Forest Biomass:

Wildfire, Ecosystem Services and Net Benefits of Bioenergy

Biomass to Energy

Mark Nechodom, PhD
Deputy Director,
USDA Office of Ecosystem Services and Markets
and Climate Science Policy Advisor, US Forest Service

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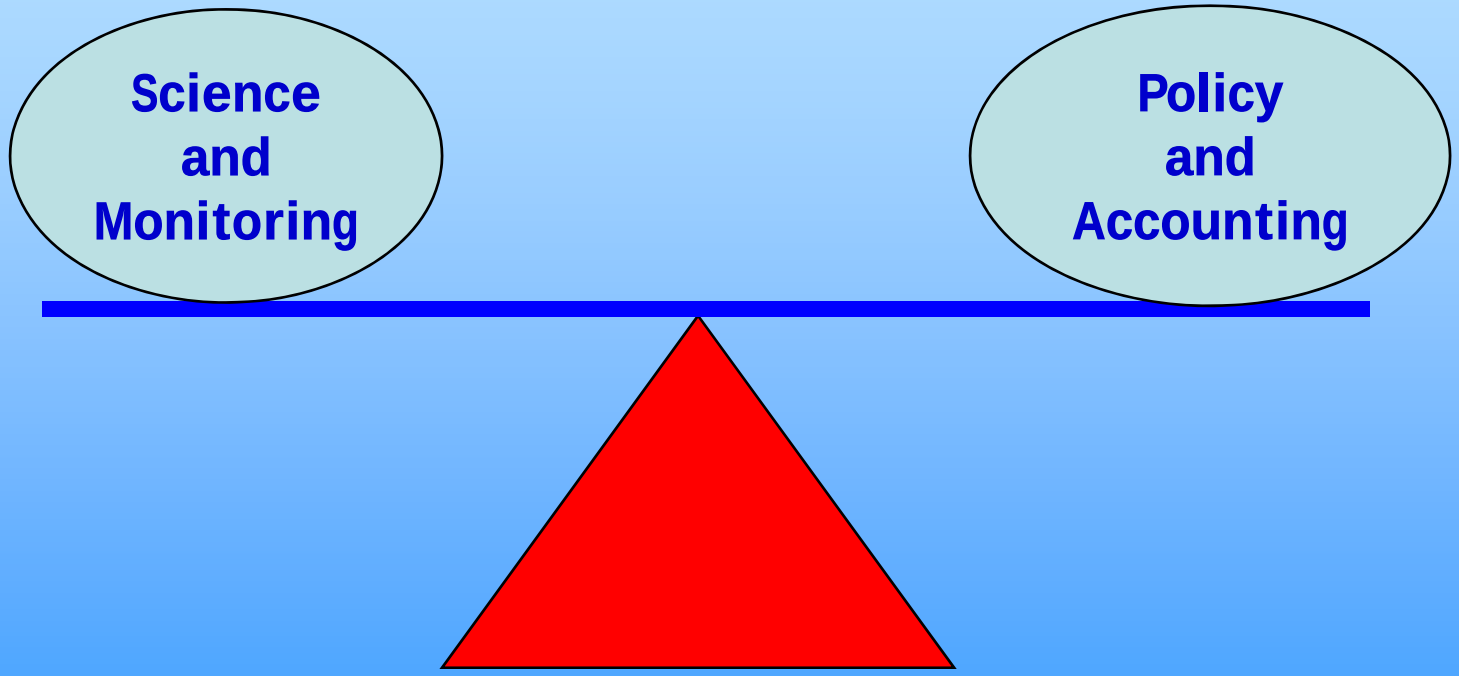
"Research Powers the Future"

Benefits of Bioenergy: What's in the balance?

