# Climate Change Research: Monitoring and Detection

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# Environmental Monitoring

- What we need to know and why
- Monitoring design for detection of climate change impacts and carbon management
- Examples of some climate change monitoring, research and integrated assessments

# Indicators for Detecting Climate Effects on Forests

- Physiology: NPP, soil respiration
- Species distributions: composition, geographical range, abundance
- Vegetation structure
- Phenology
- Natural disturbances and mortality
- Hydrology
- Possible causes: e.g., climate, air pollution

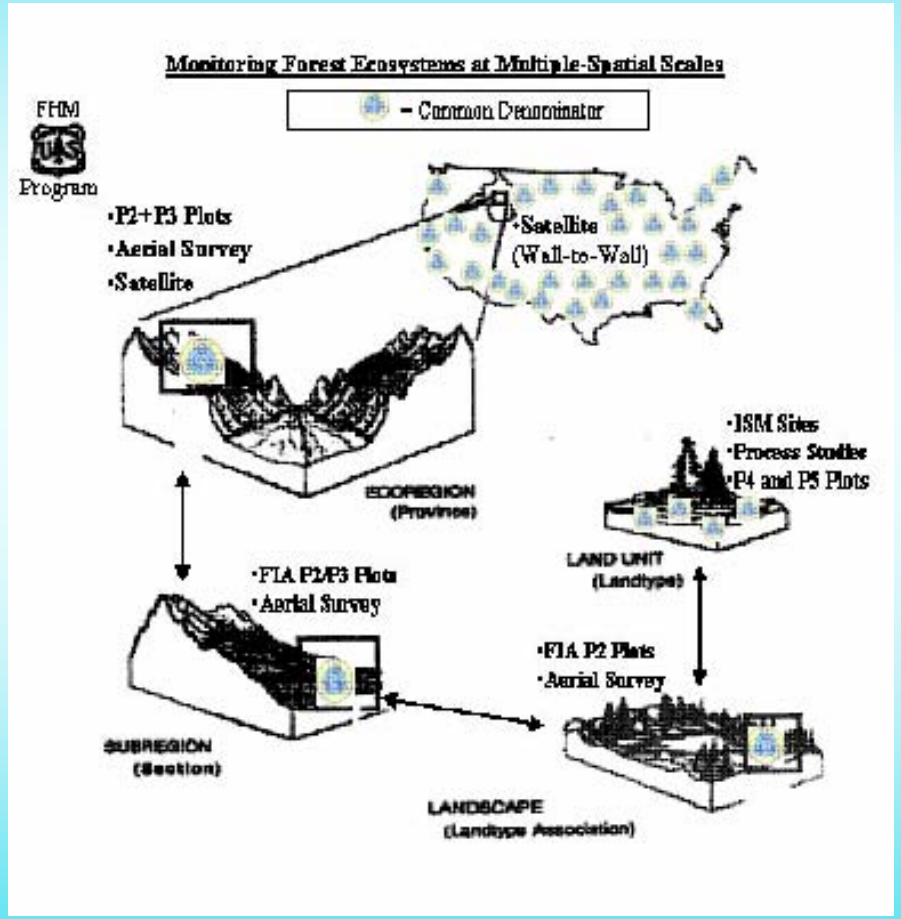
# Indicators for Monitoring The Carbon Cycle

- $CO_2$ flux
- Net primary productivity
- Net ecosystem productivity
- Land use/land cover
- Vegetation structure and biomass
- Soil carbon
- Natural disturbance and management
- Harvested products
- Climate and meteorology

# Examples of Climate Change Research

- Can the NJ Pinelands Monitoring System Detect Impacts of Climate Change: Multi-tier, multi-scale monitoring and research approach
- Effects of Long term, ecosystem level $CO_2$ and $O_3$ fumigation on Apsen clones and other deciduous species: AspenFACE
- How can you predict multiple stress interactions: Ecosystem process modeling
- Effects of Elevated $CO_2$, Temperature on Invasives: Urban to Rural Gradients

