The Response of Ecological Communities to Climate Change: Impacts and Adaptation Strategies

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The Response of Ecological Communities to Climate Change: Impacts and Adaptation Strategies

1. Ecological Communities of New Jersey: Remarkable Diversity
2. Impacts of Climate Change on Ecological Communities
3. Adaptation Strategies
4. Tools for Evaluating Habitat Vulnerability to Climate change
5. Summary

1. Ecological Communities of New Jersey: Remarkable Diversity

- Ecological community definition
- Habitat Classification Systems
- Species and Habitat Diversity in New Jersey
  - Uplands
  - Wetlands (Freshwater, Estuarine)
- Landscape Diversity
  - Geologic, Physiographic, Climatic
- Hot Spots of Biodiversity in New Jersey

Vegetation Classification and Mapping:
A Question of Scale

- "An *ecological community* is an assemblage of interacting plant and animal species that recur in predictable patterns across the landscape under similar physical conditions."
  - As a higher level of biodiversity than species, communities are often referred to as a "coarse" filter in the approach to protecting biodiversity

- "An *ecological system* is a group of ecological communities that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients."
  - Northeast Association of Fish & Wildlife Agencies will use modified ecological systems as their regional wildlife "habitat systems" in climate change models

FGDC 2011 US-NVC Hierarchy

Multi-scaled Vegetation Taxonomy

Example: New Jersey Pitch Pine / Scrub Oak Barrens→

Upper Levels (physiognomic)

Class Forest and Woodland *[LULC07, LANDSCAPE MAP]*

Subclass Temperate Forest and Woodland

Formation Cool Temperate Forest *[NWI]*

Mid Levels (mix of physiognomic & floristic)

Division Eastern North American Cool Temperate Forest

Macrogroup Northern & Central Pine - Oak Woodland & Barrens

Group Pitch Pine Barrens Group

→**ECOLOGICAL SYSTEMS**

Northern Atlantic Coastal Plain Pitch Pine Barrens

Lower Levels (floristic)

Alliance *Pinus rigida* Woodland Alliance *[SAF FORESTERS]*

Association *Pinus rigida / Quercus (marilandica, ilicifolia) / Pyxidanthera barbulata* Woodland *[NHP's]*

ENSP – NHP Collaboration on Habitat Classification:

NJ State Wildlife Action Plan Climate Change

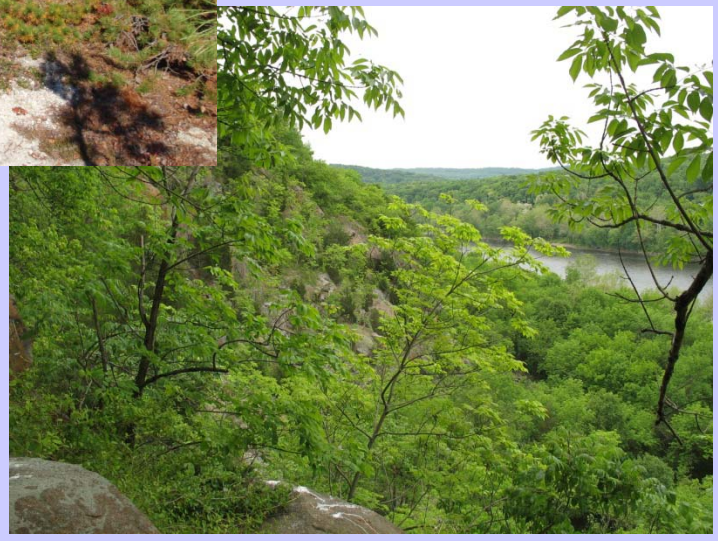
(Northeast Association of Fish & Wildlife Agencies)

Example: Pine barren riverside savanna

DEP's LU/LC	NHP	Forest Service	NE Habitat System Crosswalk
Coniferous Scrub/Shrub Wetlands	Pine Barren Riverside Bog Asphodel Savanna	Not described	**Northern Atlantic Coastal Plain Stream and River**