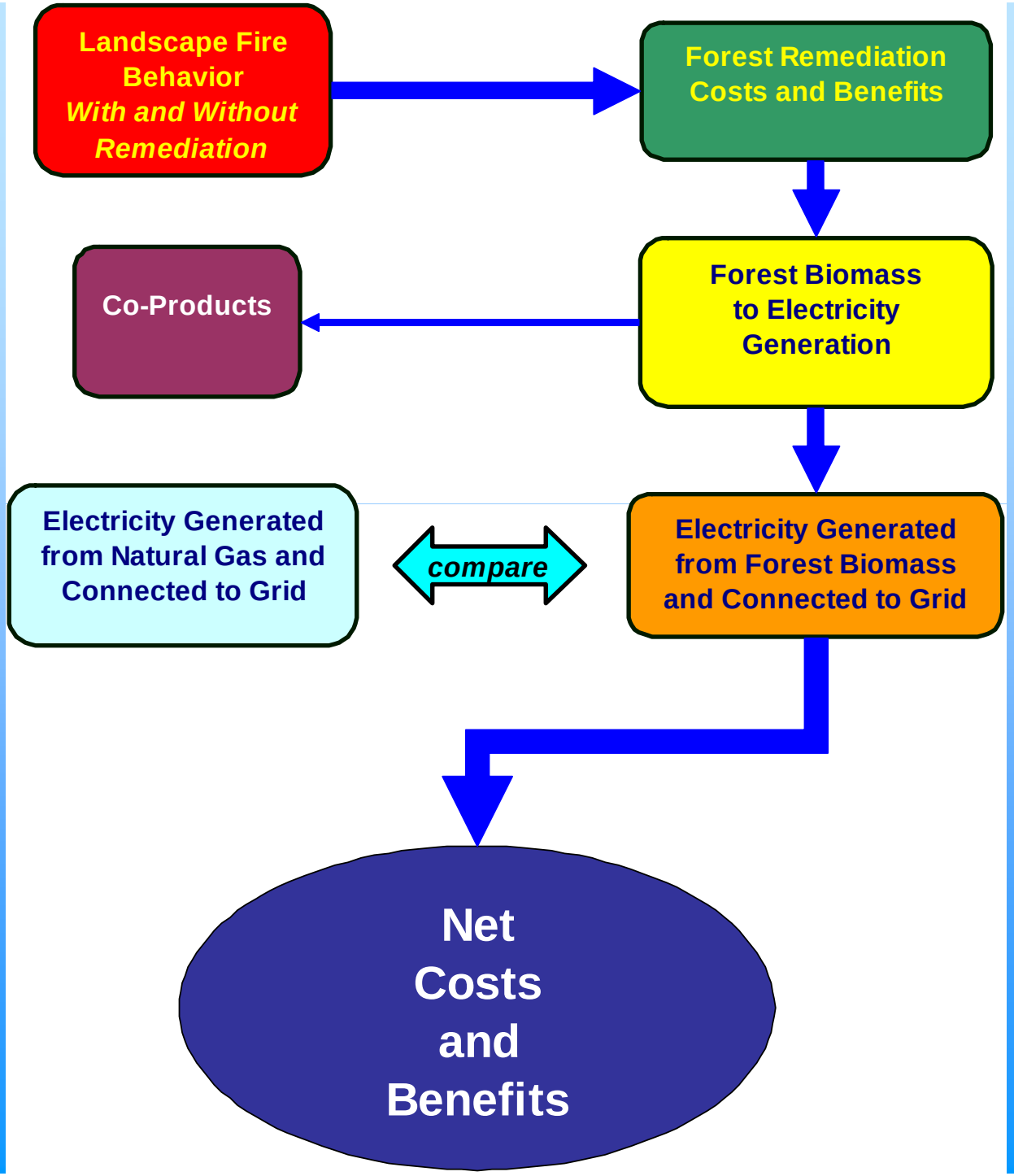


Biomass to Energy Project (B2E)

1. **Model LIFE CYCLE environmental & economic values of using forest biomass for energy production**
2. **Test effects of different forest management scenarios on wildfire behavior, total emissions and other environmental factors**
3. **Develop a decision-support framework to test policy scenarios**

Biomass to Energy

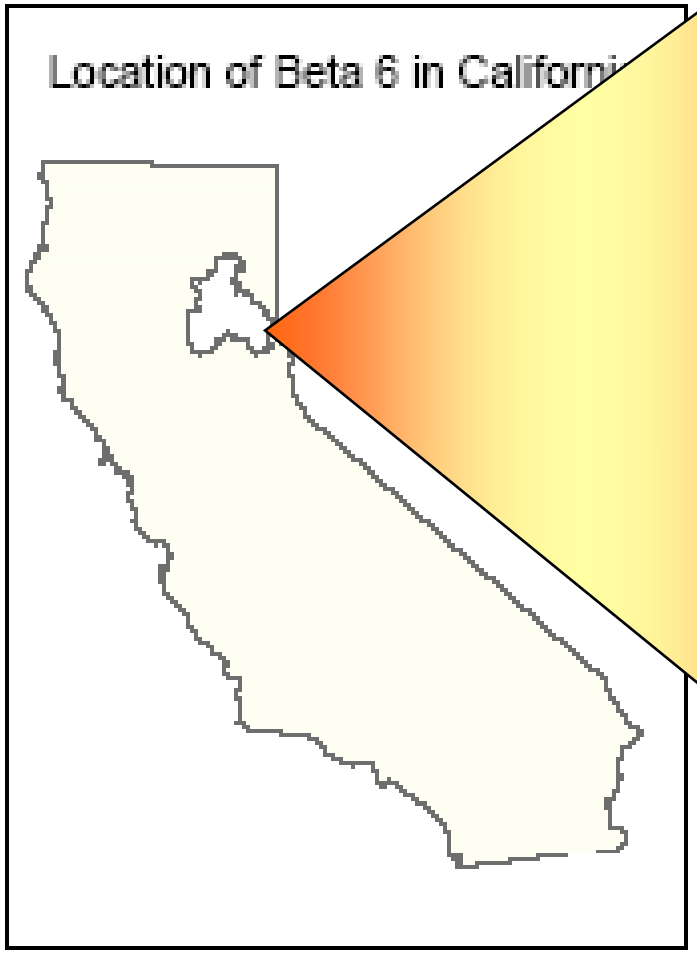
Basic Outline of B2E Model



B2E Approach

1. **Used *actual* landscapes and land uses, mapped to a real region**
2. **Used *actual* data from biomass power plants, operations and professional experience**
3. **Built a REFERENCE CASE and a TEST SCENARIO based on real-time practices**
4. **Delivered a modeling framework for further scenario development**