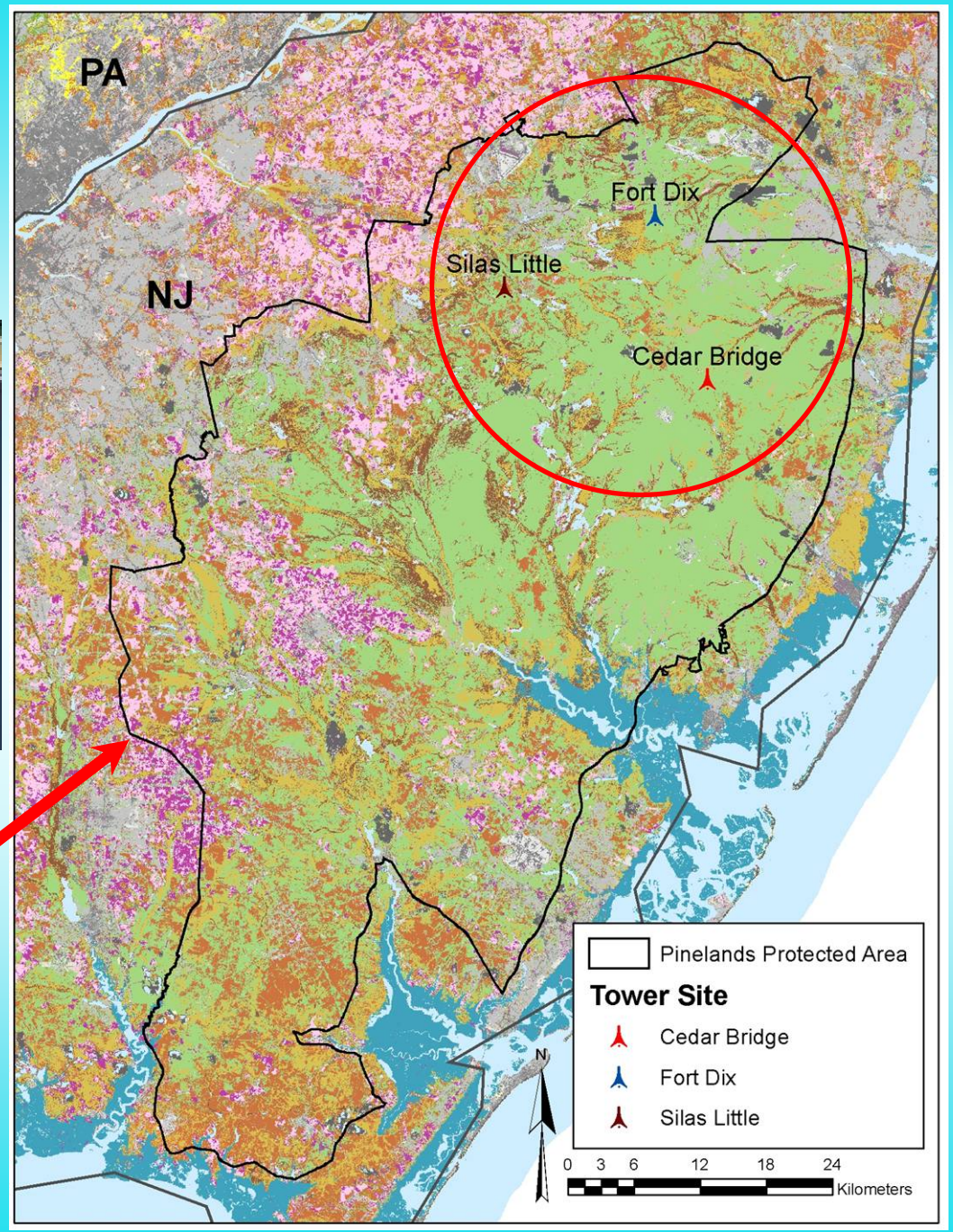
# The Multi-tier Approach to Monitoring Links Extensive Observations with Intensive Ecosystem Process Studies




USFS approach to forest health monitoring

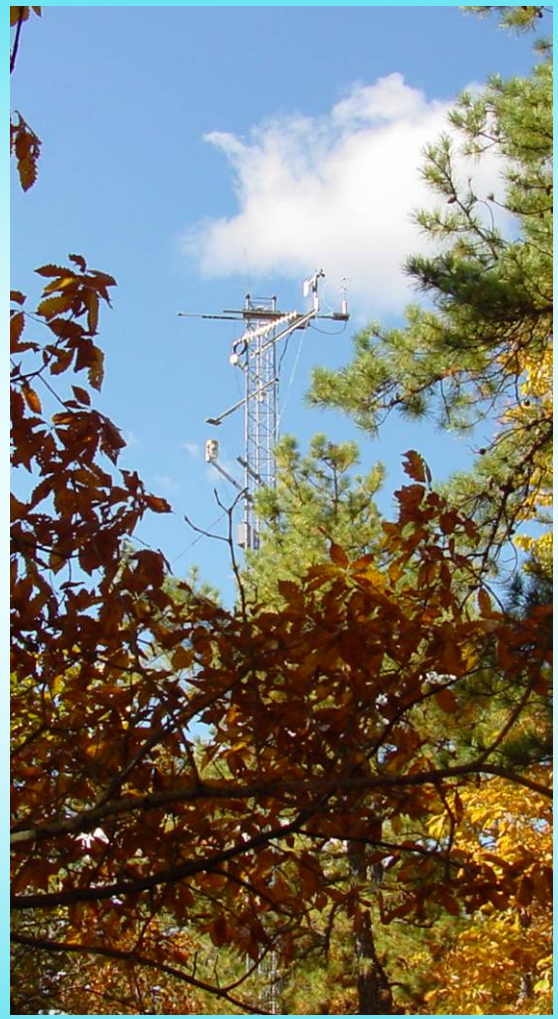
NASA MODIS with field validation – “bigfoot”

