Dynamic Modeling of Forest Ecosystem Processes and Services in North American Boreal Forests within the ABoVE Study Region

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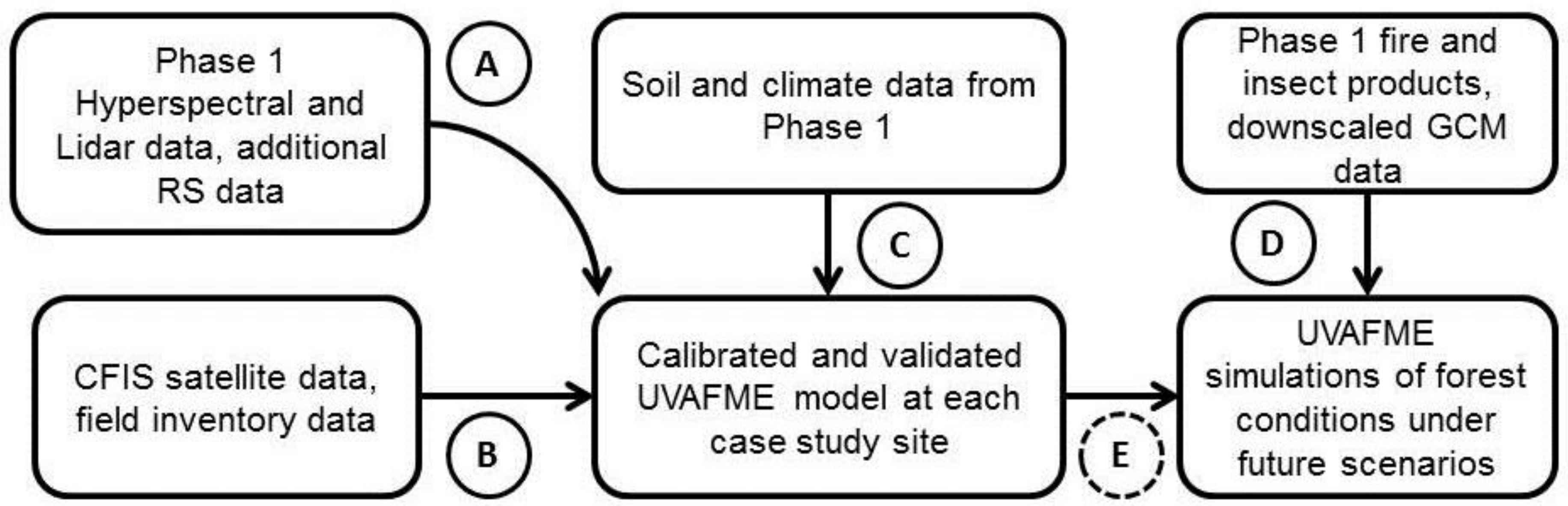
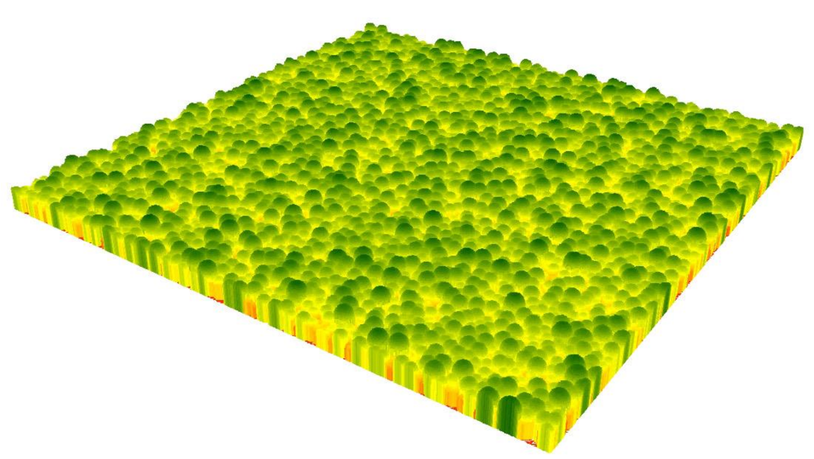
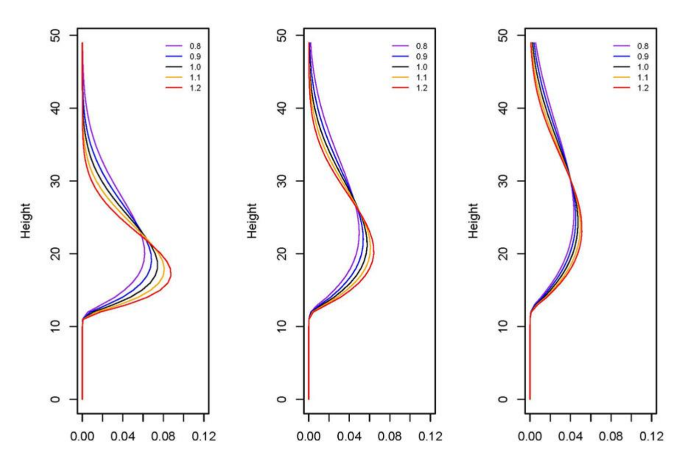
Science Objectives