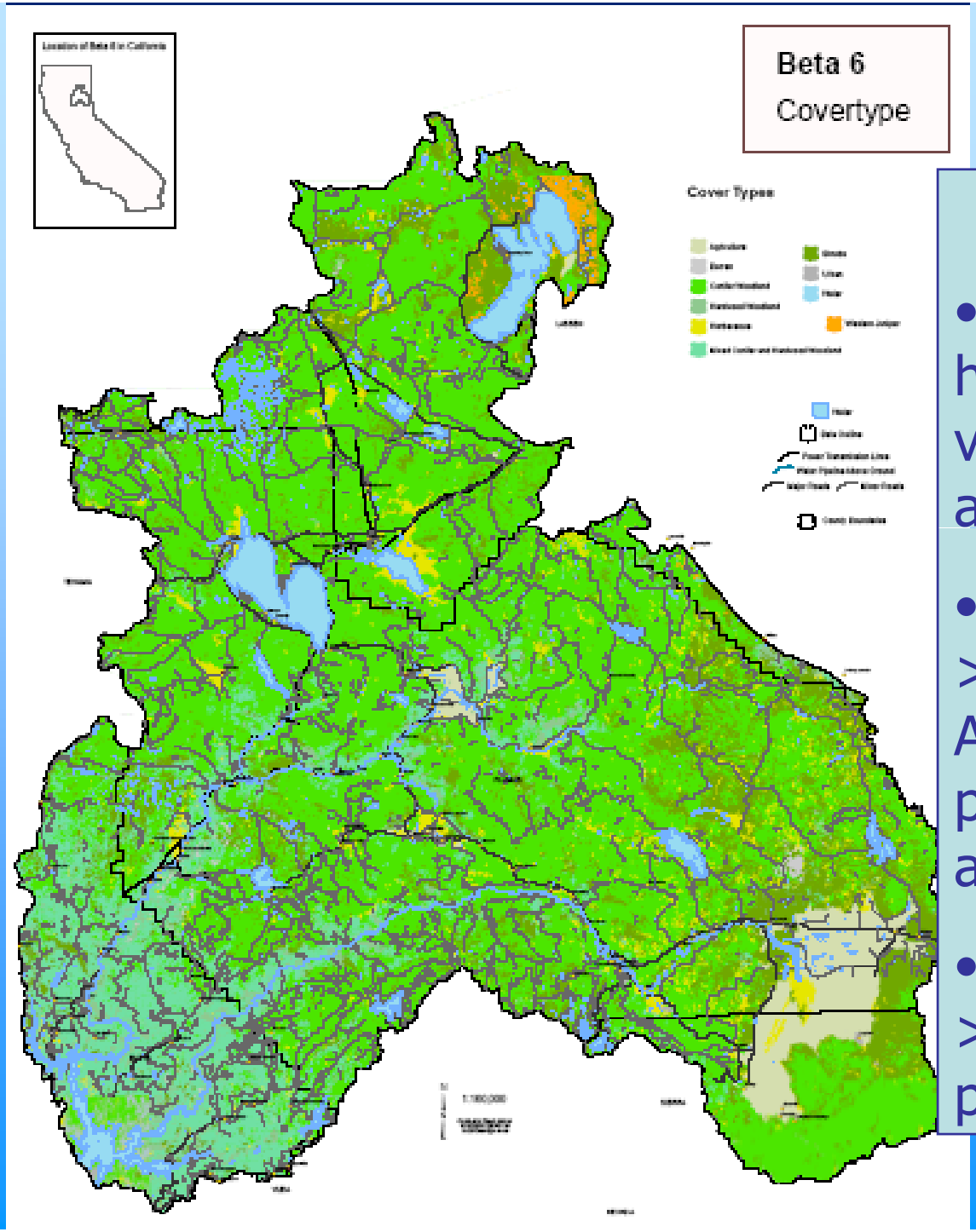
B2E Test Landscape



- 2.7 million acres
- Approx. 3% of California's land area

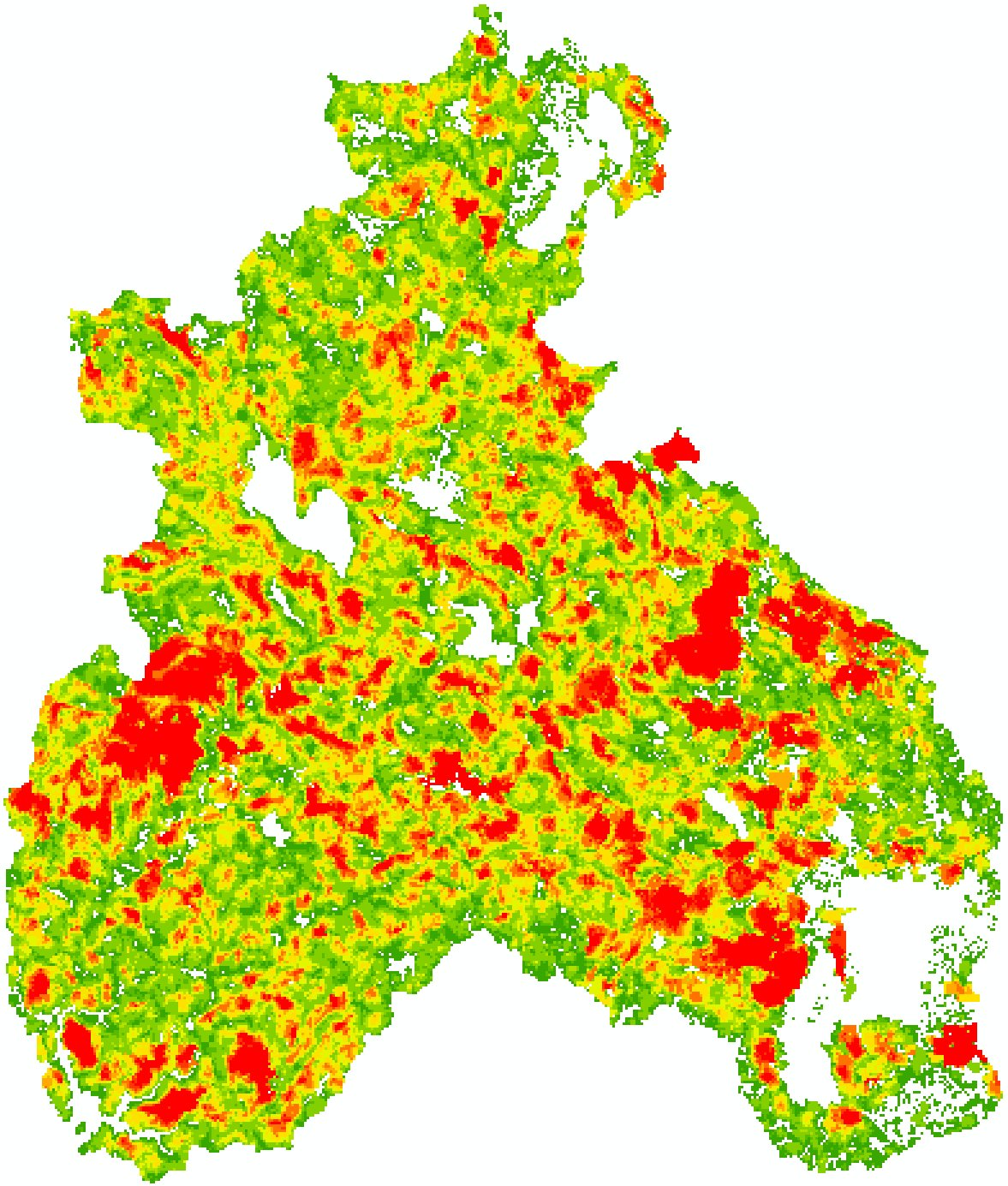
Modeling Domains

1. Vegetation – structure, changes from fire/treatment effects over 10-yr time frames
2. Fire – Using state of the art fire modeling
3. Equipment configuration – forest operation and transport
4. Life Cycle Assessment – energy and material inputs/outputs starting with forest treatments, operations, interconnection with the grid
   - Assess impacts & compare to those from energy produced by Natural Gas and California Energy Portfolio
5. Economics – costs/revenues of forest management and biomass conversion
