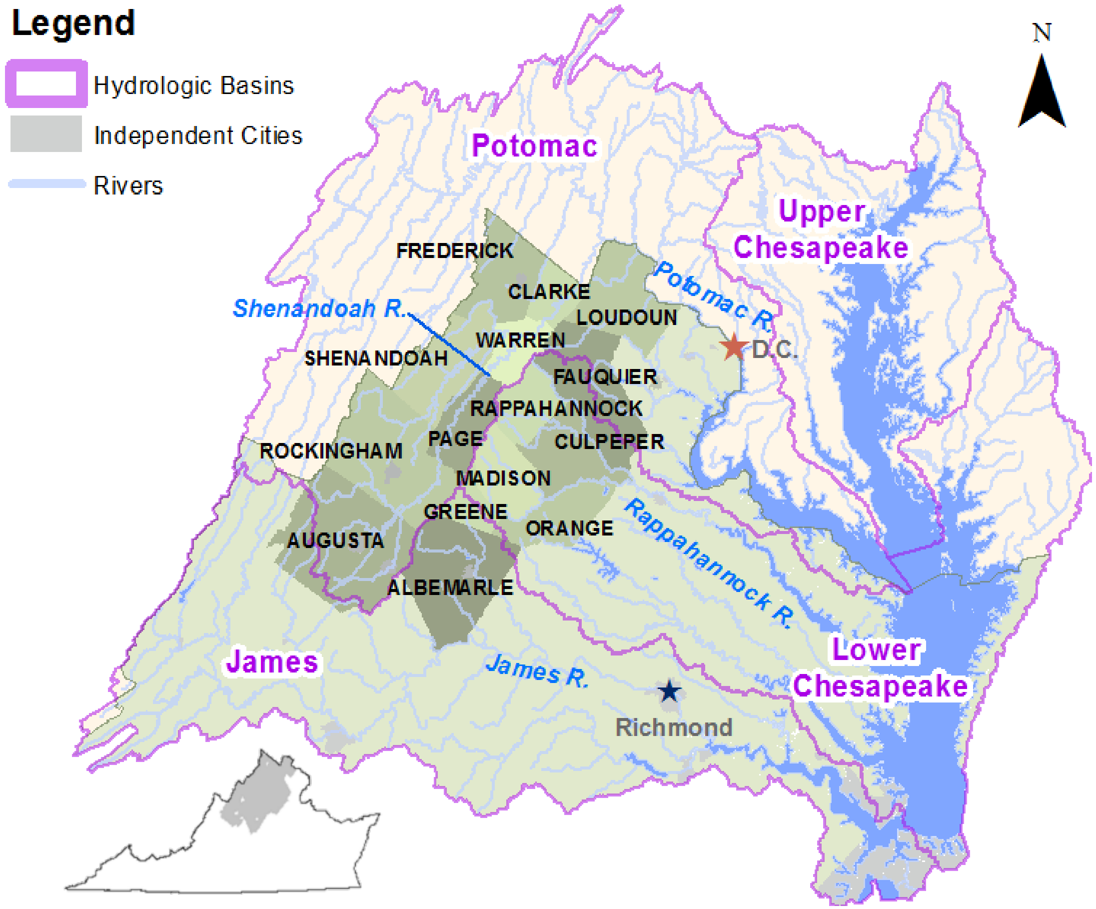
Origin: Adaptation of classic methods by military intelligence

- Conservation Entities
  - USGS
  - US Fish and Wildlife
  - Natural Environment Research Council
  - Wildlife Conservation Society
  - The Nature Conservancy
- Energy
- Corporations
  - Royal Dutch/ Shell
  - General Electric
  - Xerox
  - American Express
  - Apple
  - Deloitte consulting
- Governmental Agencies
  - Federal Highway Administration
  - US Coast Guard
  - FEMA
  - NASA
  - US Air Force

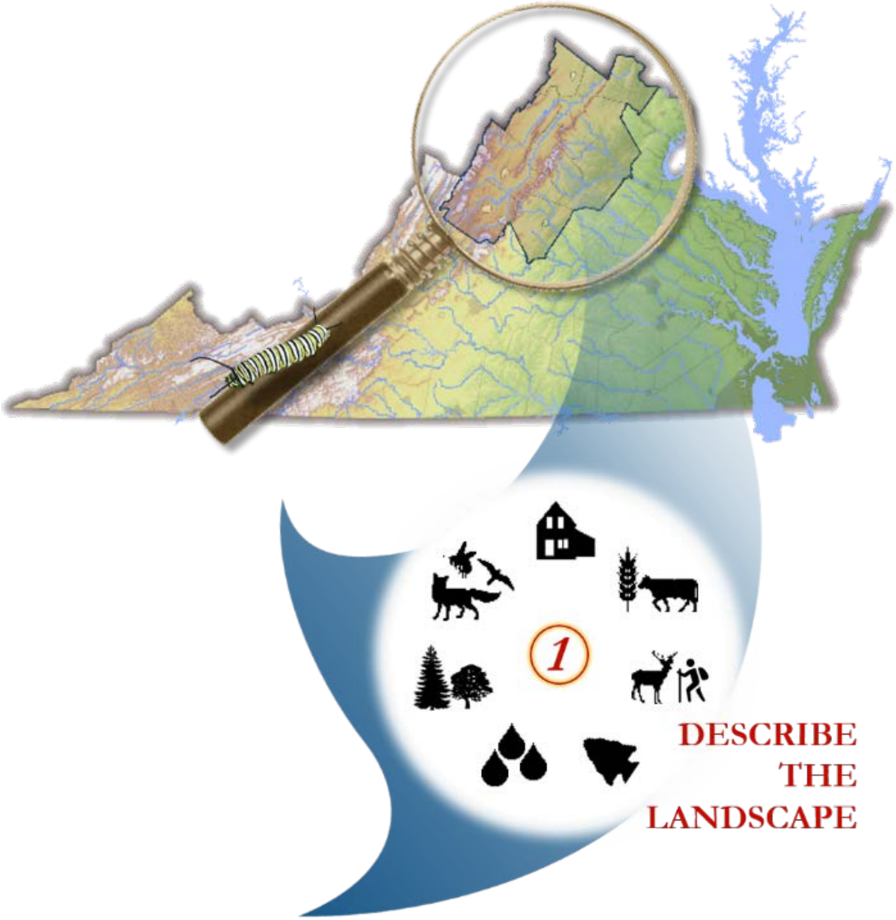
The Changing Landscapes Initiative

Visualizing potential futures for Northwestern VA

- The region
- The approach
  - Scenario planning
    - Collaborative
    - Stakeholder driven
    - Regionally specific
    - Integrates socio-economic & ecological data
    - Model potential futures
- The products
  - Knowledge-sharing network
  - Data-driven adaptive planning tool