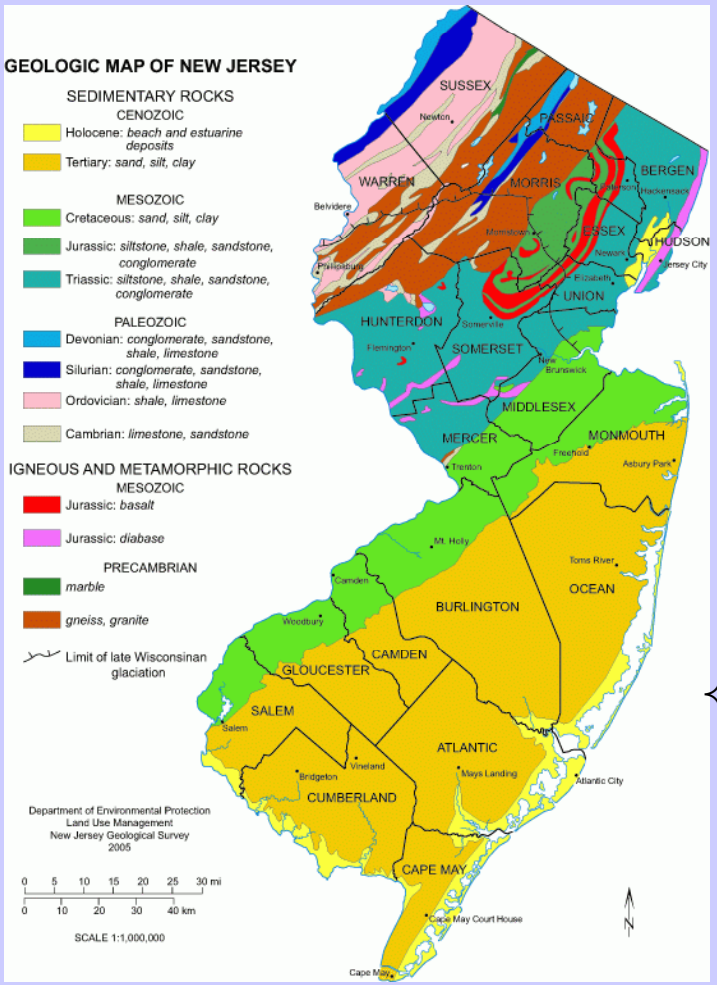
NORTHERN ATLANTIC COASTAL PLAIN STREAM AND RIVER ECOLOGICAL SYSTEM:
This system is found throughout the northern Atlantic Coastal Plain from Virginia to New Jersey along low-gradient small streams and rivers with little to moderate floodplain development. This system is influenced by overbank flooding, groundwater seepage and occasional beaver impoundments. The vegetation is a mosaic of forests, woodlands, shrublands, and herbaceous communities. …