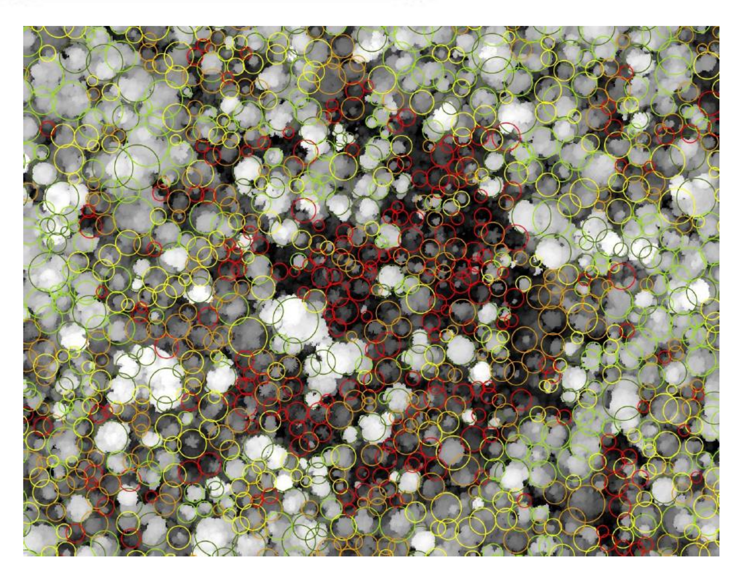
1.) Simulate the dynamics of forest patterns and processes under future climate and disturbance scenarios at two distinct case study sites using an individual-based forest gap model that has been calibrated and validated with remotely sensed products.

Our central hypothesis (**H1**) for objective 1 is that future changes in climate and disturbance will **substantially alter the structure and composition of forest ecosystems** across our case study sites (Tanana Valley State Forest, Prince Albert National Park).