The Changing Landscapes Initiative

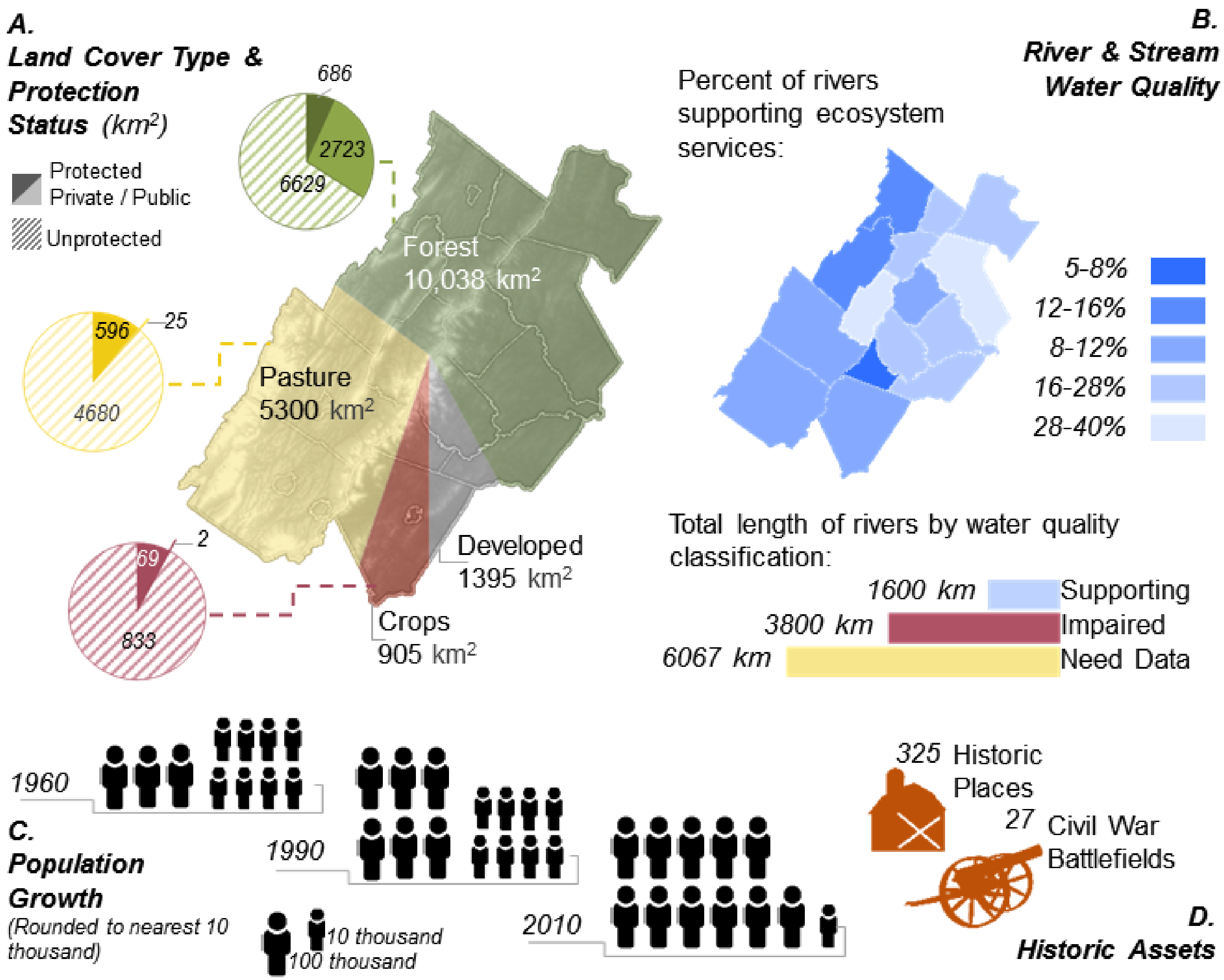


Describe the landscape

- Land use
  - Development, agriculture,
- Natural resources
  - Forestry, water, air
- Open space
  - Parks and protected areas
- Cultural/ Historical sites
- Environmental health
  - Plants and wildlife
- Energy
- Social/ Economic welfare
  - Population, Income, Education

The Changing Landscapes Initiative

- Land cover
- Protected areas
- Water quality
- Population
- Historic and Cultural assets



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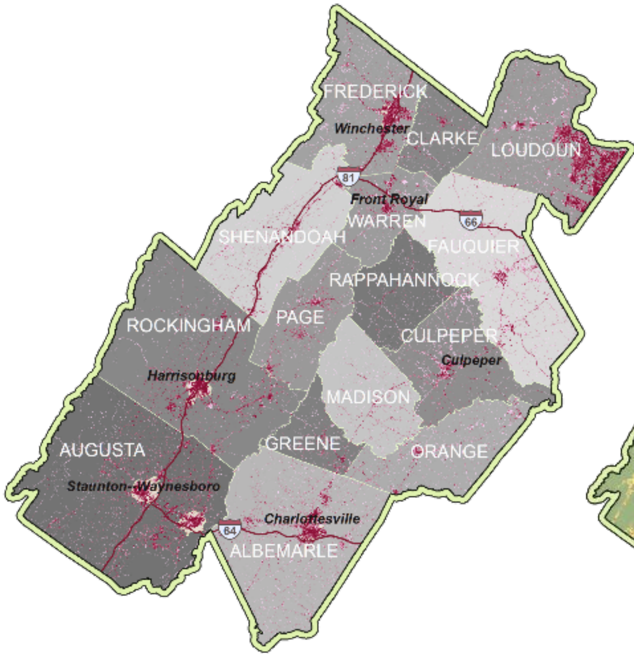
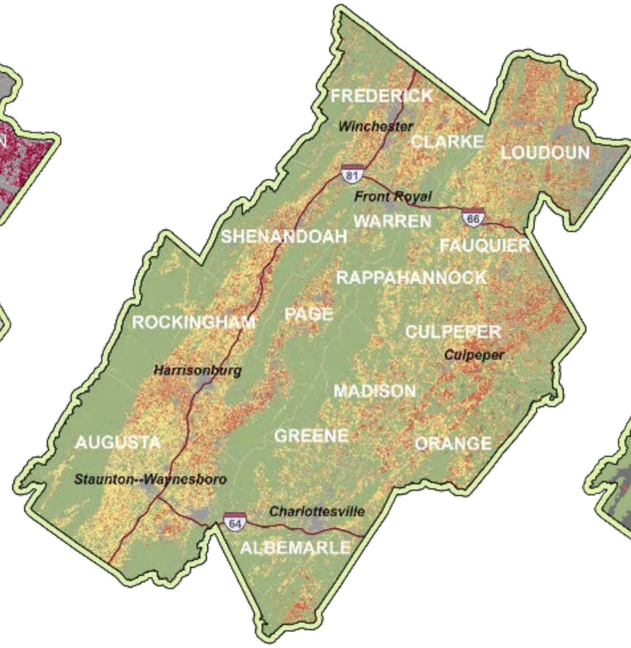
Regional data in spatial form



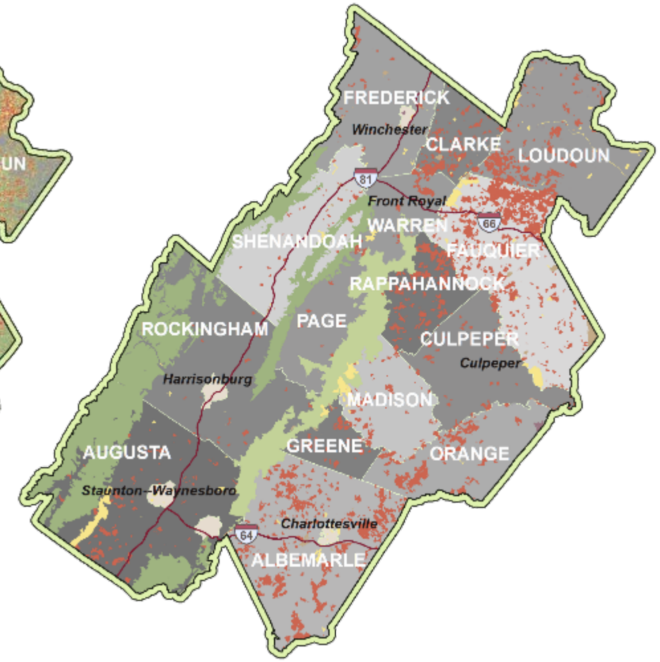
Urban areas

- *Impervious surface*



Land cover

- *Forest*
- *Pasture*
- *Crops*
- *Development*



Protected areas

- *Easement*
- *Historic/Cultural*
- *Nat. Forest*
- *Nat. Park*
- *Other*
- *State Lands*