6. Ecosystem Services – framework to consider non-market values of ecosystem services
7. Wildlife Habitat – Veg conditions from treatments – used to assess impacts on biological indicators
8. Watershed – effects on soil erosion on aquatic systems and key aquatic indicators
9. Forest Landscape Carbon – total fate of carbon in forest ecosystem



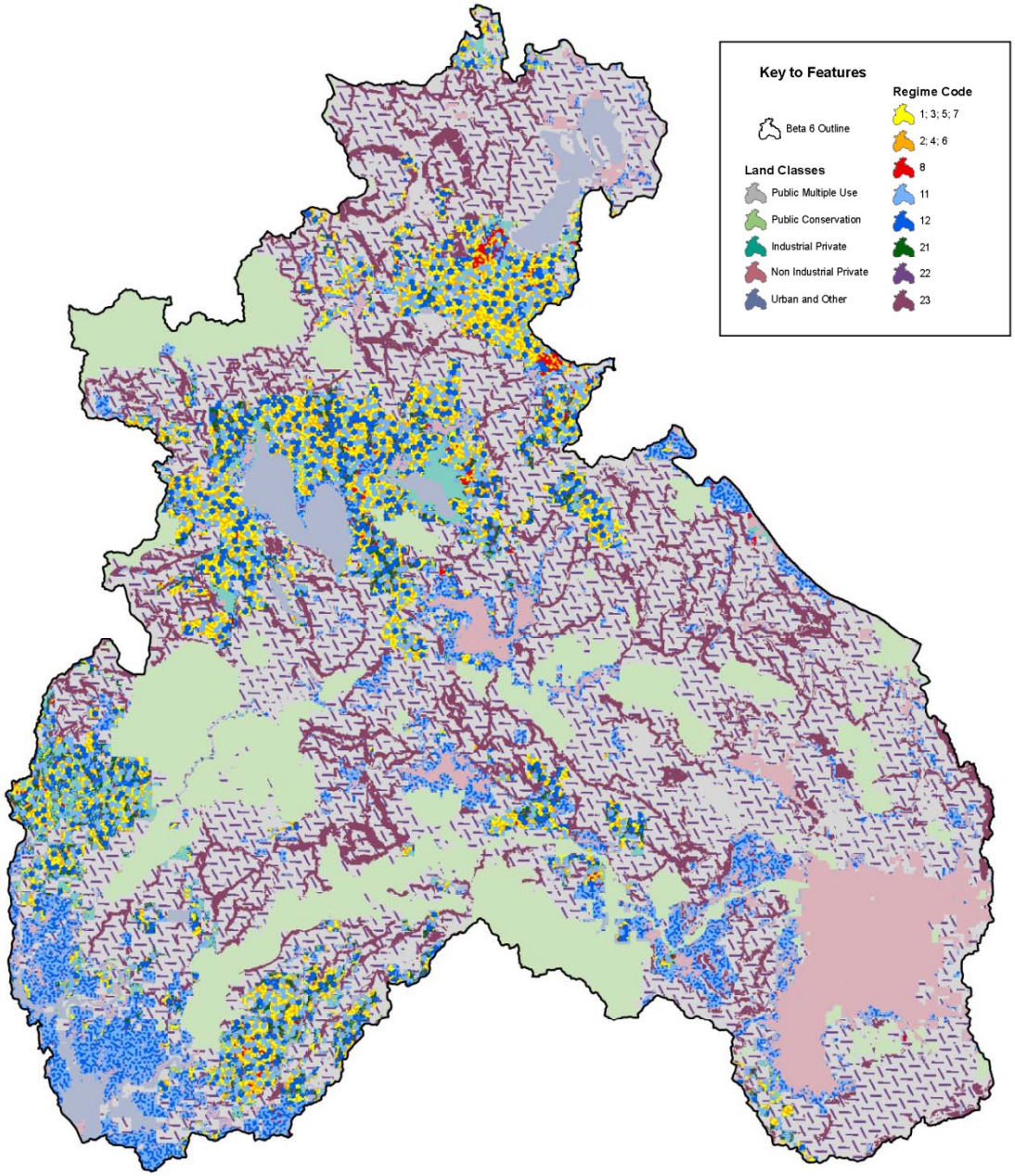
Vegetation Mapping

- 2.7 million acres - Very high diversity of vegetation, infrastructure and human uses
- 82 Veg types based on >450 Forest Inventory and Analysis (FIA) inventory plots in the actual study area
- Extrapolated plots to >2,200 individual polygons with GIS analysis