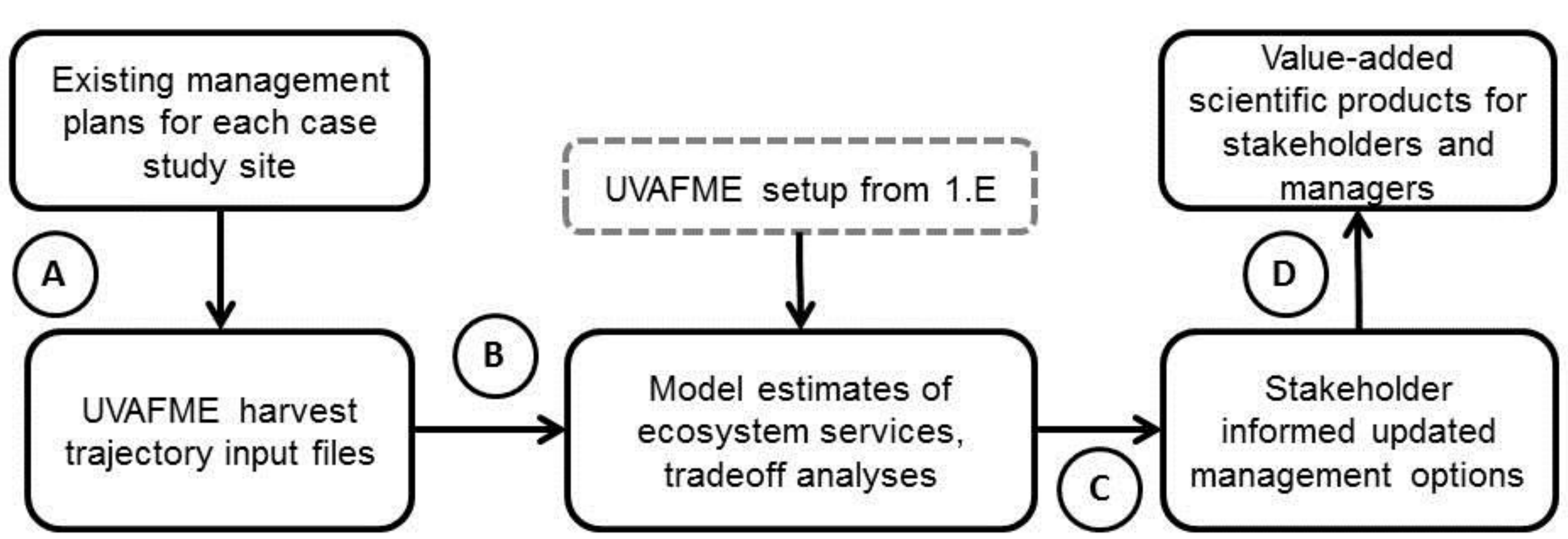




Comparisons between LiDAR returns and synthetic forests models based on DBH and height data (*Left, Center*) provide valuable training data for individual-based forest models (Palace *et al.* 2016). Automated crown detection algorithms and high-resolution LiDAR (*right)* will help initialize model runs.

2.) Assess tradeoffs in the delivery of ecosystem services under a set of stakeholder-informed management strategies at each study site using coupled forest-gap and ecological economics model output.

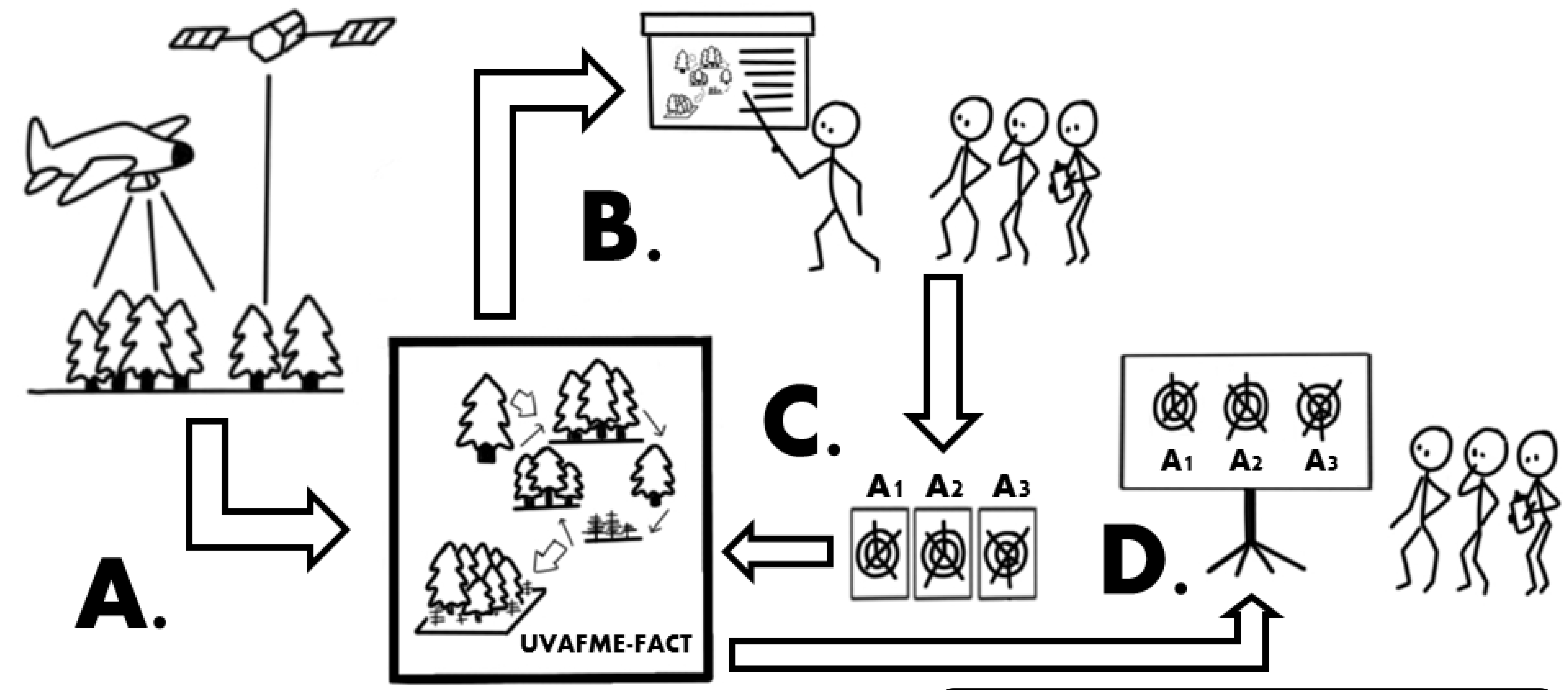
Our central hypothesis (**H2**) for this objective is that extending current forest management strategies will subsequently lead to **diminished provisioning of ecosystem services**; stakeholder-led adaptive management strategies will **mitigate these losses**.



Project Workflow

B. Gap models simulate birth, growth, death, gap and landscape dynamics of forest stands under climate and disturbance scenarios.