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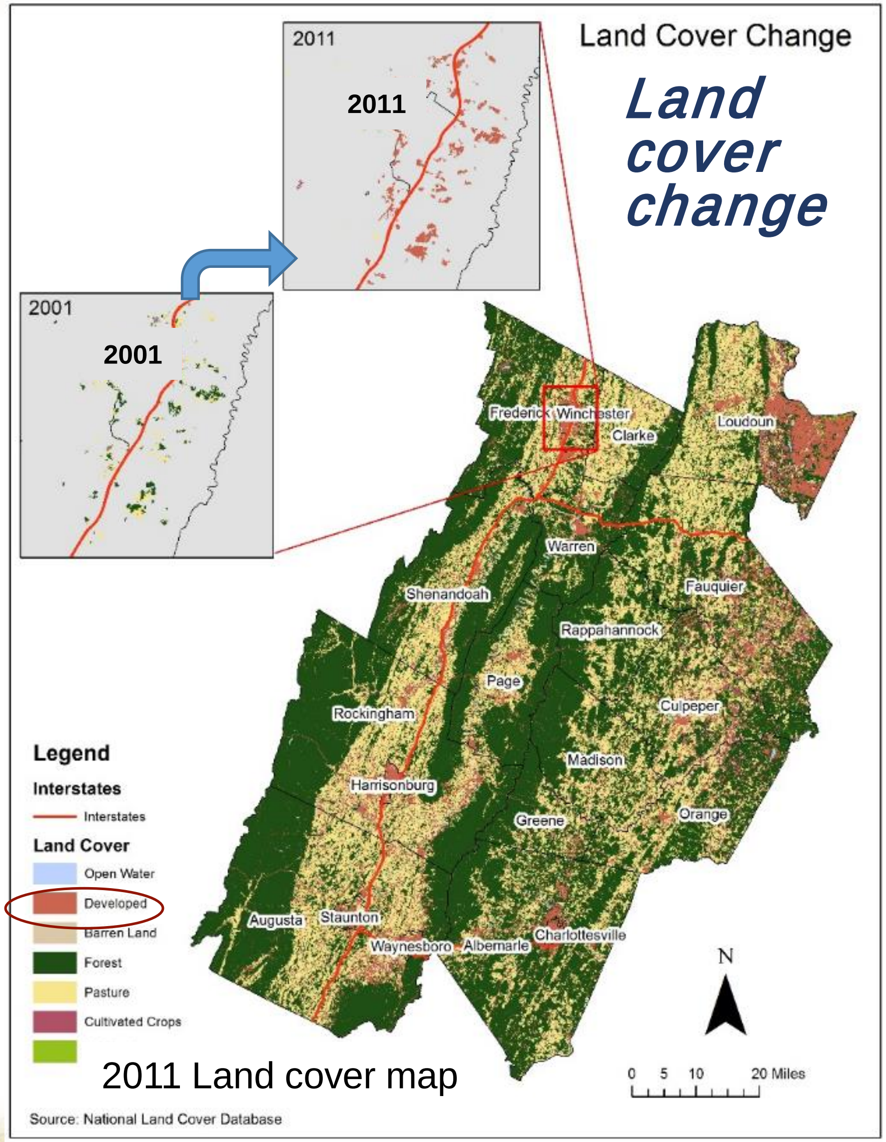
VIRGINIA WORKING LANDSCAPES

The Changing Landscapes Initiative

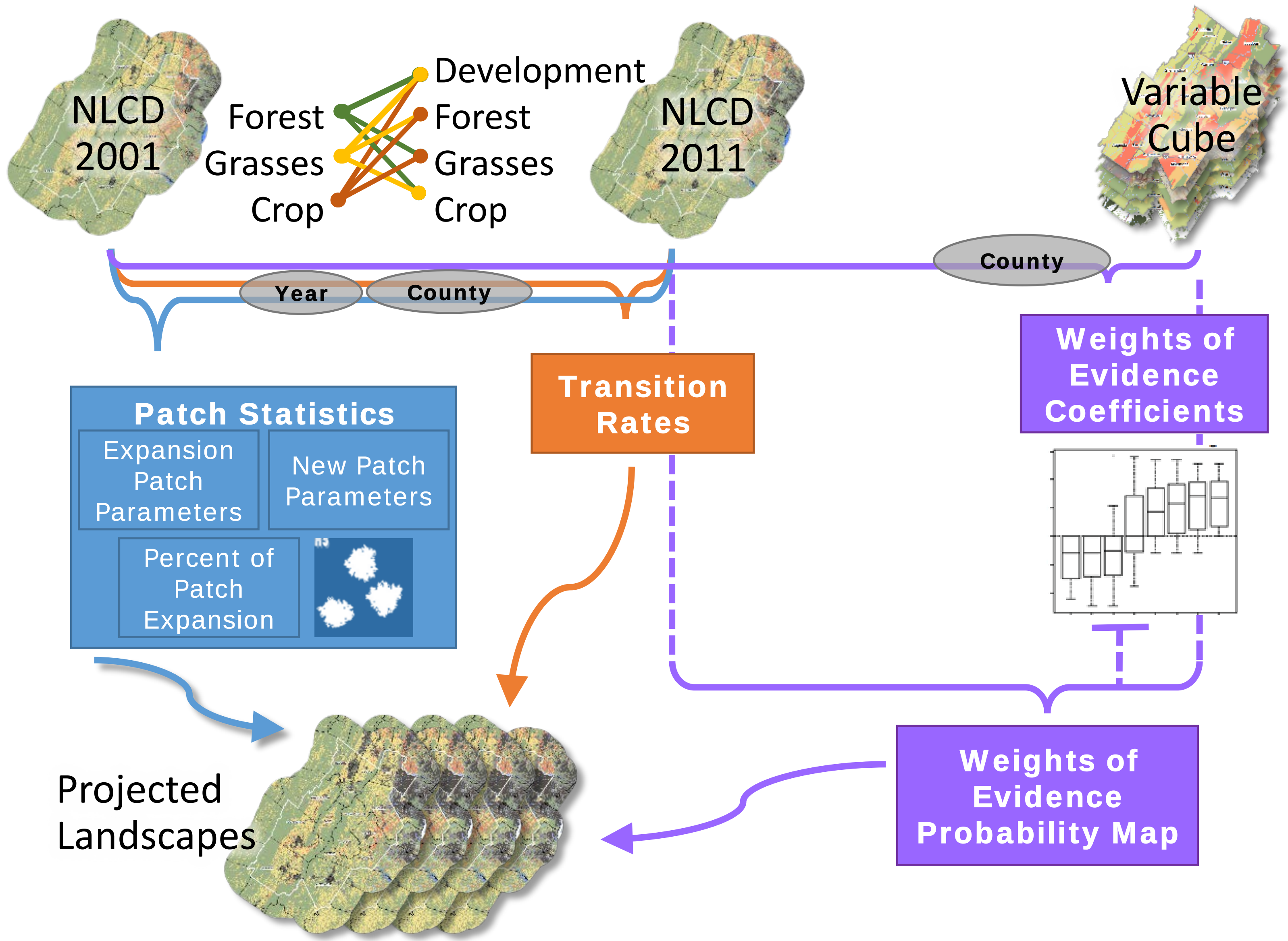
Threats or contributors to quality of life (Drivers)

- Conversion from Forest and Agriculture → Development
  - Follows existing road network
  - Primarily in northern part of region
- Impacts
  - Rural atmosphere
  - Open space
  - Water amount and quality
  - View shed
  - Forest connectivity
  - Existing habitat quality