Burn Probabilities

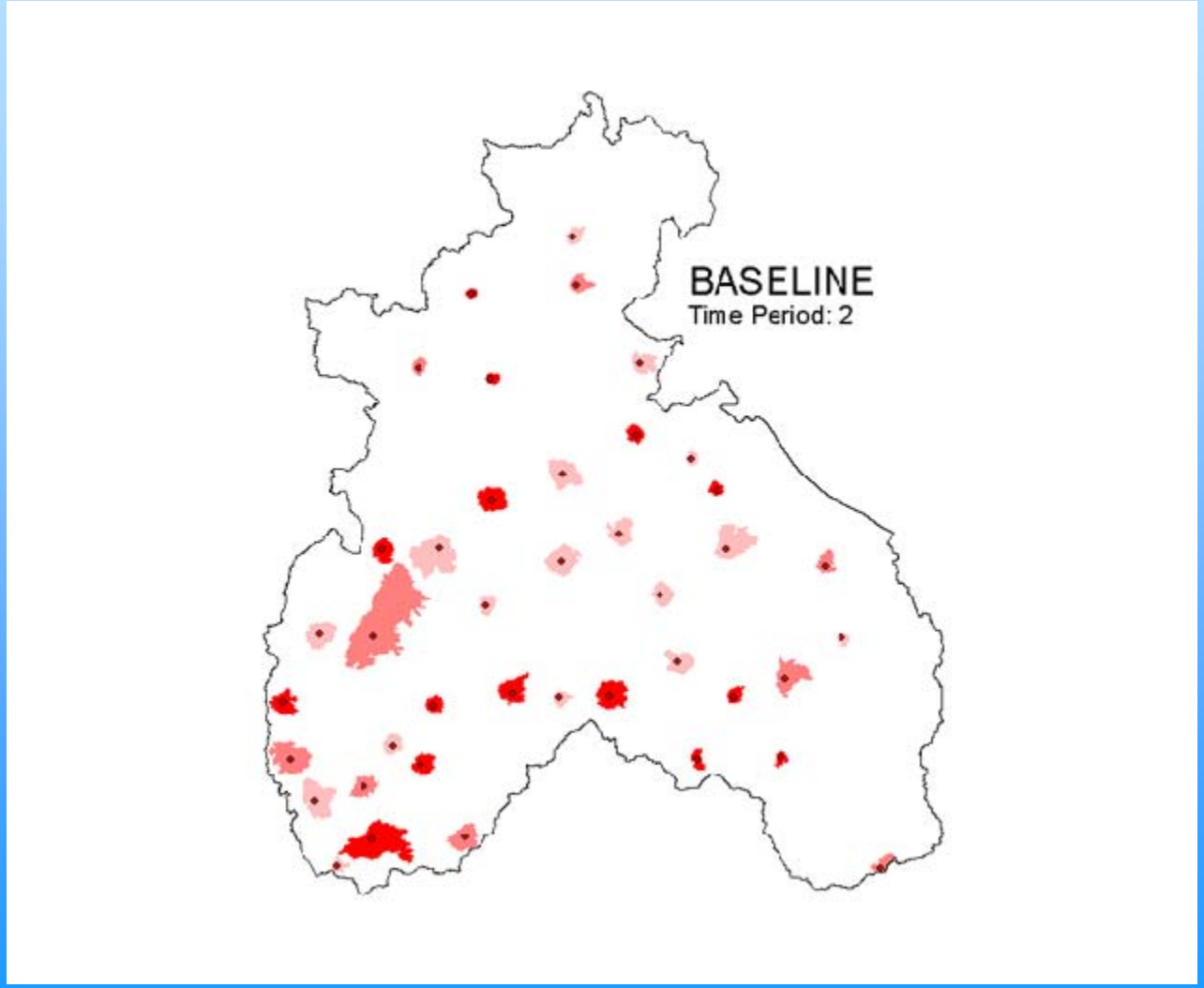
- 60 years of fire history data
- FLAMMAP analysis to establish hazard and risk
- Randomized ignitions across risk surface
- Select "representative ignition points" (RIPs) and fire-size class for each decade