# Example: a Multi-tier Monitoring Site

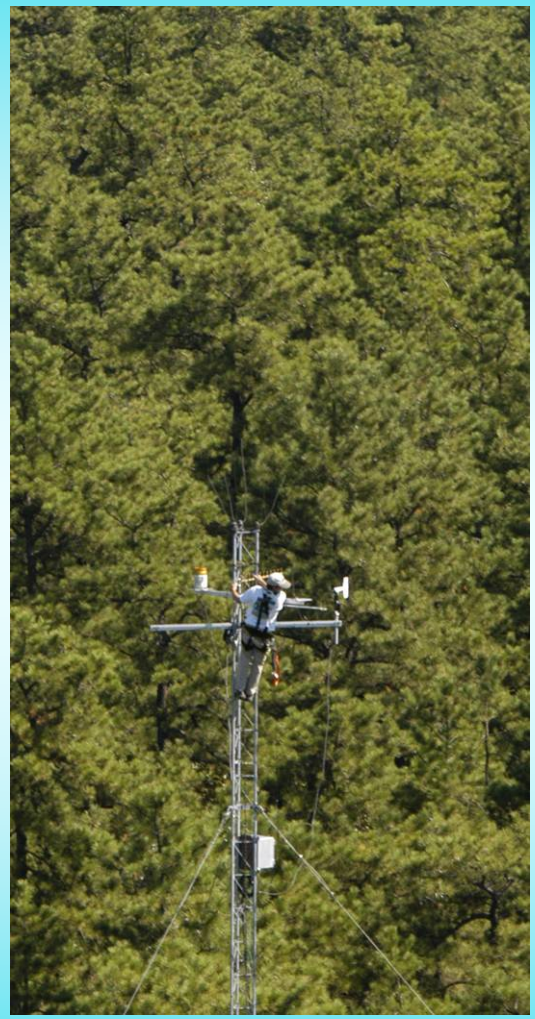


# NJ Pinelands Eddy Flux Sites

Oak/Pine – Silas Little



Pine/Oak- Ft. Dix

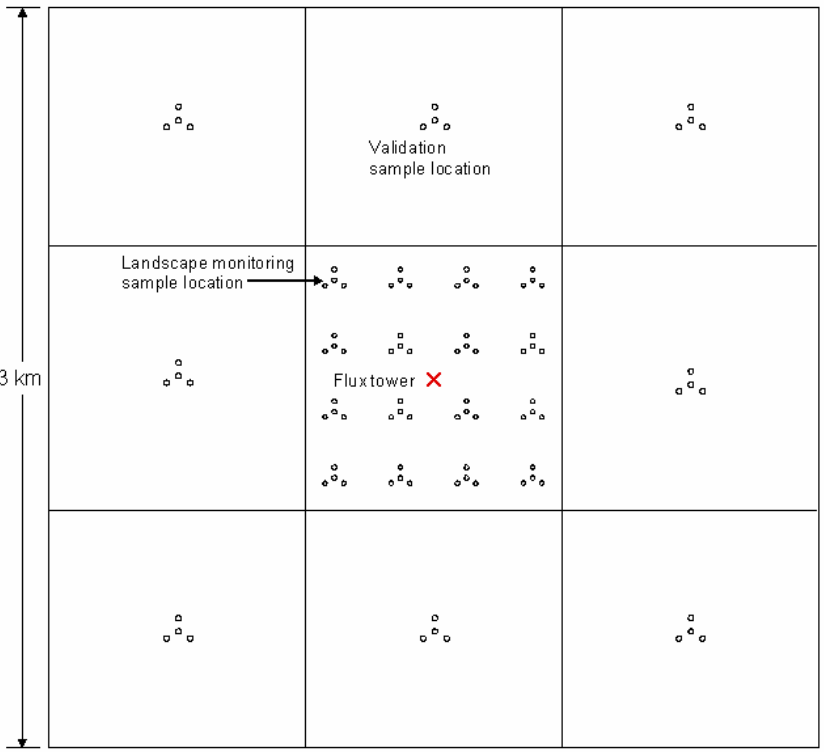


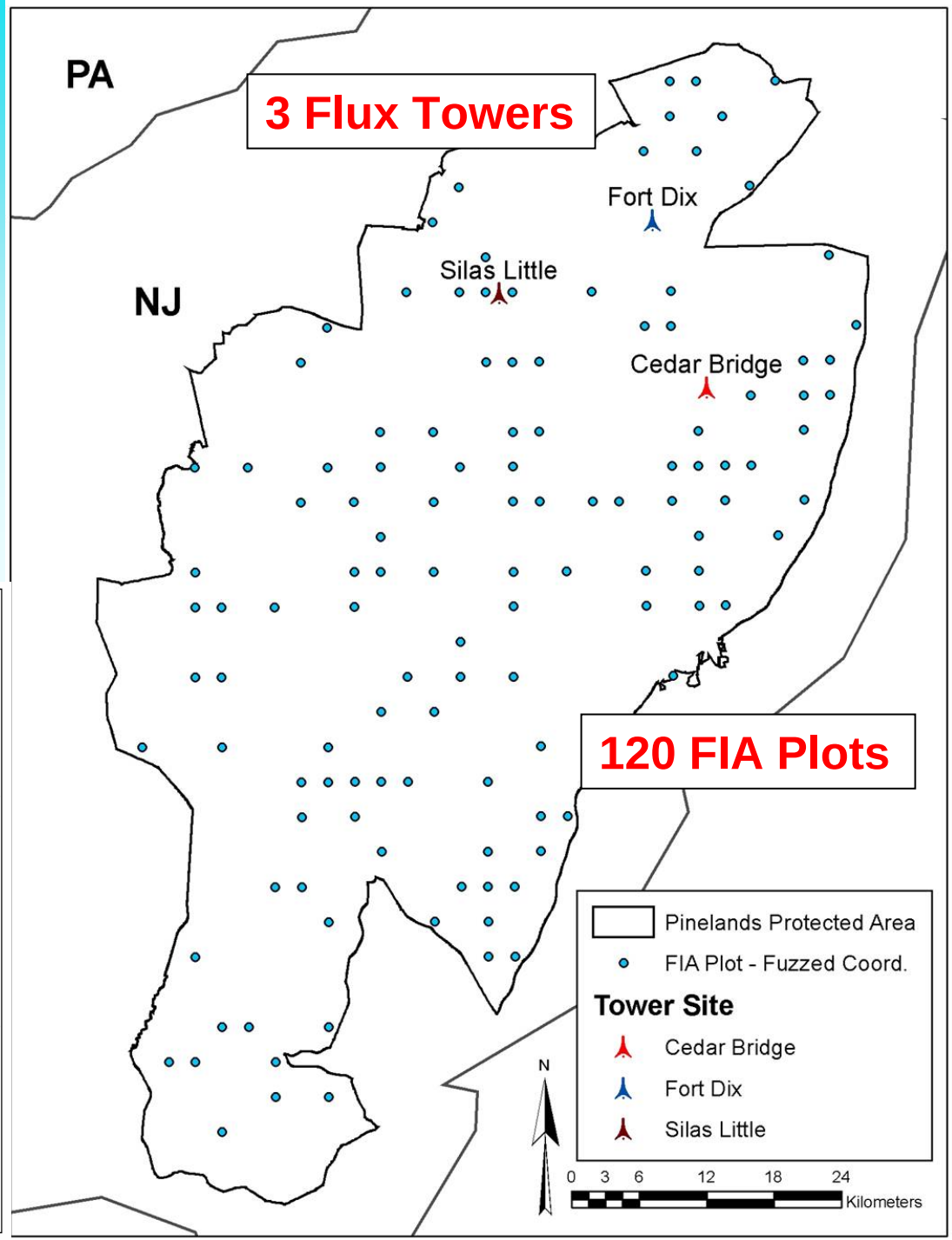
Pine/Scrub Oak-
Cedar Bridge

# Monitoring Research

## Multi-tier Data Sets for NJ Pinelands Protected Area

**At Each