

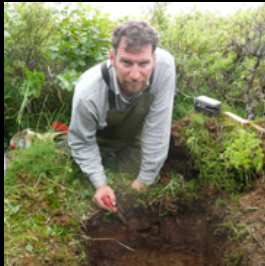
An aerial photograph of a dense, green forest. In the foreground, a white research tower with various instruments and yellow cables is visible. The sky is overcast with grey clouds.

Bringing forest management into Earth system models: Insights from observations and theory

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AMS 4th Biogeosciences / 33rd AgForMet
Talk 3.1
May 14, 2018

MANagement and Disturbance in FORest Ecosystems

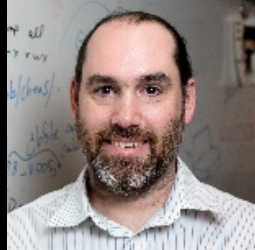
NSF EF-1241860; EF-1702835, (Macrosystems Biology)



Bill Kleindl



Christie
Staudhammer



Mike Dietze



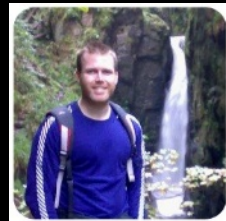
Ankur Desai



Greg Starr



Jerry Franklin



Paul Stoy



Christy Rollinson



Mike Binford

Post-Docs

Jackie Hall, Afshin
Pourmokhtarian,
and Justin
Becknell



Ryan Kelly



Sherry Fu



Matt Marsik

Grad
Students



Di Yang



+Chandrashekar Deshmukh (APRIL)

What is forest management?

- And how do current Earth system models represent it?



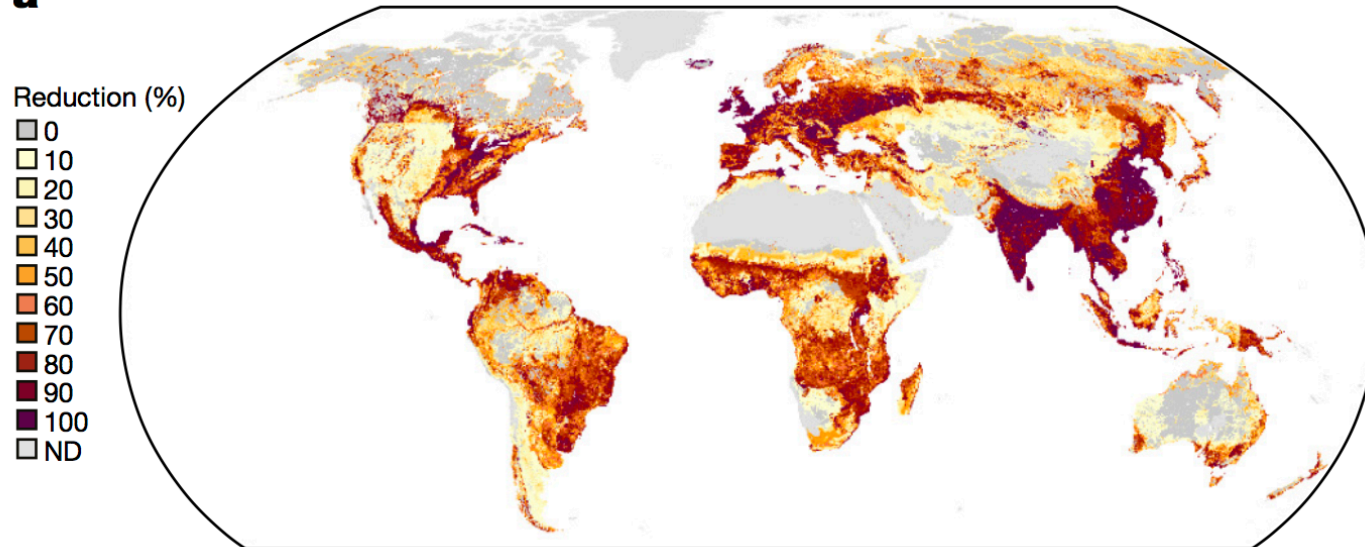
Linda Parker, USFS



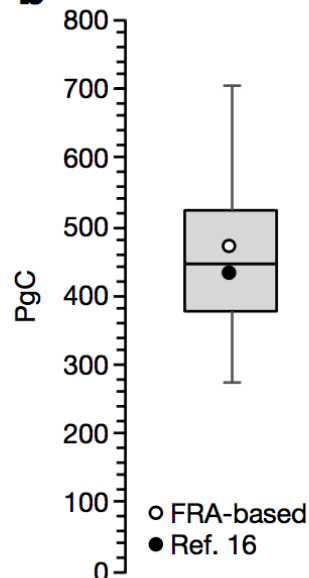
Unexpectedly large impact of forest management and grazing on global vegetation biomass

