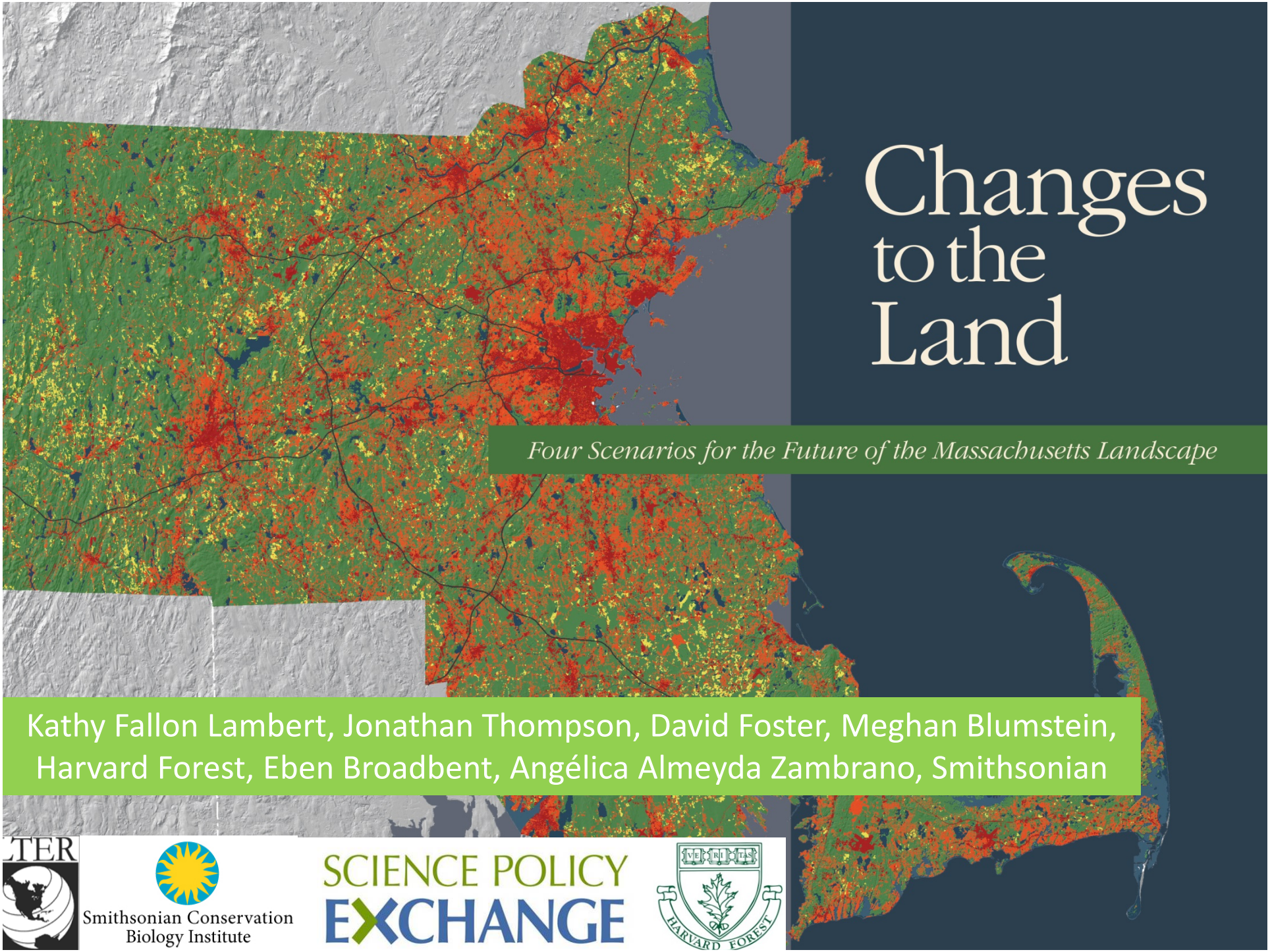


Changes to the Land

Four Scenarios for the Future of the Massachusetts Landscape

Kathy Fallon Lambert, Jonathan Thompson, David Foster, Meghan Blumstein,
Harvard Forest, Eben Broadbent, Angélica Almeyda Zambrano, Smithsonian

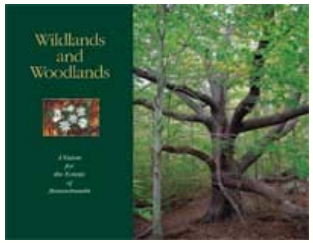
LTER

Smithsonian Conservation Biology Institute

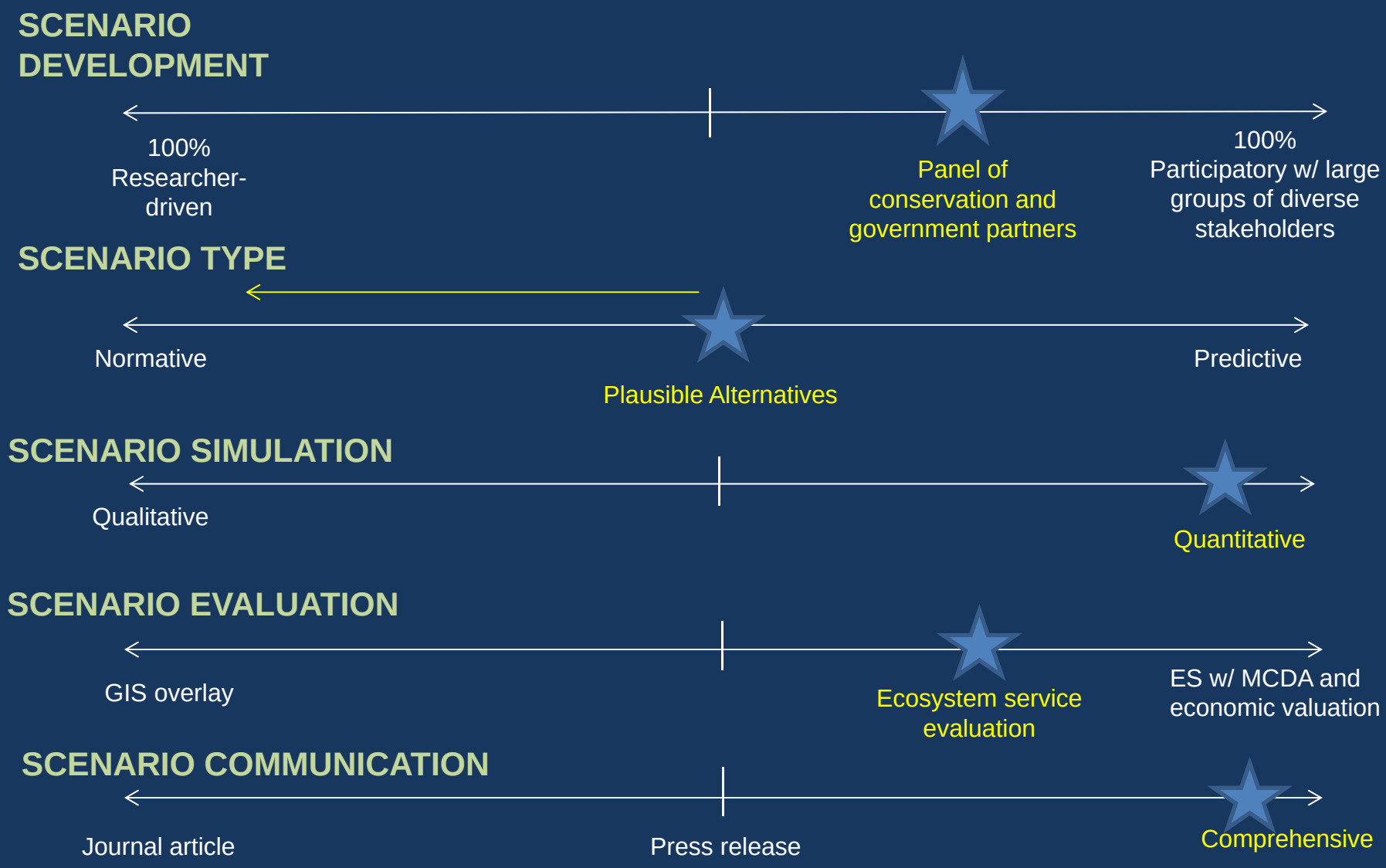
SCIENCE POLICY EXCHANGE

HARVARD FOREST

Forest Cover and Population Change in New England



Scenarios Approach



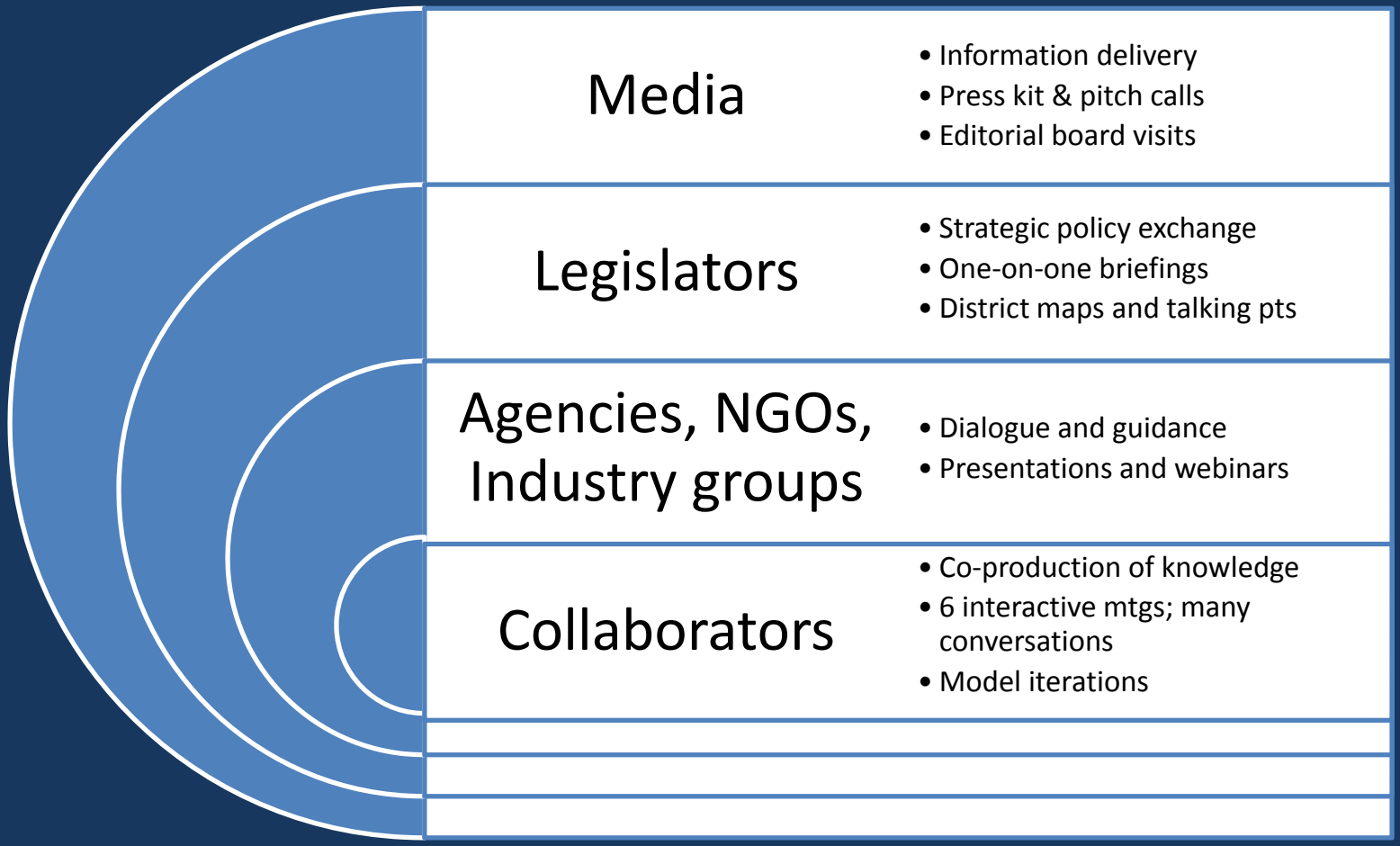
Team

Jonathan Thompson, Harvard Forest
David Foster, Harvard Forest
Meghan Blumstein, Harvard Forest
Eben Broadbent, Smithsonian
Angélica Almeyda Zambrano, Smithsonian
Kathy Fallon Lambert, Harvard Forest
Clarisse Hart, Harvard Forest

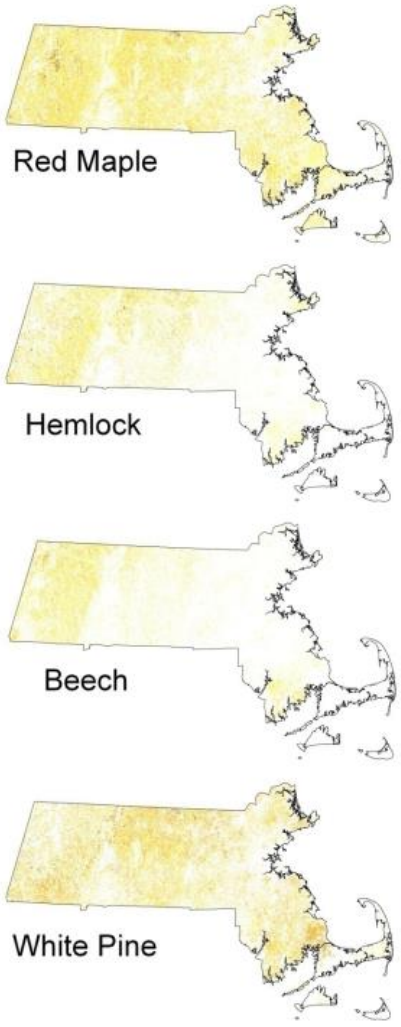
Doug Olson – O2 Design
Joe Macarron – Reos
Linda Mirabile - RavenMark
Barbara MacLeod, Melissa Paly - Cross Current Communications

