Interactions among Climate, Land Use, Ecosystem Services, and Society

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ECOSYSTEMS + SOCIETY

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Introduction

Ecosystem services are the foundation for economic vitality, environmental health, and clean water across the Granite State. Collectively, they support many of New Hampshire's major industries, sustain our health and well-being, and serve as an anchor for our cultural identity.

NH EPSCoR's *Ecosystems & Society* project integrated **ecosystem measurements, process-based models, and social science** to better understand how climate and land cover change affect key terrestrial and aquatic ecosystem services across multiple scales. It built a bridge between spatially and temporally explicit forest and hydrological models to the construction of indicators of ecosystem functioning that are interpretable by lay stakeholders.

## Ecosystem Sensors and Function

Integrated Sensor Network

A novel **high-intensity distributed sensor network** was built to better understand ecosystem function and the impacts of climate variability on New Hampshire ecosystems.

Data from the integrated sensor network was used to validate linked ecosystem models.

The integrated sensor network captures a wide range of ecosystem responses throughout the state; data collection is ongoing.

Aquatic Sensor Network

- Installed at stream headwater sites, large river sites, and at an extensive statewide aquatic network of stream and river sites
- Measured pH, dissolved oxygen, specific conductivity, temperature, turbidity, and nitrate
- 10 sites, fall 2012-present, 15 min temporal resolution
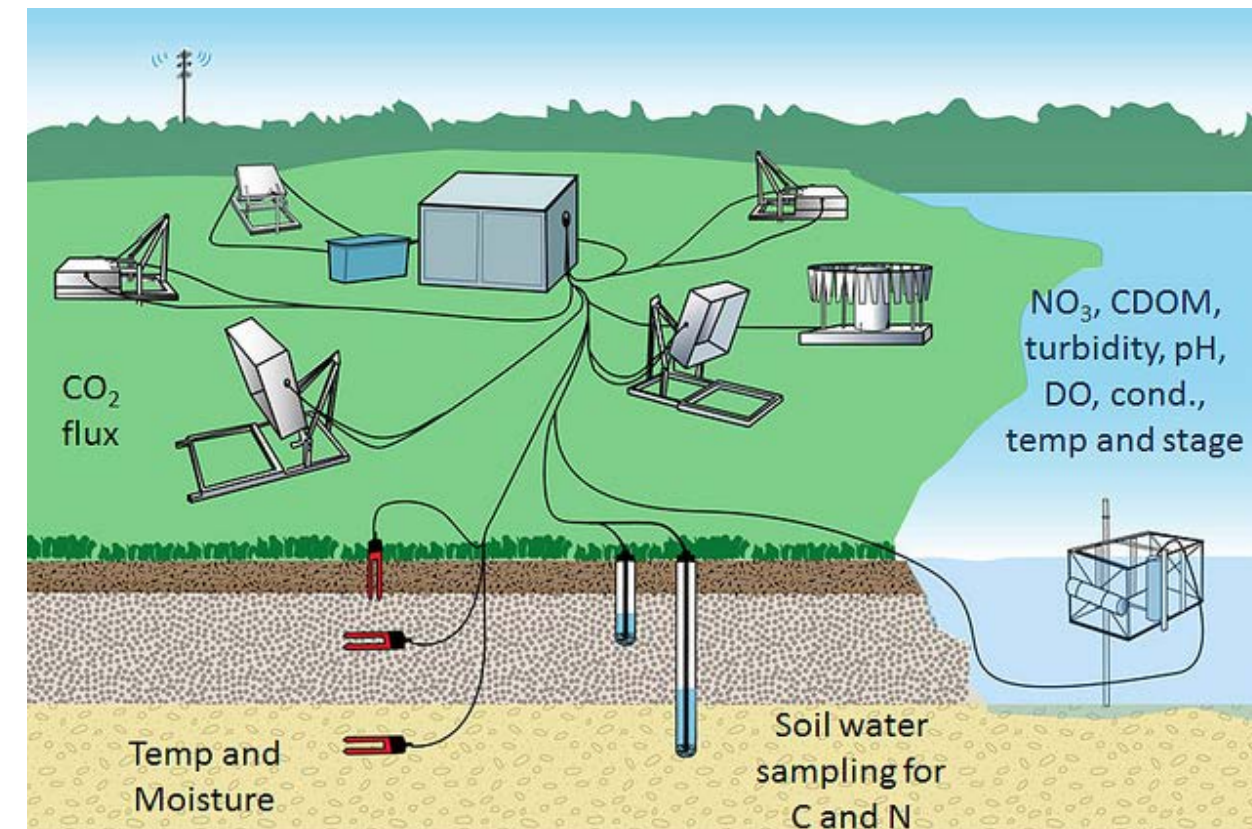
Integrated aquatic and soil sensor networks.

