Fire in the Pines: A Landscape Perspective of Human-induced Ecological Change in the Pinelands of New Jersey

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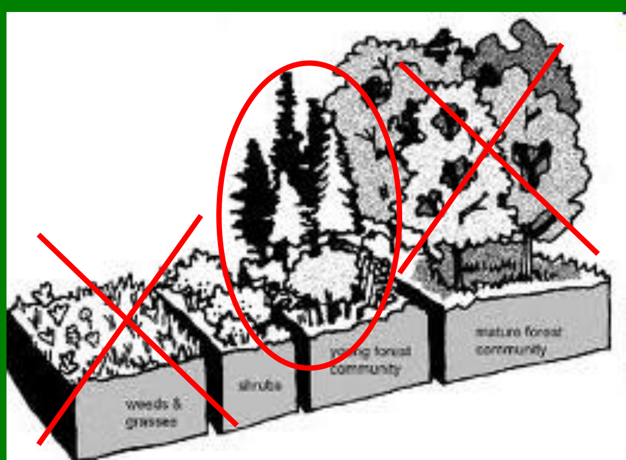
Ecology: Fire and succession

The New York Times

Fire in the Pine Barrens: Keeping the Oak at Bay

By IVER PETERSON
Published: May 29, 1992



Ecology: Fire effects

Unique Ecology

Endemic species, unique habitat

Fire adaptations

Nutrient poor, sandy soils

Threatened Pine Barrens Tree Frog

Dwarf Pine plains region

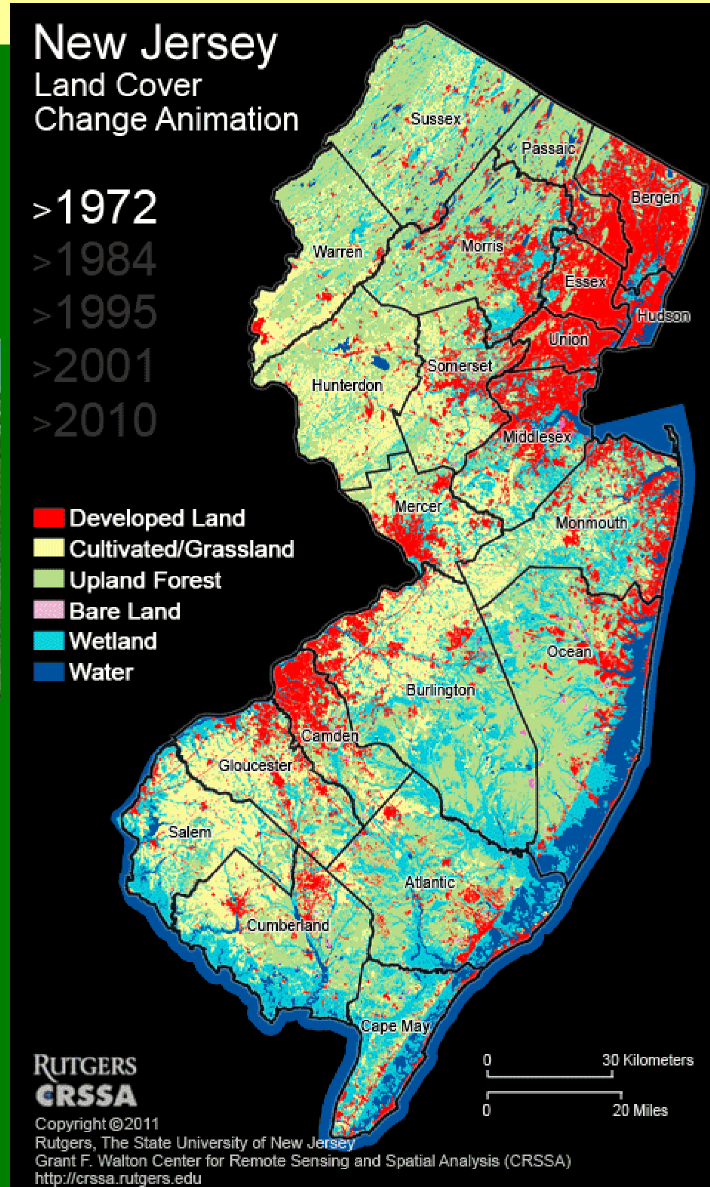
Endangered Swamp Pink

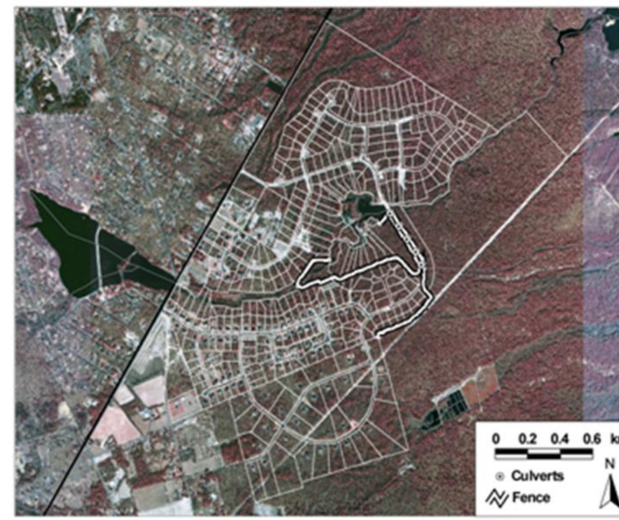
Endangered Northern Pine Snake

Rare Curly-grass fern

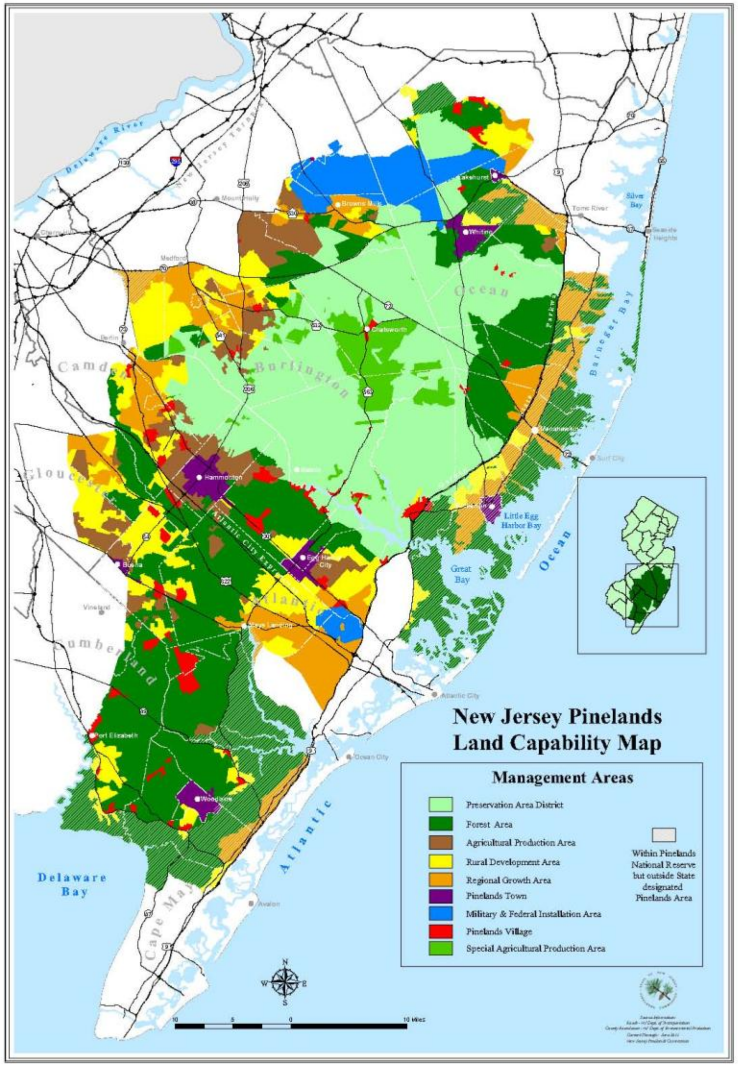
Michael Hogan photography
USFS
NJ Pine Barrens and Down Jersey

Human: Development





Human: Pinelands National Reserve



Created in 1978 as first National Reserve and now designated a US and International Biosphere Reserve

Administered by Pinelands Commission via CMP

~1,000,000 acres / **550,000 ha**

Human: New Jersey Forest Fire Service

Established in 1906 to protect life, property and forest resources, early Rx fire 1950s

"The goal is to limit the number of wildfires to under 2,000 annually and the acreage burned to less than one half of one percent (.5%) of the 3.15 million acres protected (all of NJ), or 15,750 acres."

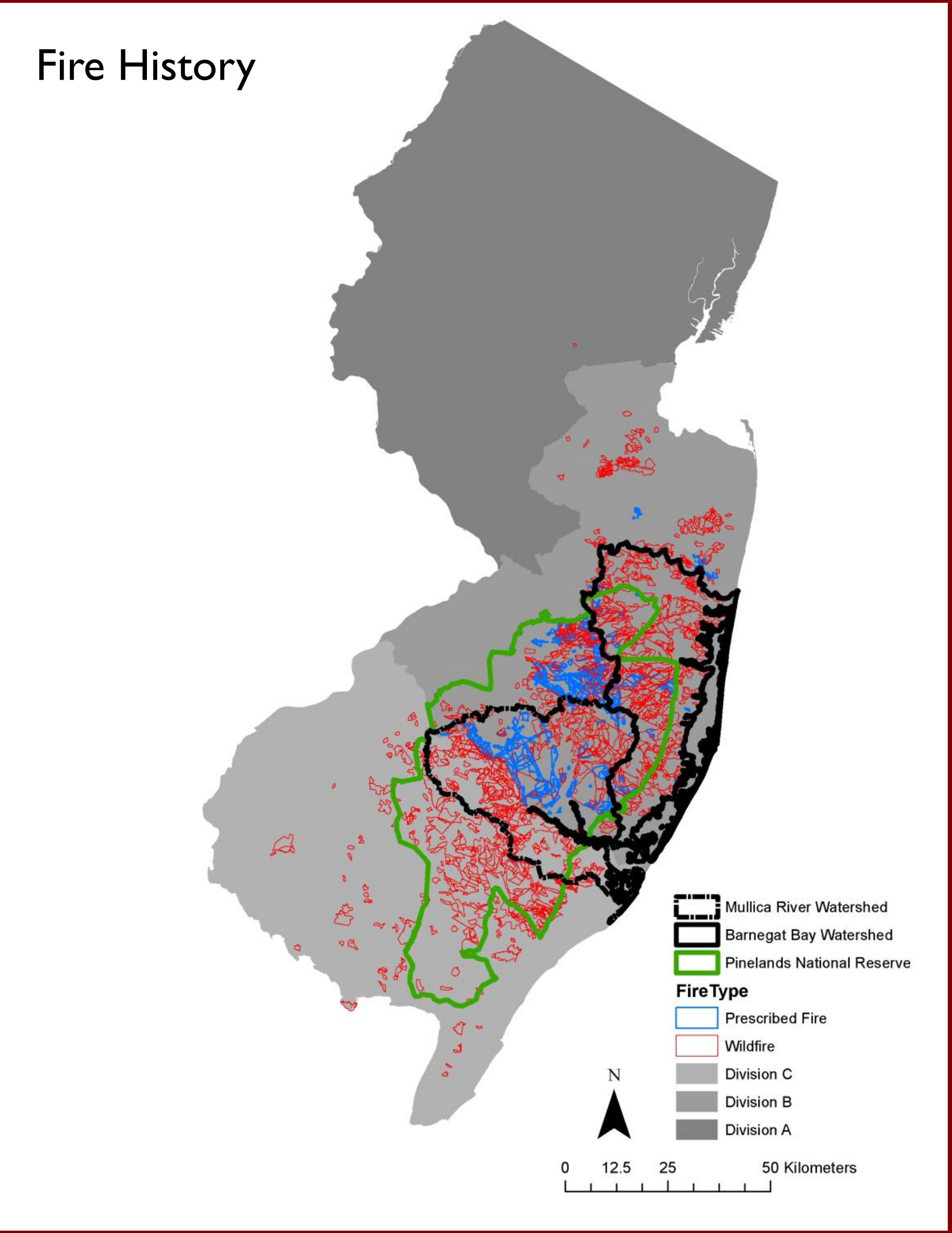
Coupled Human-Environment System

How does the Pinelands ecosystem affect us?

- Fire danger dictates development patterns
- Carbon sequestration

How do we affect the Pinelands ecosystem?

- Disturbance
  - Wildfire (accidental or arson)
  - Altered land
  - Climate change
- Management
  - Prescribed fire/ suppression
  - Protected areas

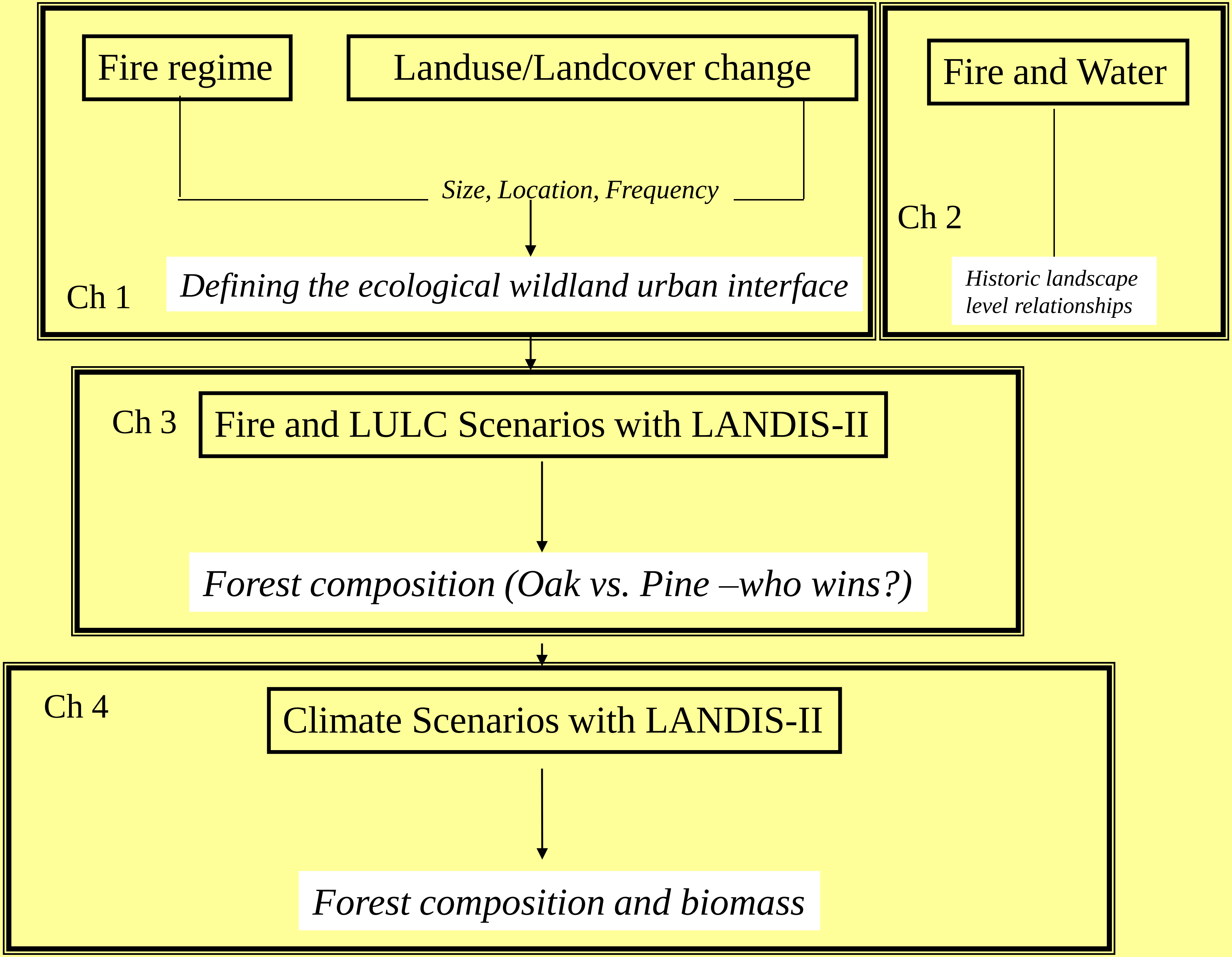


Paper map dataset
Focus on Barnegat and Mullica
1927-2002

2167 fires total
963 wildfires
1204 prescribed

'Large fires' >100 acres
Rx fire all sizes
3 interns, 2 years

Other info:
Cause of fire
Acres reported
Acres calculated
Fire start date
Fire end date