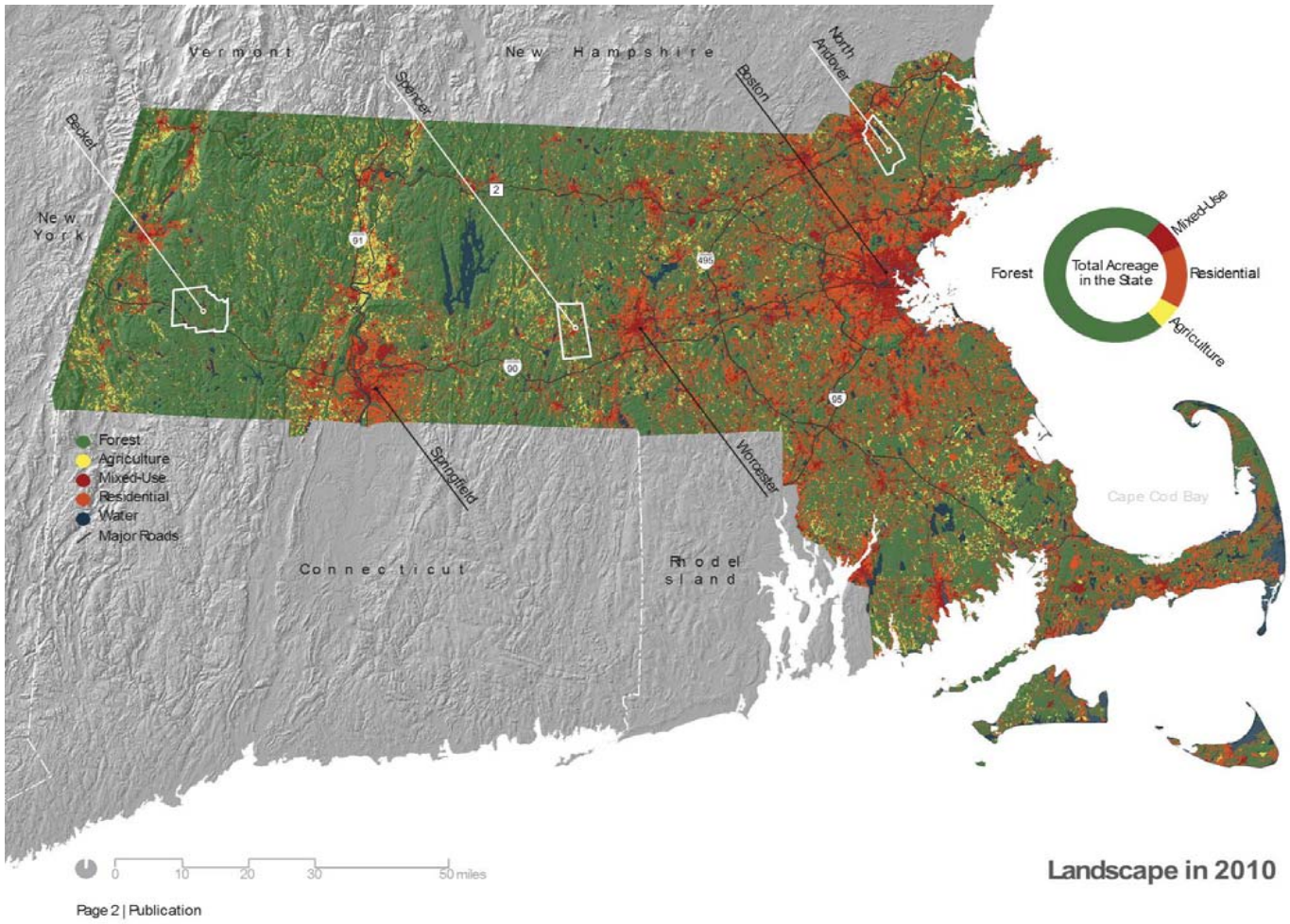
Kathleen Baskins - Director of Water Policy, MA Energy & Environmental Affairs
Stephanie Cooper, Assistant Secretary for Land and Forest Conservation, MA EEA
Andy Finton, Senior Ecologist, The Nature Conservancy
Kurt Gaertner, Director of Sustainable Development, MA EEA
James Levitt, Director, Program on Conservation Innovation, Harvard University
Robert O'Connor, Director Land and Forest Conservation Services, MA EEA
Robert Perschel, Executive Director, New England Forestry Foundation
Lisa Vernegaard, former Vice President for Sustainability, The Trustees of Reservations

Spheres of Engagement



Initial Conditions





Thompson et al. 2011

Scenario Narratives

RECENT TRENDS

Continuation of the conservation, development, agriculture, and timber harvest trends from 1999-2005.

Scenario Narratives

Continuation of the conservation, development, agriculture, and timber harvest trends from 1999-2005.

Rapid economic growth and rolled back regulations; minimal land use planning; the removal of conservation restrictions; and an early pulse in forest harvesting.

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Damage from rapid environmental change leads to increased interest in stewardship. Forested landscape is managed as valuable living infrastructure; development is targeted towards gateway cities; conservation doubles; sustainable harvesting increases.

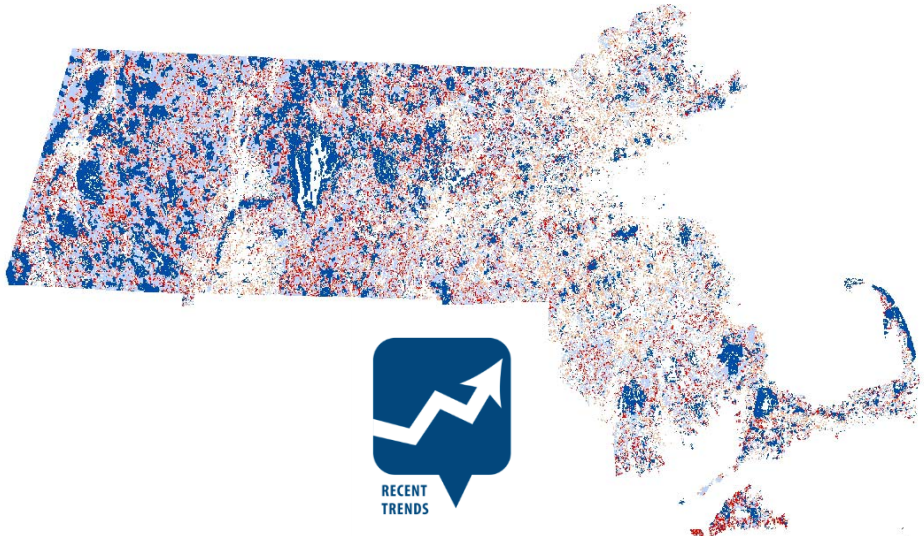
How Much Change?

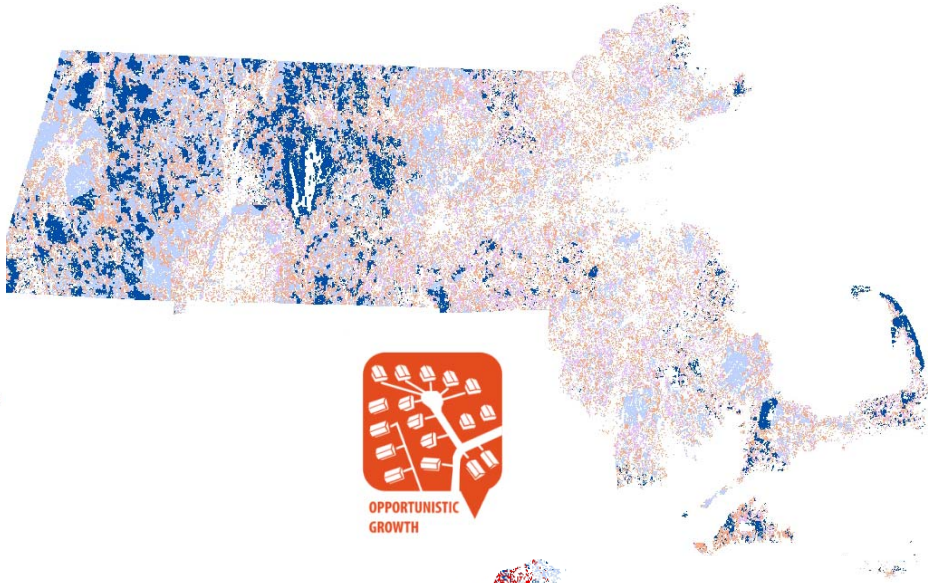
LAND USE PRESCRIPTIONS (acres per year)	Recent Trends	Opportunistic Growth	Regional Self-Reliance	Forests as Infrastructure
DEVELOPMENT	7,500	10,000 - 15,000	4,000 – 5,500	6,000-7,000
AGRICULTURE	0	0	2,000- 10,000	0
TIMBER HARVEST	25,000	20,000-35,000	36,000-61,000	34,000-45,000
CONSERVATION	10,000	2500	4000	15,000

What kind/intensity?

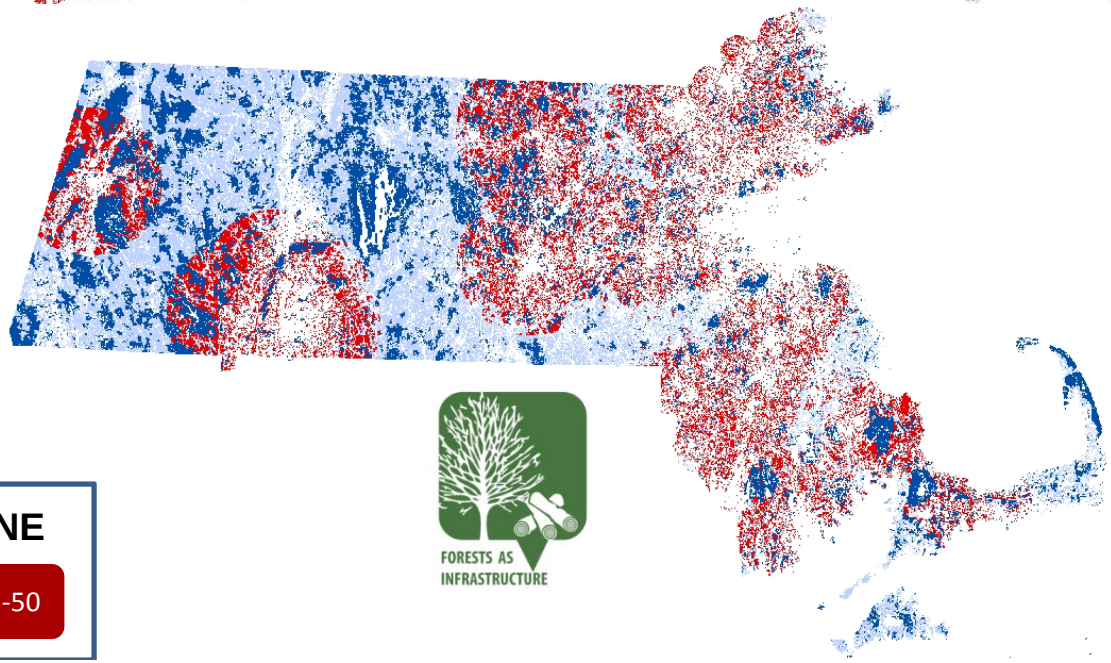
Land Use		Recent Trends	Opportunistic Growth	Regional Self-Reliance	Forests as Infrastructure
Forest Conservation		Random	Random	Random	66% priority
Development	Dispersed residential	65%	50%	60%	30%
	Clustered mixed-use	34%	40%	39%	65%
	Very large commercial	1%	10%	1%	5%
Harvest	Improvement forestry	0	10%	10%	60%
	Long-term forestry	66%	30%	20%	30%
	Short-term revenue	34%	0	0	0
	Short-term revenue with biomass	0	40%	50%	10%
	Biomass clearcut	0	20%	20%	0

Where?





Factors:
Protection status
Population density
Road density
Distance to city
Distance to built

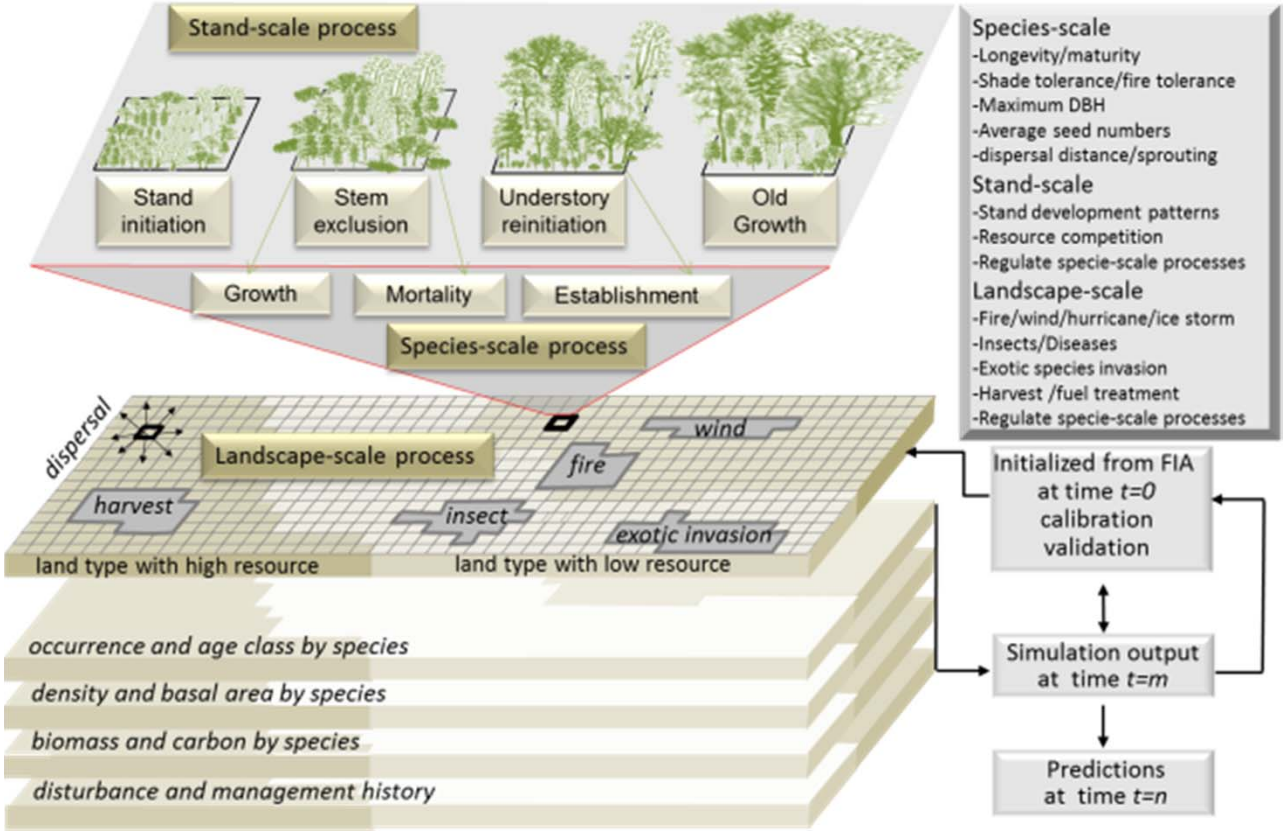


PERCENT OF TOTAL EVENTS IN ZONE

0	1-10	11-20	21-30	31-40	41-50

Scenarios to Simulation

LANDIS-II: Succession and Disturbance Model



0.25ha (0.6ac) grain

5 year time-steps

50 yr temporal extent

1.2mil ha study area

25 tree species

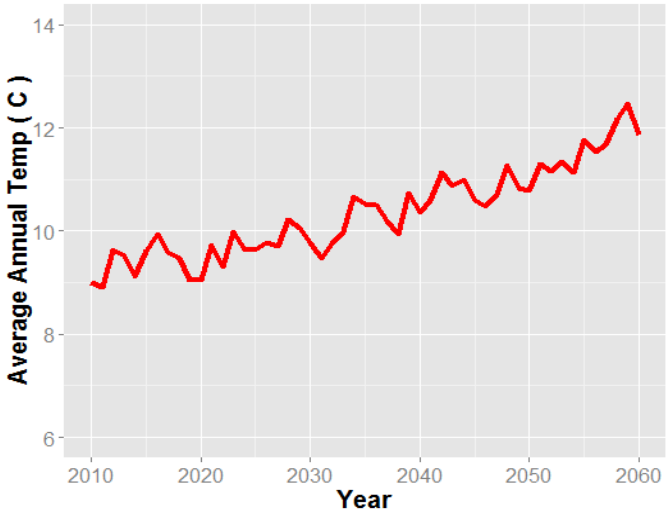
amazon web services

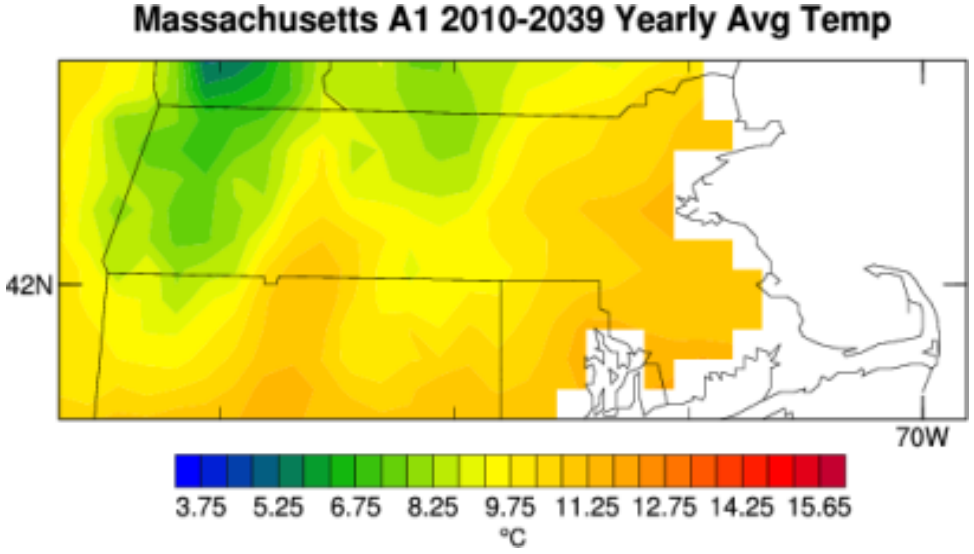
1. Removes forest
2. Protects forest
3. Harvests and regrows trees