Karl-Heinz Erb¹, Thomas Kastner^{1,2*}, Christoph Plutzer^{1,3*}, Anna Liza S. Bais¹, Nuno Carvalhais^{4,5}, Tamara Fetzel¹,

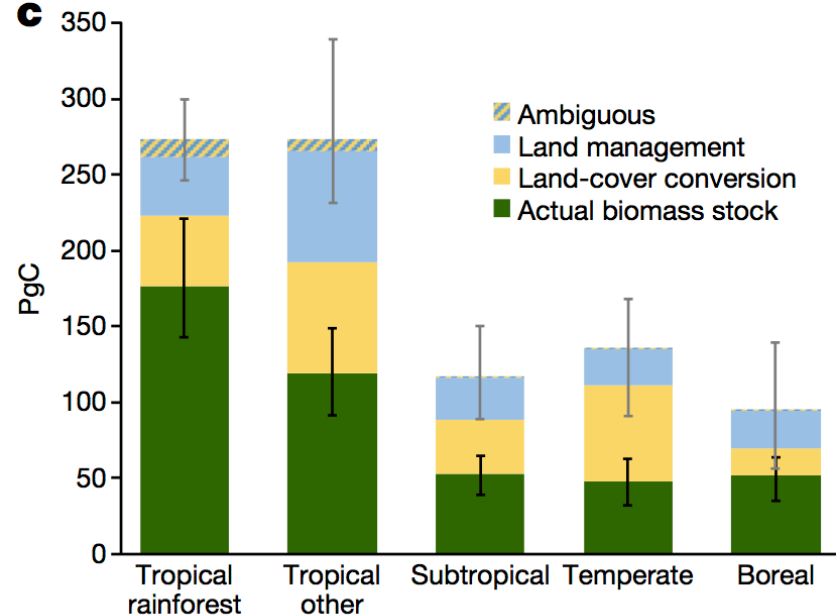
a



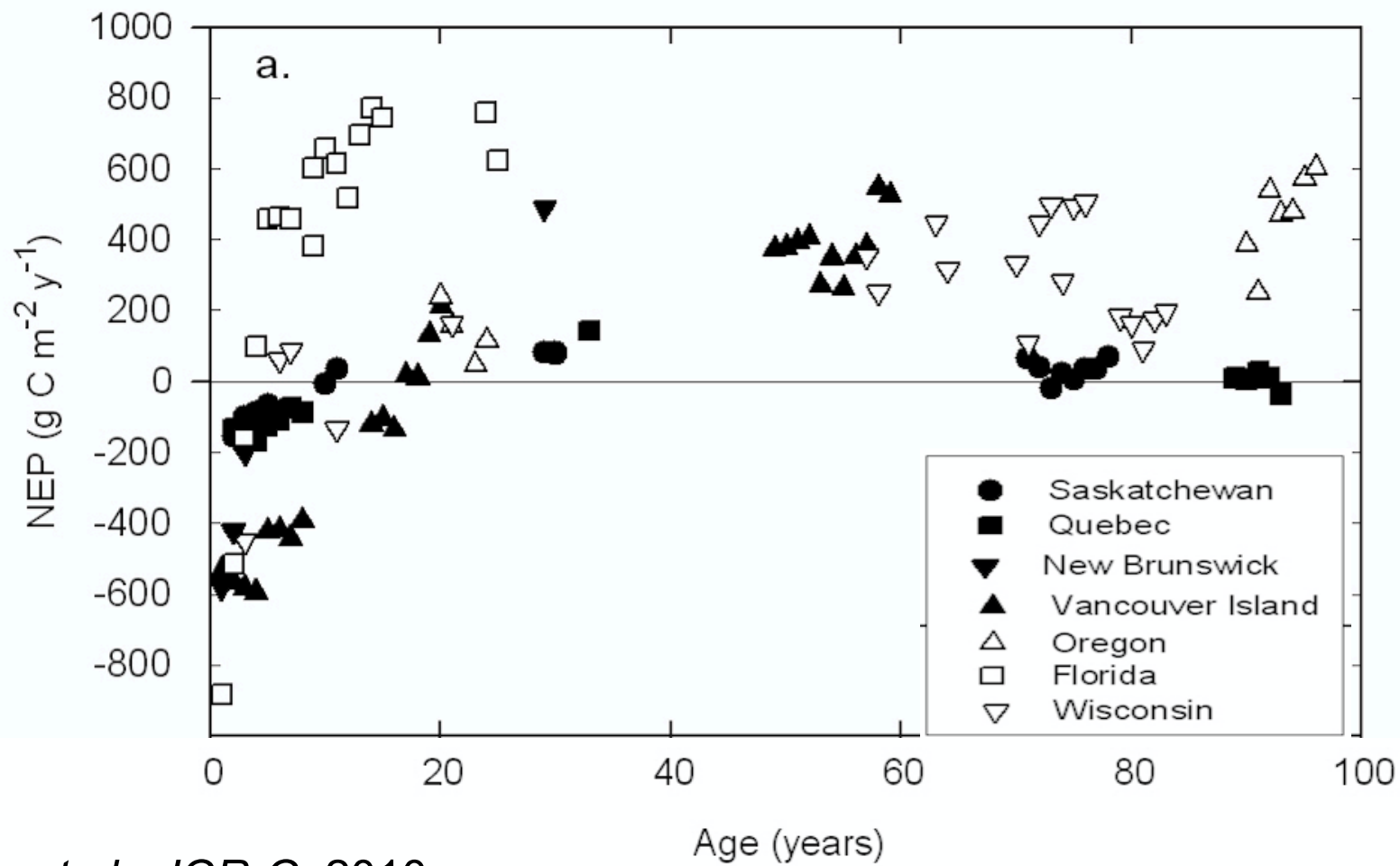
b



c