Treatment Scenarios

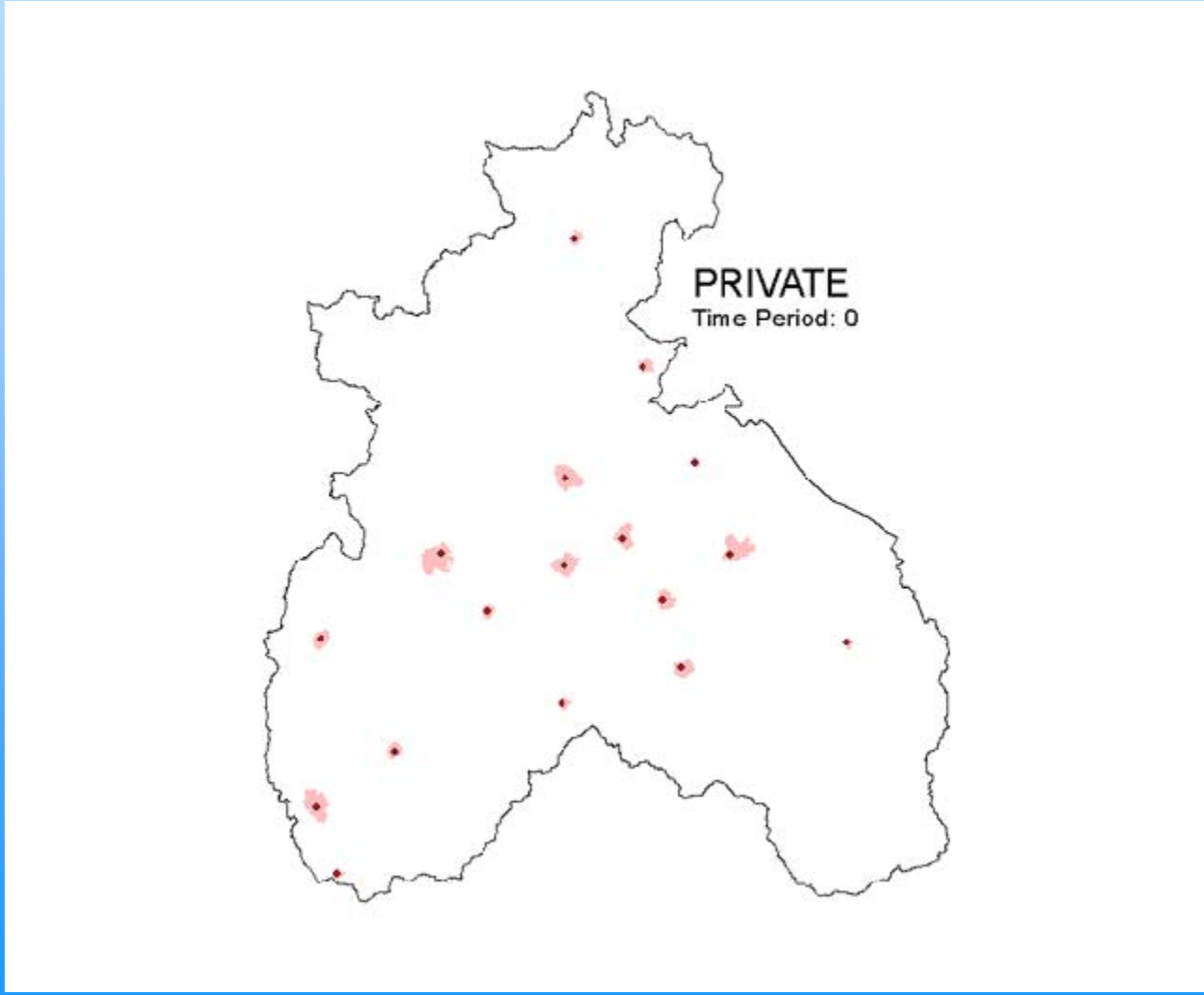
- 13 different treatment prescriptions
- Treatments applied at beginning of each decade (x 4 decades)
- Equipment and operations calculated for LCA
- Effects of treatments modeled

Baseline *without* Management



Note: this is an animated picture showing growth of wildfire perimeters during each decade. A printed version will not display the modeled wildfires.

Test *with* Management



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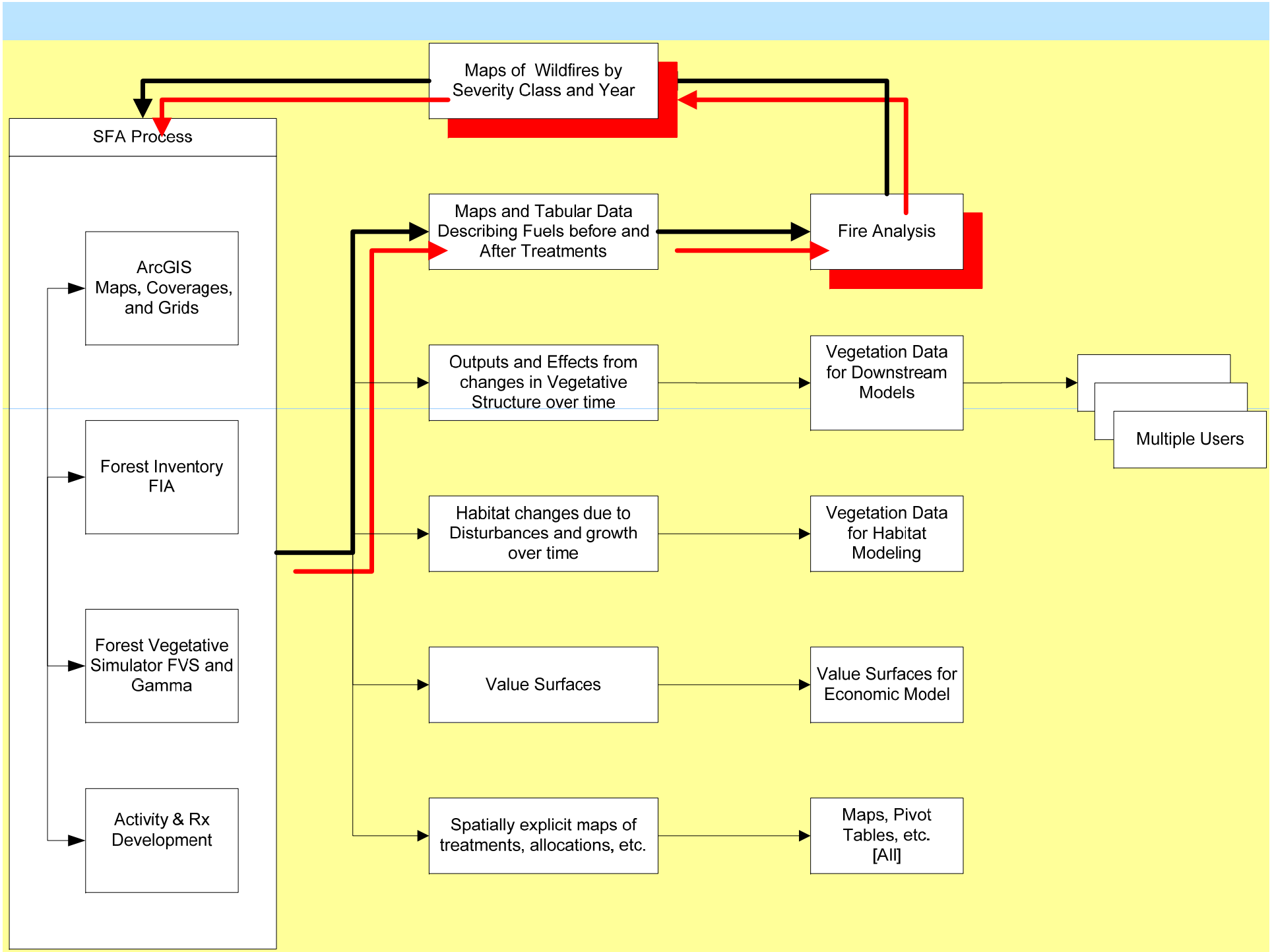
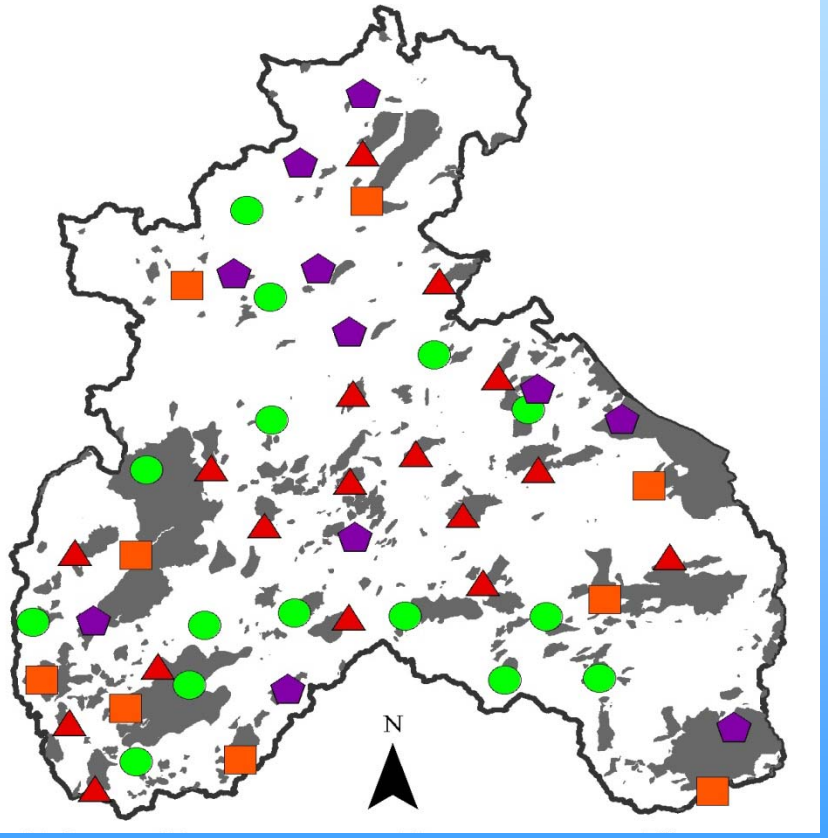