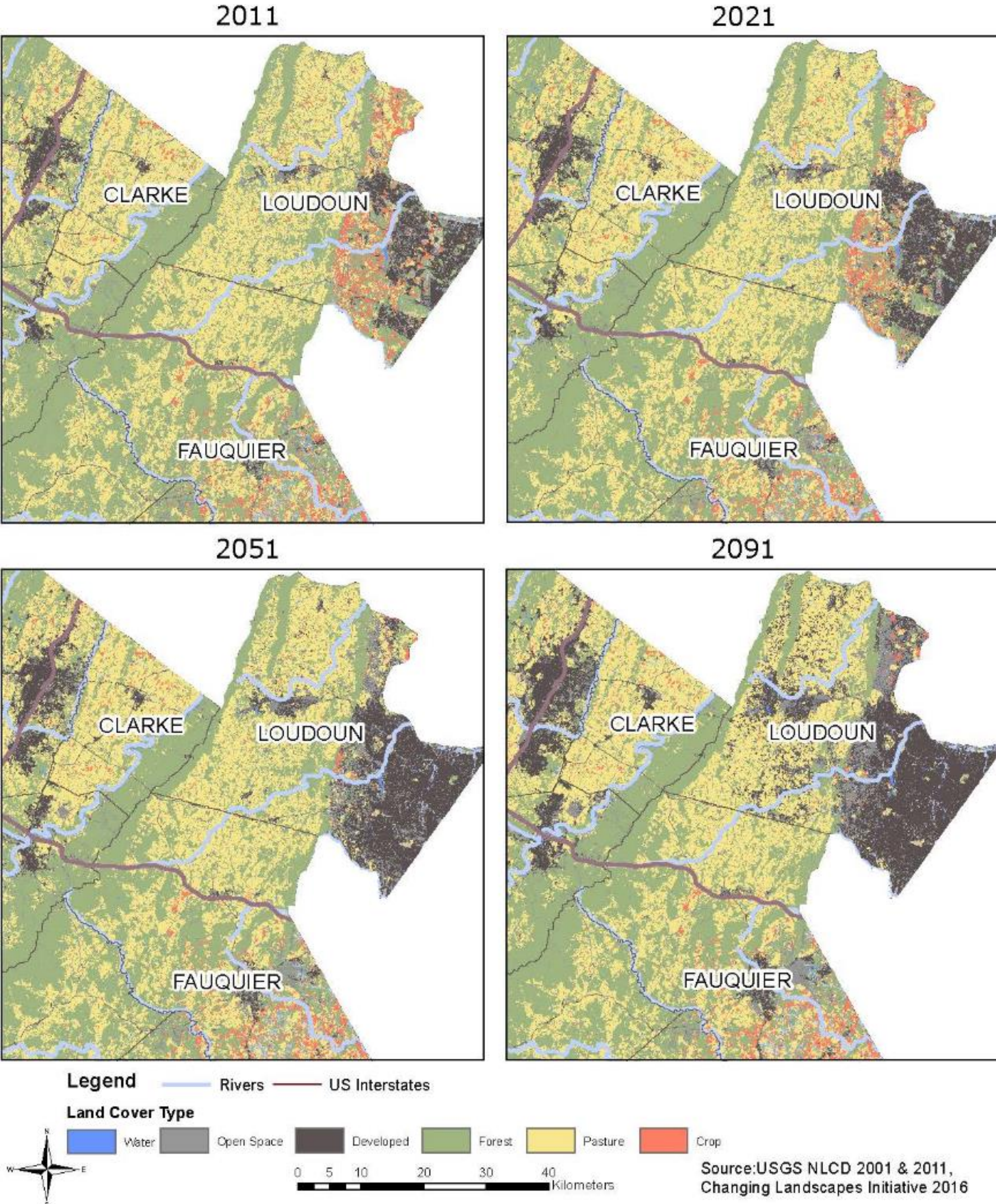
2011 Land cover map

Land use model: Dinamica (http://csr.ufmg.br/dinamica/)



Soares-Filho, B. S., Pennachin, C. L., Cerqueira, G. 2002. DINAMICA – a stochastic cellular automata model designed to simulate the landscape dynamics in an Amazonian colonization frontier. Ecological Modelling 154, 217 - 235.

Scenarios for Status Quo Growth over 80 years



These are projections of a land use model (Dinamica) based on recent trends for each county.

Mean annual transition rates for these counties in past 10 years:

Forest to Development:
0.004 (Clarke) – 0.064 (Loudoun)
Pasture/Crop to Development:
0.0007 (Clarke) – 0.014 (Loudoun)
Pasture/Crop to Forest: > 0.0001

Next Step is to merge these with alternative land use policies identified by stakeholders, for example:

Status Quo*
Forest Conservation
High Density Housing
Agricultural Land Conservation

Futures maps are of landuse and/or water quality, which lead readily into ecosystem services

One ecosystem service needs to be biological diversity of key suites of organisms (economic, ecological, well-being)

Can we add Biodiversity to Scenario Planning?

- Need restrictive habitat requirements for animals
- Create species distribution models linked to scenario models
- Use Drivers to change landuse and thereby affect wildlife

In *Changing Landscape Initiative* we measure:

Pollinators

Grassland Birds

Large Mammals

Forest Invasive Plants

Stream Macroinvert. (planned)

Habitat Links:

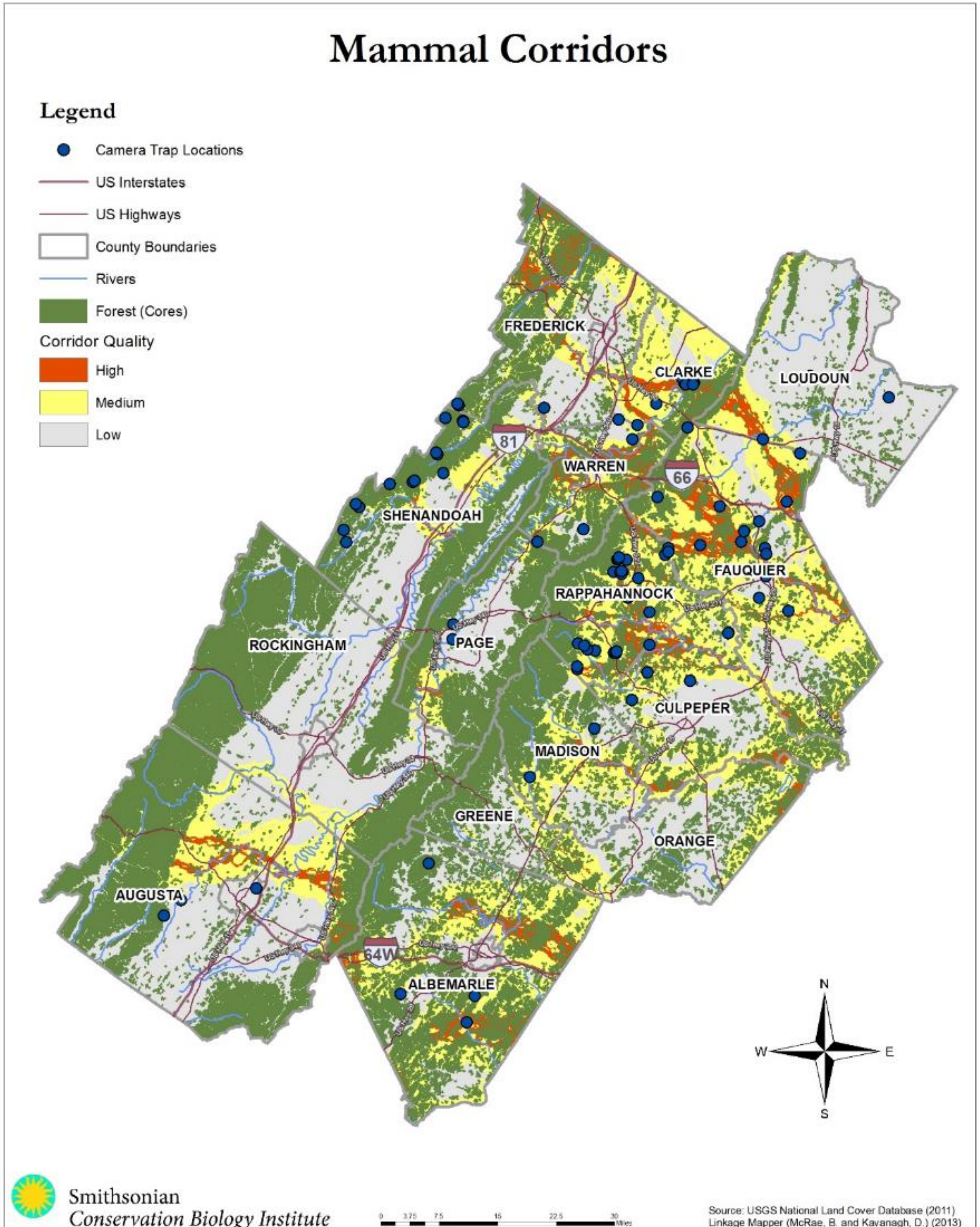
Grasslands

Grasslands

Forest corridors

Forest edge

Stream buffer



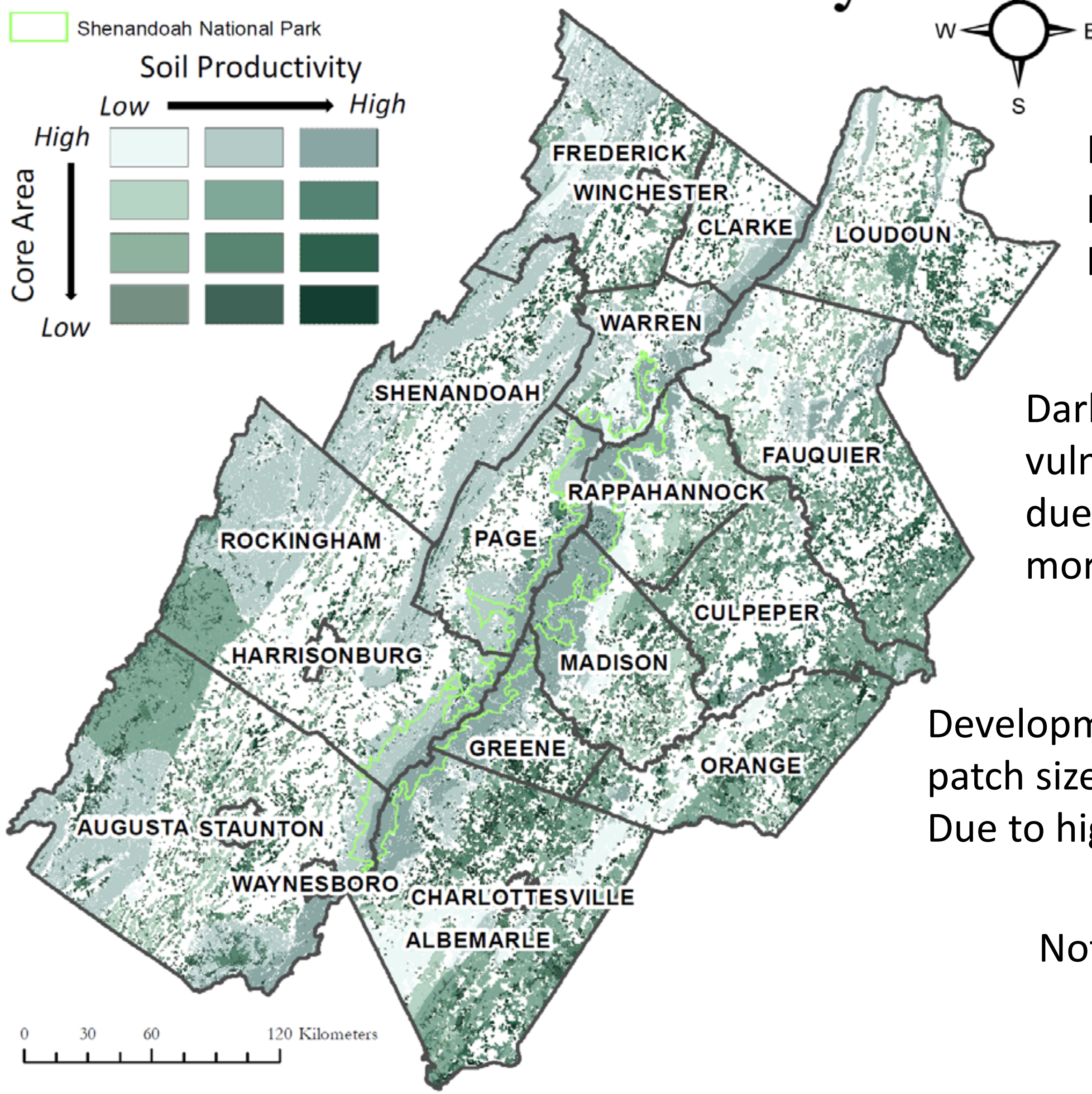
Identify mammal species tied to:
Large forest patches
Connectivity
Forest edge

70 sites sampled to date with camera traps; 140 additional planned by 2018

Potential forest corridors between intact forest patches:

- ~ 7 leading out of SNP to eastern patches
- ~ 2-5 between SNP and National Forest lands to west

Forest Invasibility



Source: USGS Soil Survey Geographic Database 2006; Davies, 1984; Schaetzl et al., 2012; USGS NLCD 2011

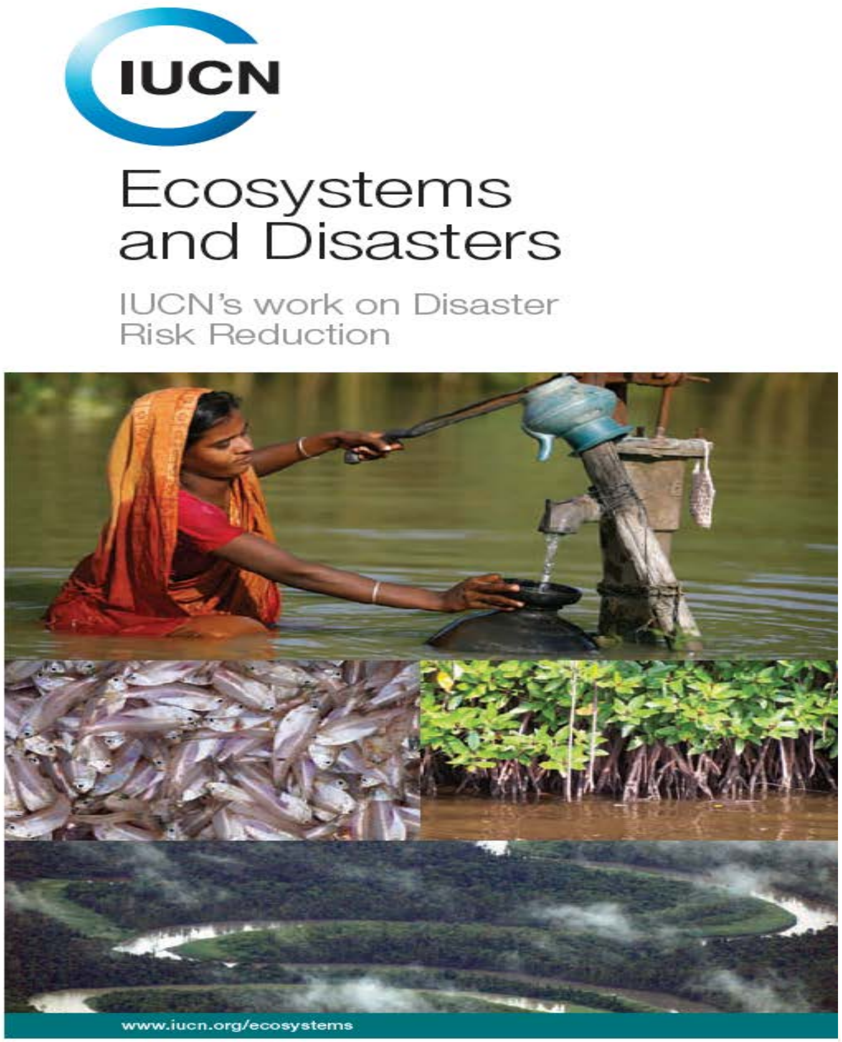
In 2016 - 210 surveys for invasive plants along 100 m transects; 600 planned by 2018

Darker forest patches are more vulnerable to invasion by exotic plants due to higher soil productivity and more forest edge per ha of forest.