Fire regime
Landuse/Landcover change
Size, Location, Frequency
Ch 1
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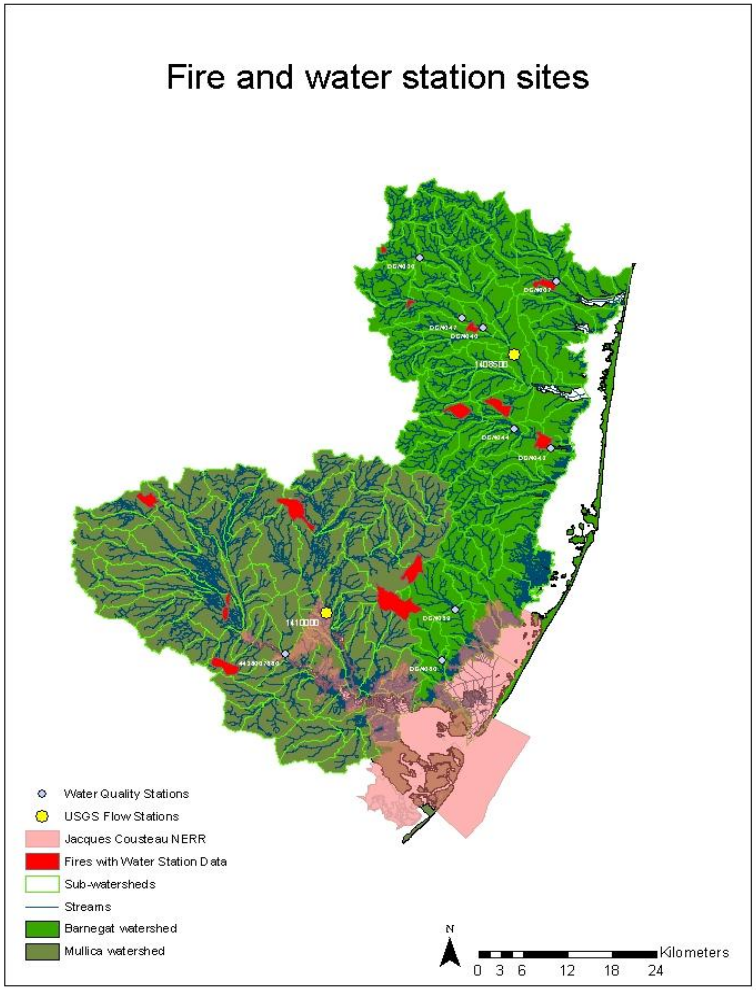
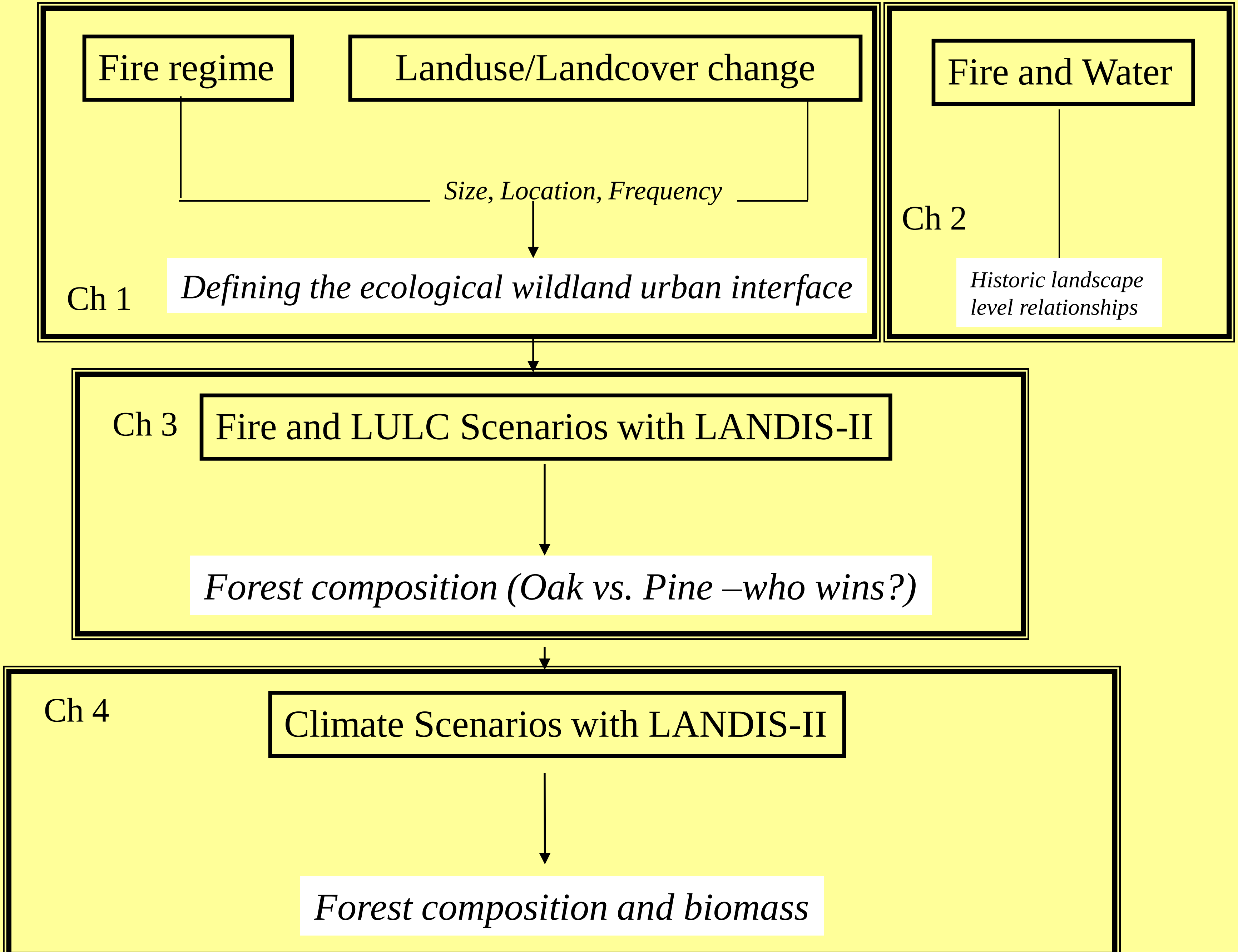
Chapter 2: Effects of wildfire on water quality



pH	p-value
Distance to station	0.347
Percent basin burned	0.248
Days before fire	0.359
Days after fire	0.379
Hectares burned	0.314
Overall model	0.251
SC	
Distance to station	0.925
Percent basin burned	0.861
Days before fire	0.490
Days after fire	0.439
Hectares burned	0.798
Overall model	0.890
Turbidity	
Distance to station	0.759
Percent basin burned	0.202
Days before fire	0.396
Days after fire	0.564
Hectares burned	0.158
Overall model	0.599

s B/A fire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Chapter I – the WUI challenge

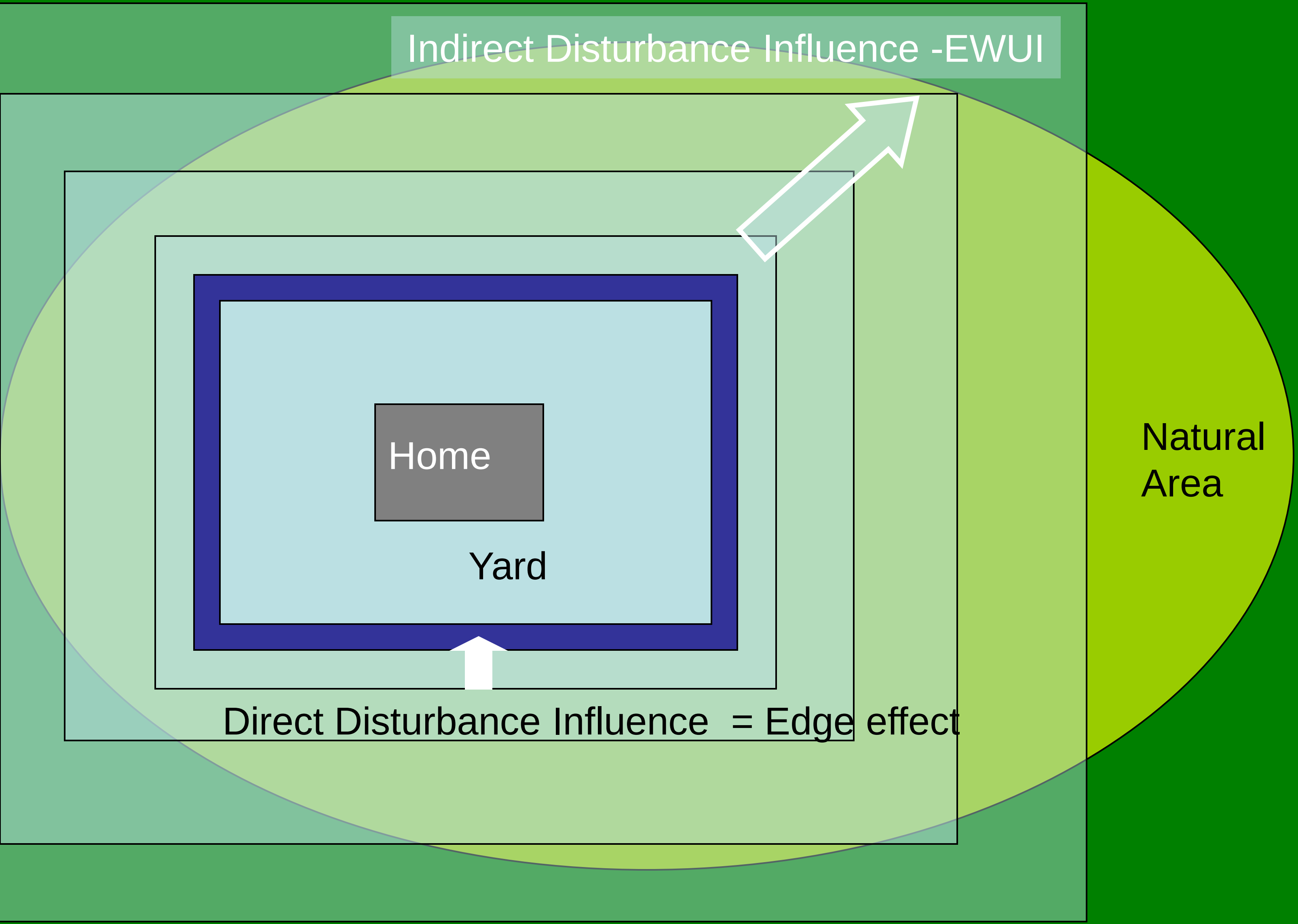
By marking, we project ourselves onto the environment (Huyghe 1962).

- How does our presence alter adjacent **ecological** processes?

"How altered landscapes will themselves influence disturbance regimes is not known (Turner 2005)".

- **Ecological Wildland-Urban Interface (EWUI)** or the spatial extent to which altered land, through indirect changes in disturbance regimes, influences the adjacent ecology of natural areas

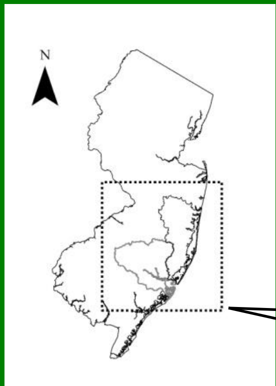
Area of Ecological Influence



How to estimate the EWUI:

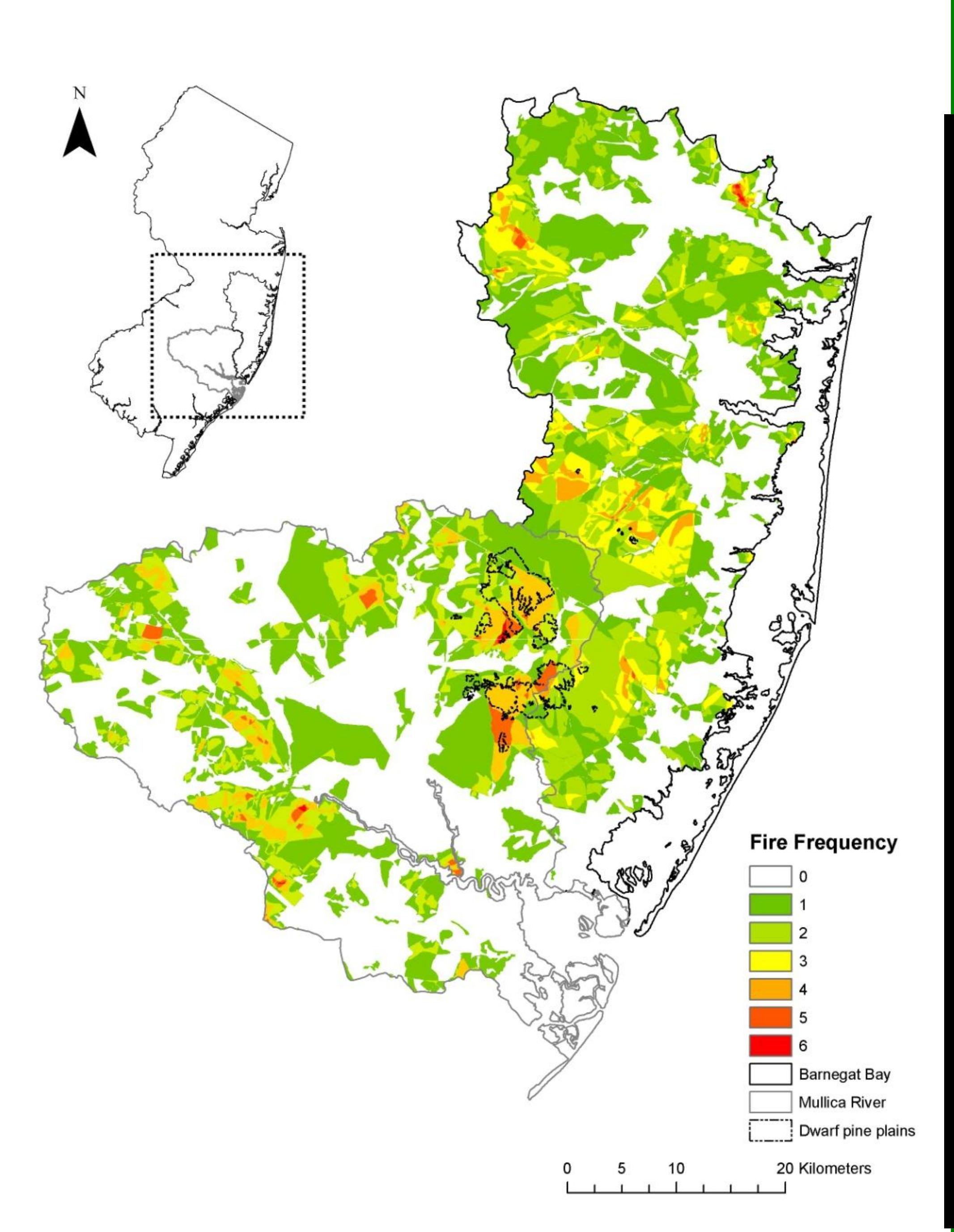
1. Spatial/temporal measure of human influence (altered land)
2. Record of spatial/temporal disturbance regime (fire)
3. Spatial measure of an ecological pathway (forest succession)
4. Method of evaluating the spatial extent and intensity of the human influence (buffer areas of altered land) on the disturbance regime and ecological pathway