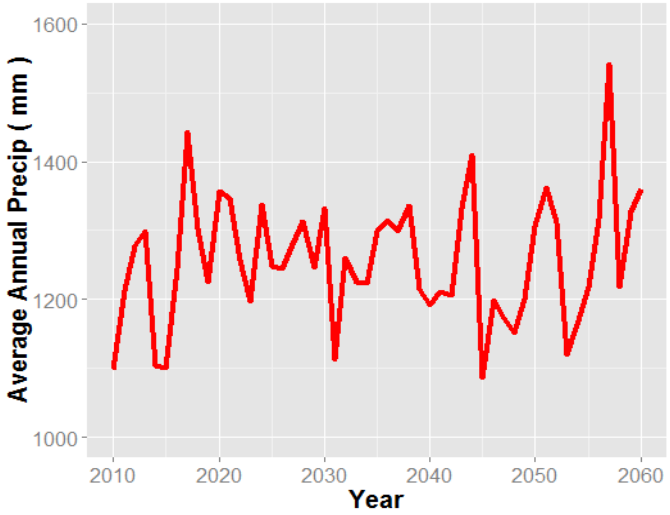
A1F1 IPCC CLIMATE

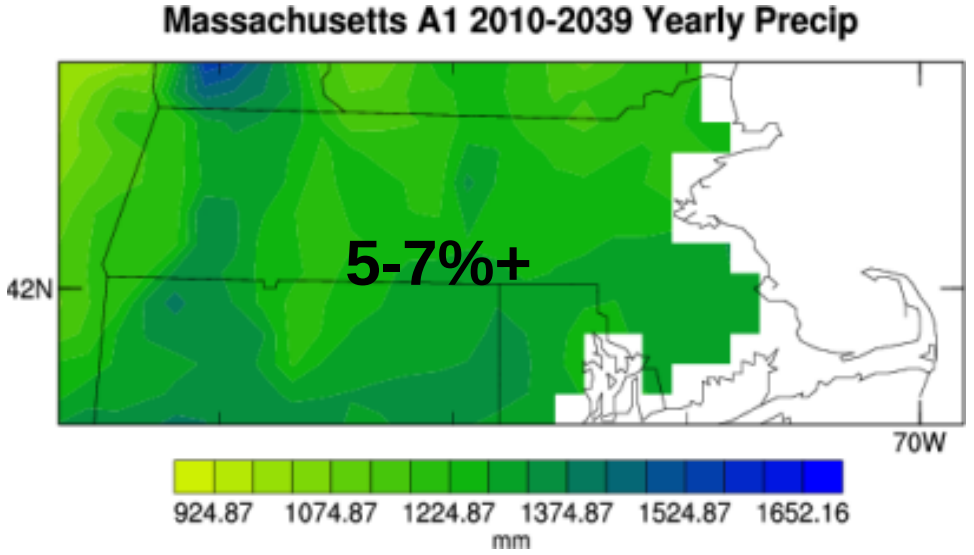
APPLIED TO ALL SCENARIOS

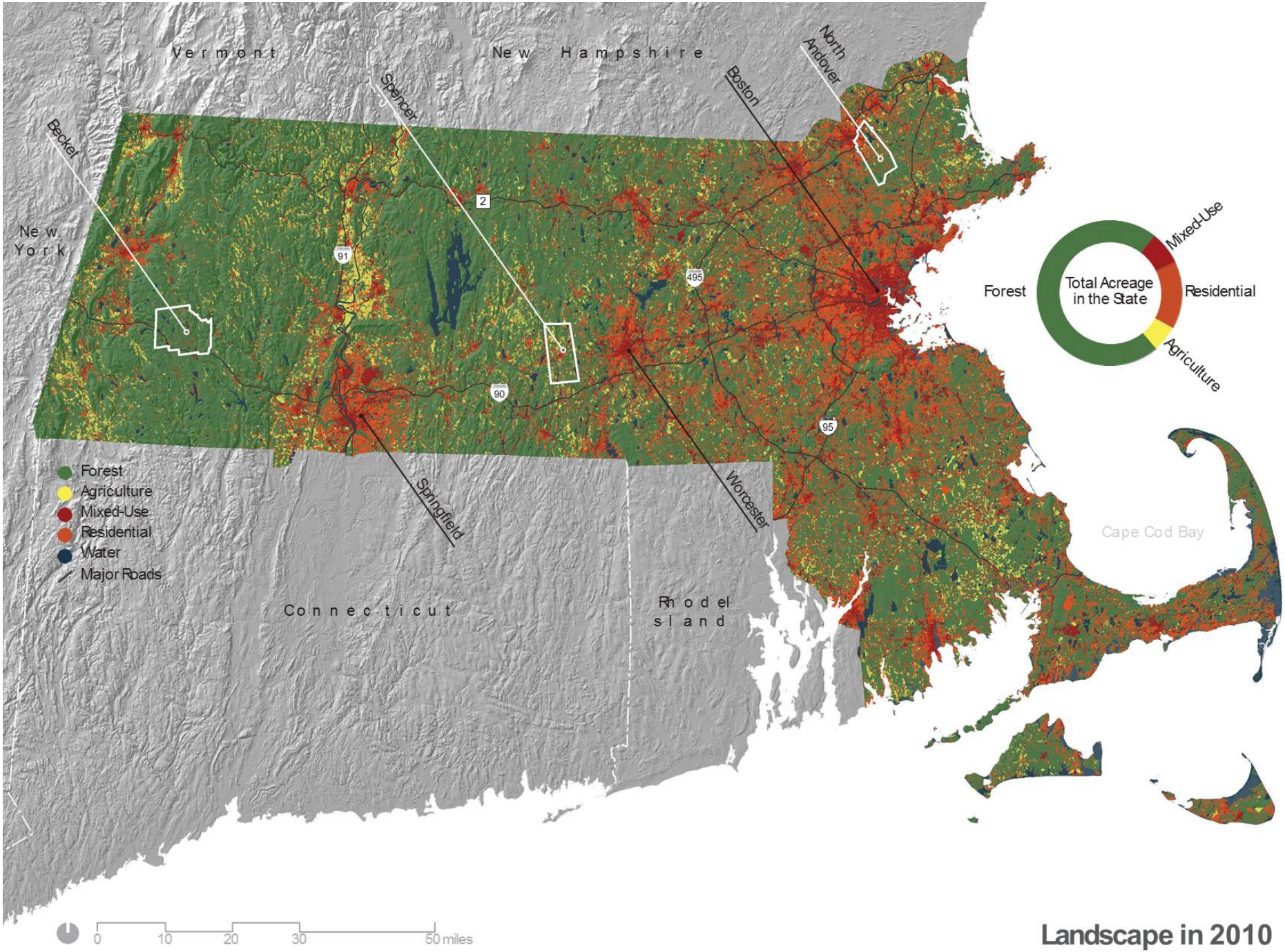
(640 ppm CO2 by 2060 ---- Northeast Climate Impacts Assessment (Hayhoe et al 2008))