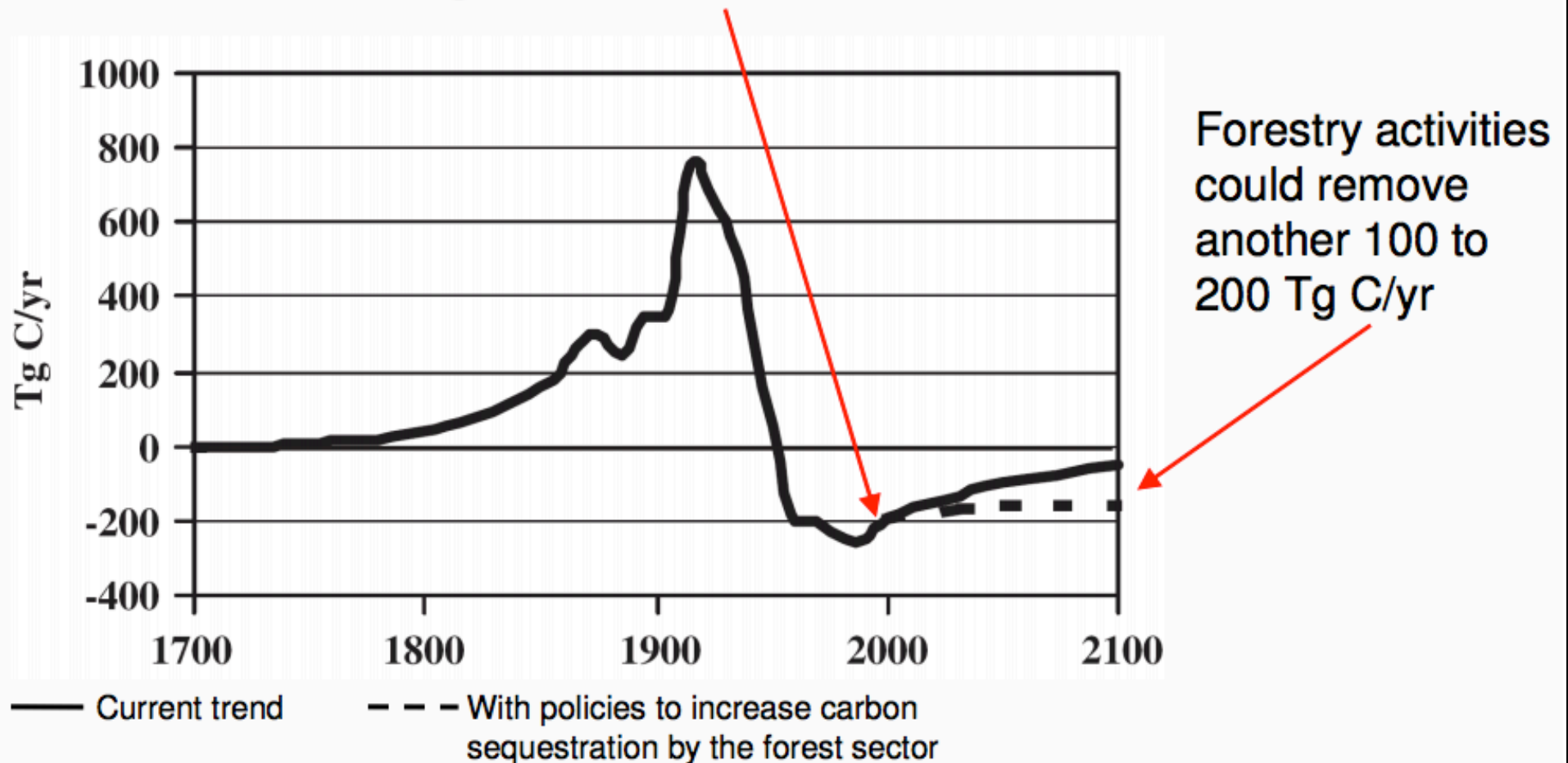
We know forest age determines NEP



Amiro *et al.*, *JGR-G*, 2010

We know carbon management practices have significant potential

US forests annually sequester the equivalent of 10% of US carbon dioxide emissions from burning fossil fuels