Soil Sensor Network

- The aquatic sensor network is integrated with a soil sensor system to provide coupled measurements of vegetation, soil conditions, snow cover, and headwater stream response
- Measured precipitation, wind speed and direction, air temperature, soil temperature, soil moisture, soil specific conductance, soil profile carbon dioxide concentration, snow depth, snowpack carbon dioxide concentration
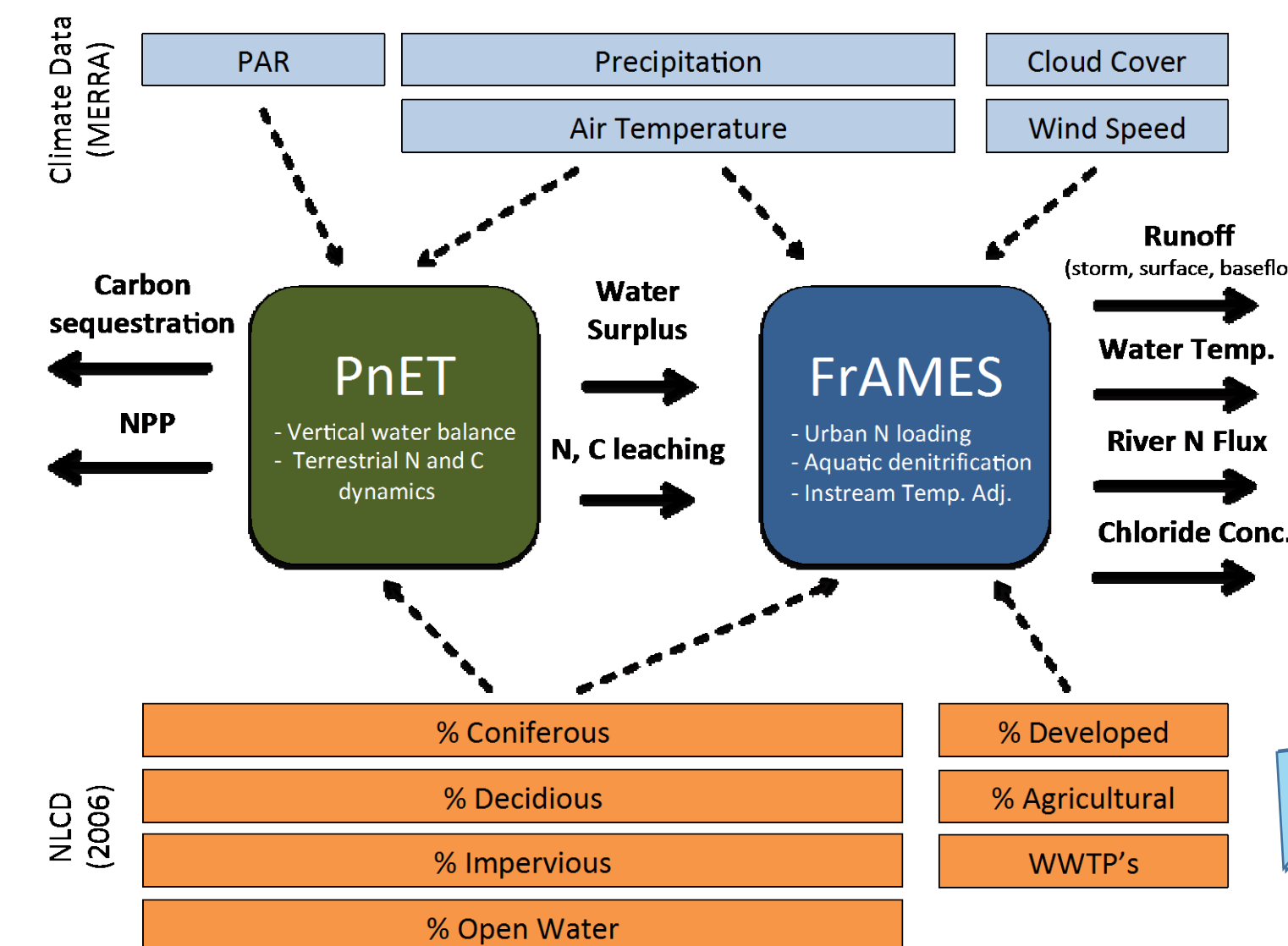- 6 sites, fall 2012-present, 10-60 min temporal resolution
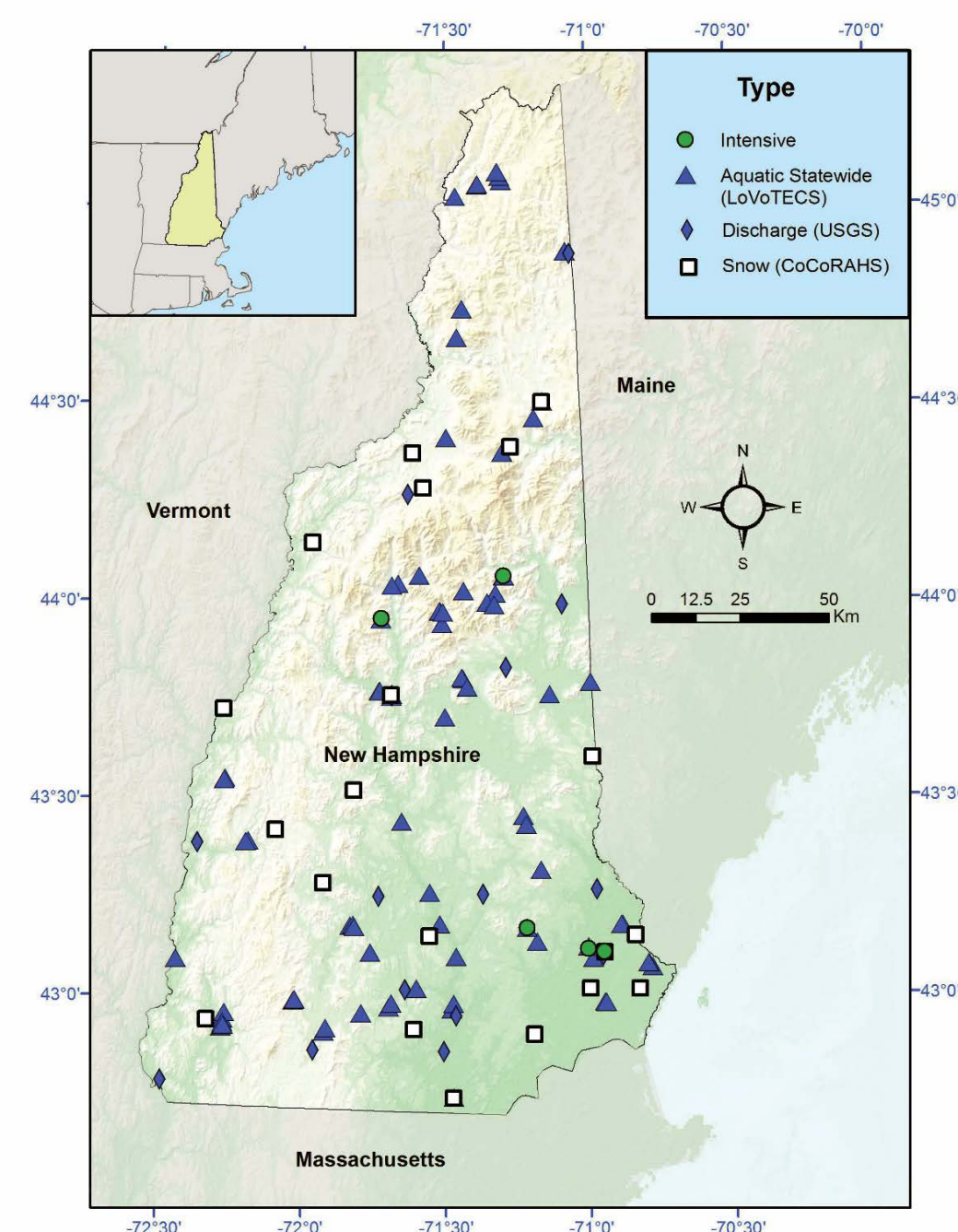
Sensor data was collected from 146 sites across NH.