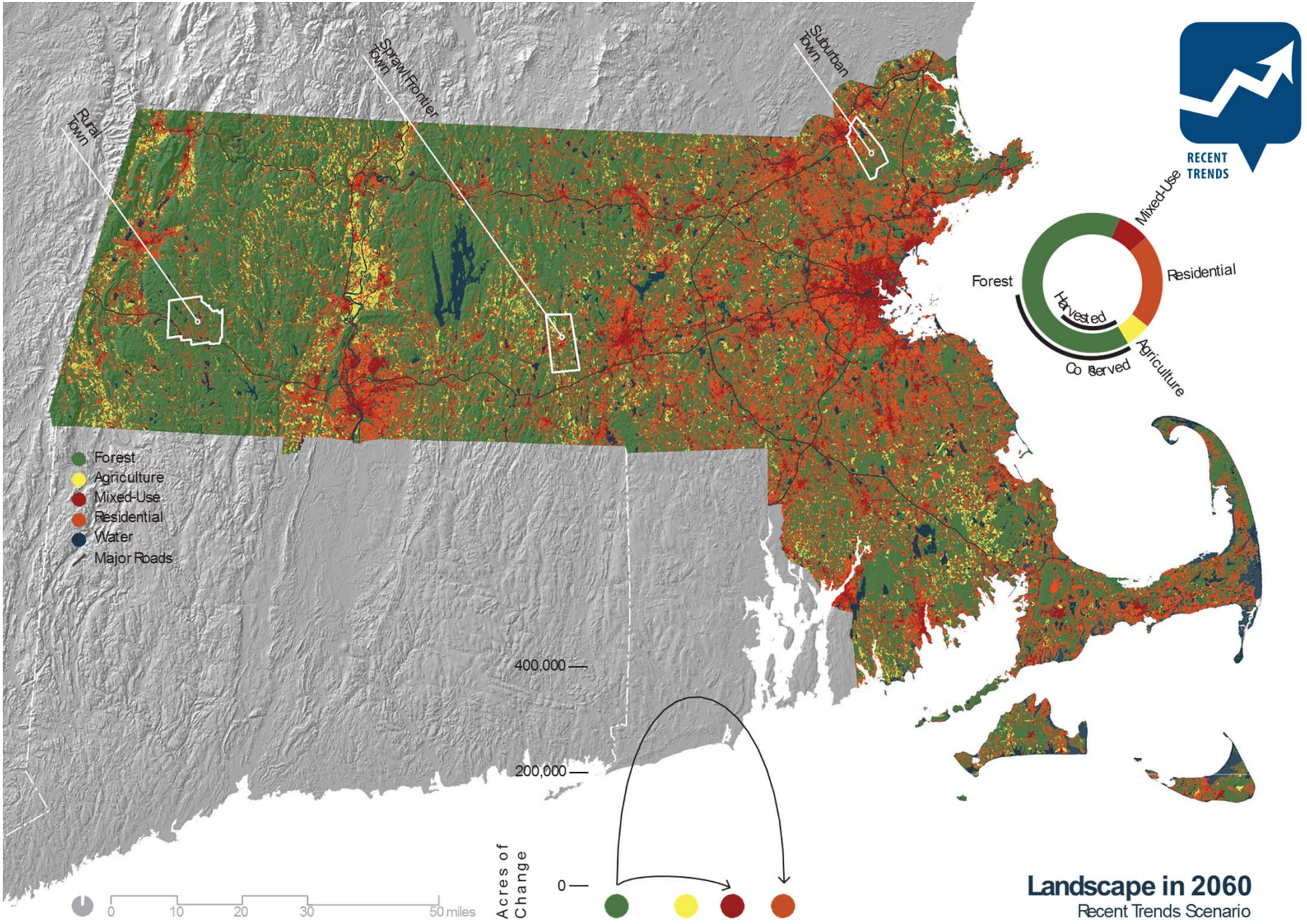


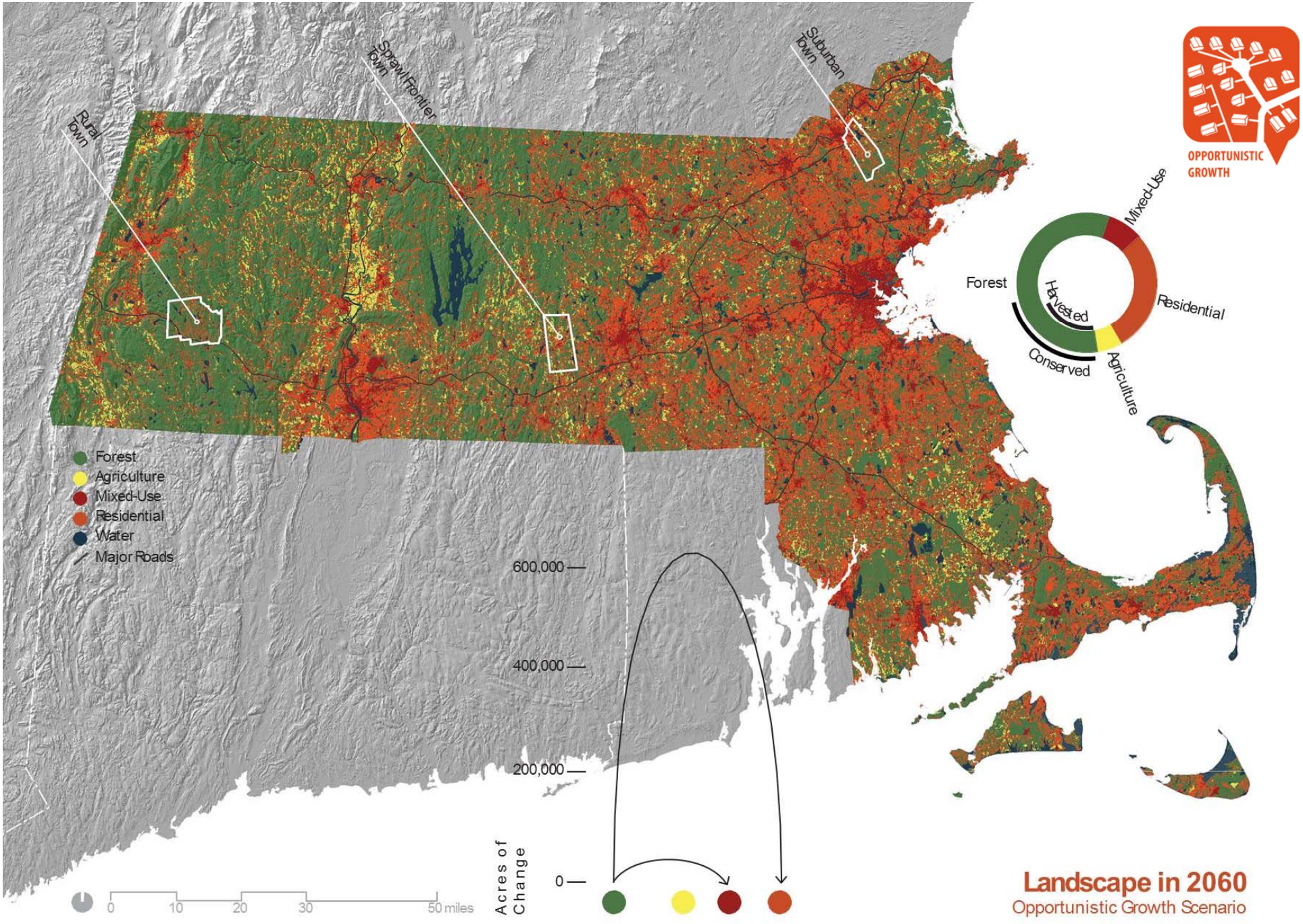


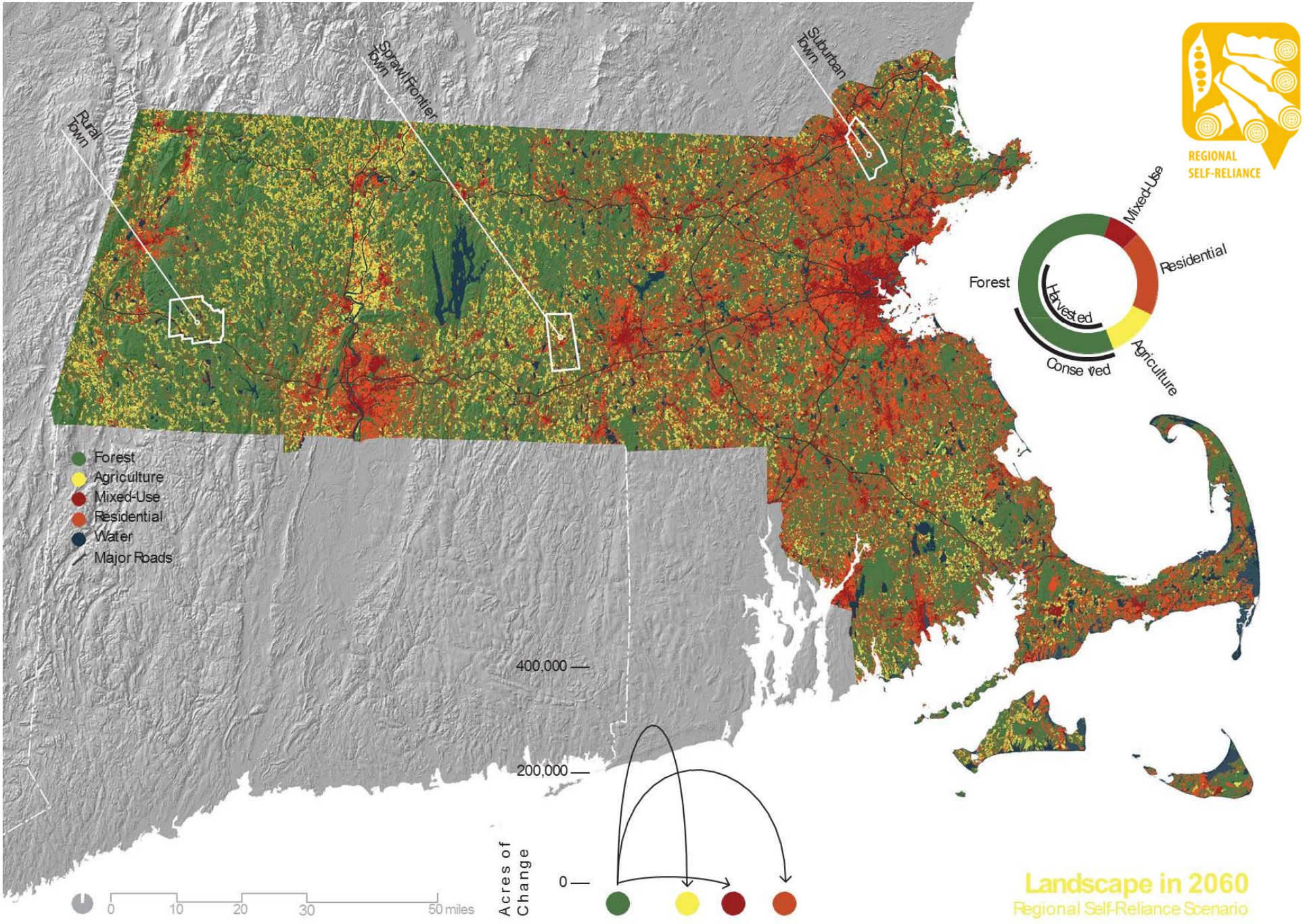


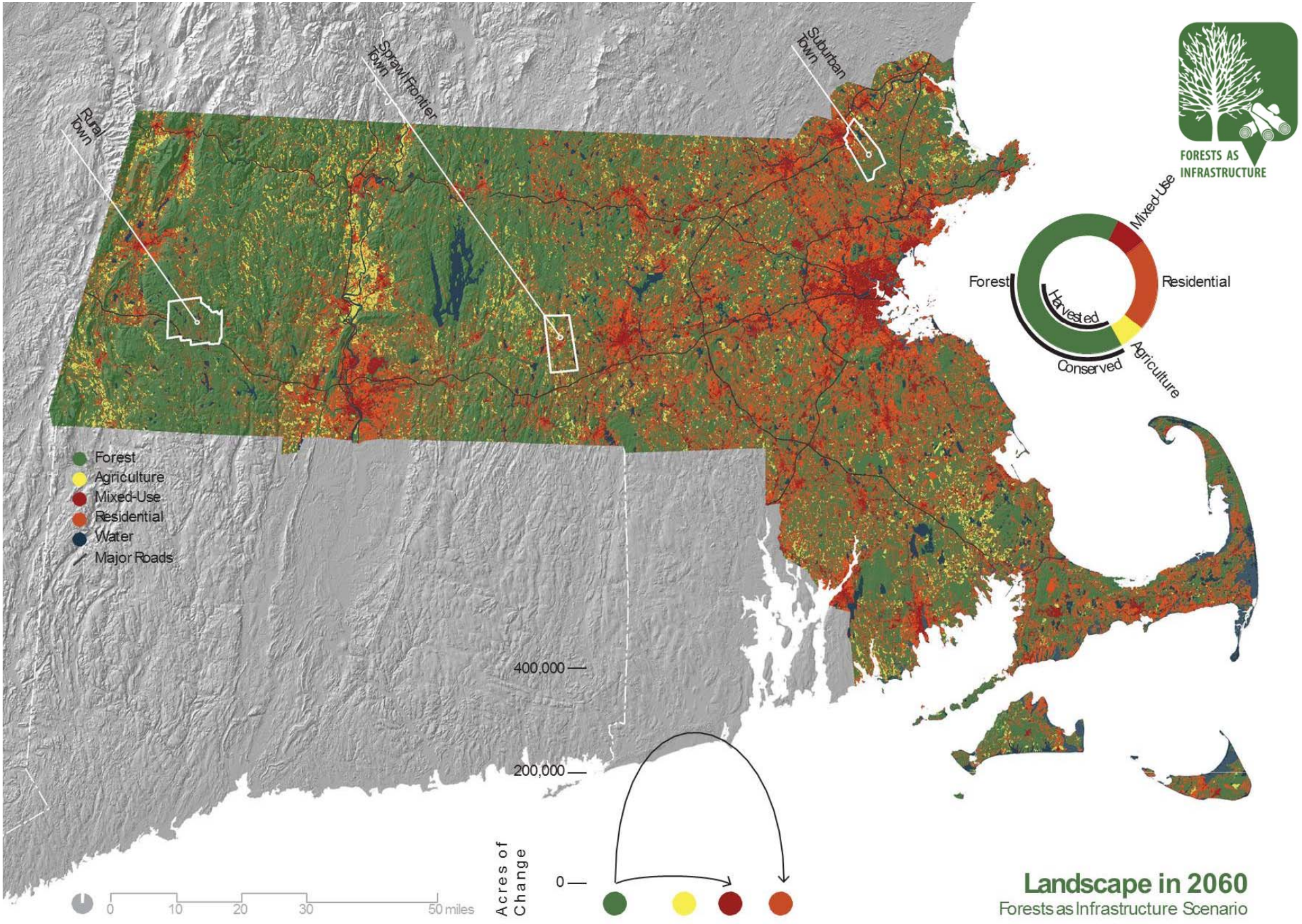


Landscape in 2010

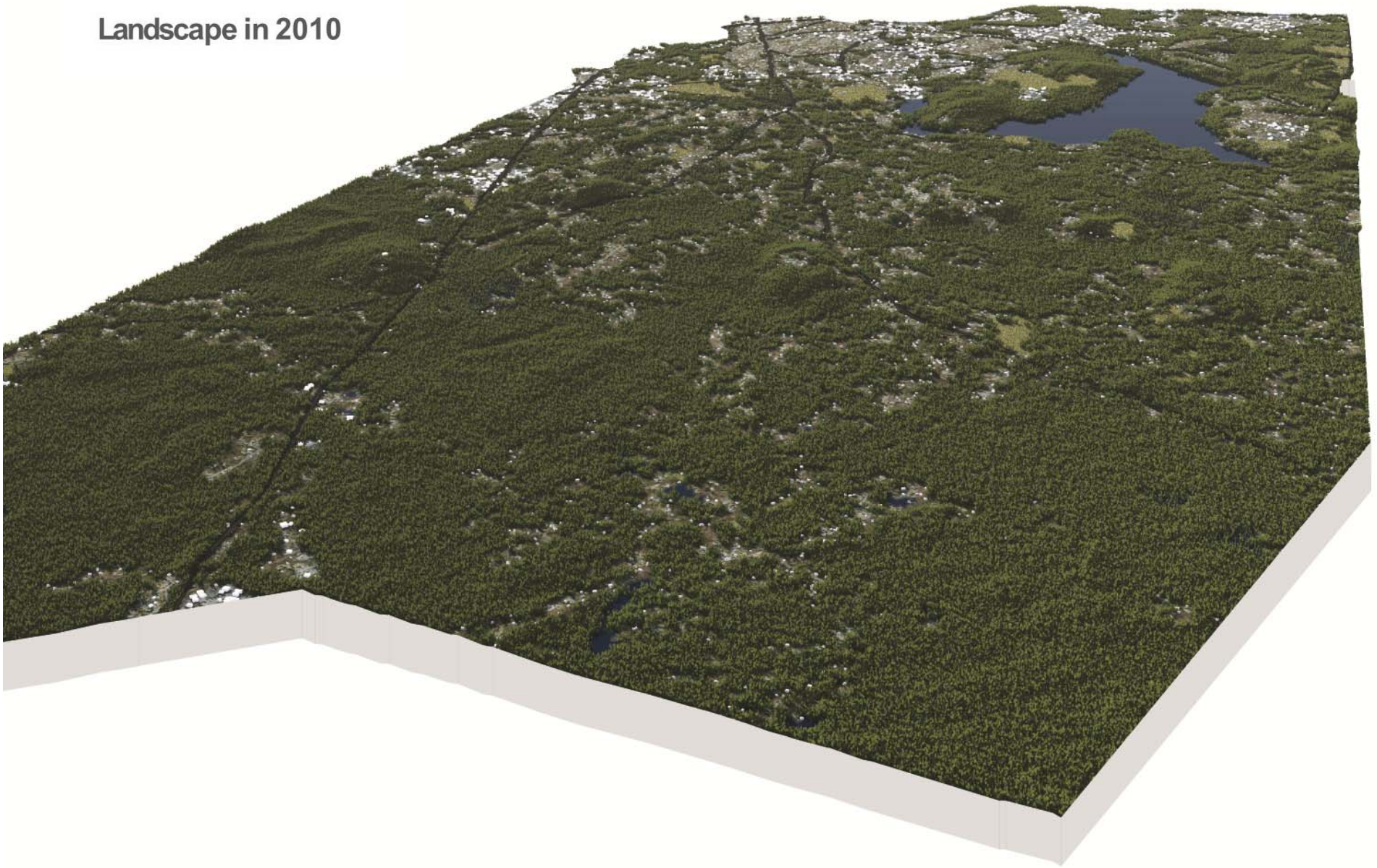

Rural Town
Sprawl Frontier Town
Suburban Town
RECENT TRENDS
Mixed-Use
Residential
Forest
Harvested
Agriculture
Conserved
Forest
Agriculture
Mixed-Use
Residential
Water
Major Roads
400,000
200,000
0
Acres of Change
0
10
20
30
50 miles
Landscape in 2060
Recent Trends Scenario


Rural Town
Sprawl Frontier Town
Suburban Town
OPPORTUNISTIC GROWTH
Mixed-Use
Residential
Agriculture
Conserved
Harvested
Forest
Forest
Agriculture
Mixed-Use
Residential
Water
Major Roads
600,000
400,000
200,000
0
Acres of Change
0
10
20
30
50 miles
Landscape in 2060
Opportunistic Growth Scenario

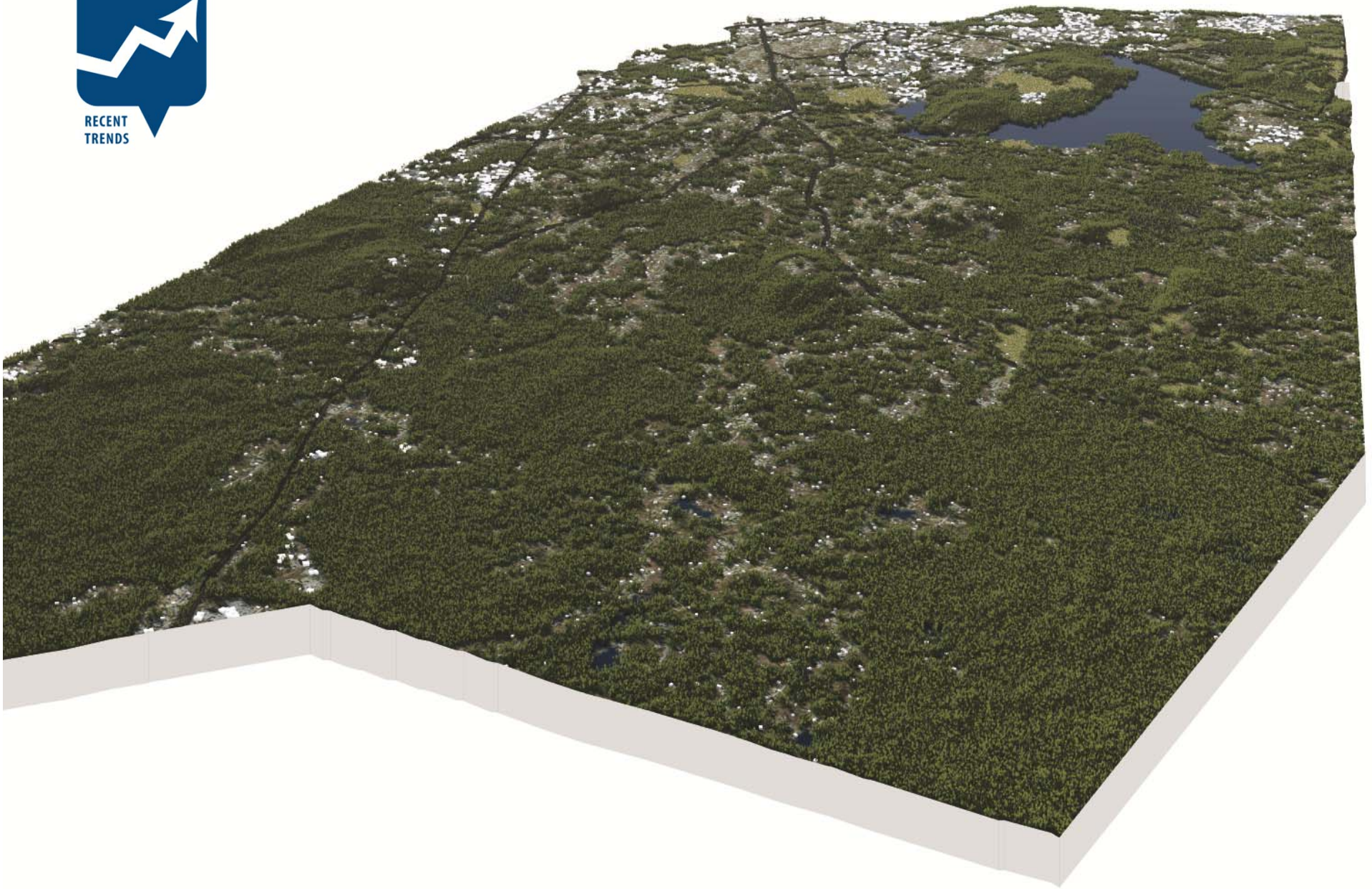

Rural Town
Sprawl Frontier Town
Suburban Town
REGIONAL SELF-RELIANCE
Mixed-Use
Residential
Forest
Harvested
Agriculture
Conserved
Forest
Agriculture
Mixed-Use
Residential
Water
Major Roads
400,000
200,000
0
Acres of Change
0
10
20
30
50 miles
Landscape in 2060
Regional Self-Reliance Scenario