Ecological (Habitat) Diversity in New Jersey
UPLANDS



Ecological (Habitat) Diversity in New Jersey
WETLANDS

NJ's diverse geology and landforms support remarkable biodiversity

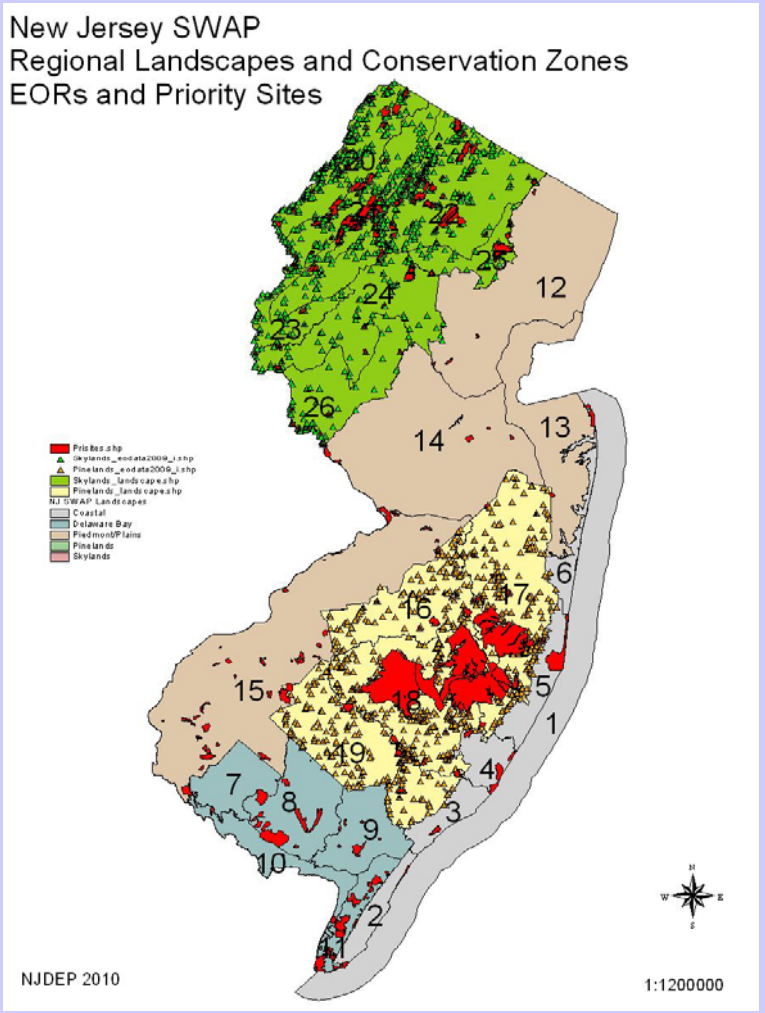


✧ 5 Physiographic Provinces

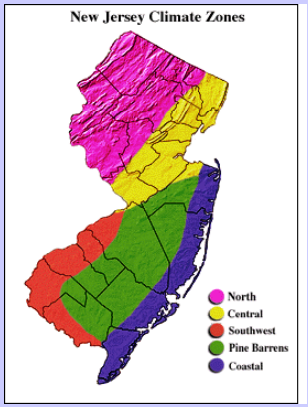
✧ 2134 native plants (822 of conservation concern

300+ ecological communities (115 rare)

✧ **33 ecological systems**



2. Impacts of Climate Change on Ecological Communities/Habitats in New Jersey



Predicted Changes in Climate

- Temperature
- Precipitation
- Unprecedented severe weather events
- Sea level rise

Potential impacts to ecological communities/ecosystems

- Flooding (hydroperiod changes - fresh and tidal)
- Drought (stresses to plants, early senescence)
- Fire frequency and intensity (drought, succession)
- Growing season duration (plant phenology)
- Pollinators (nectar/pollen)
- Invasive species (negative allelopathy)
- Habitat Fragmentation/Integrity (sprawl, migration corridors disrupted)
- Ecosystem Processes/Functions (wetlands and uplands)

3. Adaptation Strategies

- ✧ Resiliency (capacity to adapt)
  - keystone species
  - ecological processes
  - habitat integrity
- ✧ Migration (ability to move)
  - Geological and topographic corridors for migration
  - Buffers for coastal landward migration

Ecosystem Resilience

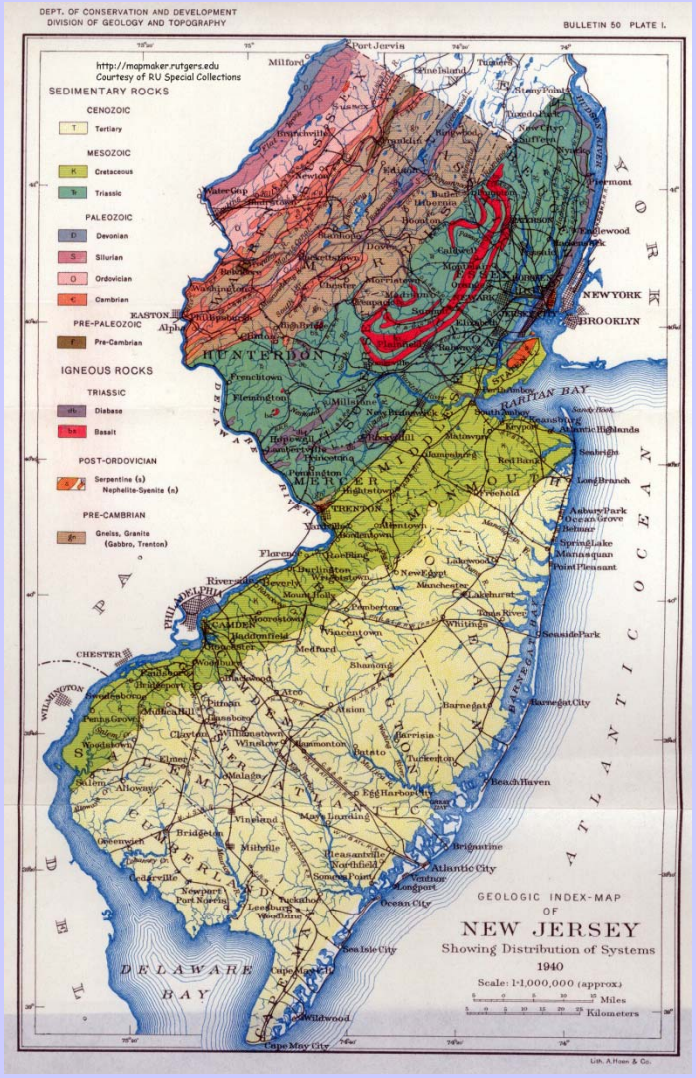
- *"Most ecosystems — like forests or wetlands — have an amazing ability to recover from disturbance. RESILIENCY is that capacity to recover. And we now understand that certain key characteristics need to be in place for a system to bounce back."*