Ecosystem Modeling

Linked Terrestrial and Aquatic Models

Terrestrial and aquatic ecosystem process models were linked to simulate hydrologic and water quality characteristics related to ecosystem services at regional scales. Integrated two existing models:

- PnET, a forest ecosystem model – simulates forest water, carbon, and nitrogen dynamics
- FrAMES, a river network model – gridded model that represents land cover and land use to simulate runoff and nitrogen dynamics through watersheds
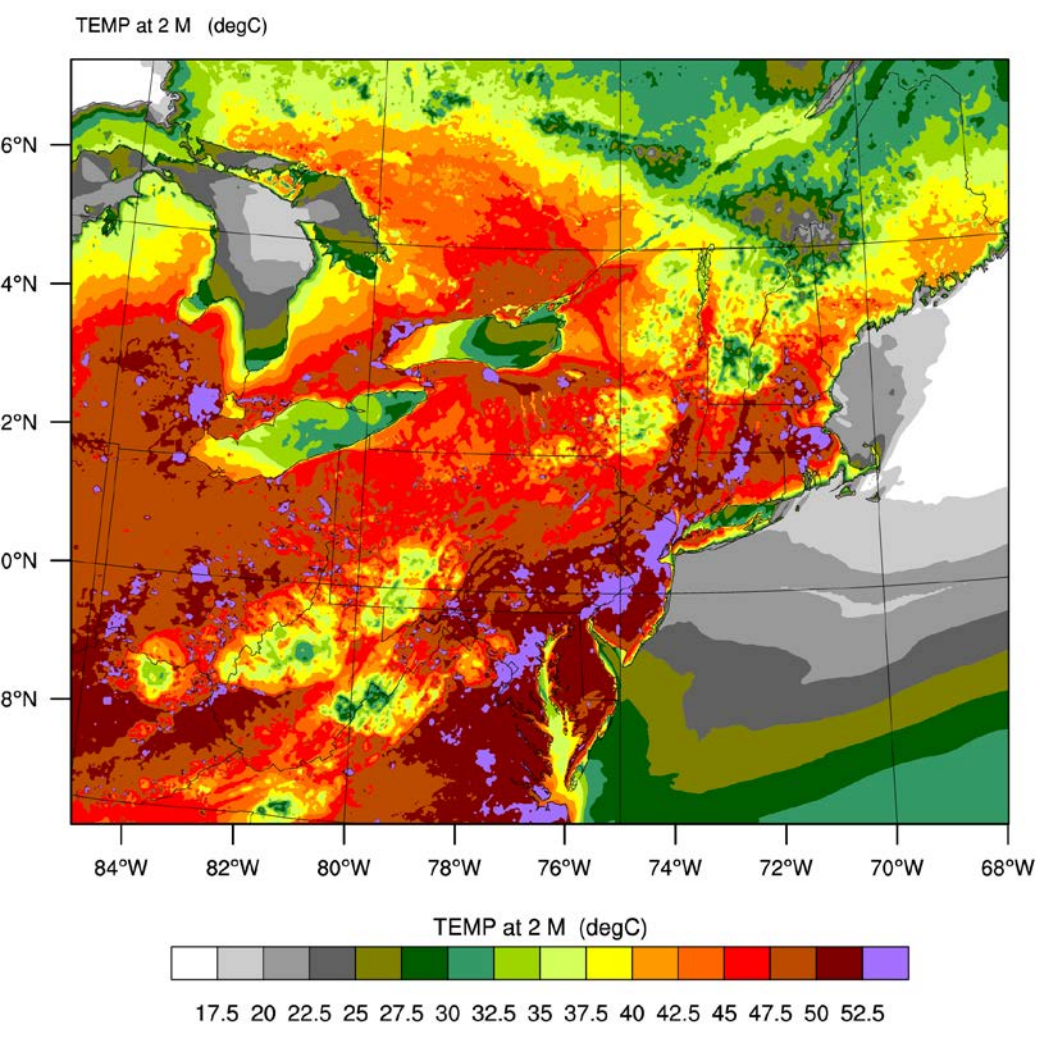