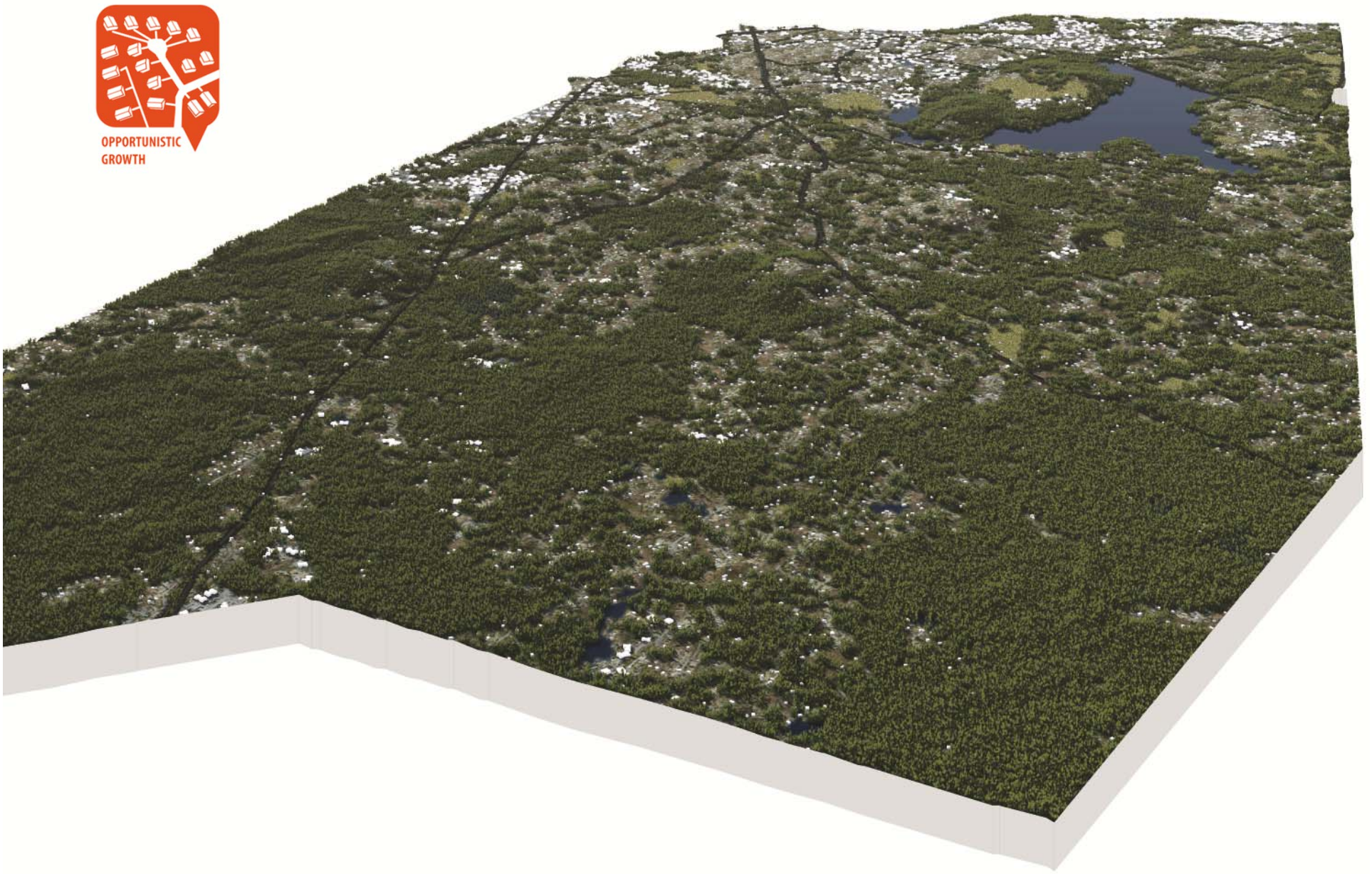

Rural Town
Sprawl Frontier Town
Suburban Town
FORESTS AS INFRASTRUCTURE
Mixed-Use
Residential
Agriculture
Forest
Harvested
Conserved
Forest
Agriculture
Mixed-Use
Residential
Water
Major Roads
400,000
200,000
0
Acres of Change
0
10
20
30
50 miles
Landscape in 2060
Forests as Infrastructure Scenario

Landscape in 2010

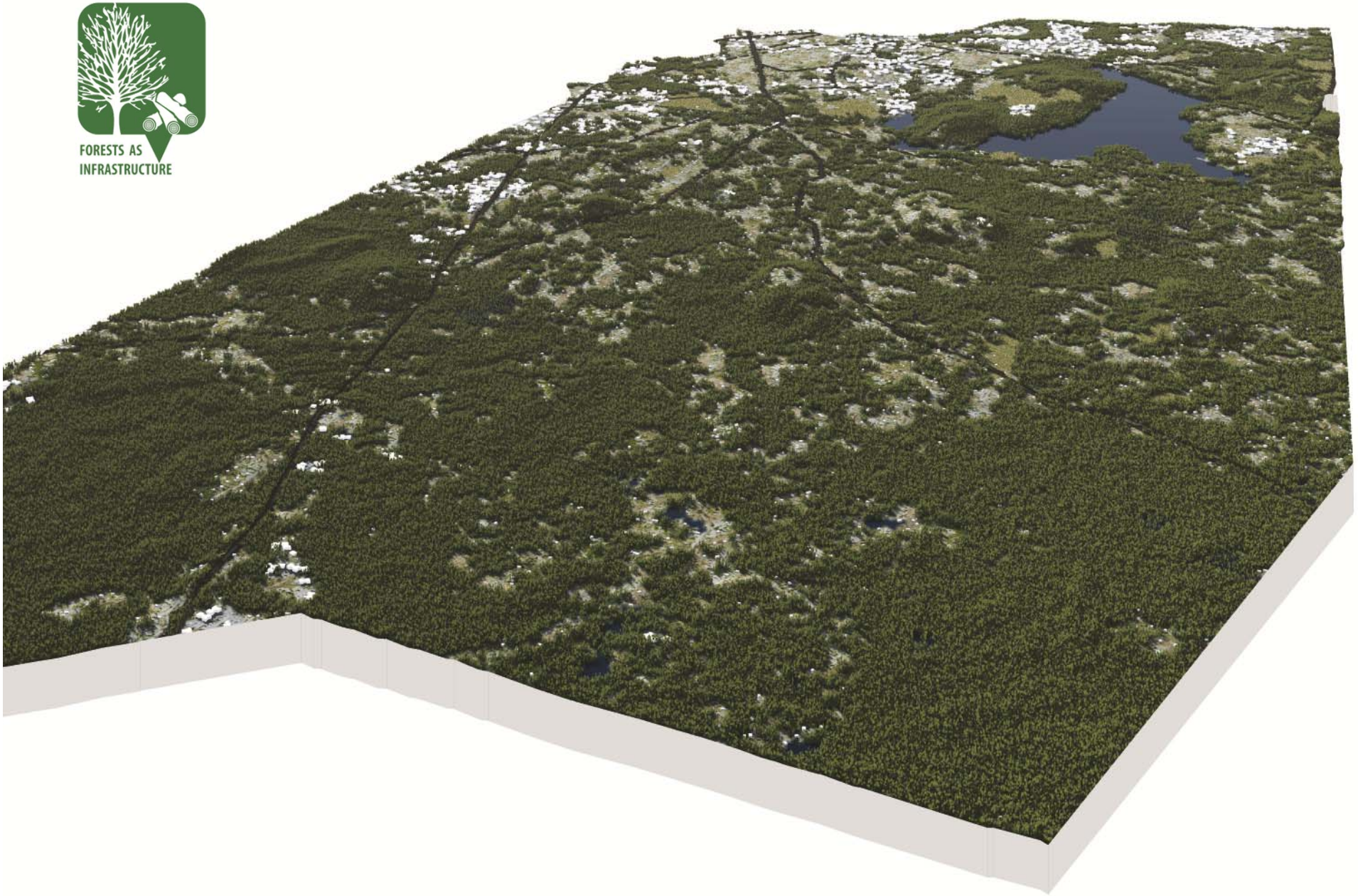


RECENT
TRENDS




OPPORTUNISTIC
GROWTH

FORESTS AS
INFRASTRUCTURE



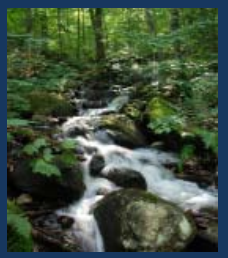
Scenario Consequences

InVEST | Integrated Valuation of Ecosystem Services and Tradeoffs | natural capital PROJECT

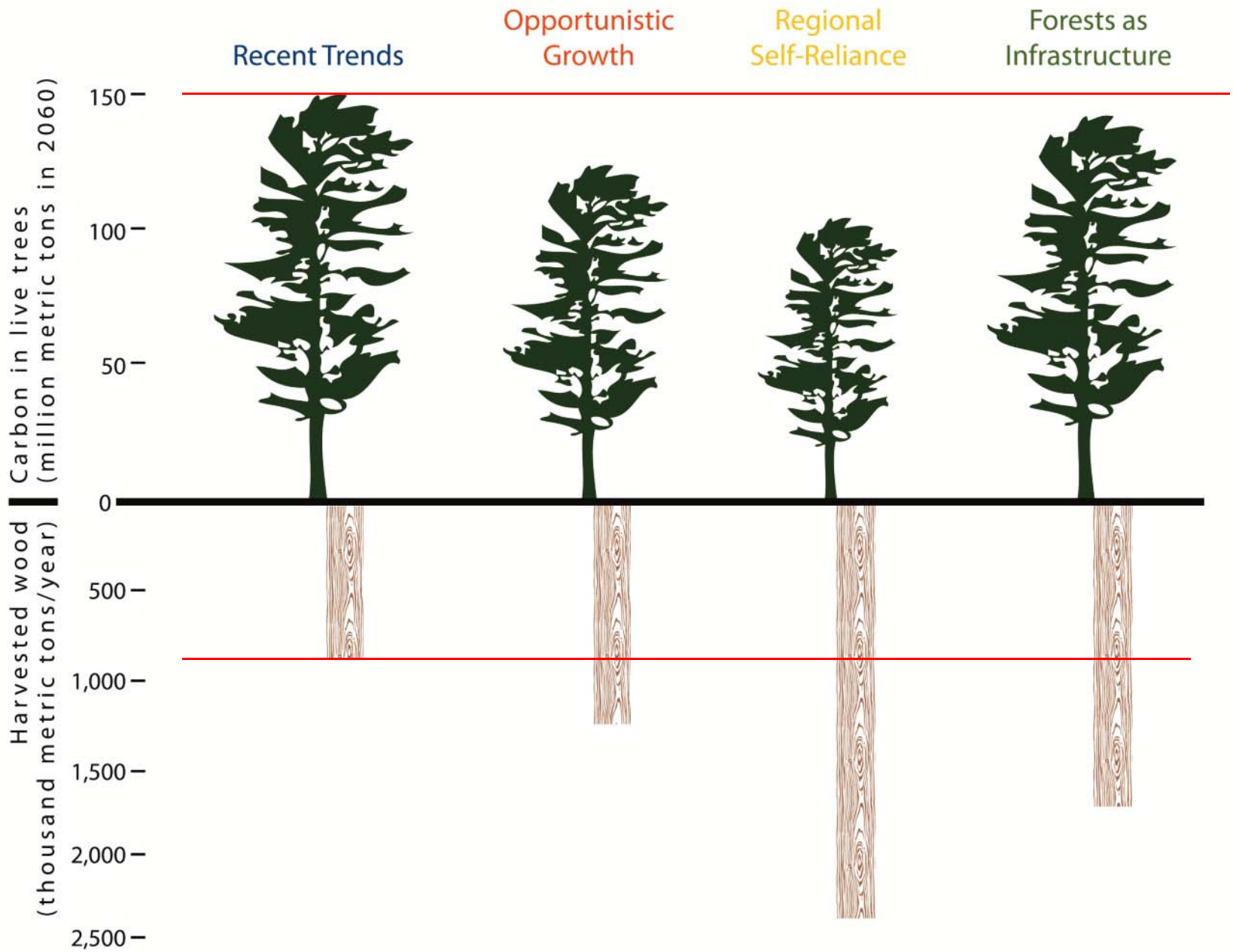
1) **Direct Human Uses**
   - Developed
   - Agricultural land
   - Timber

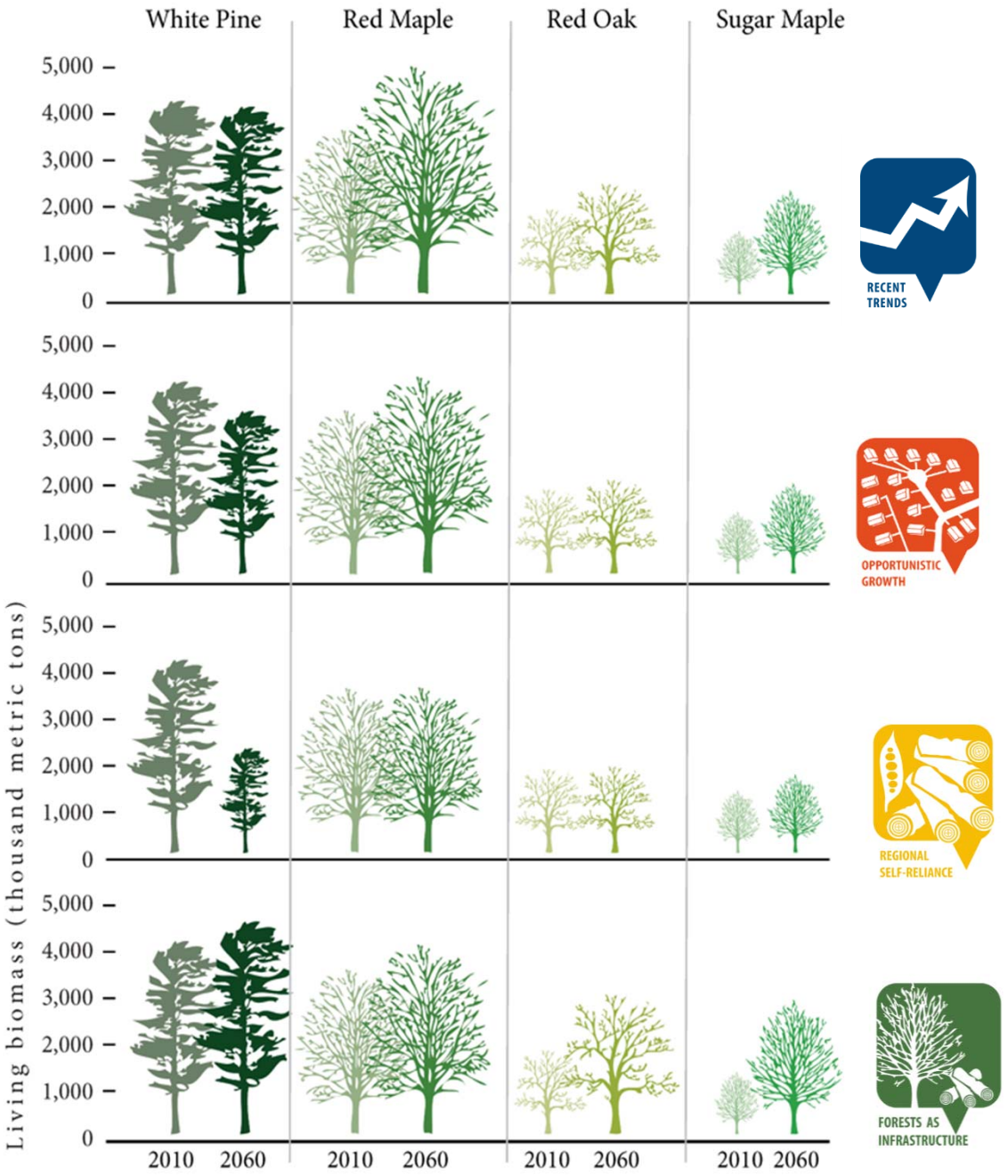
2) **Ecosystem Services**
   - Carbon sequestration
   - Infilitration (pervious surface)
   - Runoff regulation
   - Nitrogen and phosphorus retention

3) **Biodiversity**
   - Conserved land
   - Interior forest habitat quality
   - Restoration of valuable tree species