Tower:** Dense Network of FIA Plots with additional carbon measurements

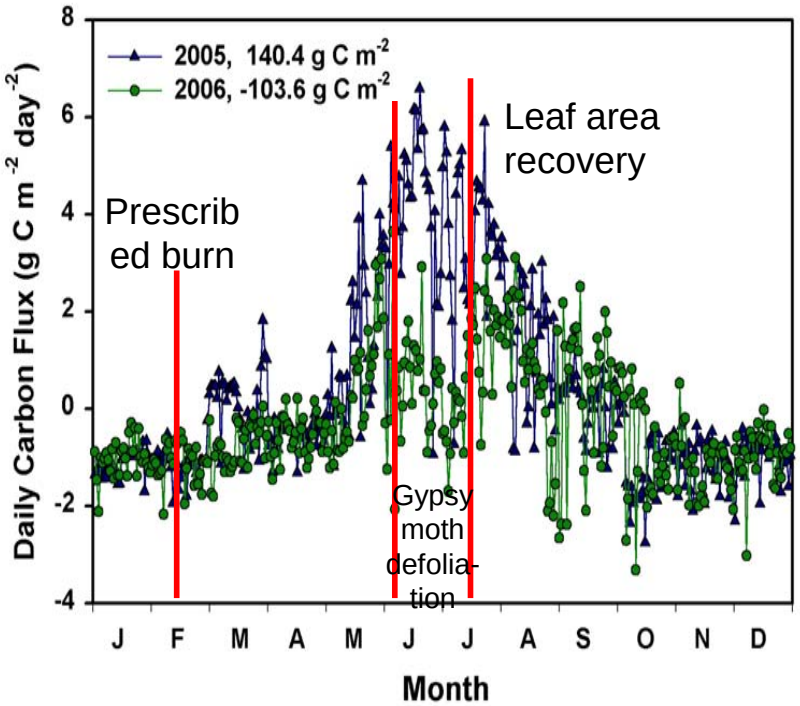


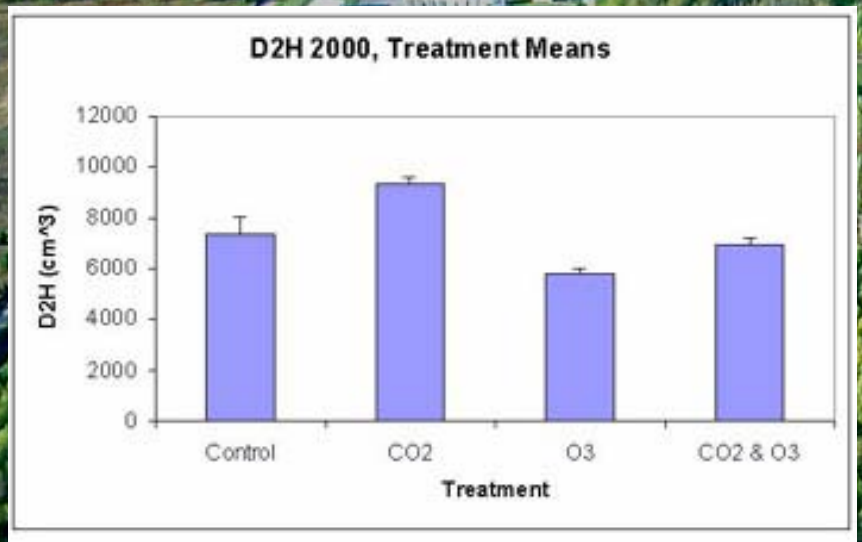
# Can the NJ Pinelands Monitoring System Detect Impacts of Climate Change?

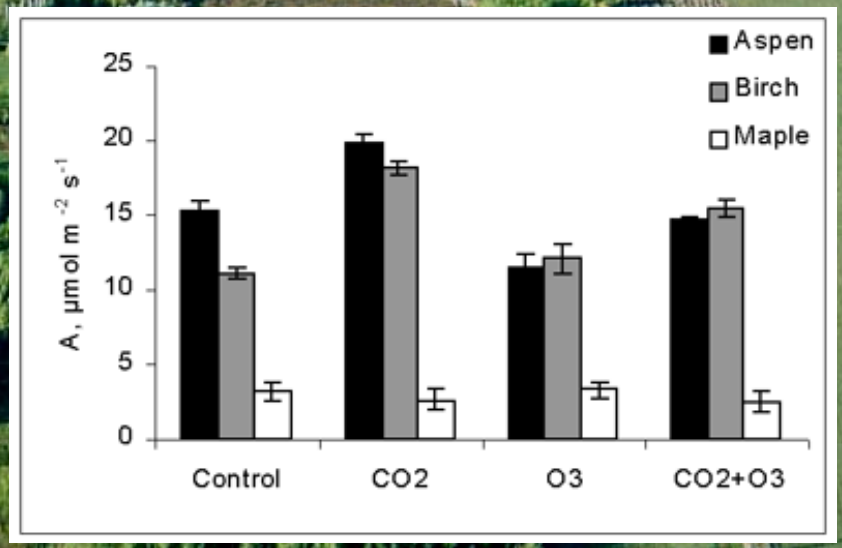
- **FIA data for species composition, long-term growth and mortalilty**
- **Intensive biometric measurements (e.g., soil respiration, veg. structure)**
- **Flux towers for climate variability and disturbance impacts**
- **Ability to conduct vegetation management experiments**
- **Urban to rural gradient to simulate $CO_2$ and warming**
- **Models for analysis, synthesis, and projections (PnET-CN, CASA)**
- **Stakeholders: NJ Pinelands Commissions, NJ Forest Fire Service**