1. Human Influence

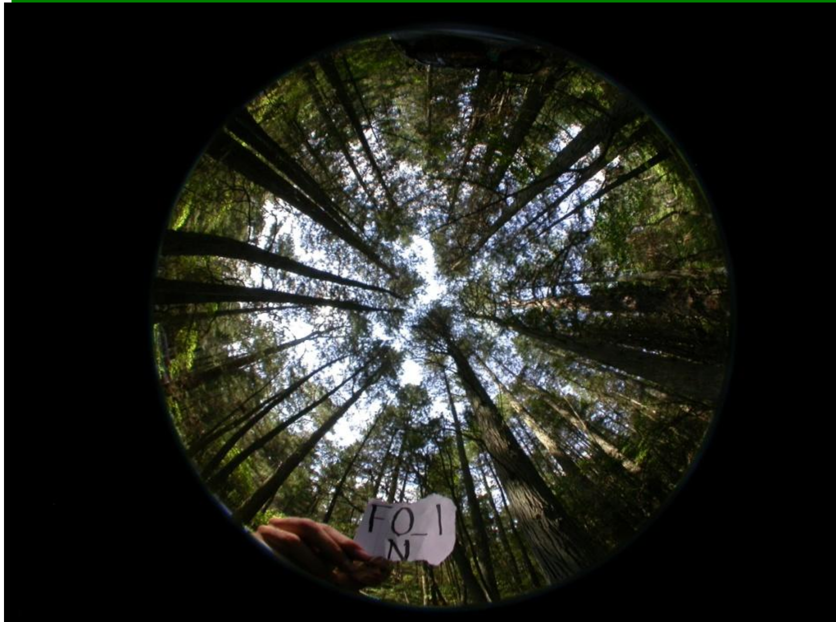


Altered land 1986

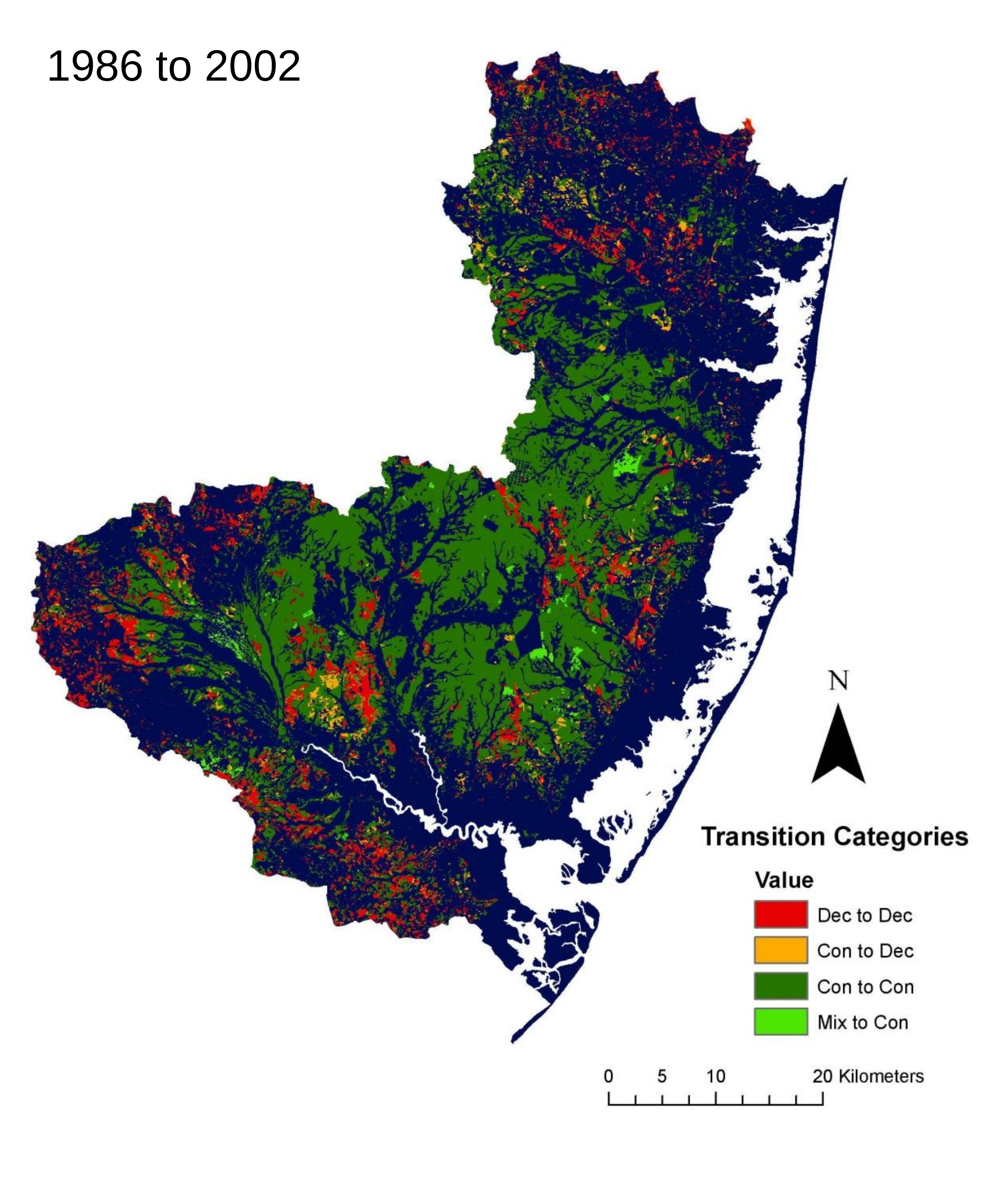
Altered land 2002

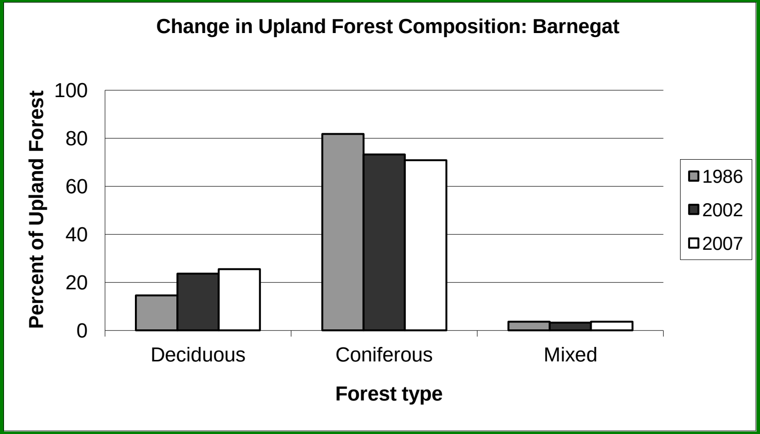


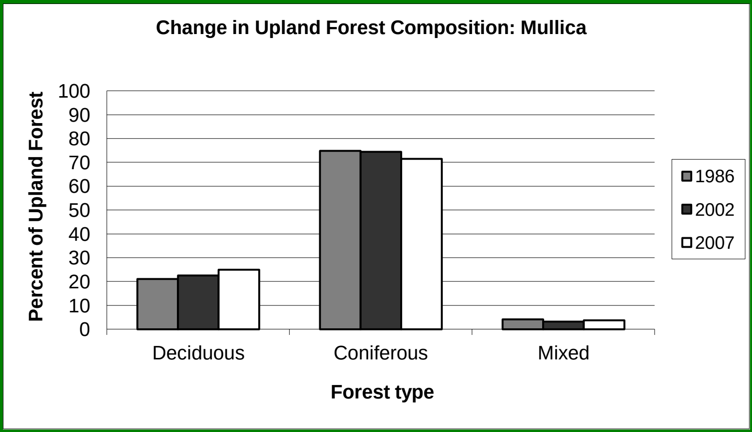
2. Record of disturbance



3. Ecological Pathway

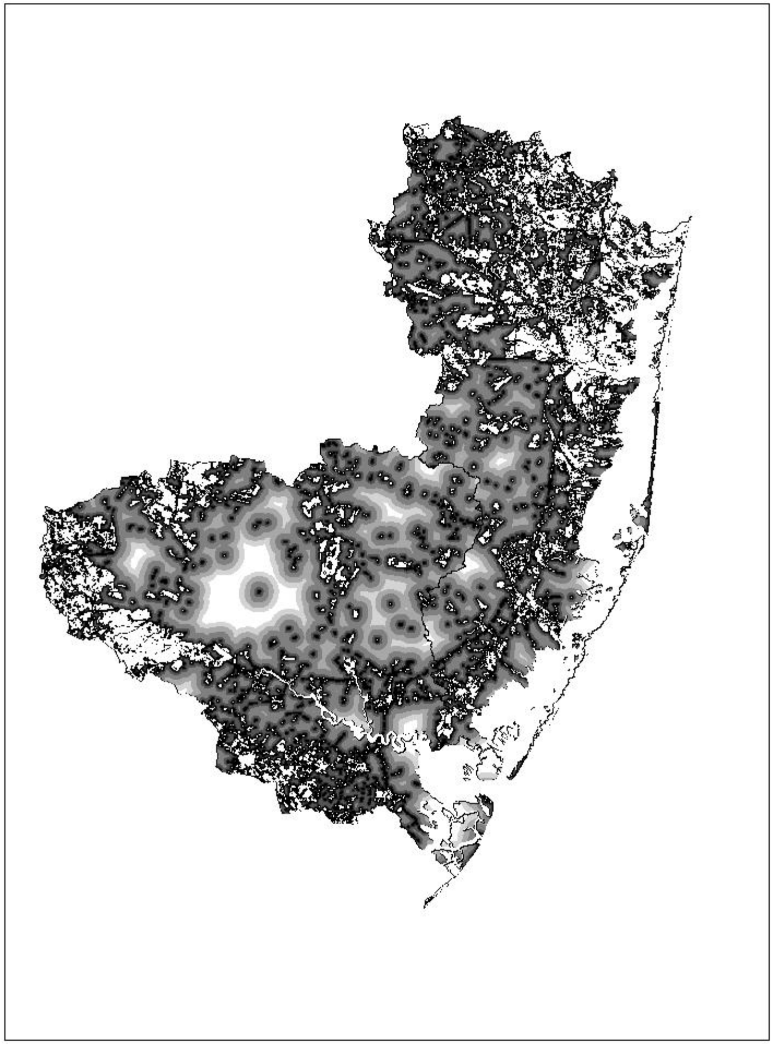




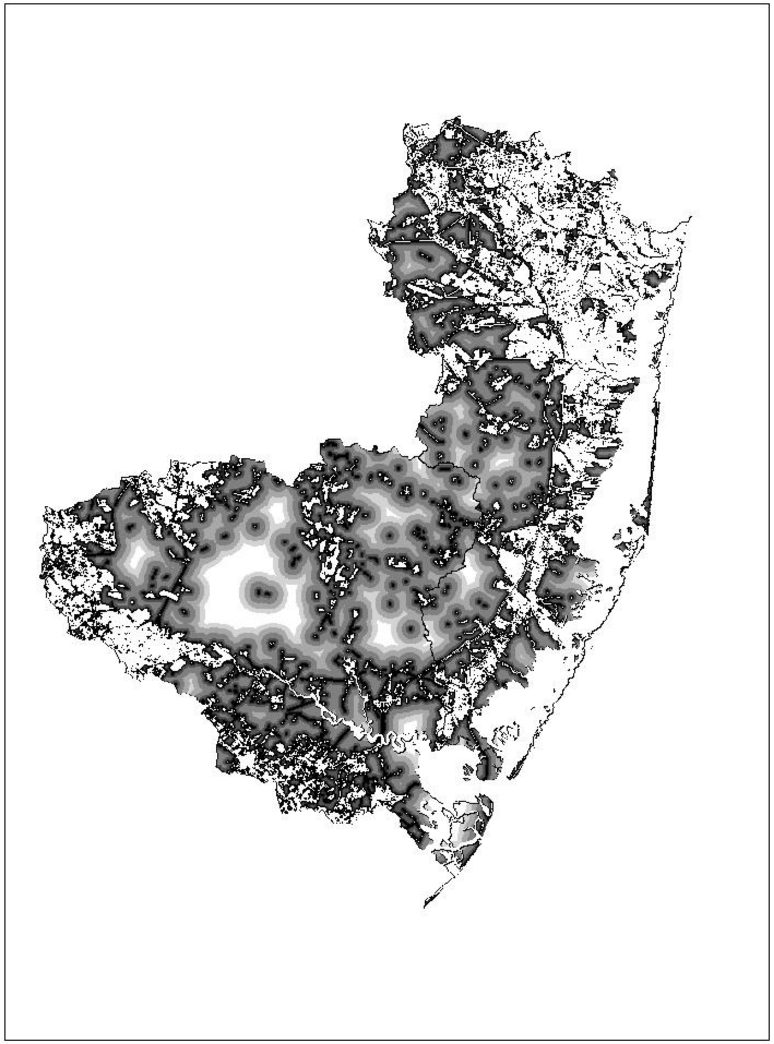


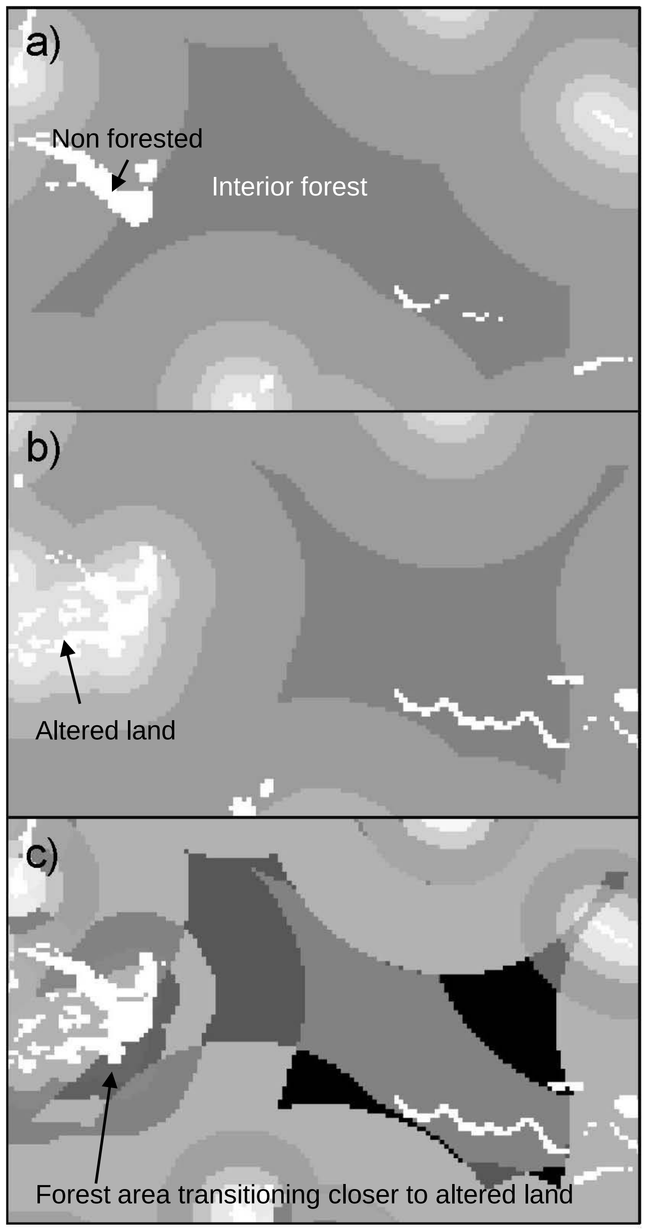
4. Method for extent of influence

Buffers 1986

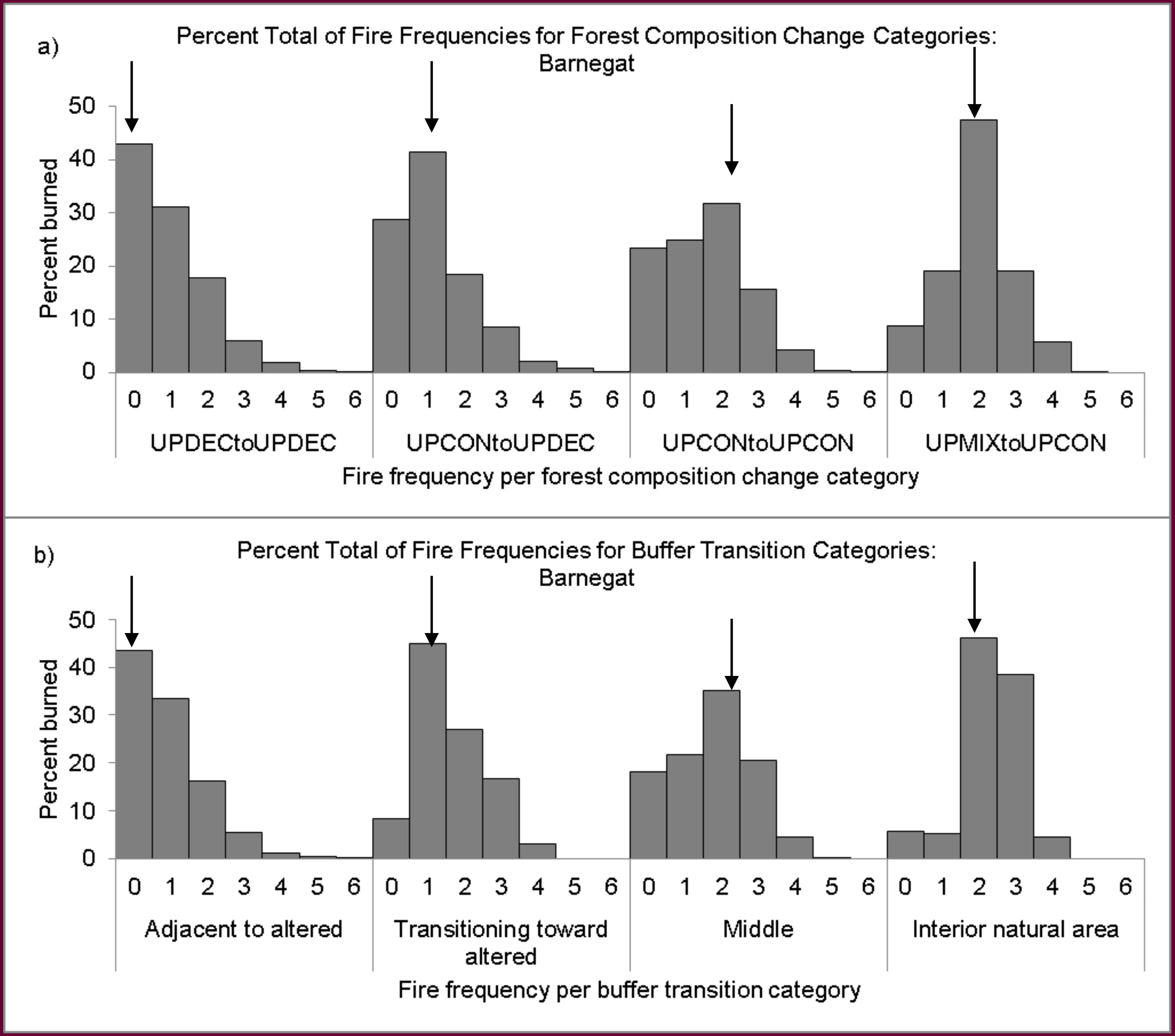


Buffers 2002

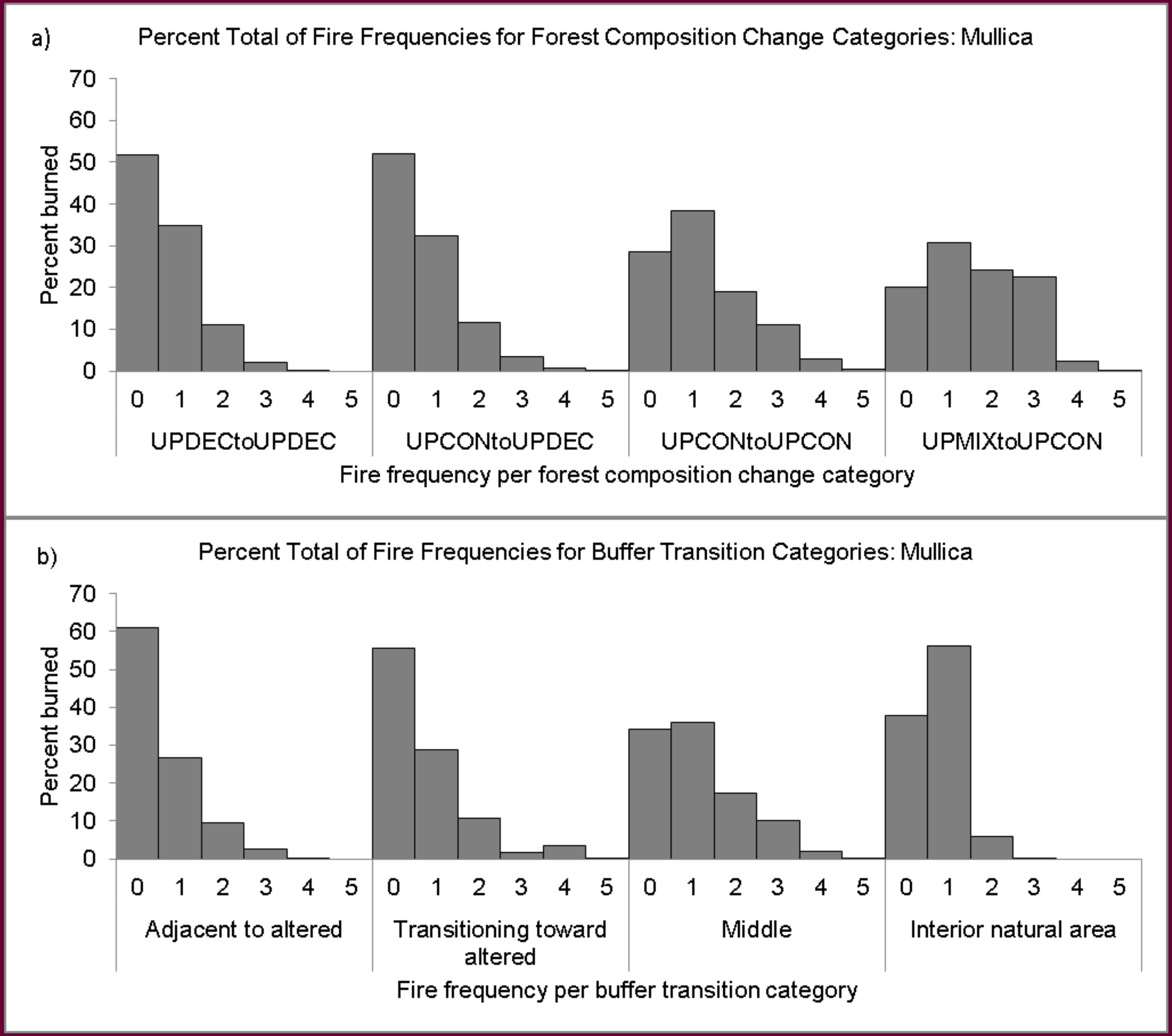


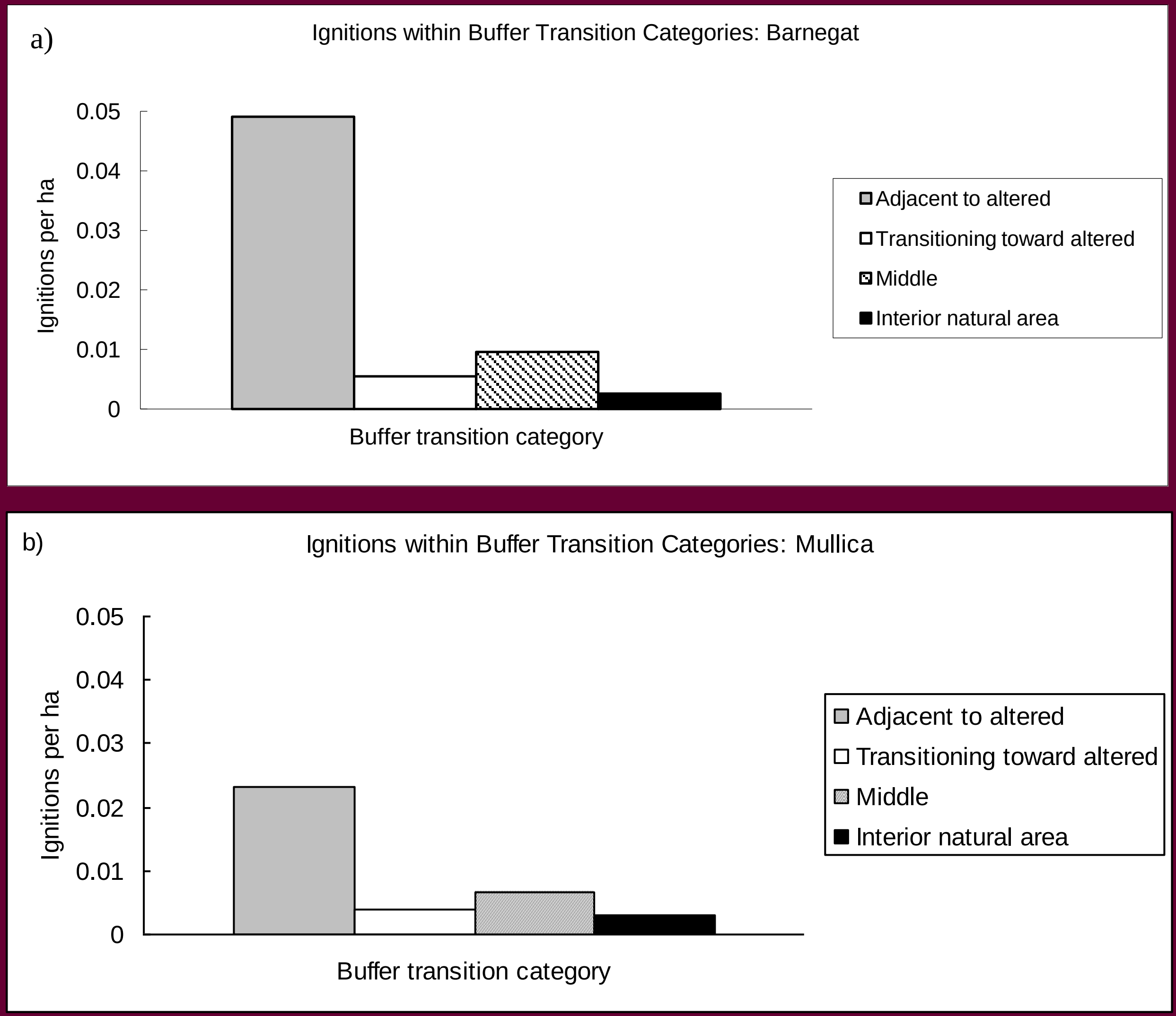

a)
Non forested
Interior forest
b)
Altered land
c)
Forest area transitioning closer to altered land

Succession vs. Proximity to altered land



Succession vs. Proximity to altered land





a)
Ignitions within Buffer Transition Categories: Barnegat
0.05
0.04
0.03
0.02
0.01
0
Ignitions per ha
Buffer transition category
Adjacent to altered
Transitioning toward altered
Middle
Interior natural area
b)
Ignitions within Buffer Transition Categories: Mullica
0.05
0.04
0.03
0.02
0.01
0
Ignitions per ha
Buffer transition category
Adjacent to altered
Transitioning toward altered
Middle
Interior natural area

<u>Ecological Wildland-Urban Interface (EWUI)</u> or the spatial extent to which altered land, through indirect changes in disturbance regimes, influences the adjacent ecology of natural areas

Conclusions:

- The EWUI extends 240-480m from altered land into interior natural areas of the Pinelands of New Jersey
- Areas with different disturbance and altered land histories will vary in EWUI extent and magnitude of ecological influence

"How altered landscapes will themselves influence disturbance regimes is not known (Turner 2005)".