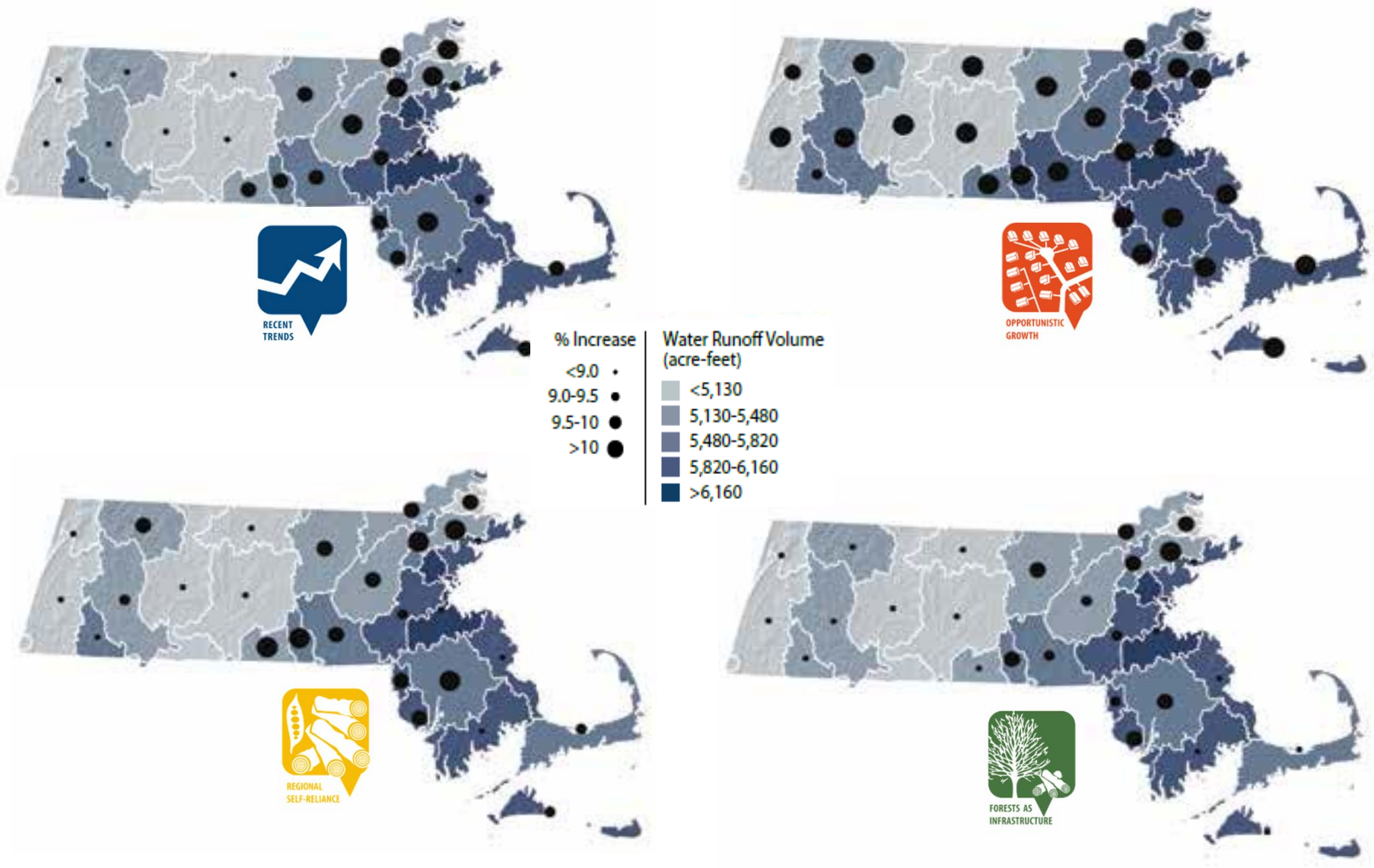


Carbon Storage and Wood Harvest



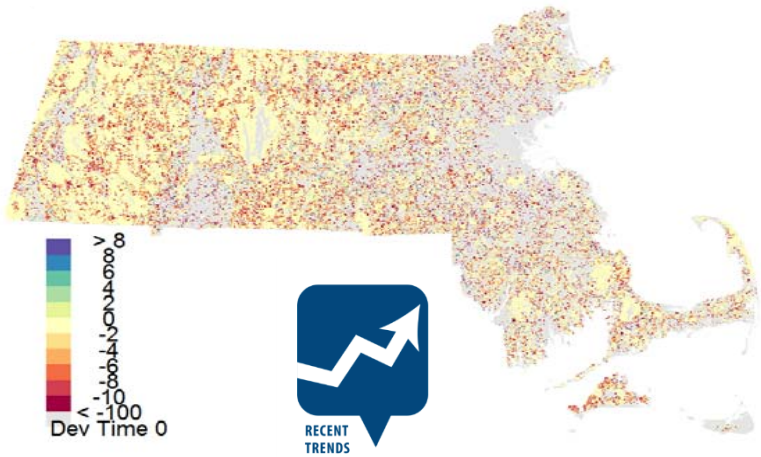

White Pine
Red Maple
Red Oak
Sugar Maple
5,000
4,000
3,000
2,000
1,000
0
Living biomass (thousand metric tons)
2010
2060
RECENT TRENDS
OPPORTUNISTIC GROWTH
REGIONAL SELF-RELIANCE
FORESTS AS INFRASTRUCTURE

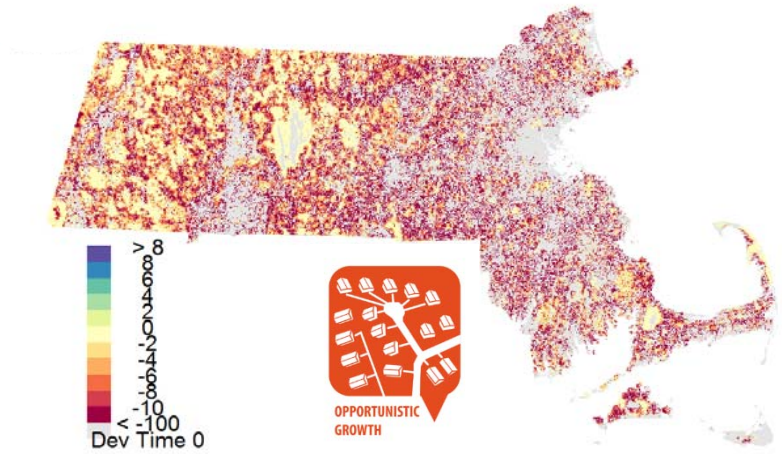
Annual Surface Water Runoff

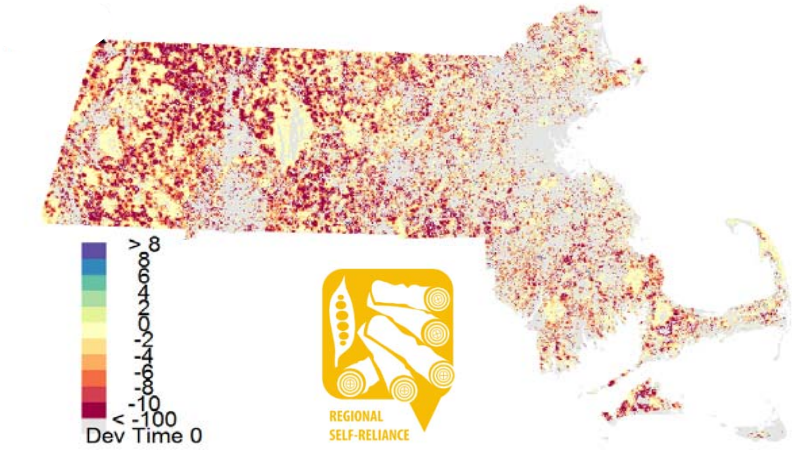


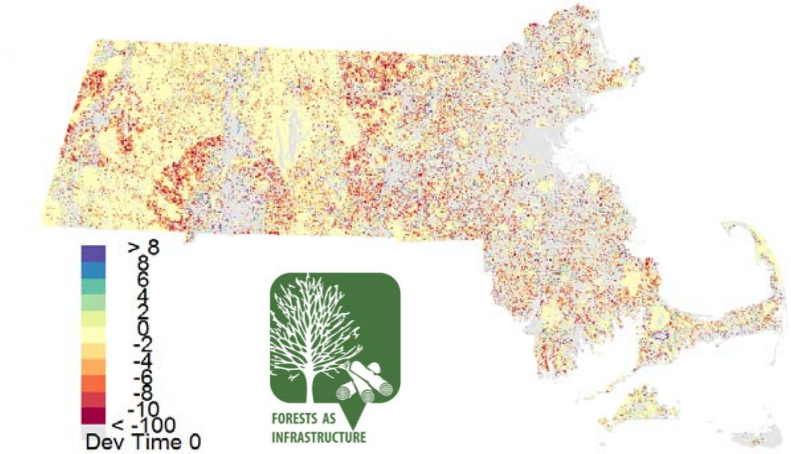
Interior Forest Habitat Quality

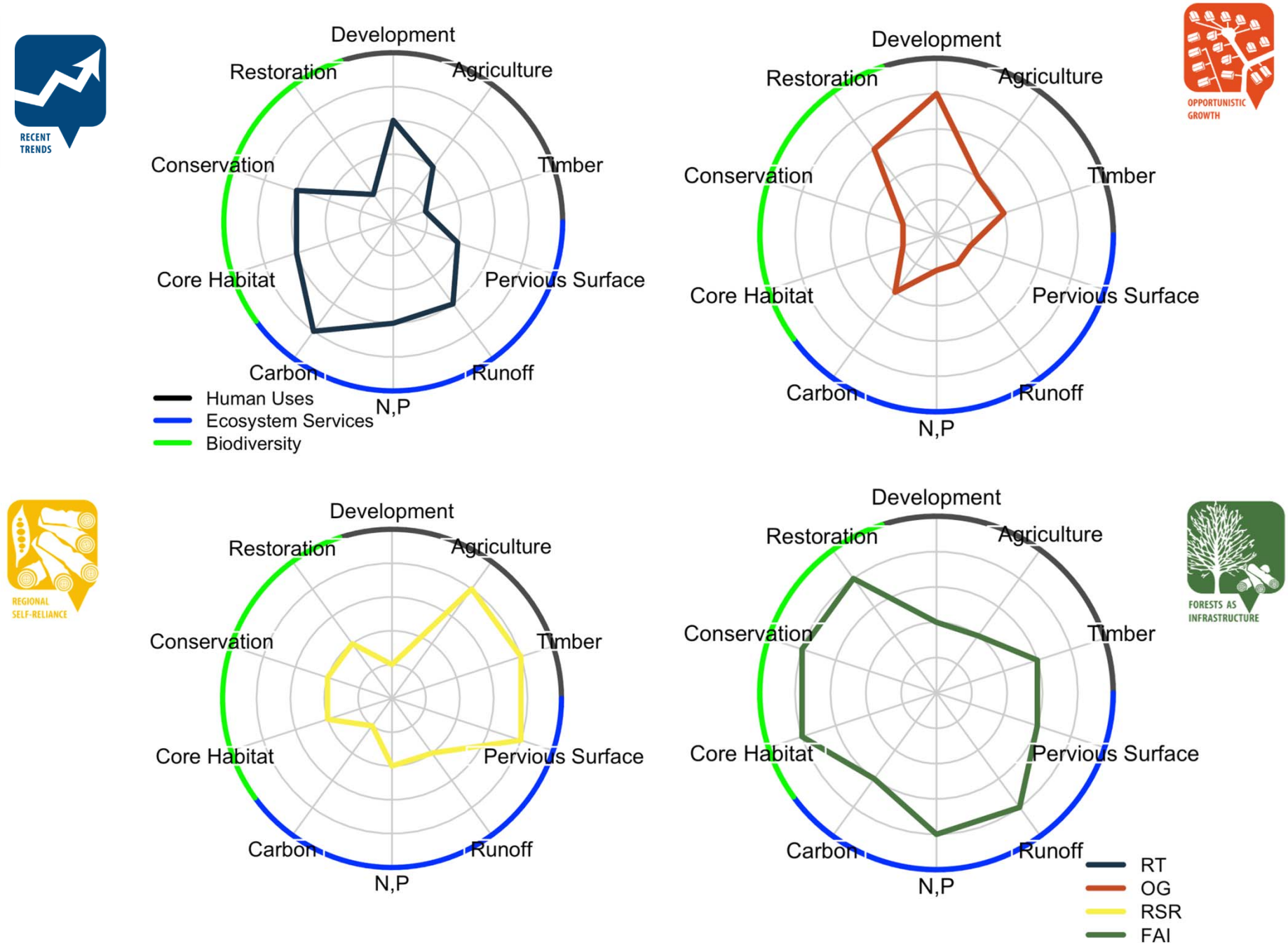
Percent decrease (2010 – 2060)










RECENT TRENDS
Development
Agriculture
Timber
Pervious Surface
Runoff
N,P
Carbon
Core Habitat
Conservation
Restoration
Human Uses
Ecosystem Services
Biodiversity
OPPORTUNISTIC GROWTH
REGIONAL SELF-RELIANCE
FORESTS AS INFRASTRUCTURE
RT
OG
RSR
FAI