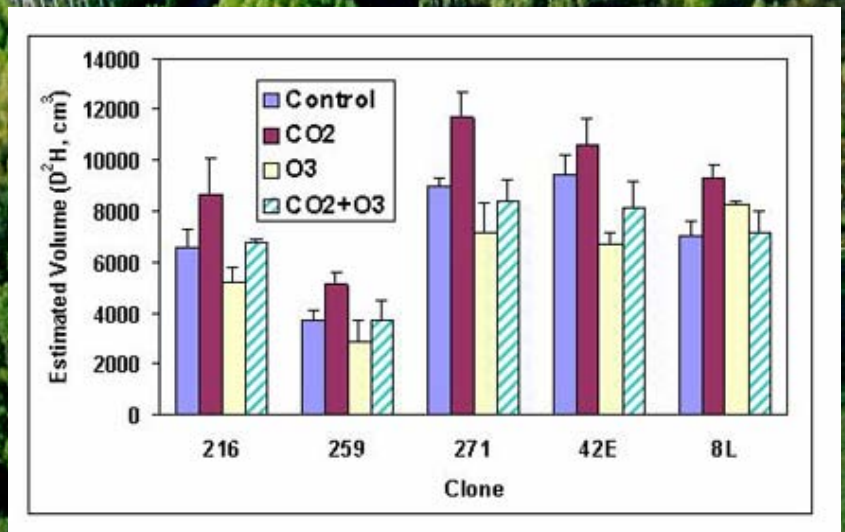
**Climate variability and defoliation impacts on $CO_2$ Flux**