Development and road creation will decrease patch size and have more impact in east
Due to higher soil productivity

Not yet linked to scenario models

How to Plan for Extreme Disturbance (Disaster)



5 reasons ecosystems matter to disaster risk reduction:

- Human well-being depends on intact ecosystems to withstand and recover from disasters.
- Ecosystems, such as wetlands, forests, and coastal systems can provide cost-effective natural buffers.
- There are clear links between resource degradation and disaster risk. Degraded ecosystems make communities more vulnerable to disaster impacts.
- Disasters can affect biodiversity through the spread of invasive species, mass species mortality, loss of habitat and poorly designed post-disaster clean-up efforts.
- Ecosystem degradation reduces the ability of natural systems to sequester carbon, exacerbating climate change impacts.

Role of Stakeholder Process

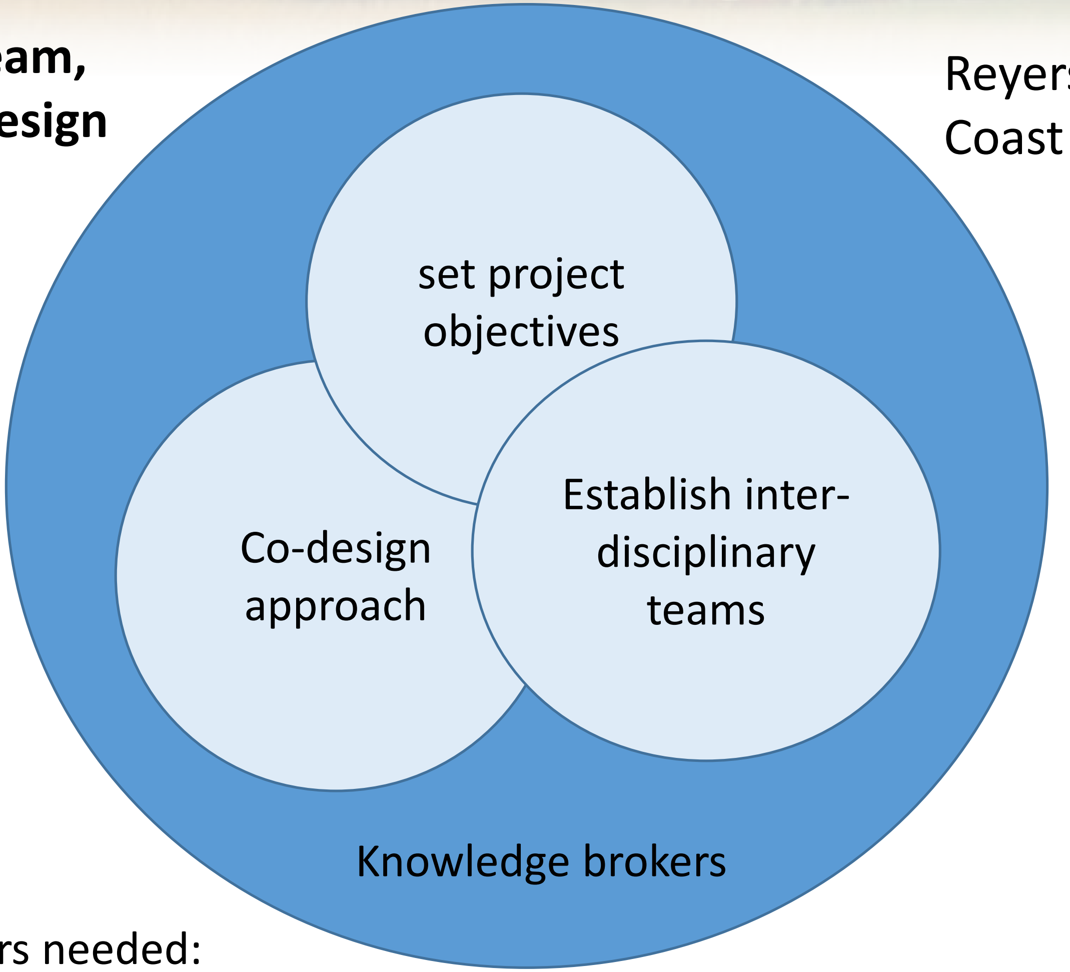
Stakeholders are involved at beginning of process:

- Provide buy-in to concepts and the need for planning
- Need to identify local/regional drivers
- Need to identify shared outcomes
- Will be the ones doing the work

Planning for a Disaster

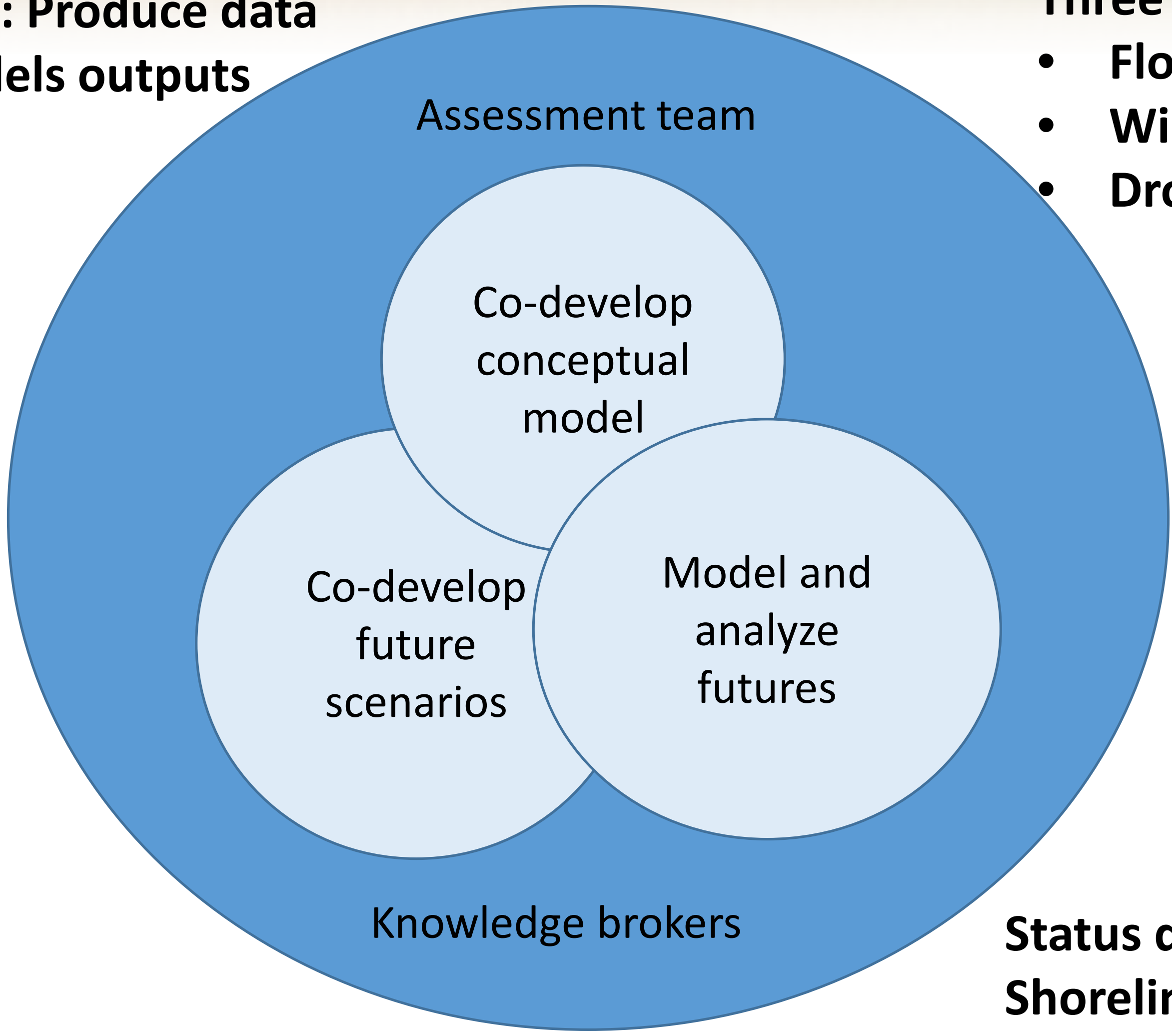
<u>Step One</u>: Form team, assign roles, co-design project