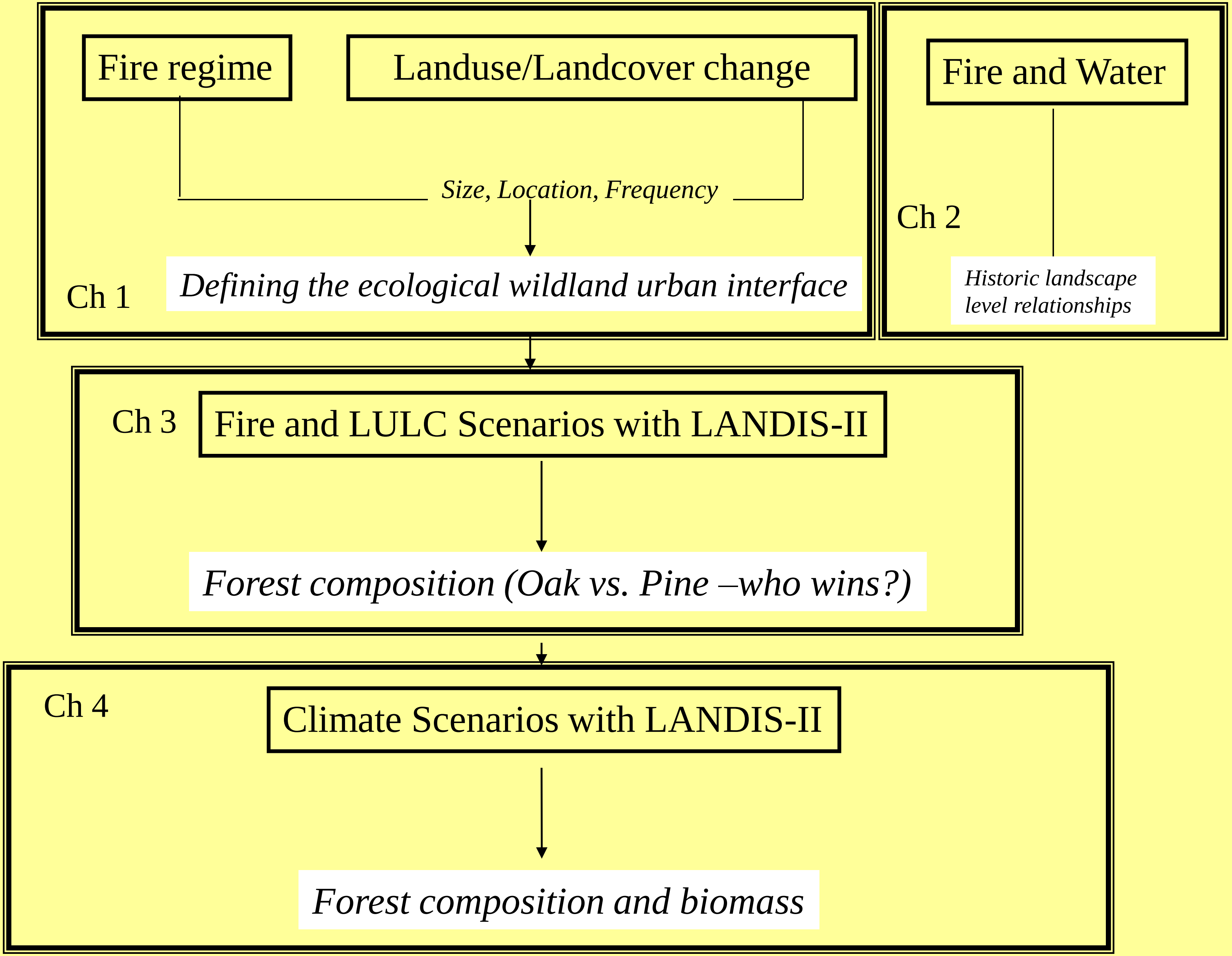
- Altered land can have a large indirect affect on disturbance regimes and thus ecological processes in adjacent natural areas
- Elucidating EWUI factors will assist in predicting future ecological change under different management plans

NJ Forest Fire Service - SECTION B10

Ecological

Wildland/Urban Interface in the NJ Pinelands

Clustering altered land may reduce EWUI effects and magnitude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Chapter 3: The future's so bright…

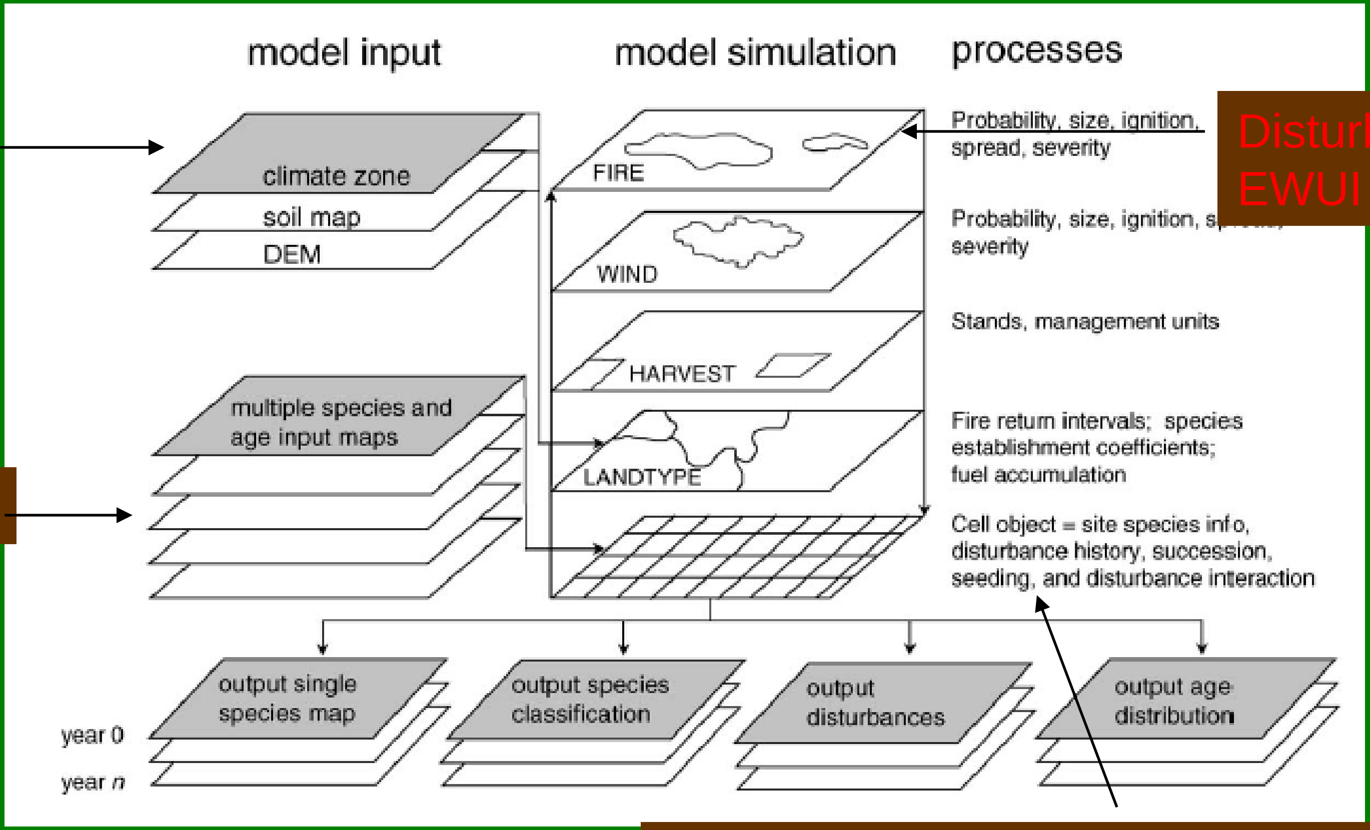
" I have sometimes been accused of being a 'modeler'.
I wish to state that I am not now nor have I ever been a modeler'.
I was (and am) an ecologist who needed a model."
Mladenoff (2005)

LANDIS-II architecture

Ecoregions

Initial Communities

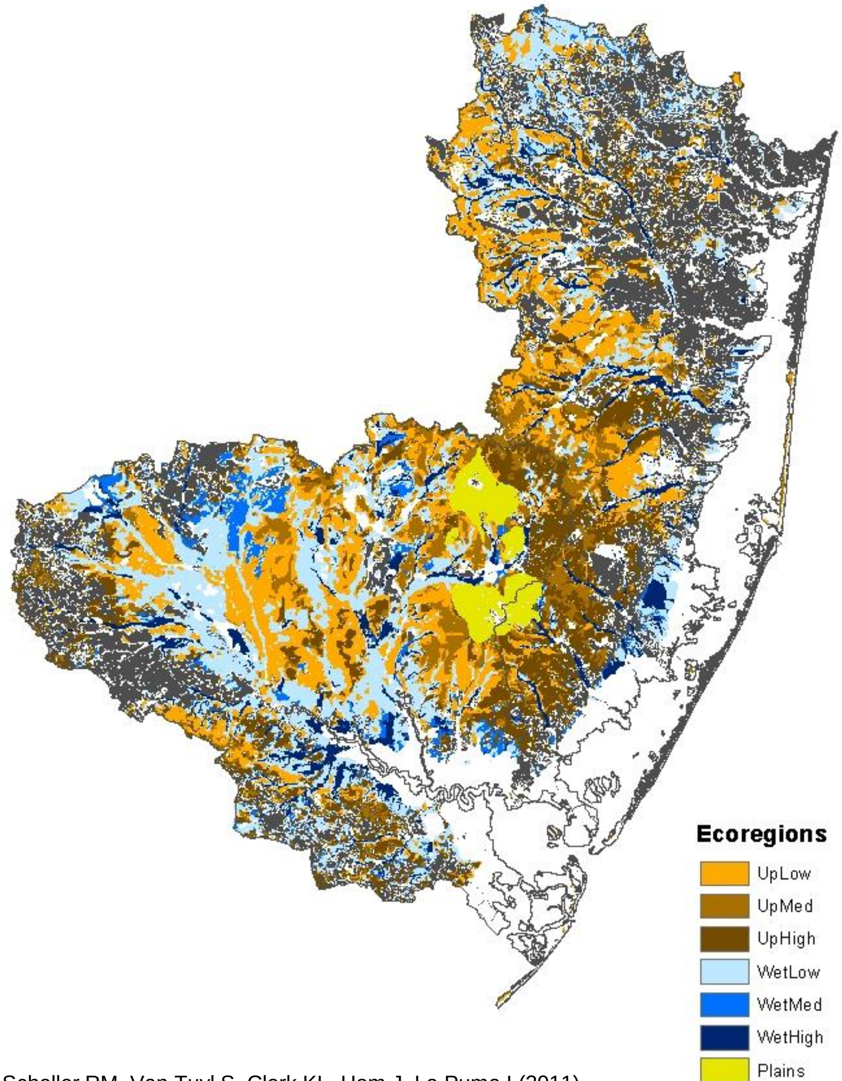
Disturbance
EWUI !!!



Seed Dispersal
Maximum Age
Maximum Biomass
Species Establishment Probability
Aboveground Net Primary Productivity

Core LANDIS-II

Ecoregions



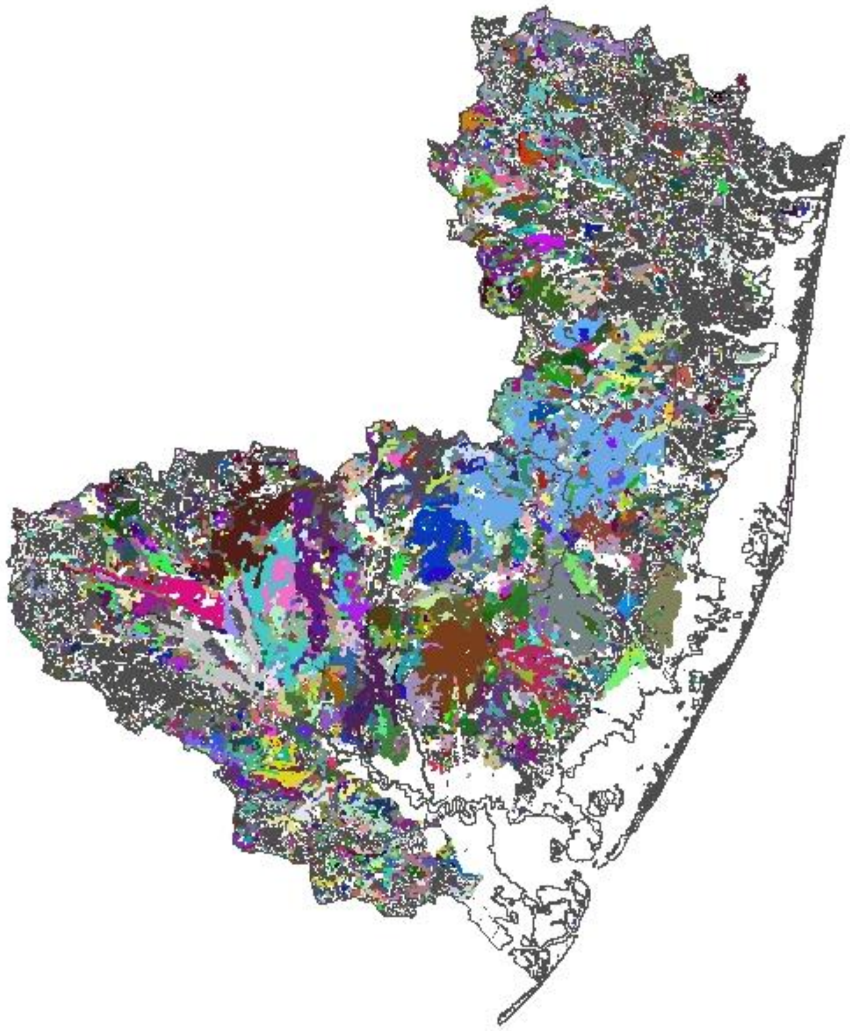
Scheller RM, Van Tuyl S, Clark KL, Hom J, La Puma I (2011)

- Split into upland/lowland using LULC
- Classed into L/M/H WHC from SSURGO data
- Added Pine Plains ecoregion for 7 ecoregions total

Description	Ecoregion	WHC (cm)
UpLow	2	6.965
UpMed	3	7.361
UpHigh	4	7.680
WetLow	5	7.469
WetMed	6	7.933
WetHigh	7	8.437
Plains	8	7.236

Core LANDIS-II

Initial Communities



Scheller RM, Van Tuyl S, Clark KL, Hom J, La Puma I (2011)

- Developed from 2005-2009 FIA data with 14 species
- Cohorts based on dbh to age relationships for all species within the FIA dataset
- FIA forest type determined by dominant species and assigned randomly to forest type polygon

Core LANDIS-II

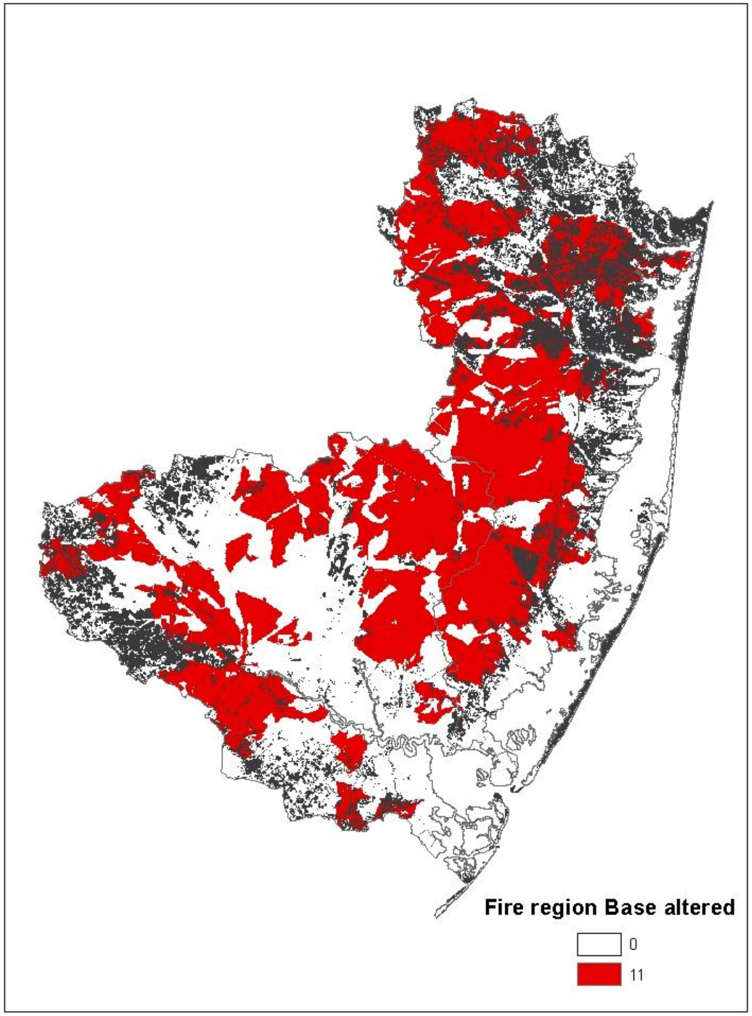
Species parameters

Species	Longevity (yrs)	Age at maturity (yrs)	Shade tolerance	Fire tolerance	Effective seeding distance (m)	Max seeding distance (m)	Probability of resprout	Min resprout age (yrs)	Max resprout age (yrs)	Post-fire regeneration
Acer rubrum	150	10	4	1	100	1000	0.5	10	140	none
Chamaecyparis thyoides	400	12	3	3	183	1000	0.5	5	100	resprout
Nyssa sylvatica	200	15	4	2	30	1000	0.75	0	100	none
Pinus echinata	200	20	1	3	60	500	0.75	5	25	resprout
Pinus rigida	200	5	1	3	60	250	0.75	5	60	resprout
Quercus alba	300	40	3	3	30	3000	0.5	5	40	resprout
Quercus coccinea	120	20	2	1	30	500	0.5	5	75	resprout
Quercus falcata	150	25	3	2	30	500	0.75	5	25	resprout
Quercus prinus	200	20	3	3	30	500	0.75	5	60	resprout
Quercus velutina	250	20	3	2	30	3000	0.4	5	25	resprout
Liquidambar styraciflua	350	25	2	2	60	180	0.75	5	50	resprout
Sassafras albidum	150	10	2	2	30	3000	0.75	5	115	resprout
Quercus ilicifolia	50	5	1	1	30	500	0.75	5	50	resprout
Quercus marilandica	150	5	1	1	30	500	0.75	5	150	resprout