  Mark Anderson Ph.D., Director of Conservation Science for The Nature Conservancy's Eastern U.S. Region

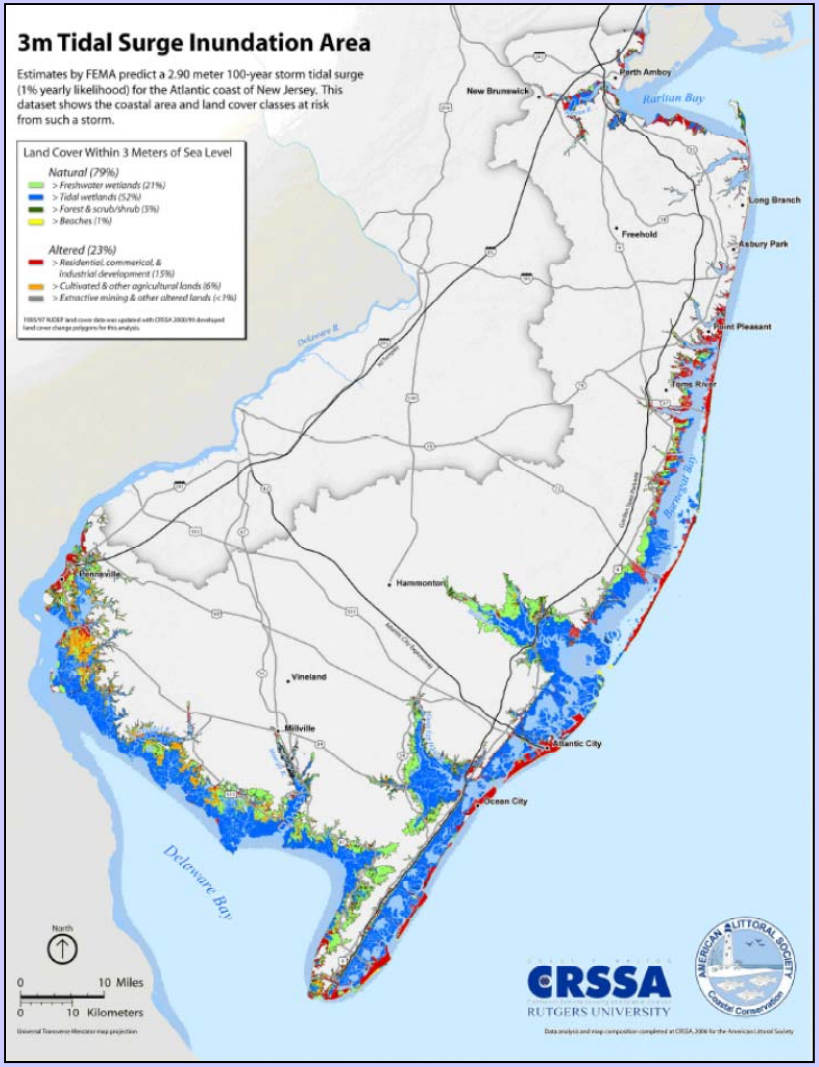
- *Key Characteristics of Healthy Ecosystems/Habitats*
  - *Soil condition (undisturbed, symbiotic mycorrhizae, organic matter decomposition)*
  - *Natural hydrology (wetland hydroperiod intact – fresh and tidal)*
  - *Normal sedimention rates (tidal marsh and floodplain systems)*
  - *Native plants and animals (lack of invasives)*
  - *Equilibrium in energy and nutrient exchange – returns to "normal" after disturbance*
  - *Ecosystems have developed over a long period of time*

Geological and topographic corridors for ecosystem migration

Example: Calcareous forests are restricted in distribution to dolomite or limestone bedrock ridges in northwest NJ. The species are adapted to high pH conditions and topographic relief. The bedrock continues into adjacent NY State. Land use in both states would determine whether this ecosystem and associated species could “migrate” north as climate changes.