Maps of Wildfires by Severity Class and Year
SFA Process
Maps and Tabular Data Describing Fuels before and After Treatments
Fire Analysis
ArcGIS Maps, Coverages, and Grids
Outputs and Effects from changes in Vegetative Structure over time
Vegetation Data for Downstream Models
Multiple Users
Forest Inventory FIA
Habitat changes due to Disturbances and growth over time
Vegetation Data for Habitat Modeling
Forest Vegetative Simulator FVS and Gamma
Value Surfaces
Value Surfaces for Economic Model
Activity & Rx Development
Spatially explicit maps of treatments, allocations, etc.
Maps, Pivot Tables, etc. [All]

The Basic Equation:



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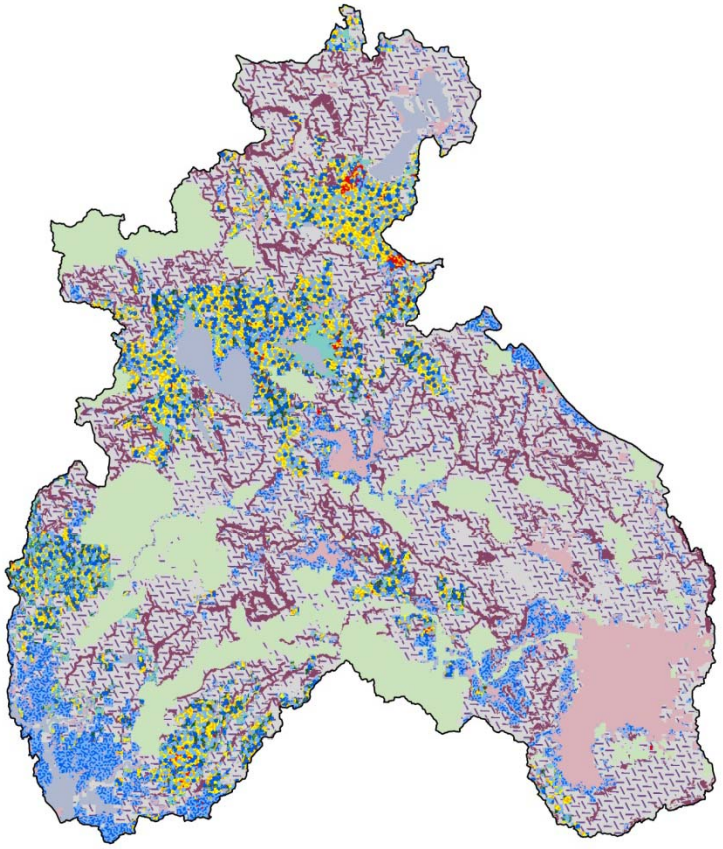