# AspenFACE – Facing the Future
# Ecosystem level $CO_2$ and $O_3$ fumigation

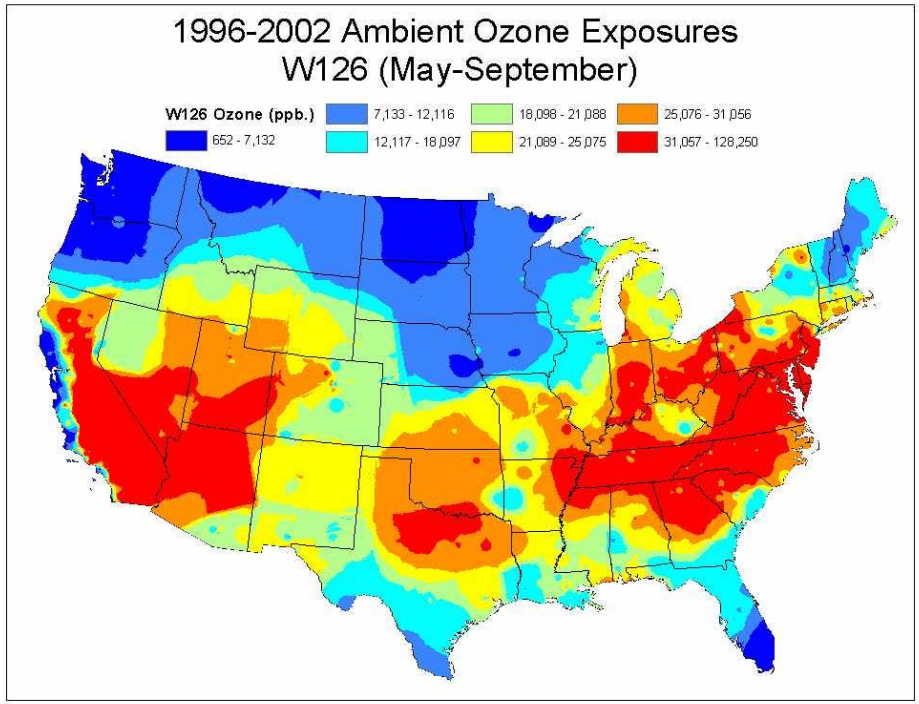


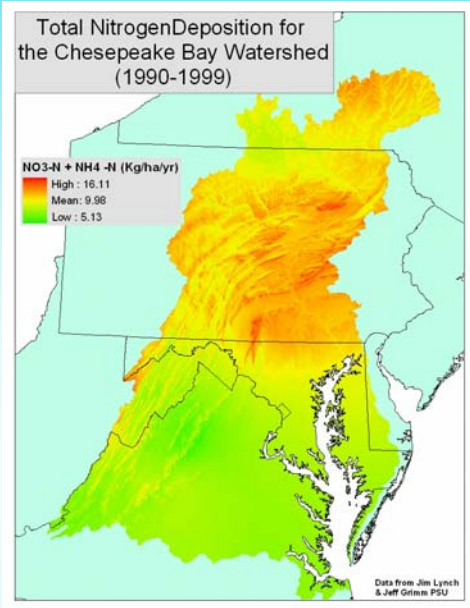



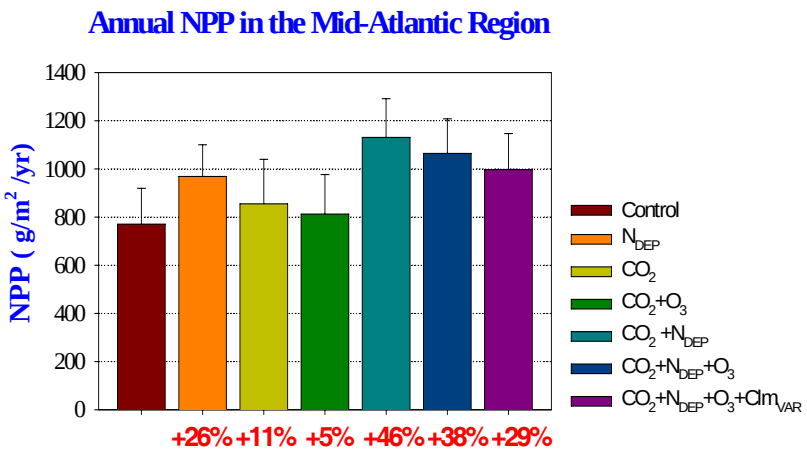

- **CO2 and O3 interaction: overestimation of CO2 effects by modelers without O3**
- **Sensitive species and clones**
- **Ecosystem level effects**
- **Delay autumn senescence**
- **Species compositional changes with CO2 and O3**
- **Aspen and birch insects and diseases may**

# Multiple Stress Factorial Model Experiments Using Ecosystem Process, Spatial Modeling



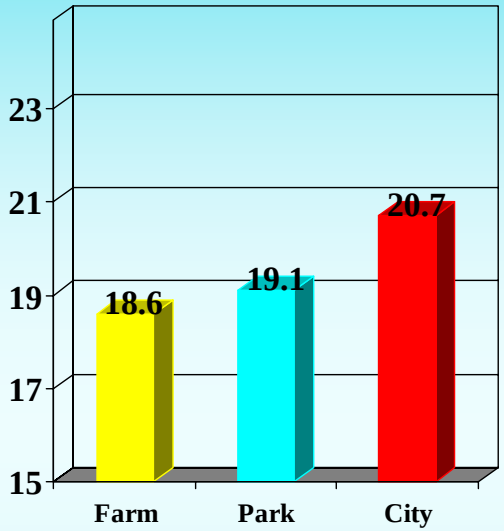




- **Identify sensitive regions,**
- **Identify sensitive forest types**
- **Predict long term effects of multiple stress interaction**