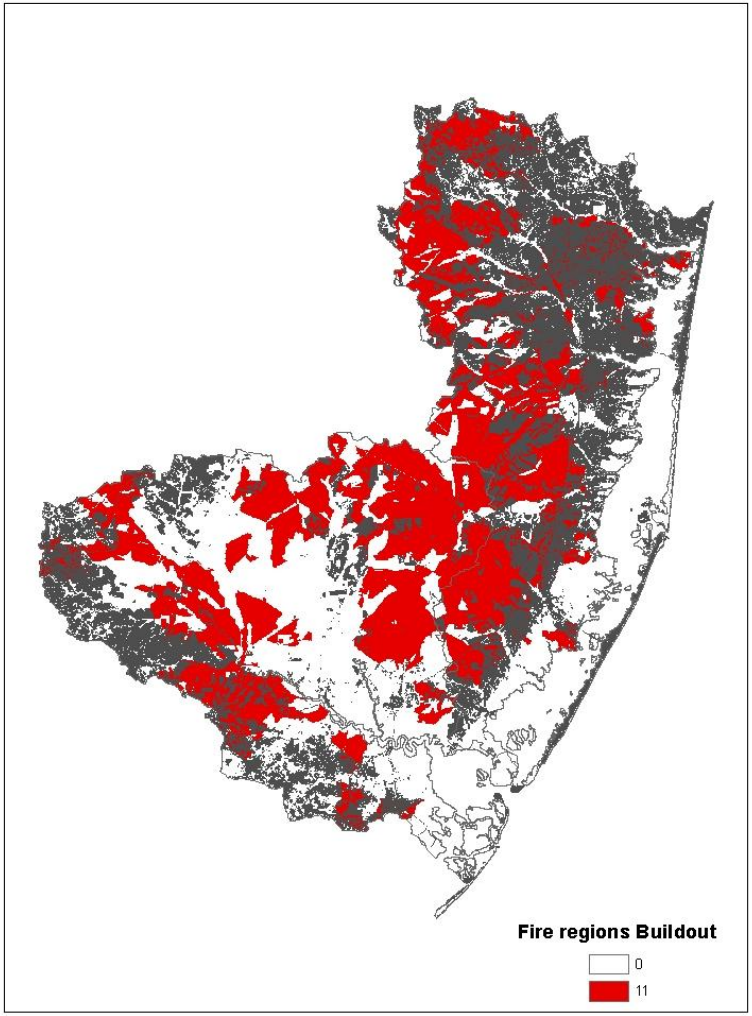
Shade and fire tolerance are on at a scale from 1 (least shade tolerant/least fire tolerant) to 5 (most tolerant). Data derived from Scheller et al (2008, 2011).