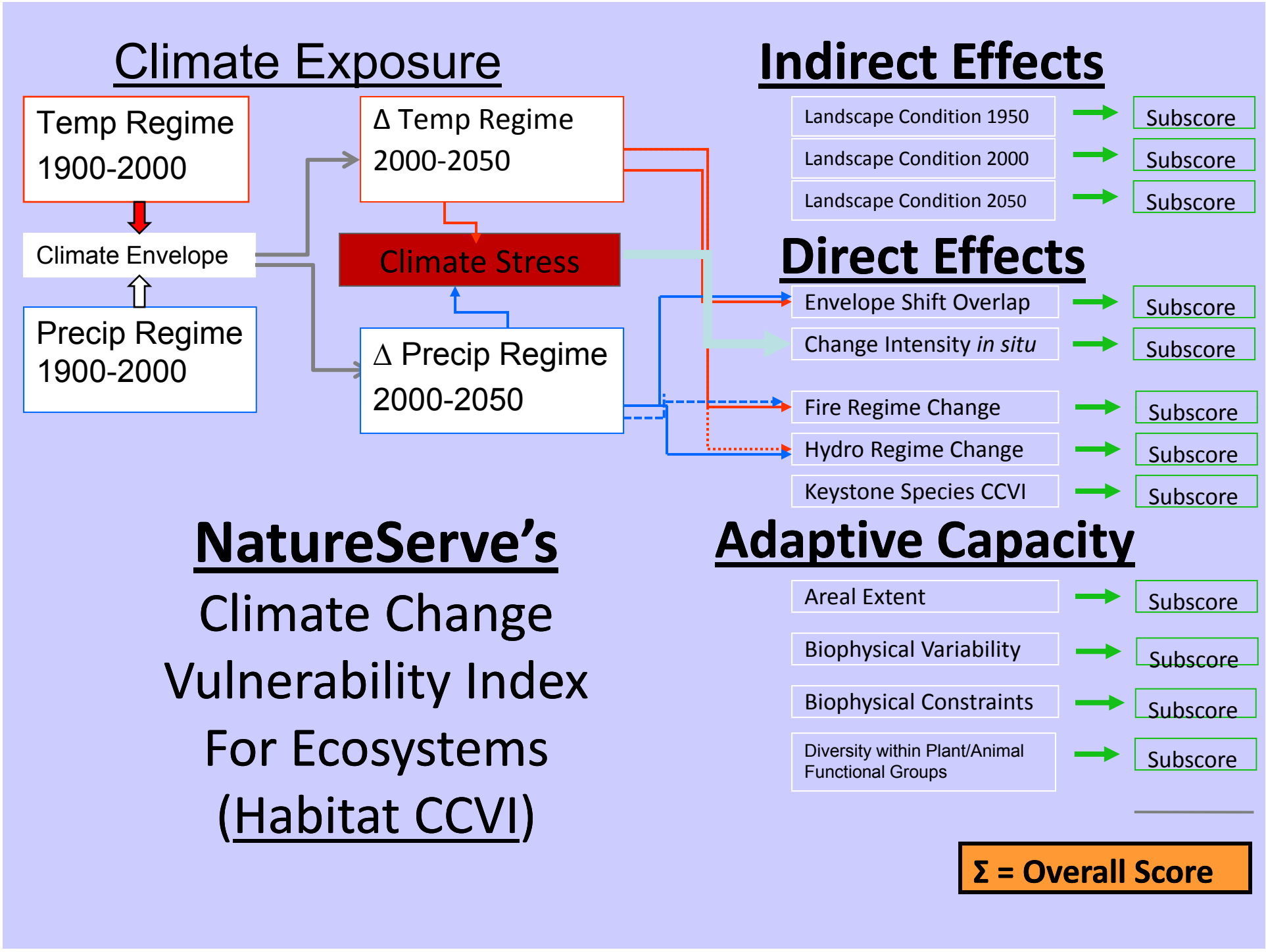
Buffers for coastal landward migration



- The tidal salt, brackish and freshwater marshes of the Atlantic Coast and Delaware Bay wrap around the coastline of peninsular NJ. As sea level rises, salinity, tidal amplitude, and extent of these tidal wetlands will change. Adjacent topography (elevation gradient), natural vegetation type, and land use barriers will determine if and/or where these ecosystems can migrate landward.