C. Model output is provided to stakeholder-based workshops and alternative management plans are elicited.



A. Remotely sensed products calibrate and initialize individual-based forest gap models.

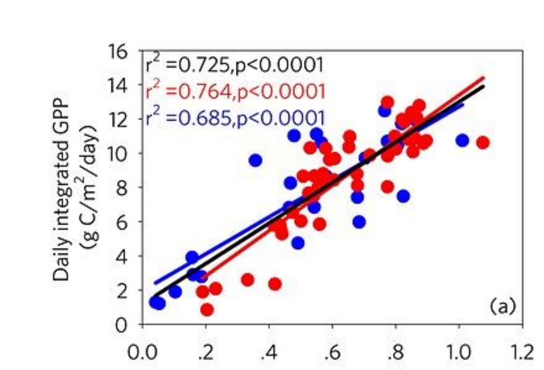
D. Simulations of alternative plans are analyzed from an ecosystem services perspective and provided to managers.

Linkages to ABoVE Phase 1 and Beyond

Our project is transdisciplinary and integrates novel techniques in the fields of remote sensing, forest ecology, decision science, and ecological economics.

Remote Sensing

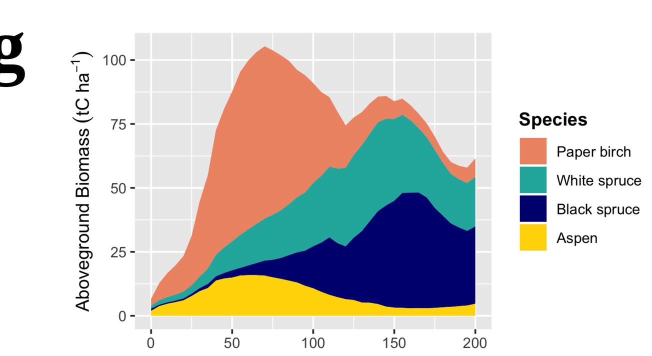
- LiDAR-based initialization of forest inventory sites.
- SIF-based estimates of GPP for model calibration.
- Utilization of ABoVE data products (LVIS, G-LiHT, CFIS, OCO-2, TROPOMI).



Yang *et al.* 2016

Ecosystem Modeling

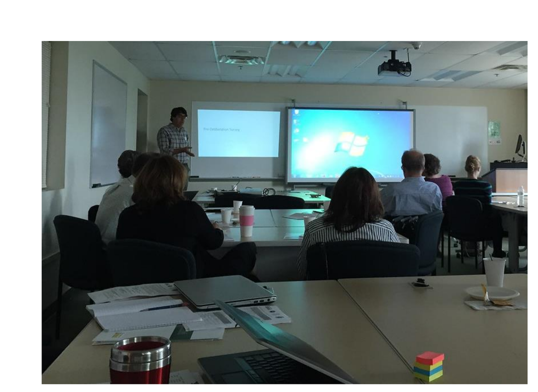
- Expansion of UV-FME to include harvest practices.
- Site initialization incorporating stocking density data.
- Analysis using segmentation algorithms (DBEST) and fast Fourier Transforms.



UVAFME Output by A. Foster

Decision Science

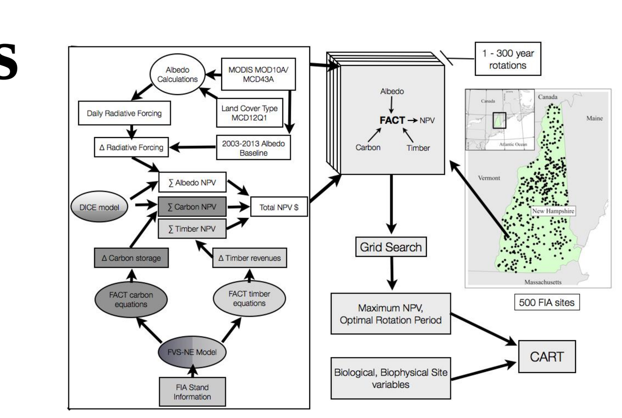
- Scenario construction in stakeholder workshops using multicriteria analysis with fuzzy pairwise comparison exercises.
- Integration of community values into management scenario and harvest inputs for model projections.



Stakeholder workshops will elicit community values to design future management scenarios.

Ecological Economics

- Integrate timber products and management strategies into a dynamic forest gap model.
- Add shadow prices of albedo and carbon in simulation runs for climate ecosystem services.
- Compare provisioning of ecosystem services using Bayesian-generalized linear models.



Prior methods to integrate these ecosystem service prices have been developed by the project team across the state of New Hampshire (Lutz et al. 2016)