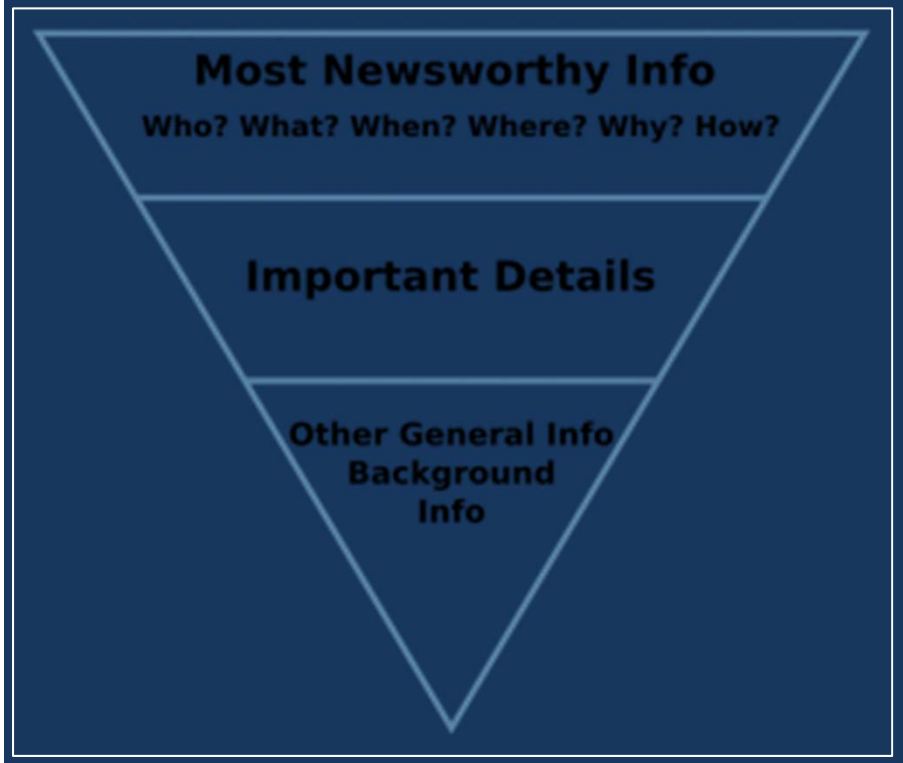
Forests as Infrastructure

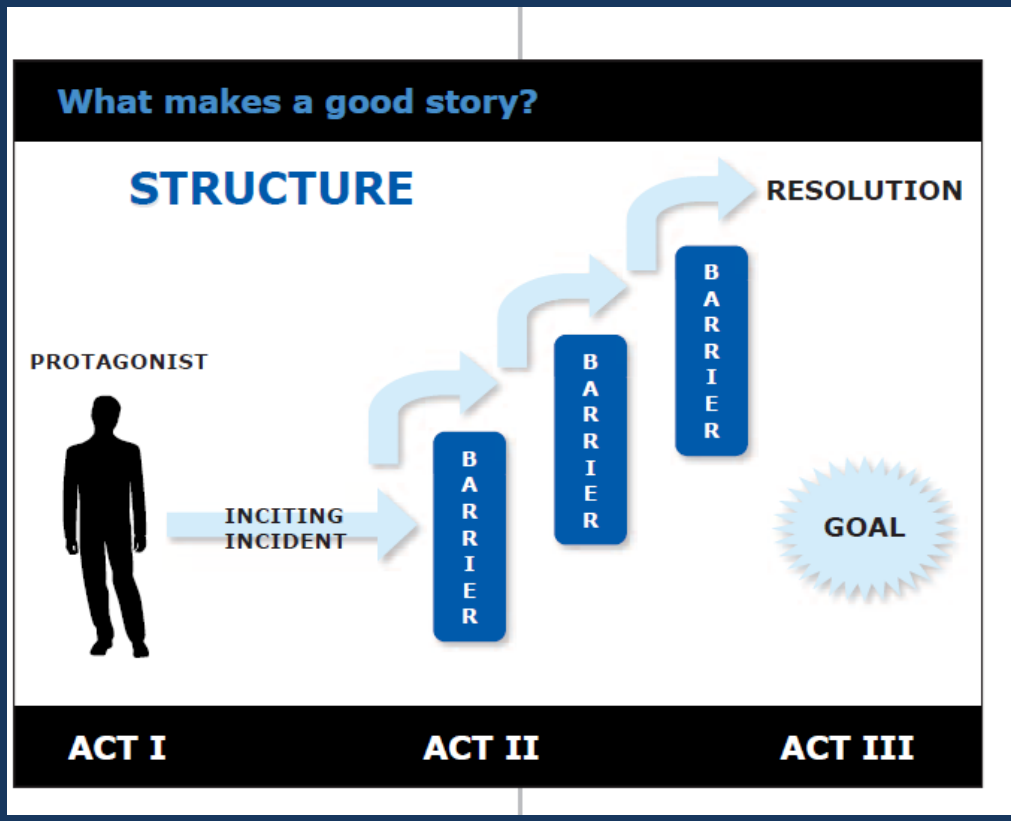
- Protects water quality by creating less impervious cover
- Limits increased runoff in nearly all watersheds
- Grows 20% more “high-value” trees
- Produces twice as much local wood
- Maintains 35% increase in forest carbon storage
- Results in 25% less forest fragmentation
- Conserves 280,000 more acres of priority forest habitat

MA Policy Linkages

1. Environmental Bond
2. Zoning Reform Act
3. Climate Action Plan – land use focus in phase 2
4. Sustainable forestry package
   - Tax credits for plans
   - Guidelines for community wood heat

Tools:

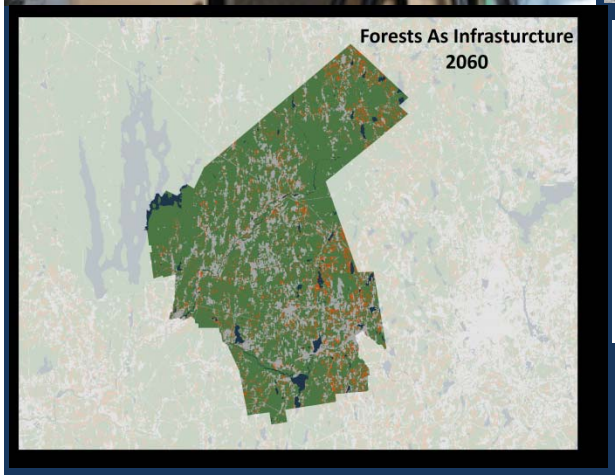




Inverted pyramid = good for breaking news (but format is more of an anti-story)

Story = good for communicating narratives/normative scenarios

Communication & Outreach



The Boston Globe

Editorials

Threat to Mass. forests shows need to reform zoning laws

December 19, 2013

Time hasn't stopped in Shutesbury, even if the faded white houses and crumbling stone walls in the tiny town near the Quabbin Reservoir look that way. As in many other parts of the Commonwealth, residents worry about what will happen if housing construction accelerates, and residential sprawl eats away at the farms and woods that residents have cherished for

http://www.youtube.com/watch?v=dFf8H3e-X0E

- Report, maps for legislators, video, press kit (b roll, photos, contacts)
- 8 stakeholder meetings
- 12 additional briefings for conservation professionals and decision-makers
- 2 press conferences; editorial board visit
- Coverage in 60 media outlets

In Summary

1. Collaborative research increases both insight and impact of science but tradeoffs must be assessed in advance.
2. Landscape models support fine-grained large scale LULC analysis at species level.
3. Interventions are needed to shift land use trajectory and retain ecosystem services/biodiversity. Collaborative scenarios processes can increased capacity of civil society organizations.
4. Combining dialogue with delivery amplifies results and motivates action.

New England Scenarios

Harvard Forest LTER

RCN: Scenarios, Services, and Society

Network for promote collaboration and address critical scenarios research needs

HARVARD FOREST

SYRACUSE UNIVERSITY
FOUNDED A.D. 1870

University of New Hampshire

MBL Biological Discovery in Woods Hole

HUBBARD BROOK RESEARCH FOUNDATION

Cary Institute of Ecosystem Studies

Back pocket slides

Matrix

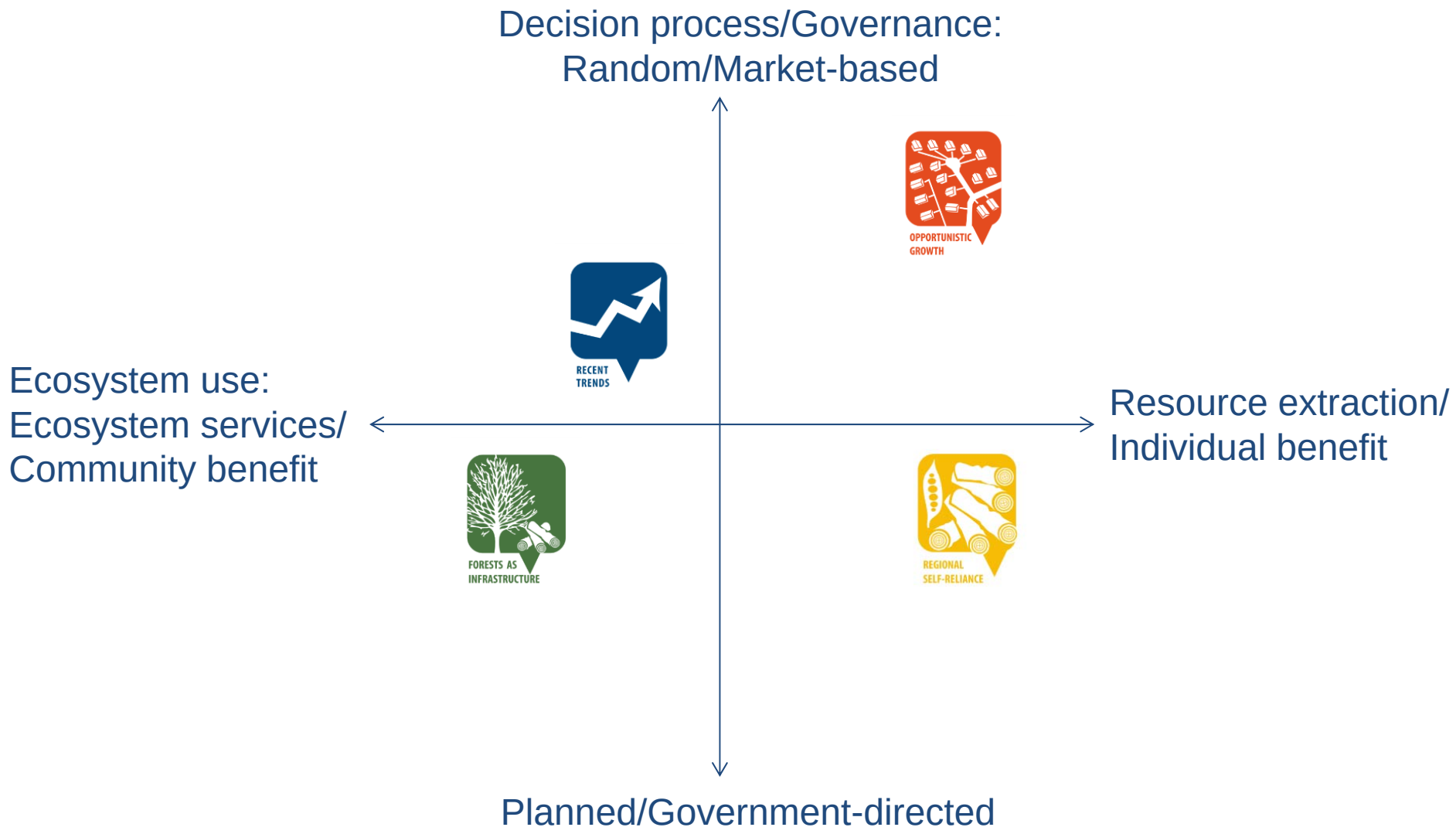
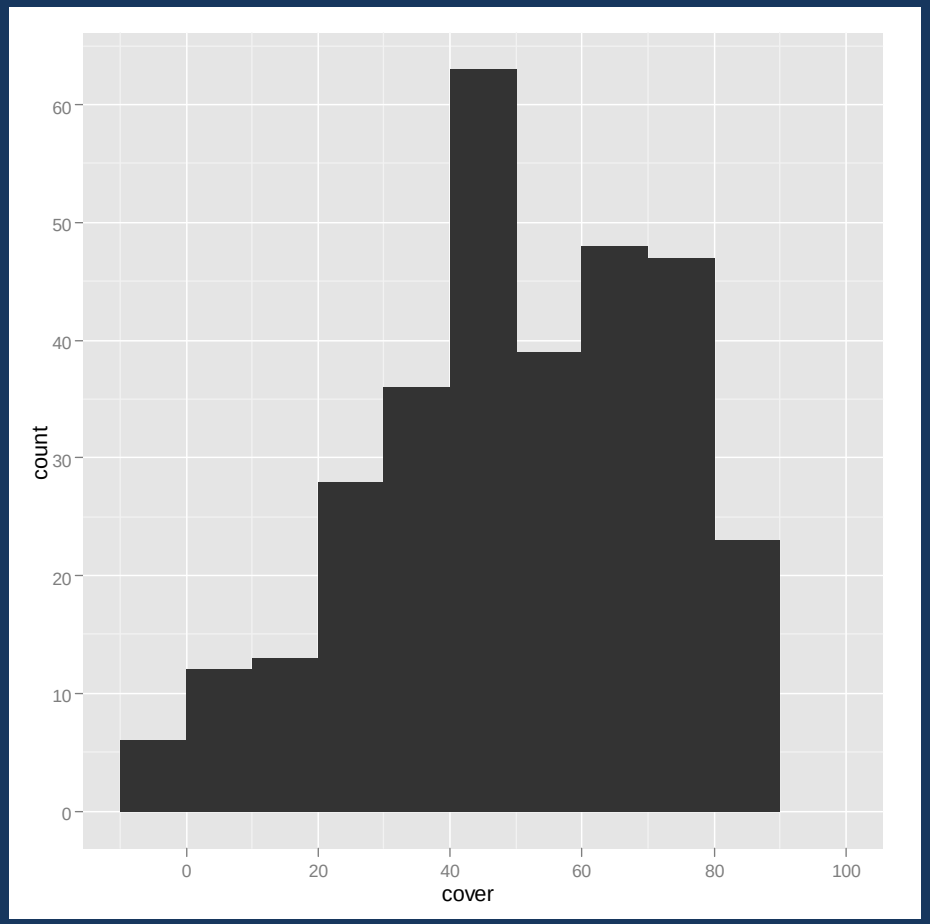
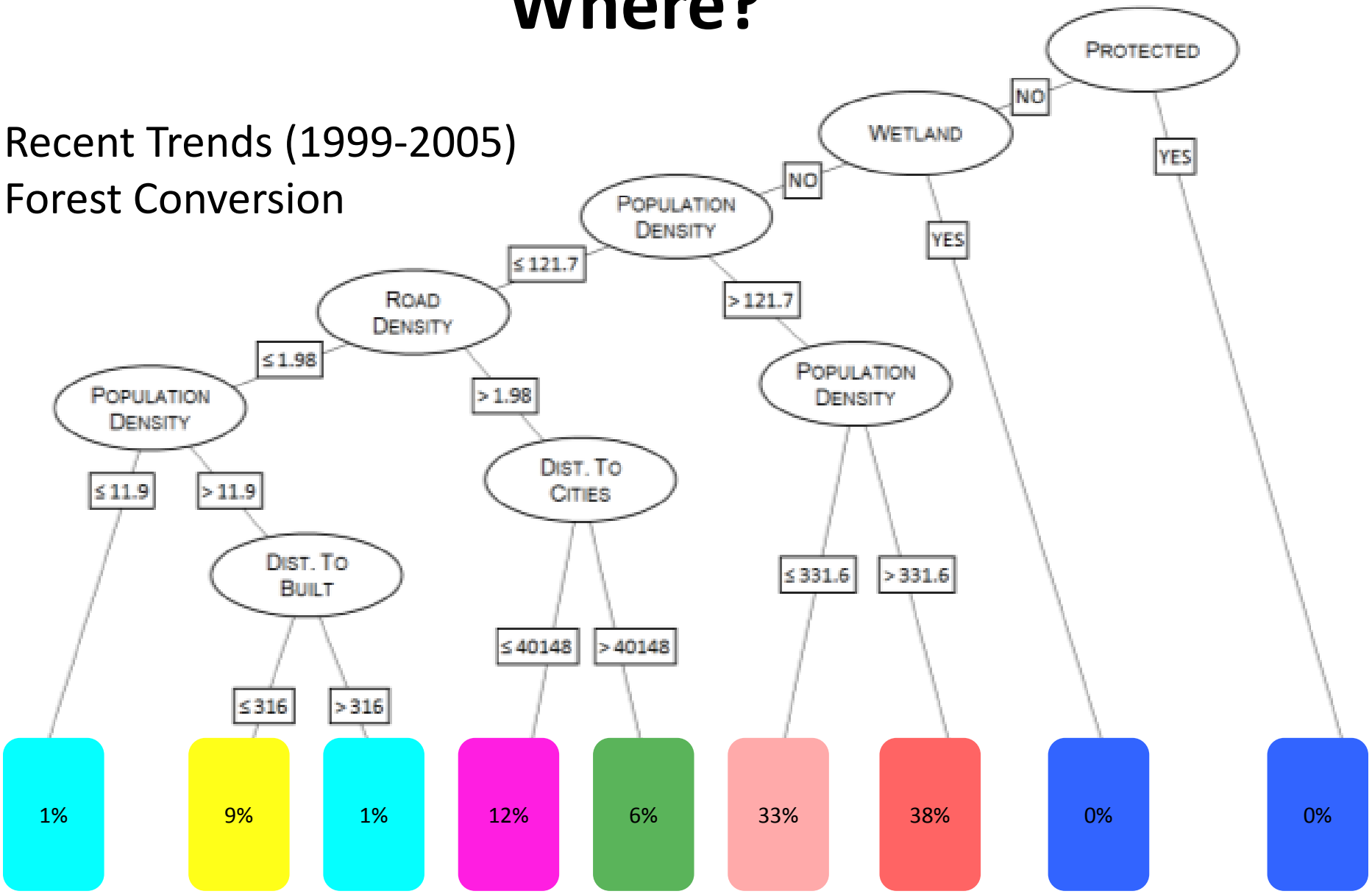

Decision process/Governance:
Random/Market-based
Ecosystem use:
Ecosystem services/
Community benefit
Resource extraction/
Individual benefit
Planned/Government-directed
OPPORTUNISTIC GROWTH
RECENT TRENDS
FORESTS AS INFRASTRUCTURE
REGIONAL SELF-RELIANCE