Land Cover Scenarios

A suite of land cover scenarios extending out to 2100 were developed to represent **a range of possible future land use conditions**. The scenarios span a continuum from spatially dispersed development to concentrated development.
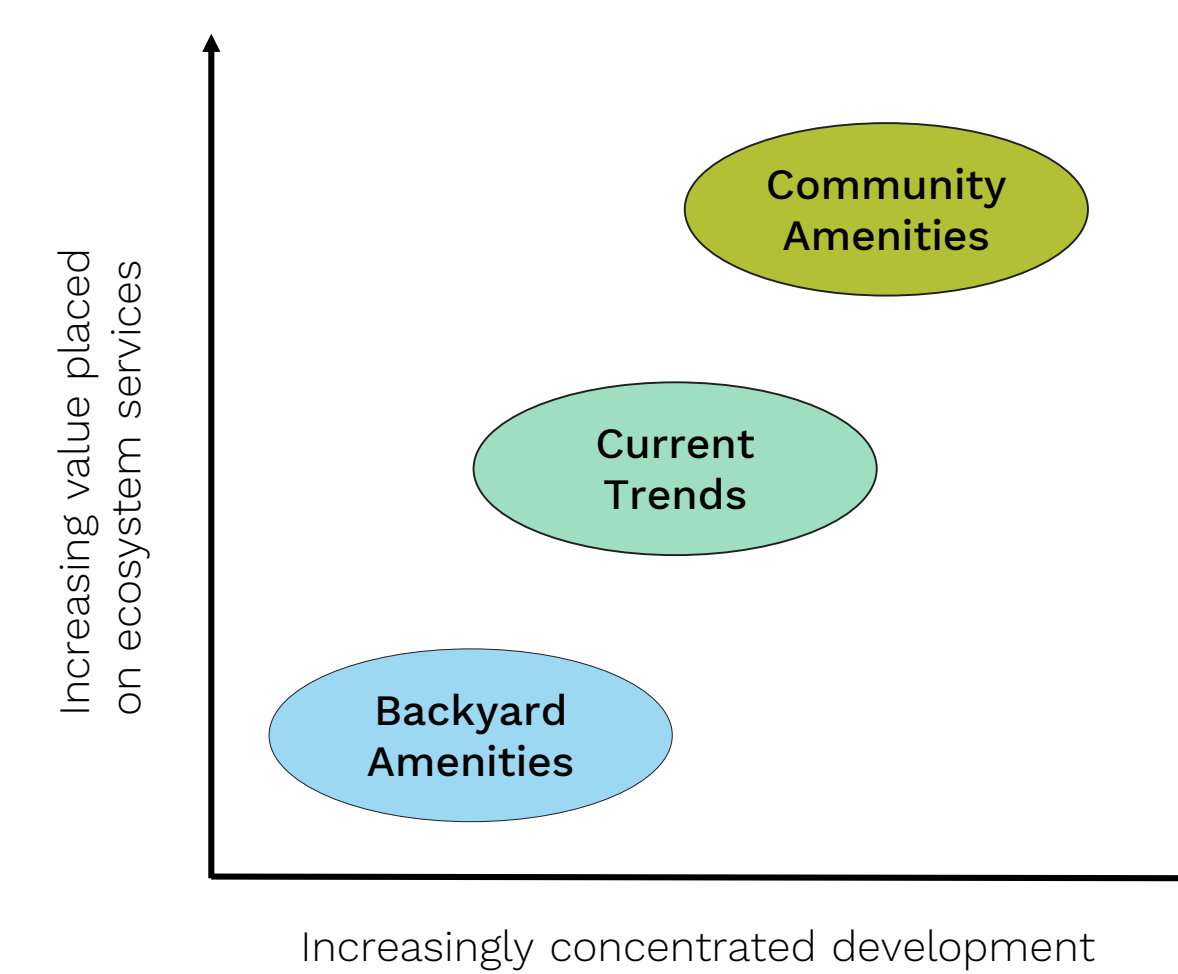
- Four land cover scenarios – no change, current trend (linear), community amenities (high value placed on ecosystem services), backyard amenities (low value placed on ecosystem services)
- Also included rapid vs slow population growth variants, and protection of wildlands vs food sustainability goals