Scenarios LANDIS-II

Current altered land



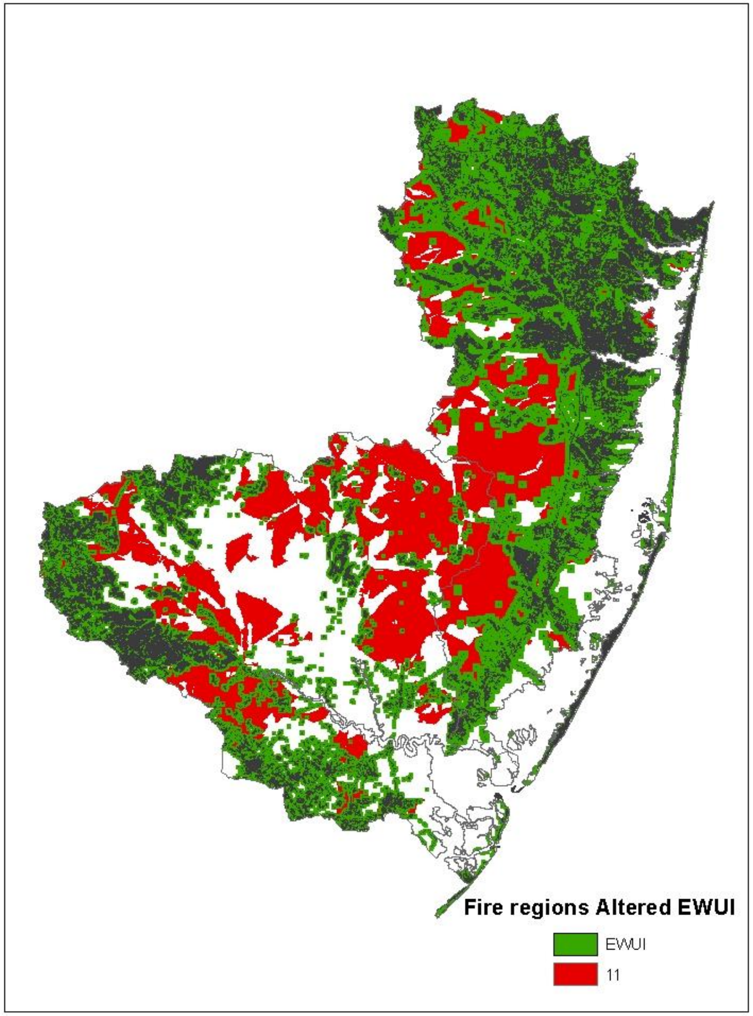
Future possible altered land

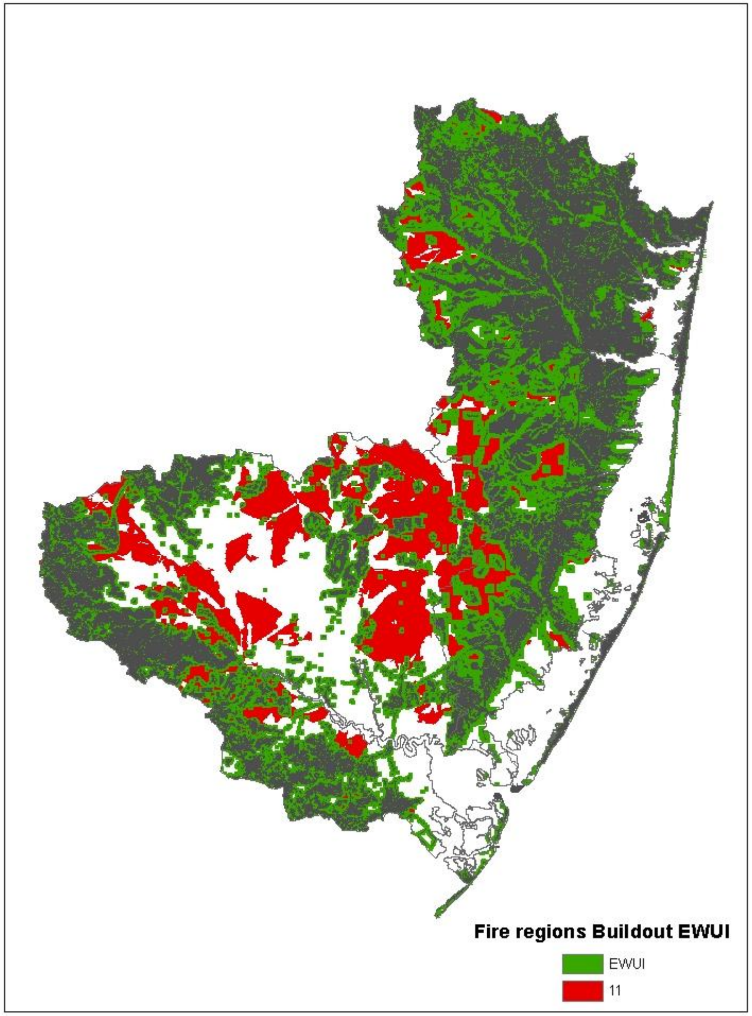


Conway and Lathrop 2005, Lathrop and Haag 2007

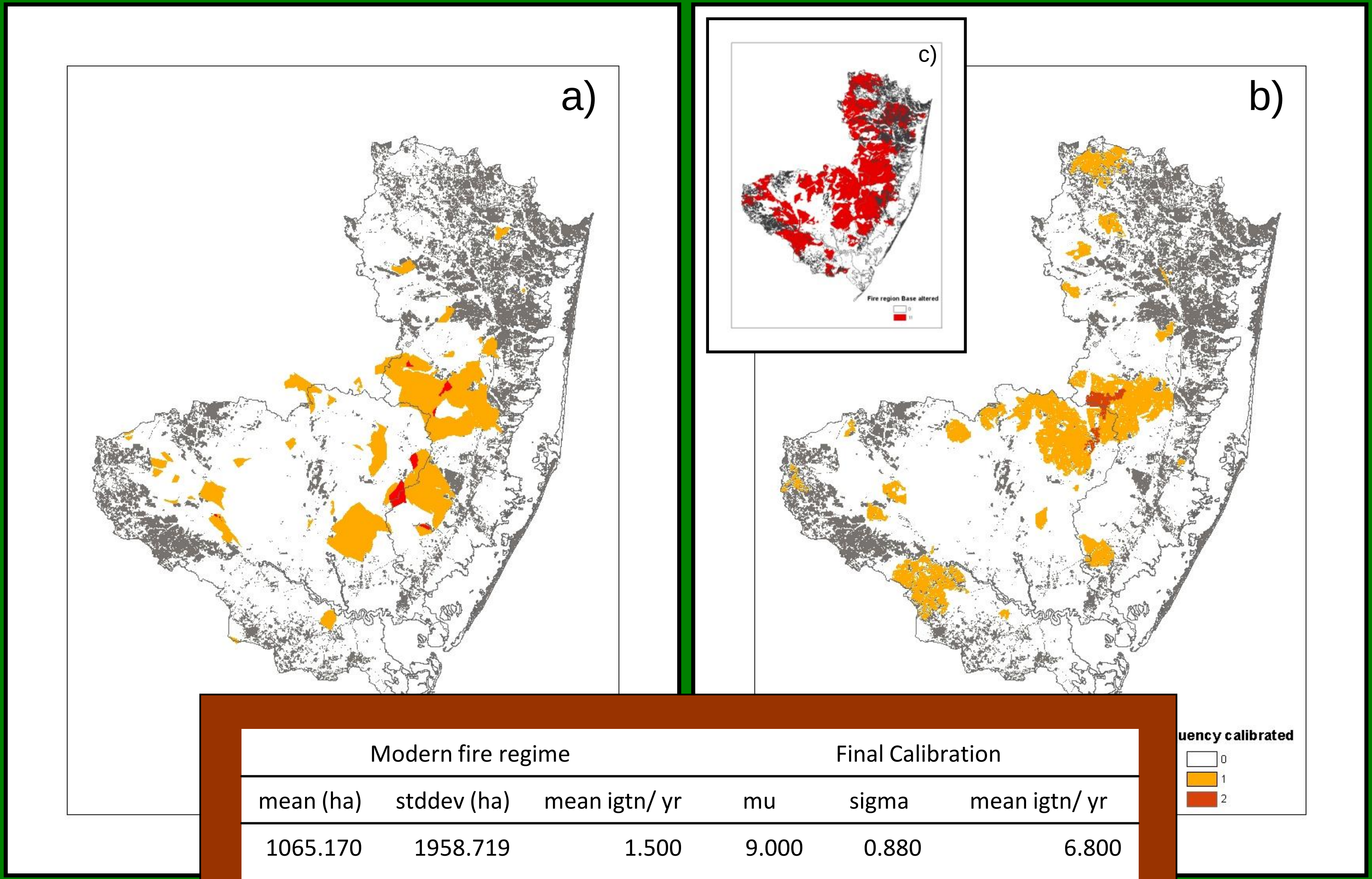
33,209 hectares = 82,061 acres

Scenarios LANDIS-II





Stochastic Fire Calibration LANDIS-II

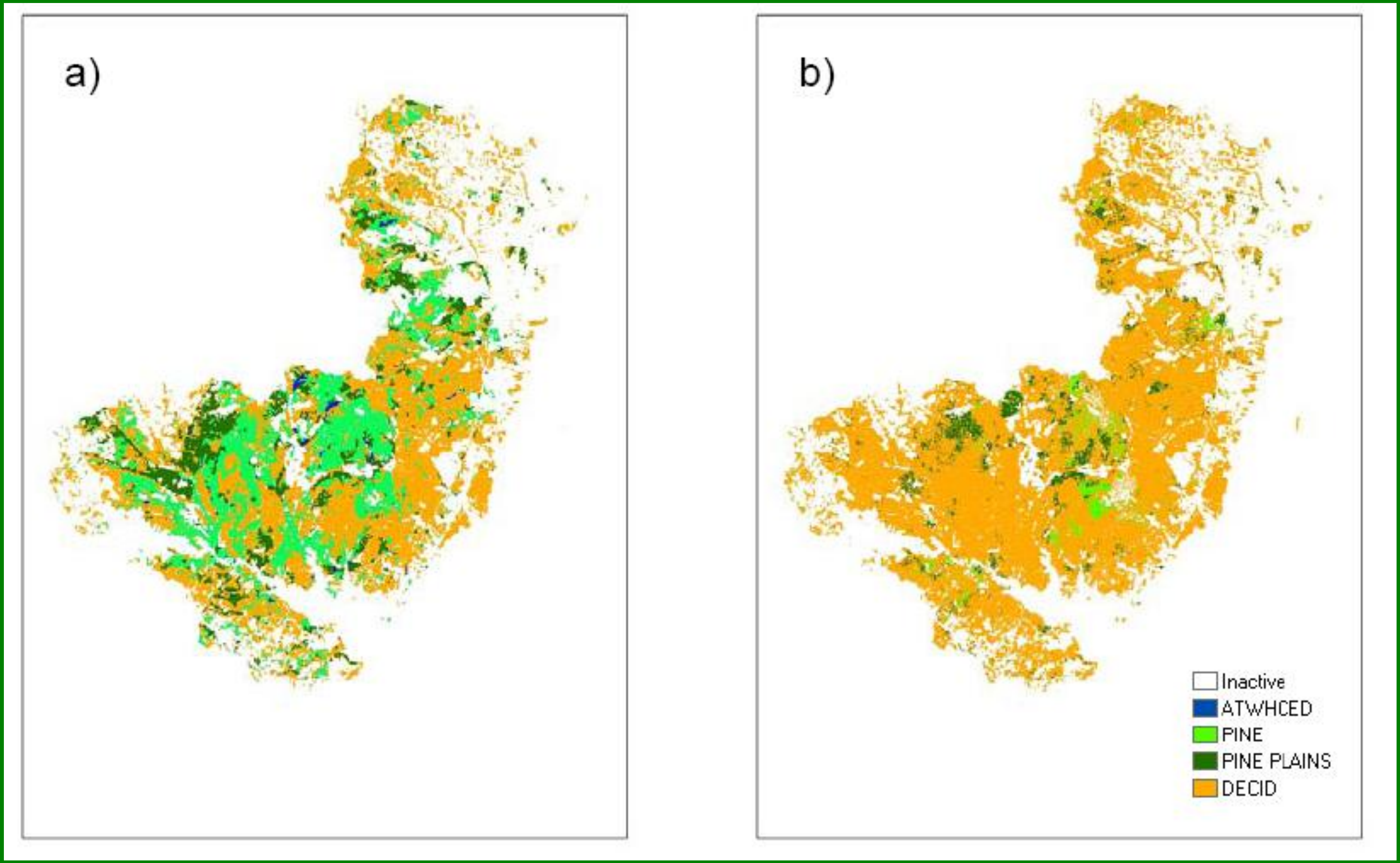


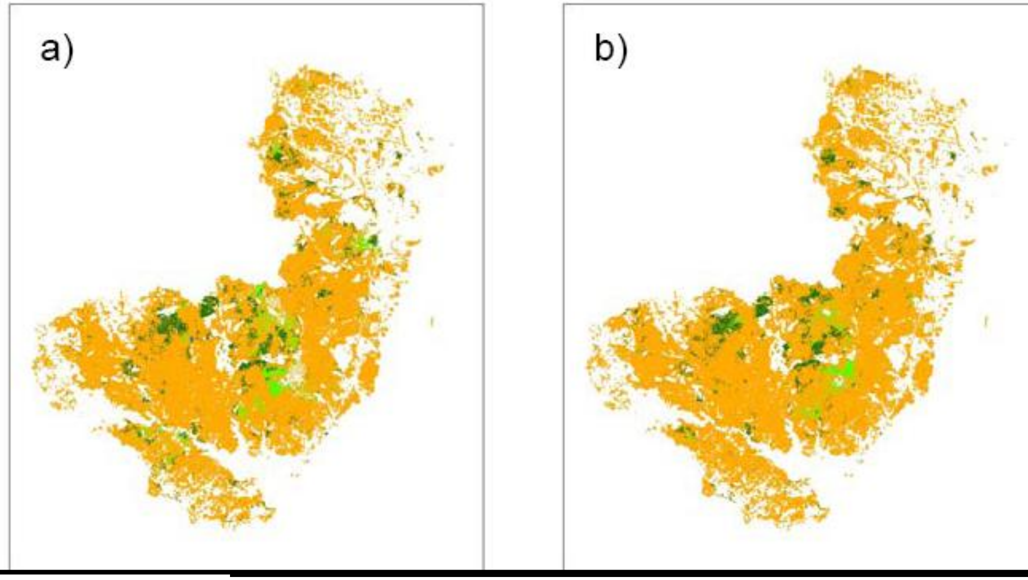
Modern fire regime			Final Calibration		
mean (ha)	stddev (ha)	mean igtn/ yr	mu	sigma	mean igtn/ yr
1065.170	1958.719	1.500	9.000	0.880	6.800
20 year modeled output			**Percent difference**		
mean (ha)	stddev (ha)	mean igtn/ yr	mean	stddev	mean igtn/ yr
1226.414	1797.160	1.450	14.073	-8.603	-3.390

Results Forest Cover

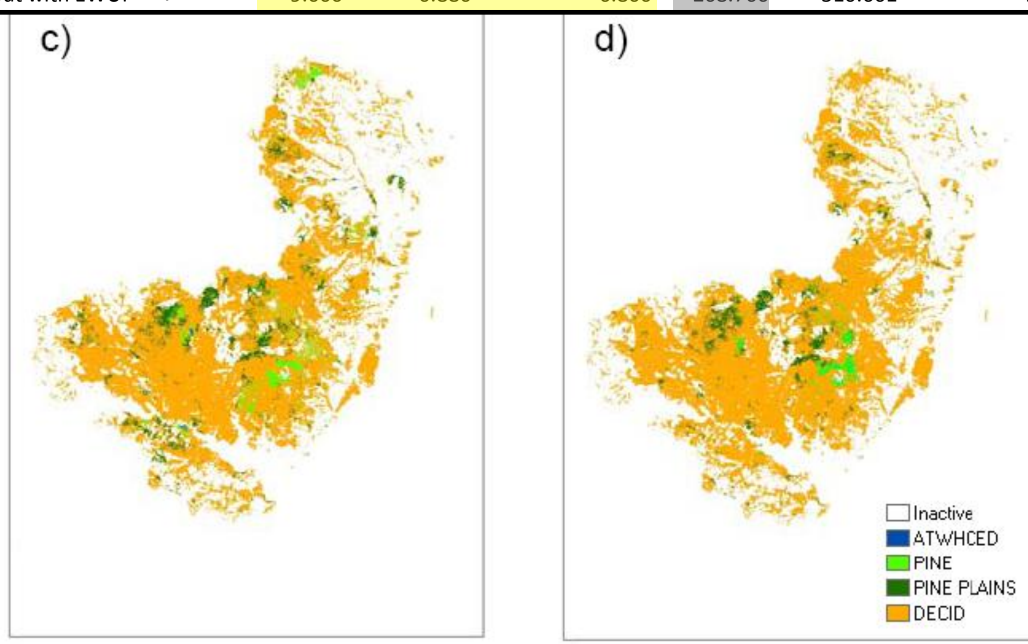
Time = 0

Time = 100

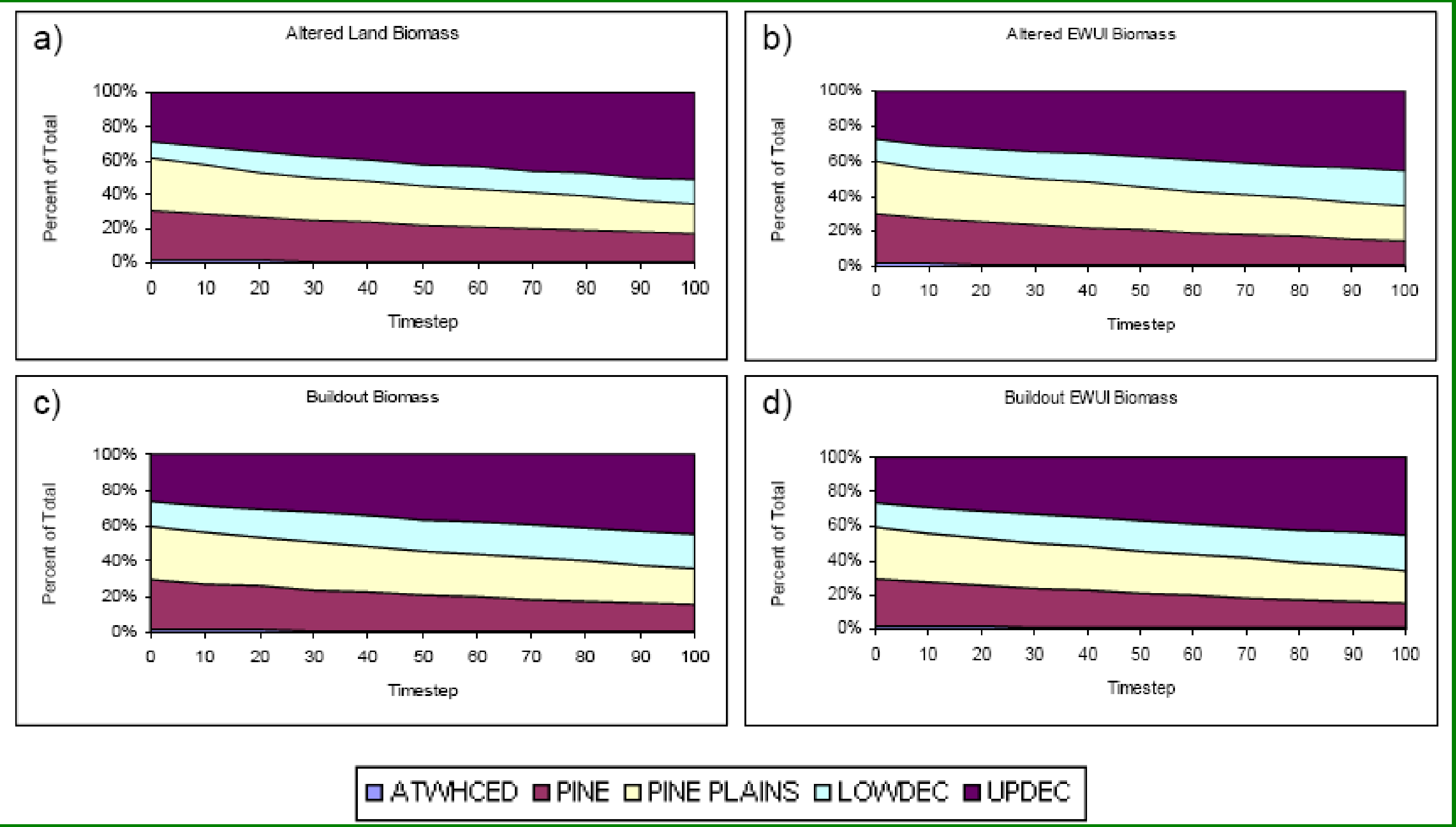




Model scenario		Final Calibration			100 year output		
		mu	sigma	mean igtn / yr	mean (ha)	stddev (ha)	mean igtn / yr
Altered land	a)	9.000	0.880	6.800	1061.509	1430.363	1.590
Altered with EWUI	b)	9.000	0.880	6.800	523.506	1021.078	1.740
Buildout	c)	9.000	0.880	6.800	699.191	936.319	1.940
Buildout with EWUI	d)	9.000	0.880	6.800	268.766	510.661	1.580



Results Percent Total Biomass



What did we learn?

"If fires are kept out … the usual forest growth that develops … follows this pattern: first, a pine stand develops; then hardwoods, chiefly oaks, seed under the pines. Later, as the pines mature and die, hardwoods dominate the stand."

--Silas Little 1978

Conclusions

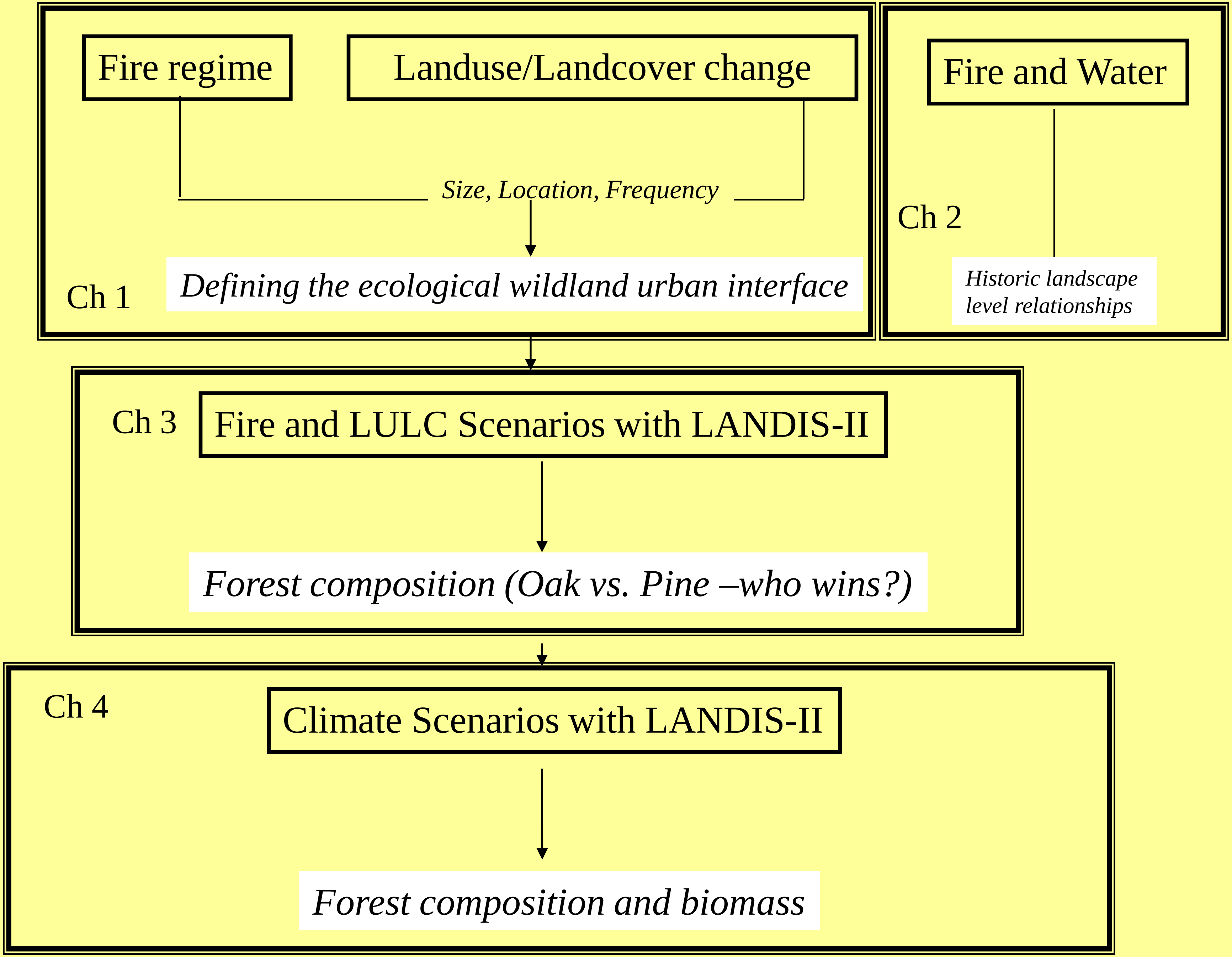
•Based on modern fire regime, model forecasts show quick decline in pine cover

•EWUI exacerbates the loss of fire

•Buildout scenarios and increased fragmentation also exacerbate the loss of fire

•Spatial results show areas of heterogeneity and where to focus efforts

•If prescribed fire outside of current Rx areas is not incorporated pine cover may be limited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Chapter 4: Climate change disturbance

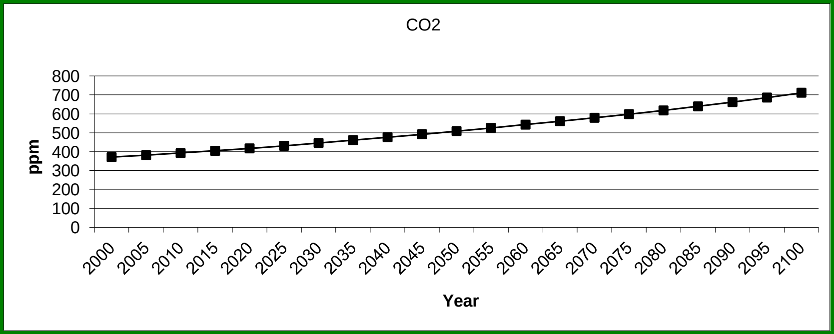
"The resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. wildfire), and other global change drivers (e.g., land-use change)."