Reyers et al. 2015 PNAS
Coast of South Africa



4 types of stakeholders needed:
Knowledge brokers: Environmental NGOs and agencies
Assessment team: Research organizations; Disaster management agency
Bridging agents: National government agencies for climate change and disaster management
Implementers: Local government and civil society (landowners)

Step Two: Produce data and models outputs needed

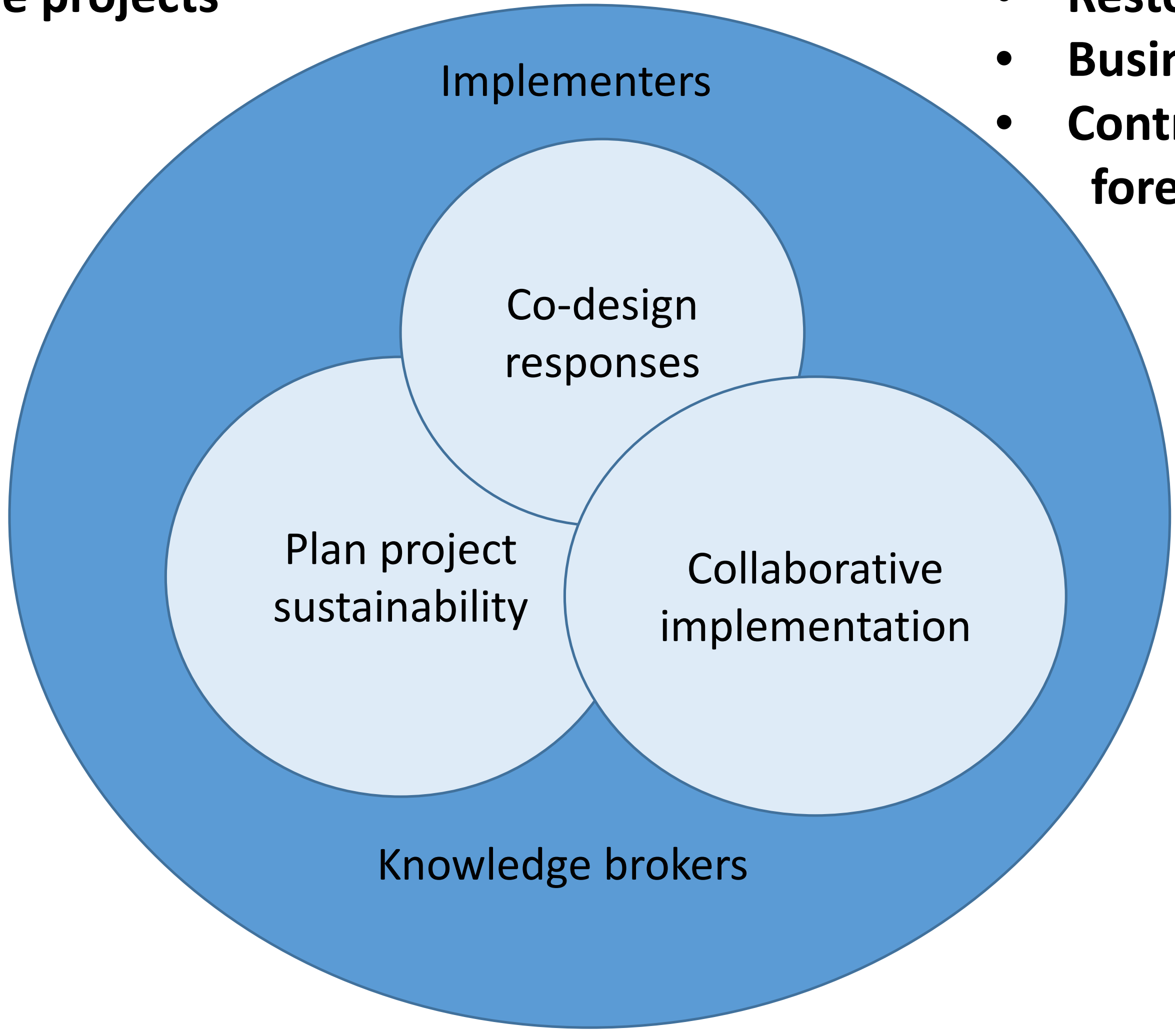


Three Scenarios Modelled:

- **Flood of coastal town**
- **Wildfire on forest hills**
- **Drought**

Status quo + disaster:
Shoreline erosion ↑ 28-152%
Fire intensity ↑ 101-280%
Drought severity ↑ 48-52%

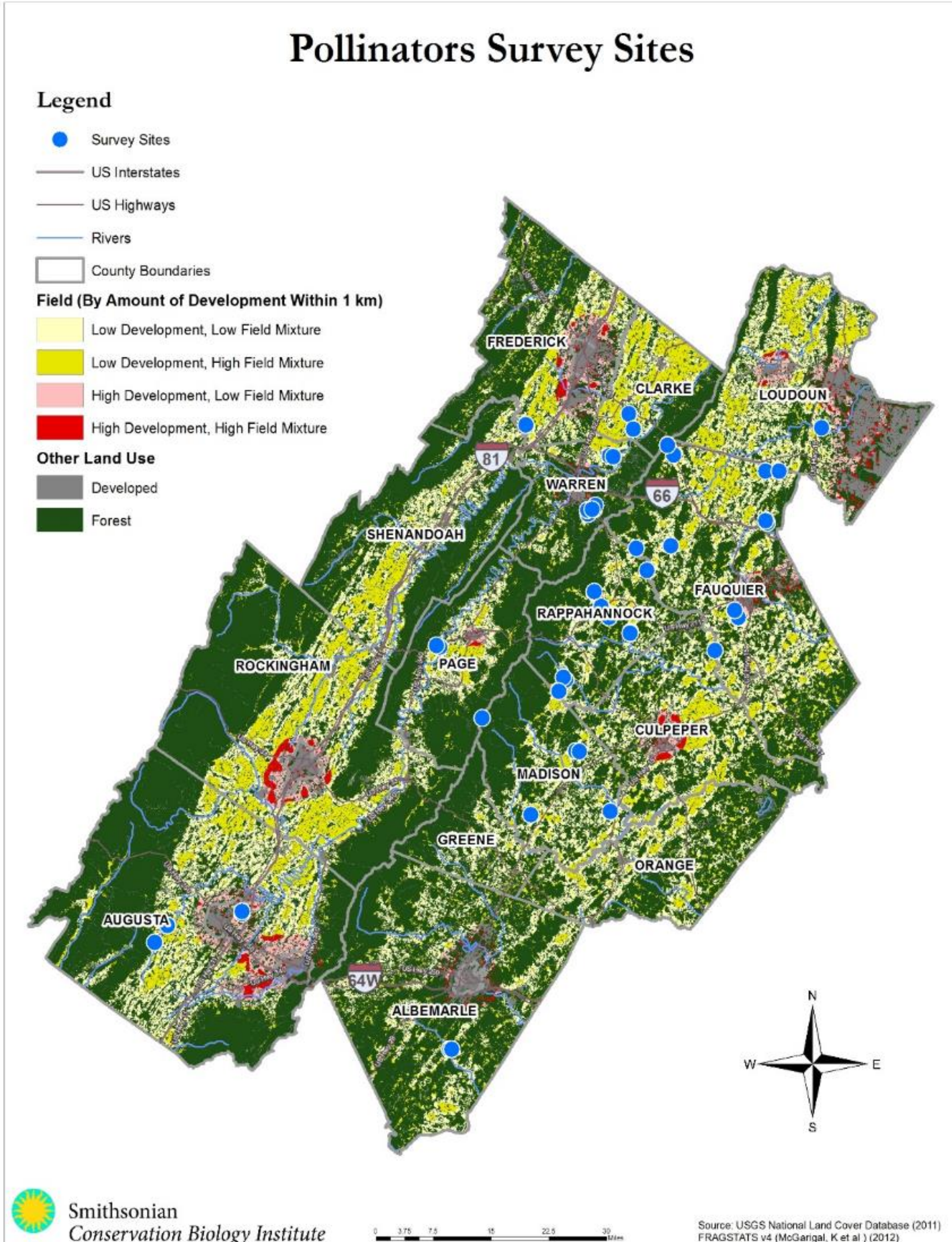
<u>Step Three</u>: Acquire funding and permissions; Implement proactive projects