Table 1: LAND USE PRESCRIPTIONS	RT	OG	RSR	FAI
DEVELOPMENT (Annual extent by end of simulation (acres))	7000	15000	4000	6000
Small Development : Within a 2.5 acre area, remove 25% of all species/age cohorts and suppress all future regeneration	65%	50%	60%	30%
Medium Development: Within a 2.5 acre area remove 50% of all species/age cohorts and suppress all future regeneration	25%	20%	35%	40%
Large Development: Within a five acre area, remove 50% of all species/age cohorts and suppress all future regeneration	9%	20%	4%	25%
Very Large Development: Within a ten acre area, remove 50% of all species/age cohorts and suppress all future regeneration	1%	10%	1%	5%
AGRICULTURE (acres)	0	0	10,000	0
Agricultural Development: Within a stand (7 to 50 ac) remove all species/age cohorts and suppress all future regeneration	0	0	100%	0
TIMBER HARVEST (acres)	26,000	20,000	61,000	45,000
Small Long-term Silviculture: Remove 100% of: White Pine older than 100 yrs and 100% of Red Oak, Red Maple, Hemlock, and Sugar Maple older than 80 yrs. Leave 15% slash. Harvest size = 20 to 35 ac	33%	15%	10%	15%
Large Long-term Silviculture: Remove 100% of: White Pine older than 100 yrs and 100% of Red Oak, Red Maple, Hemlock, and Sugar Maple older than 80 yrs. Leave 15% slash. Harvest Size = 25-50 ac	33%	15%	10%	15%
Small Short Term Revenue: Remove 100% of: White Pine older than 60 yrs and 100% of Red Oak and Sugar Maple older than 80 yrs. Leave 15% slash. Harvest Size = 20 to 35 ac	17%	0	0	0
Large Short Term Revenue: Remove 100% of: White Pine older than 60 yrs and 100% of Red Oak and Sugar Maple older than 80 yrs. Leave 15% slash. Harvest Size = 25-50 ac	17%	0	0	0
Small Short Term Revenue with Biomass: Remove 100% of: White Pine older than 60 yrs and 100% of Red Oak and Sugar Maple older than 80 yrs. Add Biomass by removing 30% across all ages and size classes. Leave only 2% slash. Harvest Size = 25-50 ac	0	10%	25%	5%
Large Short Term Revenue with Biomass: Remove 100% of: White Pine older than 60 yrs and 100% of Red Oak and Sugar Maple older than 80 yrs. Add Biomass by removing 30% across all ages and size classes. Leave only 2% slash. Harvest Size 25-50 ac	0	30%	25%	5%
Biomass Clearcut: Remove 100% of all species and size classes. Leave only 2% slash. Harvest Size = 25-40 ac	0	20%	20%	0
Improvement Silviculture: Remove 80% of all trees older than 130 years and 70% of all non-commercial species older than 40 years. Harvest size 25 -50	0	10%	10%	60%
CONSERVATION (Acres)	7500	2500	4000	15000


count
60
50
40
30
20
10
0
0
20
40
60
80
100
cover

Where?

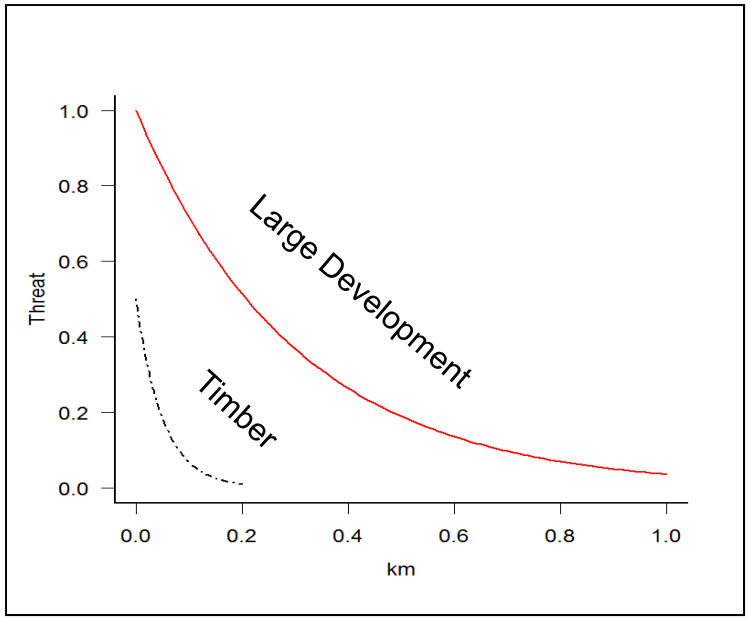
Recent Trends (1999-2005)
Forest Conversion

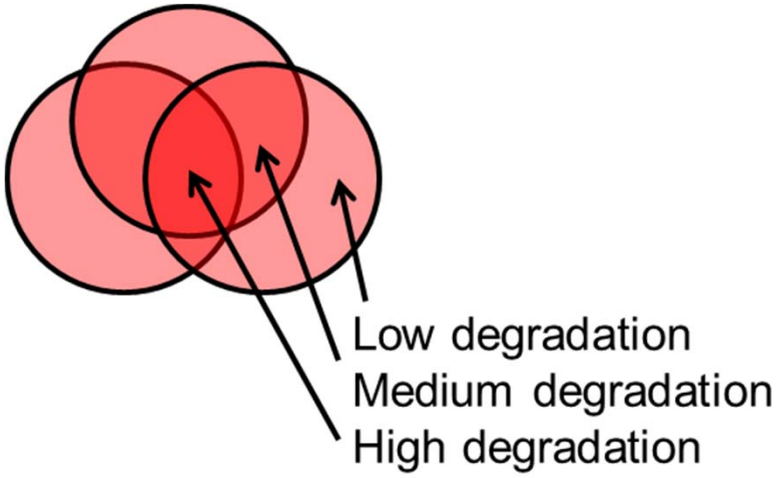


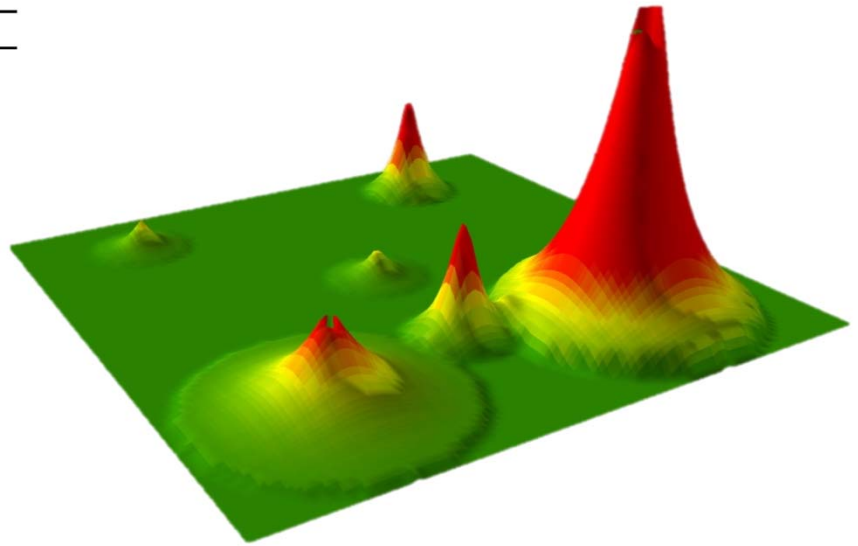
Forest Habitat Degradation

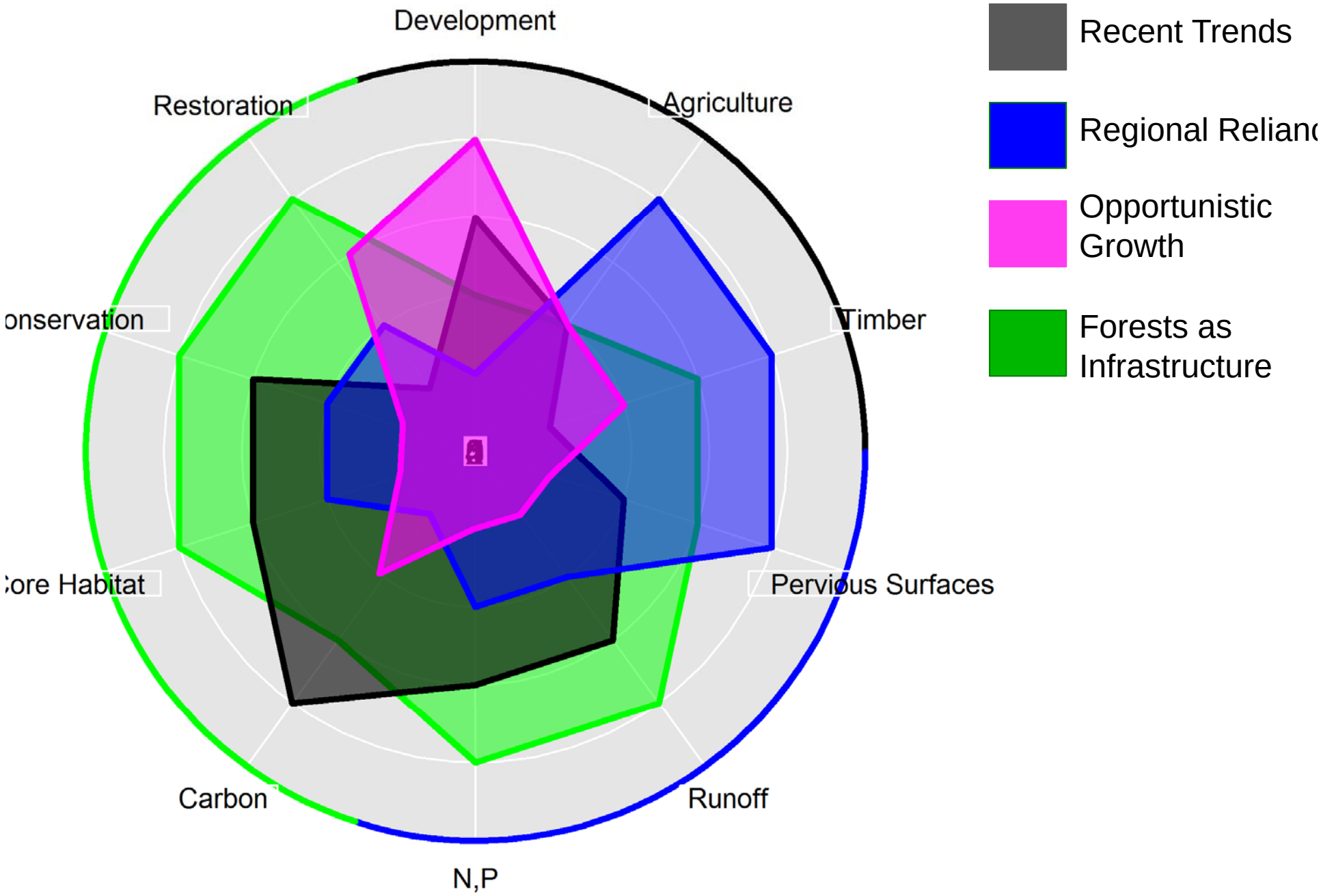
InVEST Integrated Valuation of Ecosystem Services and Tradeoffs — natural capital PROJECT

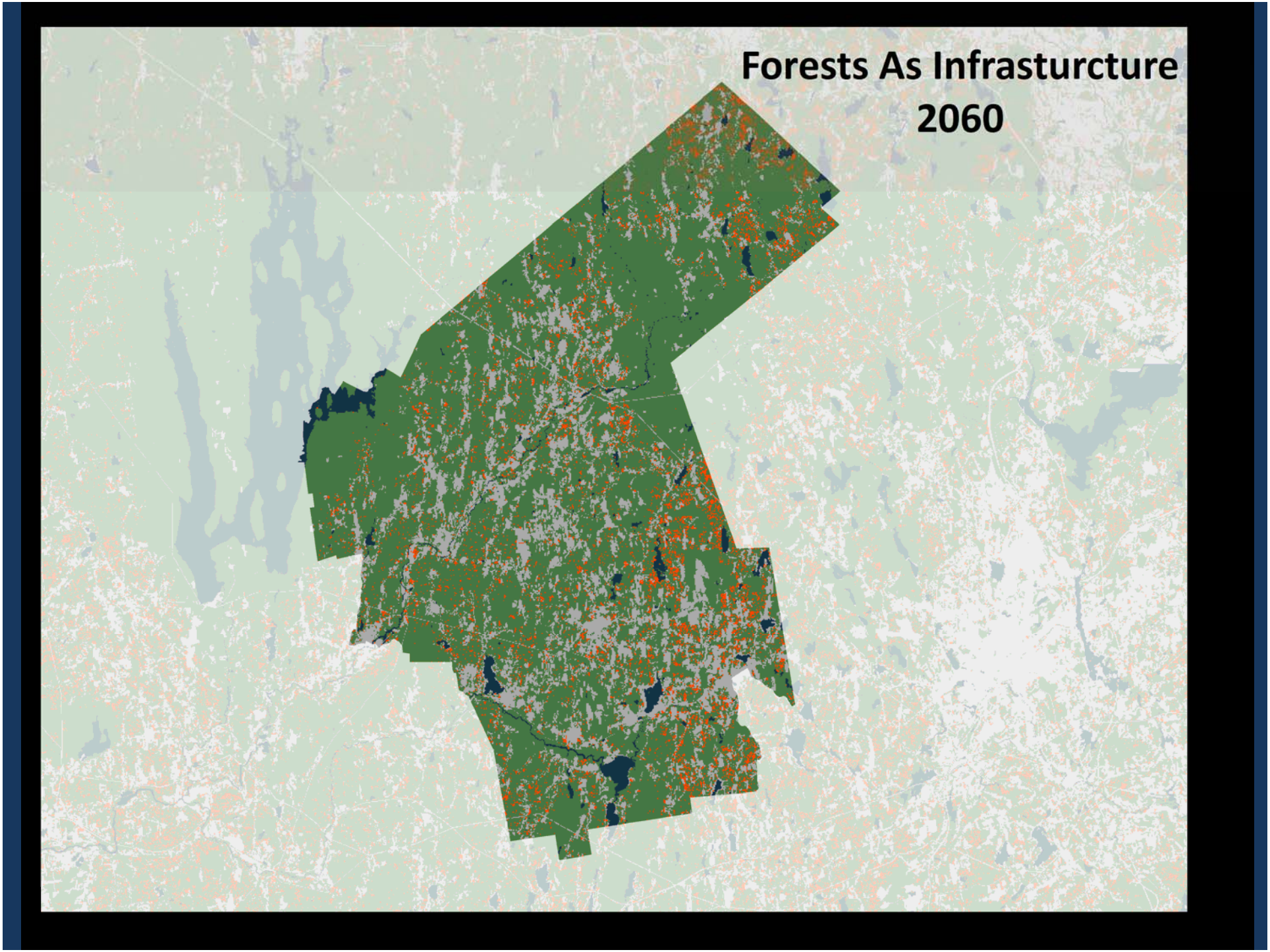
Threat	Weight	Distance	Longevity
DEVELOPMENT			
Small	0.76	0.79km	Permanent
Medium	0.81	0.96km	Permanent
Large	0.91	1.26km	Permanent
Very Large	1	1.40km	Permanent
AGRICULTURE	0.57	1.18km	Permanent
TIMBER HARVEST			
Long-term Silviculture	0.21	0.29km	5 years
Short Term Revenue	0.22	0.29km	5 years
Short Term Revenue w/ Biomass	0.36	0.40km	10 years
Biomass Clearcut	0.40	0.66km	10 years
Improvement Silviculture	0.29	0.29km	5 years
CONSERVATION	Threat * 0.69	0	Permanent








Development
Agriculture
Timber
Pervious Surfaces
Runoff
N,P
Carbon
ore Habitat
onservation
Restoration
Recent Trends
Regional Reliand
Opportunistic Growth
Forests as Infrastructure


Forests As Infrasturcture
2060