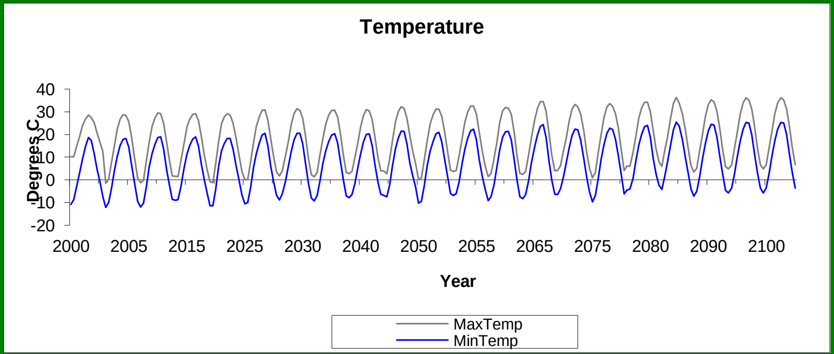
IPCC Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability

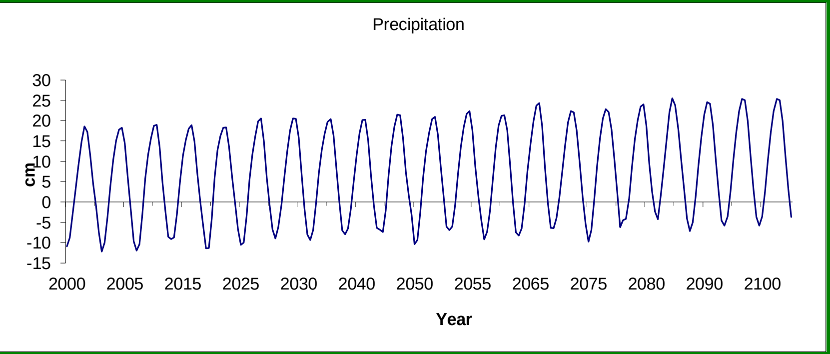
Climate Change Scenario

- A2 = Status quo
- Little cooperation
- Increasing population

- Downscaled to our region







Climate change as a disturbance

WHC for each Ecoregion

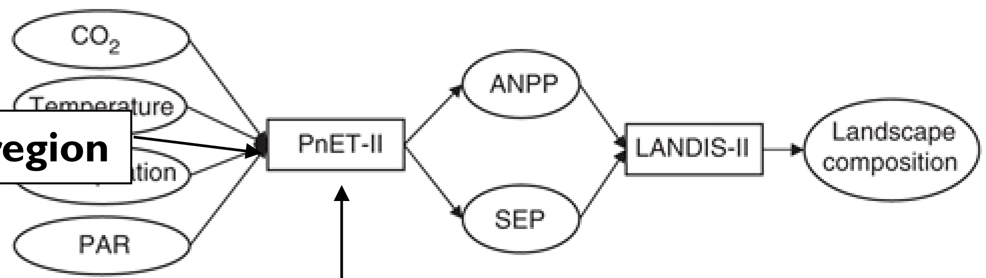
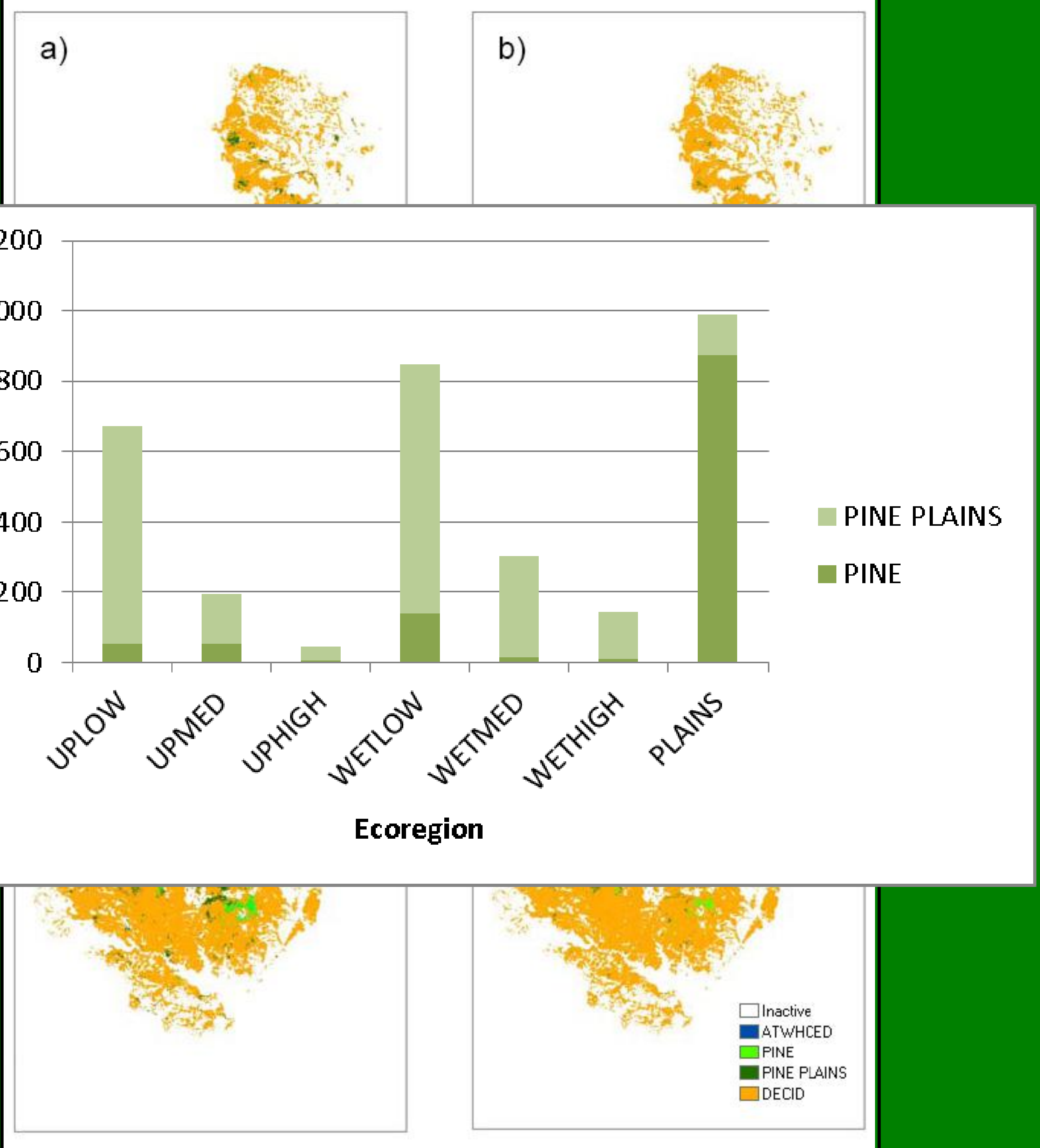


Fig. 2 Flow diagram of model coupling. The ovals represent input/output variables for a certain model. The rectangles represent models. ANPP, above ground primary production; SEP, species establishment probability.

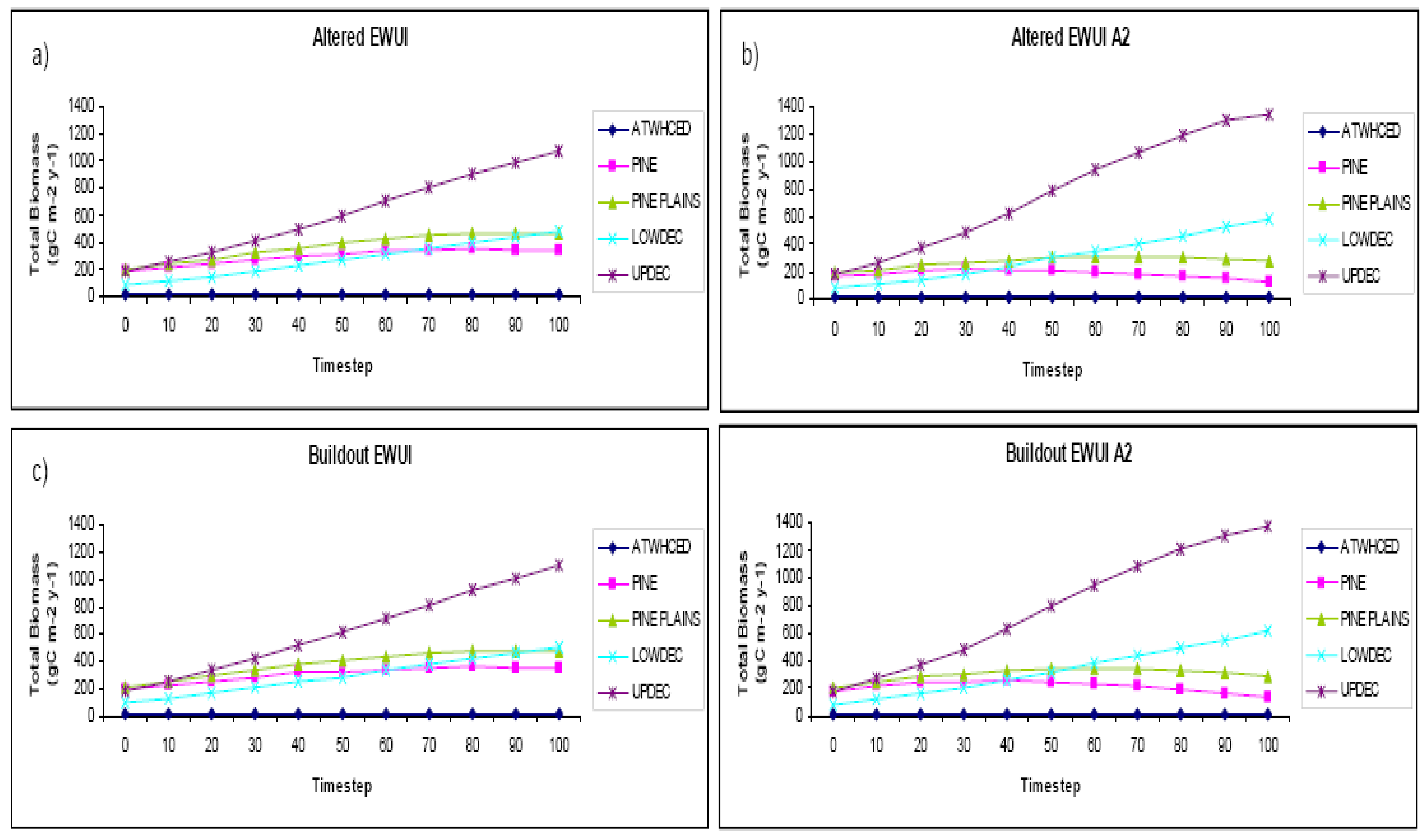
Xu C, Gertner GZ, Scheller RM (2009)

Functional group physiology: pine, southern hardwood, northern hardwood
Growing degree days: affect of temperature
on photosynthesis and species establishment
CO_2 fertilization effect of stomatal conductance and water use efficiency (yes/no)



a)
b)
1200
1000
800
600
400
200
0
Hectares
UPLOW
UPMED
UPHIGH
WETLOW
WETMED
WETHIGH
PLAINS
Ecoregion
PINE PLAINS
PINE
Inactive
ATWHCED
PINE
PINE PLAINS
DECID

Results: Total Biomass



Model limitations

- Insect defoliation (gypsy moth, southern pine beetle)
- Extremes in climate (drought)
- Epicormic sprouting abilities (effect depends on amount of fire)

Conclusions

- Climate change does not change fire regime

- Raising CO2 and temperature accelerates loss of pine cover

- Incorporating prescribed fire may be even more important for pine persistence under a changing climate

Which is better, pine or oak?

- Unique habitat
- Water quality
- Pre-colonial levels – more oak ?
- 99% human caused ‘wildfire’
- Fire safety (access)
- Carbon sequestration
- Viability under climate change, insect infestations

Management Recommendations

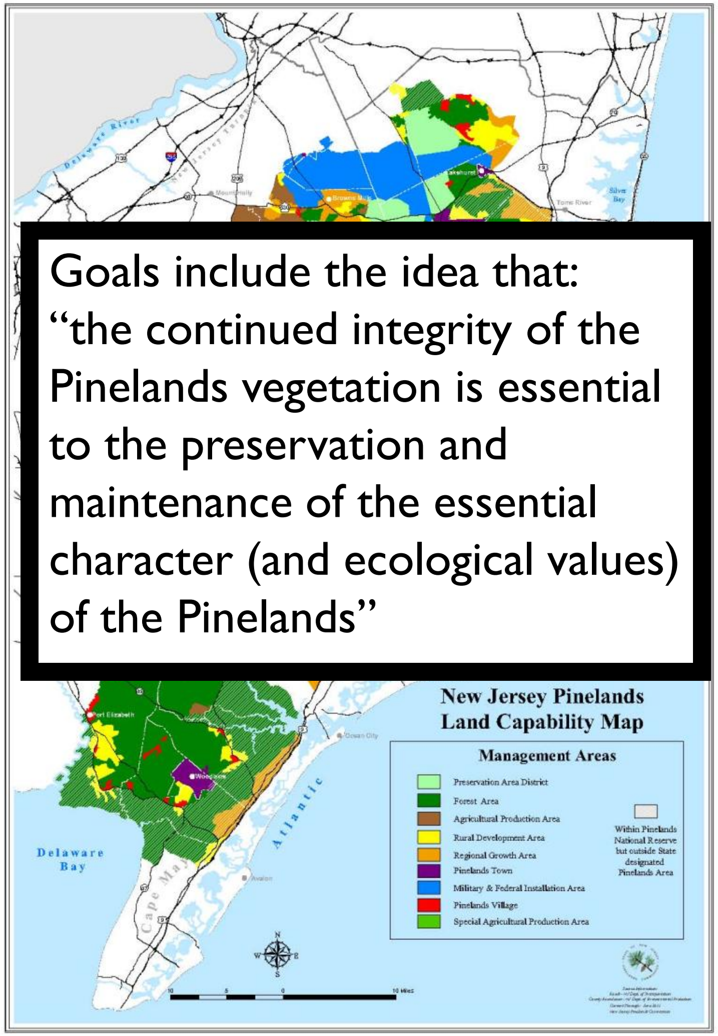
For Pinelands Commission:

Limit further fragmentation to stop expansion of EWUI

Consider climate change in management plans

For New Jersey Forest Fire Service:

Include severity in fire records
Improve prescribed fire recording
Consistent large fire records



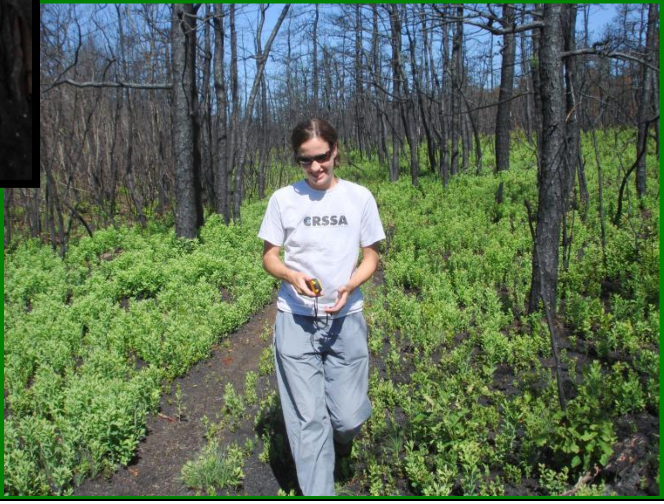
Goals include the idea that: “the continued integrity of the Pinelands vegetation is essential to the preservation and maintenance of the essential character (and ecological values) of the Pinelands”

Management Recommendations

For Land holders:
DEP, Conservation groups, Private landholders

Accidental fire won't maintain integrity of pinelands ecosystem

Expand scope to include maintenance of pine cover via ecologically based prescribed fire



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Questions?