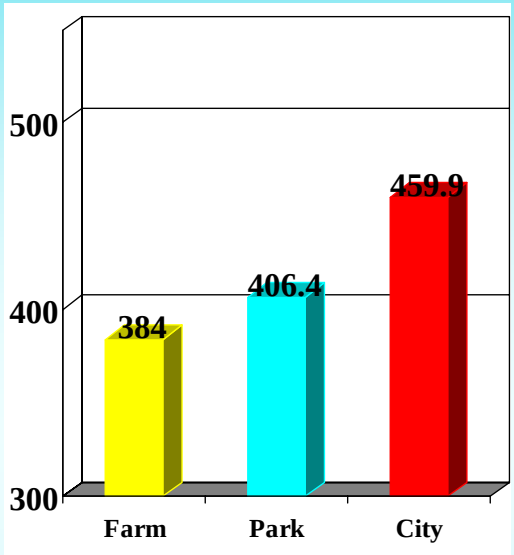


# Urban to Rural $CO_2$ and Temperature gradient: Biomass and Invasive Species

Temp




CO2

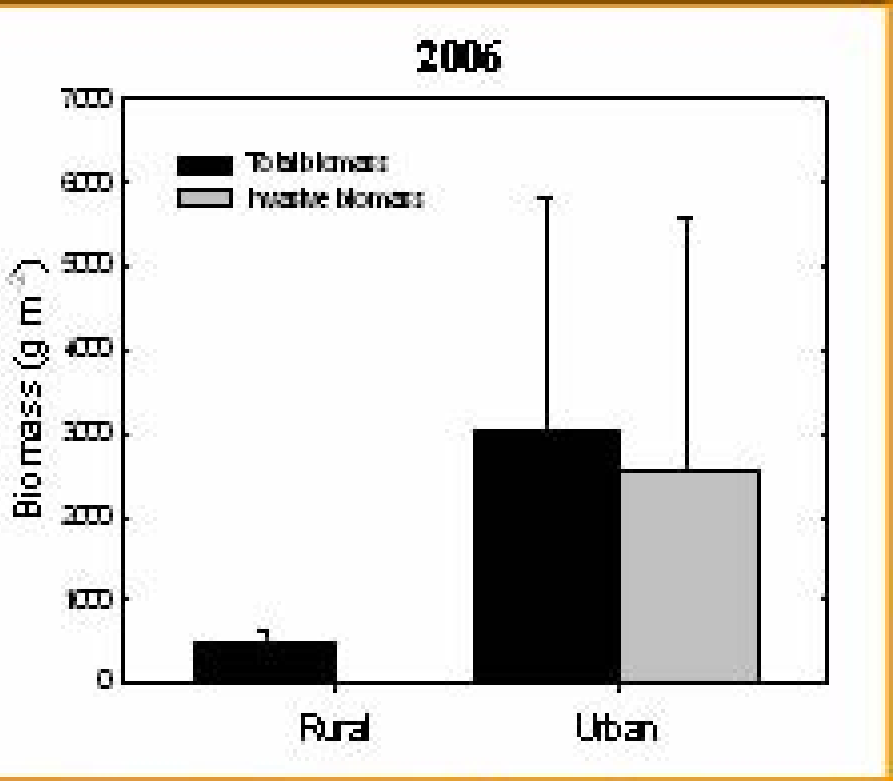



City - high, 511 ppm

Park - mid

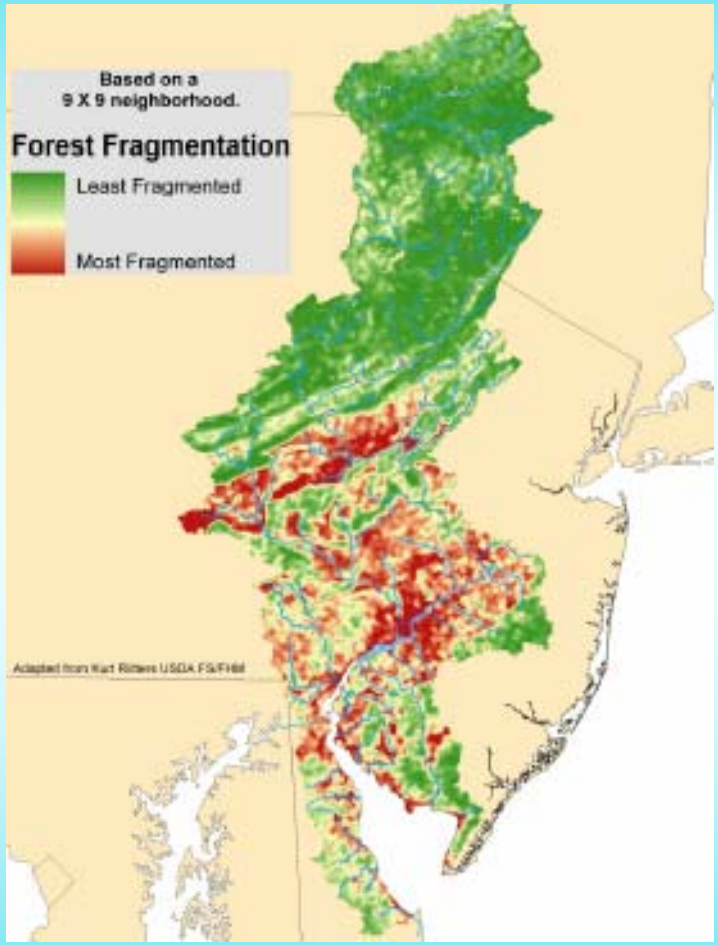
Farm - low, 386 ppm

# Weeds and Climate Change: Real Time: After 5 years



# How to Adapt Forests to Climate Change

- Reduce the impacts of other stresses: air pollution, insects and diseases
- Avoid creating barriers to species migration such as forest fragmentation
- Monitor forest health to provide “early warning” of impending effects
- Continue research to understand how forests are vulnerable and what managers can do
- Help resource managers understand current and prospective threats from climate change




**Fragmented forests of the Delaware River Basin**

# How Can We Respond to Climate Change?

***A combination of:***

- **Adaptation** – anticipate changes and adjust forest protection and management
- **Mitigation** – reduce emissions or increase sequestration of greenhouse gases
- **Research!**

**Intensive monitoring of forest/atmosphere carbon exchange**

# Conclusions: Climate Change Research and Environmental Monitoring

- Objective research, science-based monitoring and analysis is needed for policy and management – debate can focus on actions rather than data
- Need for reporting and verification for carbon management
- Current monitoring networks can be integrated and augmented to address specific analysis needs

# Thank you!