4. Tools for Evaluating Habitat Vulnerability to Climate Change

- NatureServe Habitat Climate Change Vulnerability Index (HCCVI) and Species CCVI (Bruce Young, Pat Comer)
- NEAFWA Habitat Vulnerability Model (Hector Galbraith, Manomet Center for Conservation Sciences and National Wildlife Foundation + volunteers)
- The Nature Conservancy – key habitat and ecosystem corridor modeling/mapping (Mark Anderson, Charles Ferree)
- Climate Wizard and other climate model tools


Climate Exposure
Temp Regime 1900-2000
Climate Envelope
Precip Regime 1900-2000
Δ Temp Regime 2000-2050
Climate Stress
Δ Precip Regime 2000-2050
Indirect Effects
Landscape Condition 1950
Landscape Condition 2000
Landscape Condition 2050
Subscore
Subscore
Subscore
Direct Effects
Envelope Shift Overlap
Change Intensity in situ
Fire Regime Change
Hydro Regime Change
Keystone Species CCVI
Subscore
Subscore
Subscore
Subscore
Subscore
NatureServe's
Climate Change
Vulnerability Index
For Ecosystems
(Habitat CCVI)
Adaptive Capacity
Areal Extent
Biophysical Variability
Biophysical Constraints
Diversity within Plant/Animal Functional Groups
Subscore
Subscore
Subscore
Subscore
Σ = Overall Score

NEAFWA Habitat Vulnerability Model

(Hector Galbraith + National Wildlife Federation + Volunteers)

VULNERABILITIES TO CLIMATE CHANGE OF NORTHEASTERN FISH AND WILDLIFE HABITATS

Hector Galbraith, Manomet Center for Conservation Sciences

Curtis Fisher, George Gay, and Chris Hilke, National Wildlife Federation

BACKGROUND

1. Climate change is already impacting ecological systems and species across North America
2. Assessing the vulnerabilities of ecological resources is essential step toward adaptation
3. Many states in Northeast already performing vulnerability assessments (habitats and/or species)
4. Results of state assessments need to be put in regional context for effective conservation planning and action
5. Also, many state and NGO agencies need to build capacity to address climate change and adaptation
6. Project funded by NEAFWA and U.S. Fish and Wildlife.

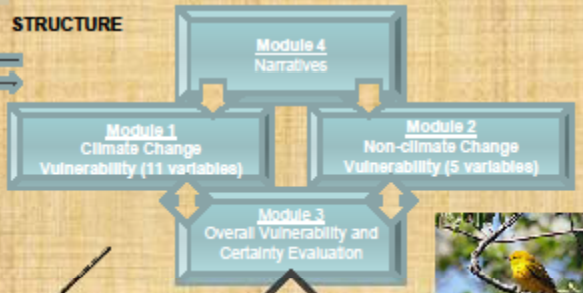
NEAFWA HABITAT VULNERABILITY MODEL

A predictive model of habitat vulnerability has been built
This model will be consistently applied to selected habitats across the Northeast
Results will provide basis for mapping geographical variation in vulnerability

PROJECT OBJECTIVES

1. Quantify the vulnerabilities of fish and wildlife habitats in the region and how these vary geographically
2. Project how habitats and species will change their status and distributions under climate change.
3. Identify potential adaptation options to safeguard vulnerable habitats and species.
4. Identify monitoring strategies to track the impacts of climate change and the effectiveness of adaptation actions.
5. Help states to increase their institutional knowledge and capabilities to respond to climate change.

STRUCTURE



Module 1 – assesses vulnerability to climate change factors
Module 2 - assesses vulnerability to other (non-climate) stressors and interactions with climate change factors
Module 3 – combines 1 and 2 into overall vulnerability
Module 4 – Makes explicit assumptions and logic steps underpinning scores (transparency) and quantifies uncertainty

UNCERTAINTY EVALUATION

-All of 16 variables assigned a certainty score (High, Medium, Low)
-Allows areas of most uncertainty to be identified
-Certainty scores combined in Module 3 into overall certainty evaluation

TASKS

1. Build habitat model to project vulnerabilities
2. Apply model to selected habitats across region
3. Map geographical variation in vulnerabilities and identify potential refugia
4. Apply existing species model to evaluate vulnerabilities of keystone/foundational spp.
5. Compile catalogue of adaptation options
6. Develop monitoring tools