Research results and feedback from stakeholders were used to design an easily-understood suite of environmental indicators to represent climate, land, and water conditions.

New Climate Model Simulations

A new climate dataset was created for New England, consisting of more than 200 climate variables at 3km horizontal resolution and hourly intervals.

- Created by dynamically downscaling global model projections under a high impact emissions scenario
- High spatial (3km x 3km across NE) and temporal (hourly) resolution of the dynamic downscaling allowed for unprecedented examination of potential future changes in extreme precipitation and temperature

UNH Climate Dynamics Prediction Lab simulates a National Weather Service heat index for July 2100.
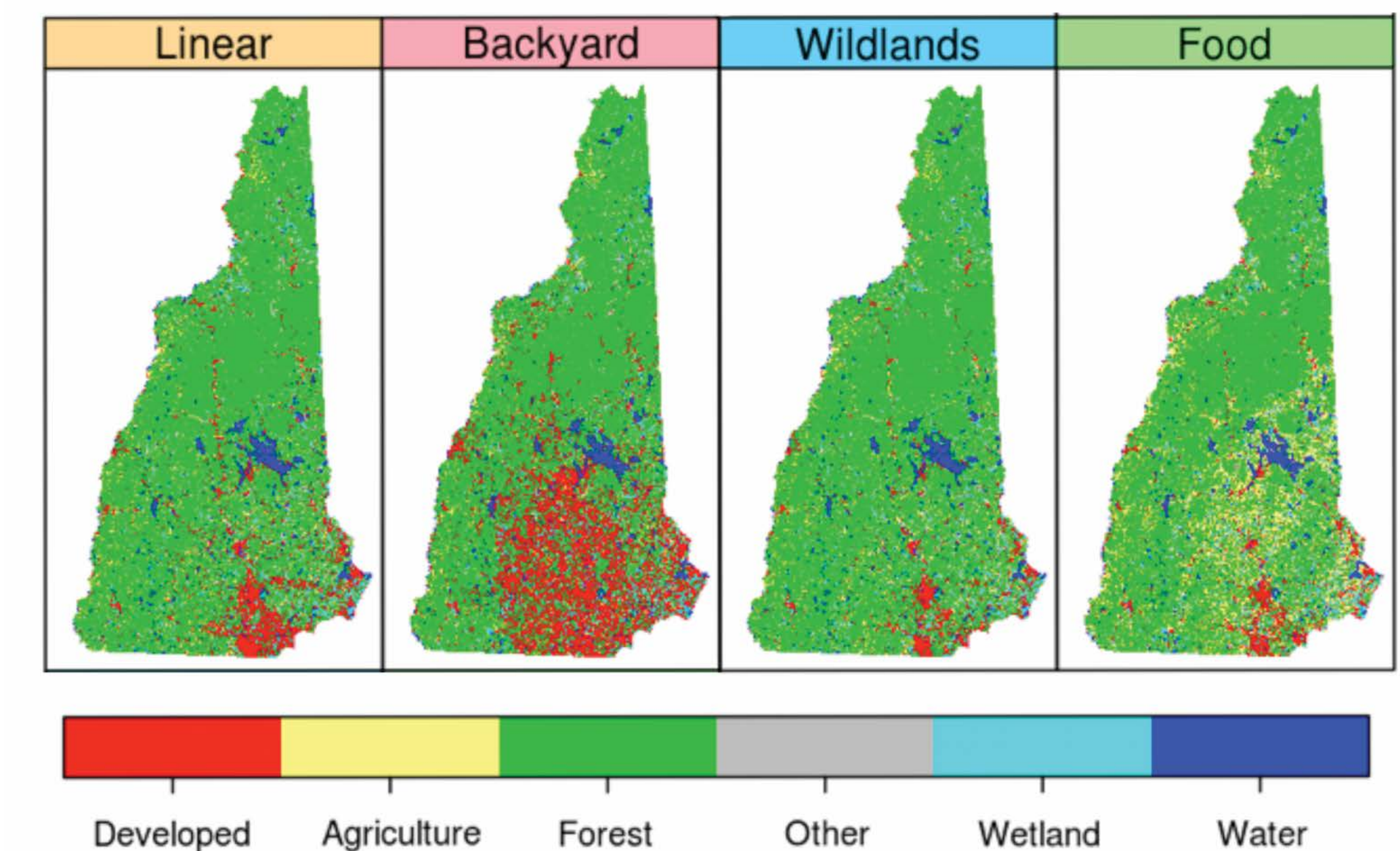
Statistically downscaled Global Climate Model Simulations and land cover scenarios served as key inputs for the linked ecosystem models.