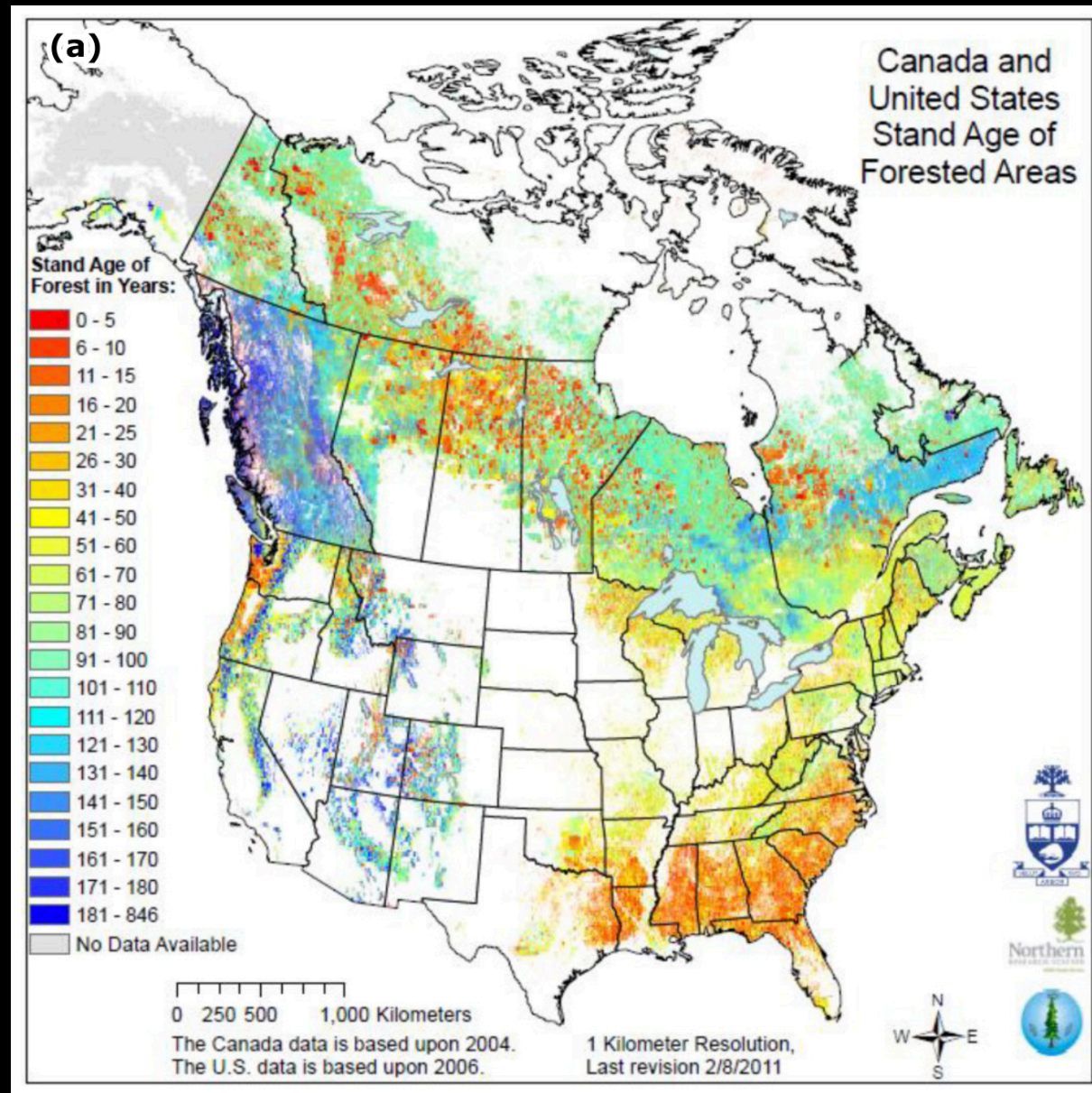
But we really don't know how to
map, observed, and simulate
forest management
to understand
continental to global scale
effects of these activities on
climate and ecosystems