HABITATS SELECTED FOR ANALYSES

Forests and Woodlands
Laurentian-Acadian Northern Hardwood Forest
Laurentian-Acadian Pine-Oak Forest
Laurentian-Acadian Pine-Hemlock-Hardwood Forest
South-Central Interior Mesophytic Forest
Central Appalachian Pine-Oak Rocky Woodland
Northeastern Interior Dry-Mesic Oak Forest
Central Appalachian Dry Oak-Pine Forest
Northeastern Interior Pine Barrens
Laurentian-Acadian Floodplain Forest
Montane Spruce-Fir Forest
Appalachian (Hemlock)-Northern Hardwood Forest
High Allegheny Wetland

Tundra
Alpine Tundra

Aquatic
Cold water fisheries
Central Appalachian Stream/Riparian
Floodplain Central Appalachian River

Wetlands
North-central Appalachian Acidic Swamp
North-Central Interior and Appalachian Acidic-Peatland
Laurentian-Acadian Wet Meadow-Shrub Swamp
Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh
Laurentian-Acadian Freshwater Marsh
Low Elevation Boreal Bogs

ROLE OF EXPERT PANELS

*40 biologists, ecologists, and planners from 13 state agencies, NGOs and federal agencies make up expert panel.
*Function is:
to help build and run habitat model
to select habitats for analyses
to peer review and critique results of model runs
to help build expertise within agencies

THREE HABITAT WORKGROUPS

	Forests	Wetlands	Aquatic
ME	Andrew Cutko	Philip DeMaynadier	Steve Walker
NH			Matt Carpenter
VT	John Austen		
MA	John Scanlon		Caleb Slater
NY		Zoe Smith	
CT	Min Huang		Neal Hagstrom
NJ	Kris Schantz	Kathleen Walz	
PA	Mary Ann Furedi Greg Podnieski	Greg Podnieskinski Mary Ann Furedi	
VA		David Norris	
WV	Elizabeth Byers	Elizabeth Byers	Kerry Bledsoe
MD	Dana Limpert	Dana Limpert	Dana Limpert

NEXT STEPS

-Apply vulnerability model to selected habitats
-Map geographical variation in habitat vulnerabilities
-Run NatureServe model on selected species
-Map likely habitat refugia
-Identify suitable indicator species for monitoring
-Begin process of identifying adaptation options

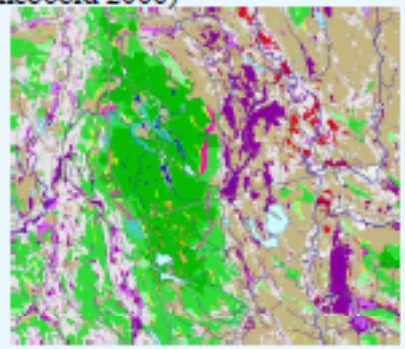
The Nature Conservancy – key habitat and ecosystem corridor modeling/mapping

(Mark Anderson, Charles Ferree)

Next Step: A Geospatial Condition Analysis of each Habitat

Terrestrial Systems

- Land cover and Canopy closure (MRLC 2001)
- Large unfragmented landscapes and forest blocks (TNC 2007)
- Conservation land parcels (TNC 2008)
- Housing density projections through 2050 by census block (Theobold 2006)
- Roads and fragmenting features (Various sources) ,
- Existing and proposed infra-structure features (TBD)
- Changed in canopy cover (CCAP)(
- Patch size and distribution (FRAGSTATS McGarigal 200)