Scenarios for land cover in 2100. Maps are shown for the Linear Trends (current trends) scenario, the Backyard Amenities (Backyard) scenario, and two scenarios from the Community Amenities family: Protection of Wildlands and Promotion of Local Food scenarios.

Human Dimensions

Human perceptions and response to ecosystems were measured through **surveys, interviews, workshops, and economic analysis** to understand how decision makers and other residents perceive and value a range of ecosystem services.


- **Deliberative stakeholder workshops** gauged social preferences regarding tradeoffs between different ecosystem services and tested hypotheses about the way deliberative groups form value judgements based on alternative presentations
- Research results were shared at **workshops for key stakeholders**, and feedback was used to link specific results to resource management needs

Deliberative stakeholder workshop.

Public Resources

Data Discovery Center

- Project data is available online at the NH EPSCoR Data Discovery Center, ddc.unh.edu
- The DDC provides data ingestion, hosting, query, visualization, and analysis tools for this and other projects
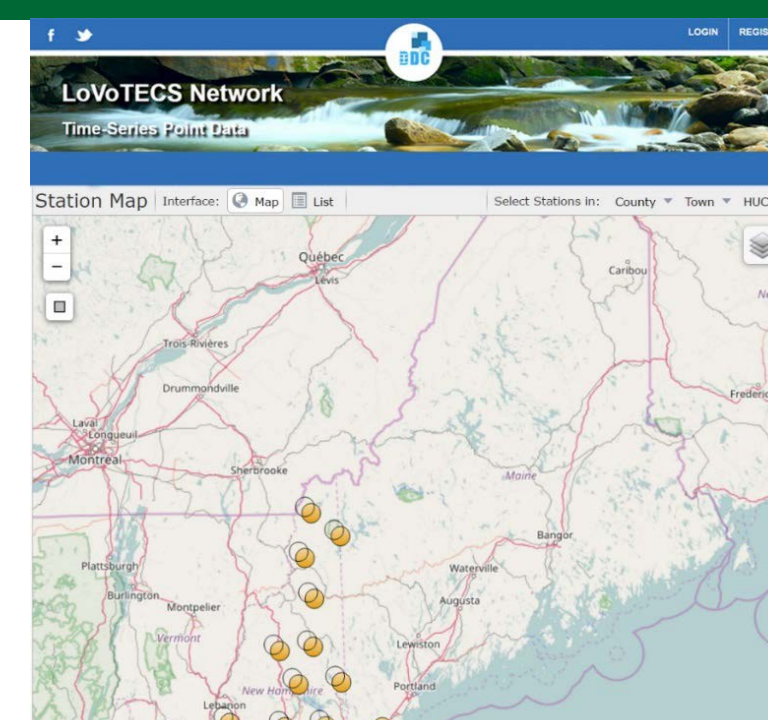
Ecosystems & Society Fact Sheets

- A series of 14 fact sheets based on key research indicators from this project that translate major findings as a resource for state agencies, municipals officials, regional planning commissions, and conservation organizations: nhepscor.org/climate-change-fact-sheets