Outcomes:

- **Established new fire breaks**
- **Restore dunes along coast**
- **Businesses join water board**
- **Control invasive plants in forest**

Mainstream Ecosystem Services into Planning



Needed for incorporation into Scenario Planning:

- Effective native bee survey protocol
- blue vane bee traps; 29 sites to date
- Bee identification – UVA and USGS
- Link bee species richness to habitat and landscape (focus on bumble bees)
- Range of native bee species detected in fields: 7-73 species (0-10 Bombus)
  Total species = 142 (12 Bombus)

Example of a Disaster

September 1, 2016: Aerial Spraying of Dorchester County, SC with Naled (Dichlorvus) for mosquito control to combat Zika virus spread

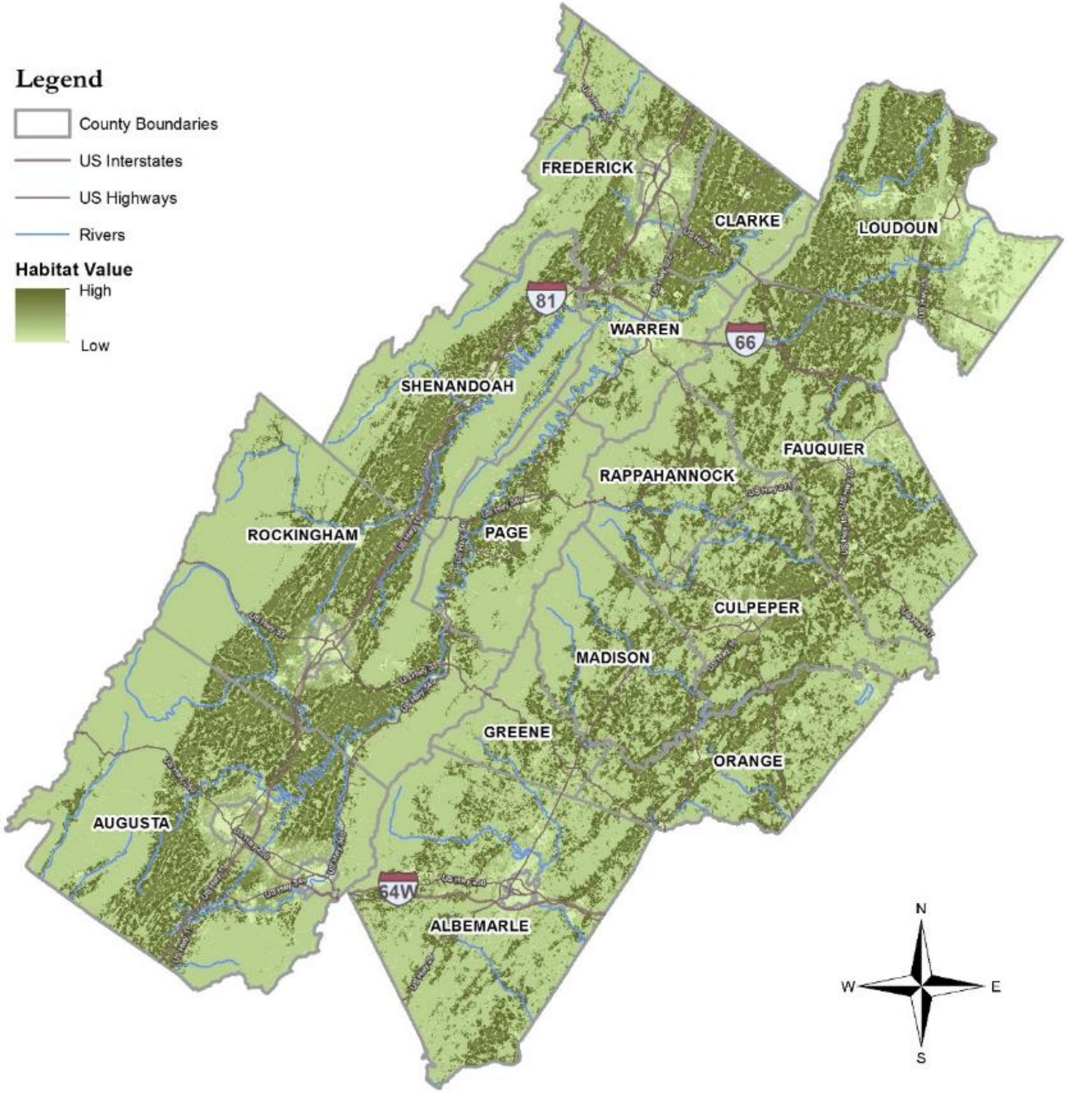
US beekeepers fear for livelihoods as anti-Zika toxin kills 2.5m bees, **The Guardian Sept 2, 2016**

Like it's been nuked': Millions of bees dead after South Carolina sprays for Zika mosquitoes. **Washington Post. Sept. 2 2016**

Aimed at Zika Mosquitoes, Spray Kills Millions of Honeybees
NY Times, Sept 2, 2016

These are domestic bees
– no idea about native bees?

Field suitability for pollinators



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Source: USGS National Land Cover Database (2011)
FRAGSTATS v4 (McGarigal, K et al) (2012)

If you spray within 1 km of High Development areas in this region – 217 km^2 of high quality pollinator habitat affected.

How does that affect ecosystem services from pollinators on nearby cropland?

How will increased distribution of developed areas impact future "disasters"?

Reasons to Consider Scenario Planning Models

- Are Proactive with Stakeholder Groups
  - Build models about things that locals care about
  - Identify and nurture 4 types of stakeholders needed for success
  - Find shared vision for future and possible paths forward
- Can Build Biodiversity into Estimates of Ecosystem Services
  - Link key species to landuse and water models
- Incorporate Scenario Planning into Risk Assessments
  - Helps stakeholders envision consequences of disaster and relative impacts of proactive activities
  - Establish that there are alternate futures based on actions now