Patch diversity metrics

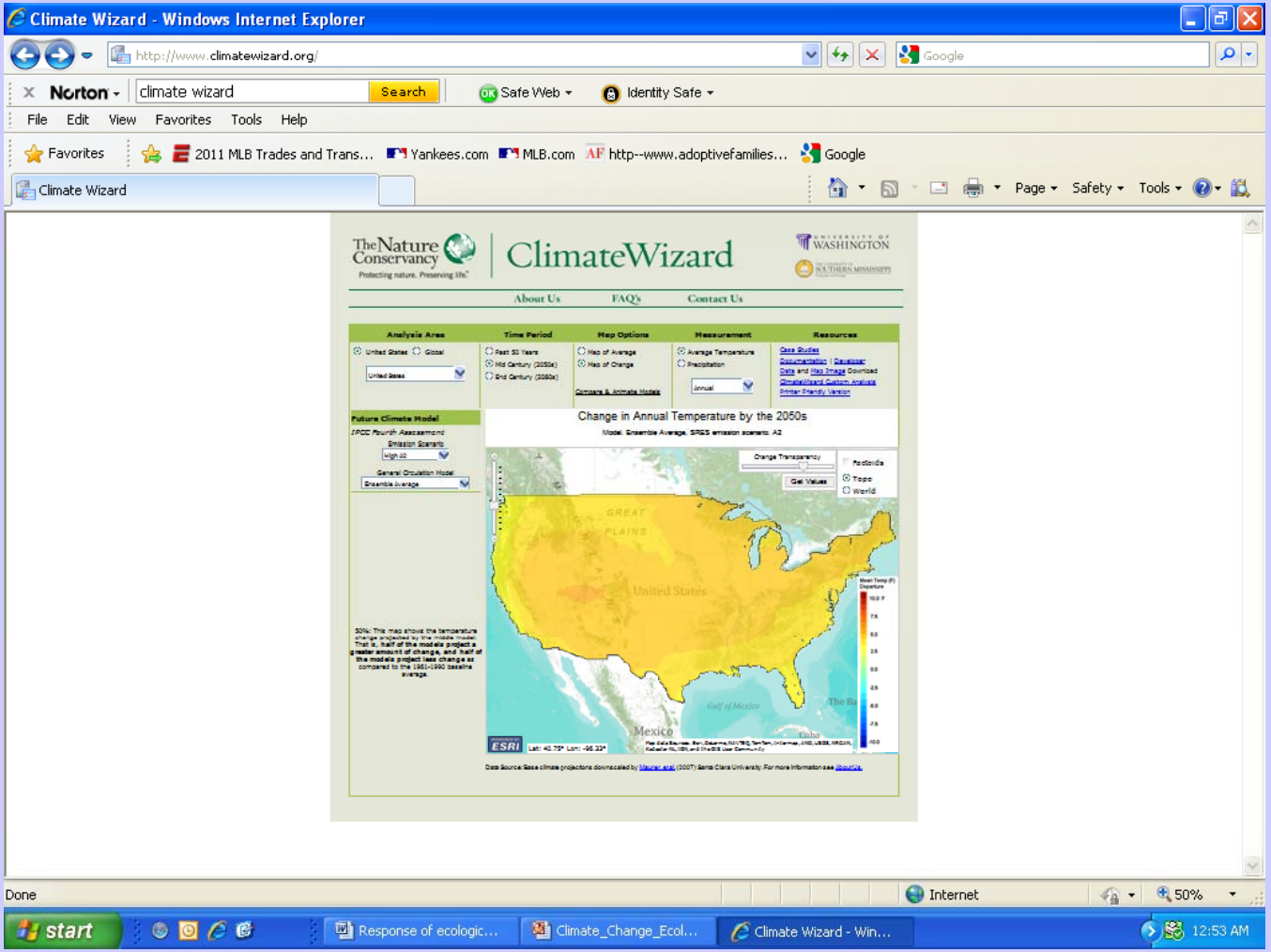
- Number and type of rare species locations (NHP 2009)
- Bedrock and Surficial Geology types (TNC 2007)
- Landform diversity base on a topographic model (TNC 2007)
- Climate and elevation zones (WORLDCLIM)
- Regional Habitat maps, Streams networks, Lakes, Ponds (Various sources)
- Regionally compiled Wetlands (NWI)

Landscape context and natural land units

Connectivity between patches of habitat (Resistant kernel analysis –Compton 2007)

Climate Wizard

(The Nature Conservancy, University of Washington, University of Southern Mississippi)



Summary

- New Jersey supports a remarkable diversity of ecological communities, plant and animal species. Ecological systems, or complexes of communities/habitats, exist at an ecoregional scale.

- Predicting the response of these habitats to climate change is difficult due to the complex interactions between species and the environment.

- Enhancing or restoring ecosystem resilience may help these habitats adapt to projected climatic changes. Protecting land in geologic corridors and coastal habitats could improve migration capacity.

- New tools, such as NatureServe's Habitat Climate Change Vulnerability Index, are being developed to help conservation biologists, land owners and managers evaluate habitat integrity and sensitivity to threats in the face of climate change.

- Land acquisition and management can be guided by the predictions developed with these climate change tools and ecological models. Monitoring is critical to develop adaptive management strategies.

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