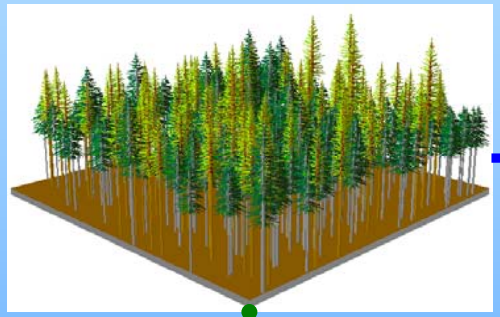
= Δ *wildfire, emissions, habitat, economics, watersheds, GHGs, etc.*

Reference Case vs. Test Scenario

- 22% reduction in the extent of wildfire and significant reductions in fire severity
- 65% reduction in greenhouse gases (from 17 to 5.9 million tons CO2 equivalent)
- $246 million savings in wildfire damage
- $4.6 million reduction in fire fighting costs
- Significant differences in watershed impacts
- No significant change in habitat quality from treatments
- Life-cycle “savings” of 120 Terawatt-hours in fossil fuel generation by using biomass for power
- 19 GWh produced from biomass power, using equivalent of .24 GWh of fossil fuels
- $1.58 billion in power generation revenues
- Biomass fuel costs $68/BDT based on treatment & transportation costs
- Plant operators can only pay up to $8.20/BDT to get acceptable rate of return

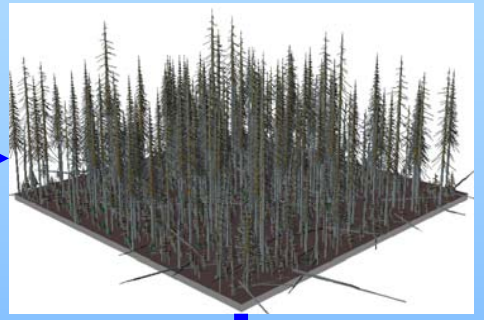
Data & Modeling Challenges

Veg. Inventory, Growth and Fuel Models



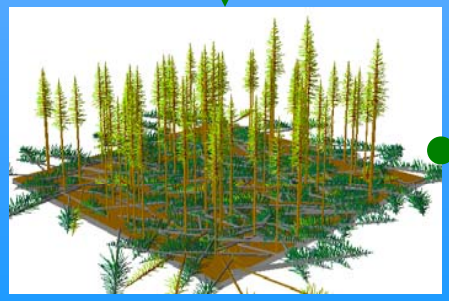
Fire Behavior Models (e.g., FARSITE, FOFEM, FLAMMAP, etc.)

Severity Classes?



FUEL MODELS?

OR **Thinned**

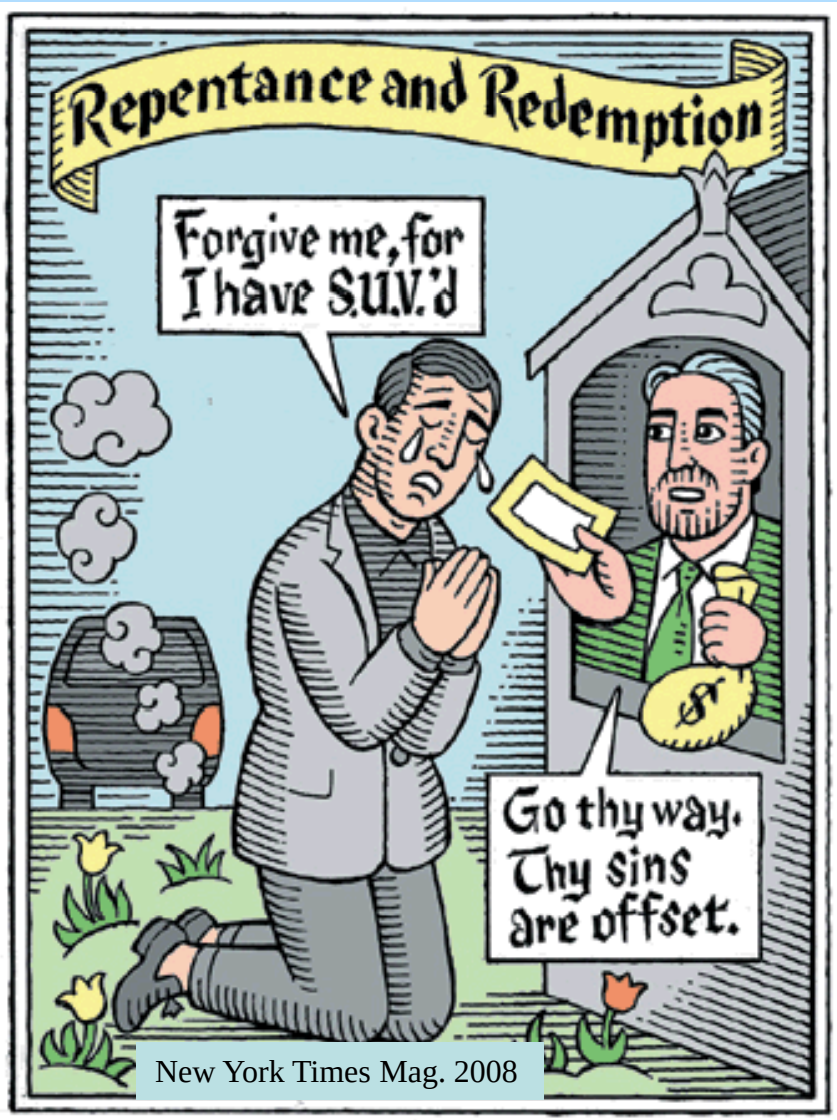


Combustion Efficiencies?

Emission Factors?

Policy and Economics

- 70% land-based emission reductions in Waxman/Markey draft
- It's not FREE anymore….
- Reduction and mitigation markets must be REAL and VERIFIABLE
- What are we buying?



New York Times Mag. 2008