So let's review some attempts

Can we better map
management?

Age structure and disturbance legacy of North American forests

Y. Pan¹, J. M. Chen², R. Birdsey¹, K. McCullough¹, L. He², and F. Deng²



Pan *et al.*,
Biogeosciences,
2011

Management Functional Types

Production Forestry maximizes wood or pulp production



Preservation Forestry maintains a baseline state to preserve species, ecosystem services, recreation, and aesthetic value



Source: TJ Gehling

Passive Management may be exploited for timber but lacks any active management practice other than desultory harvest



Source: RJ Peterson

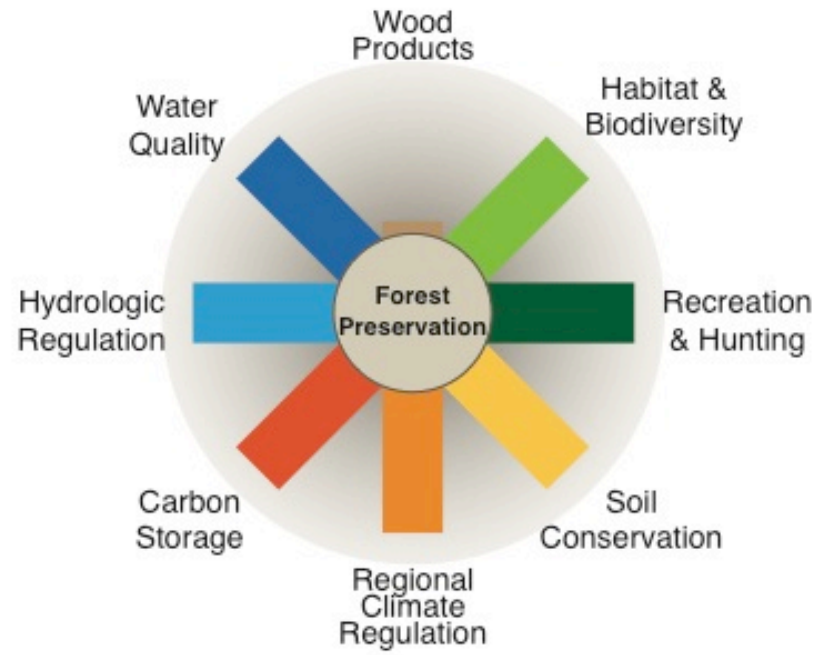
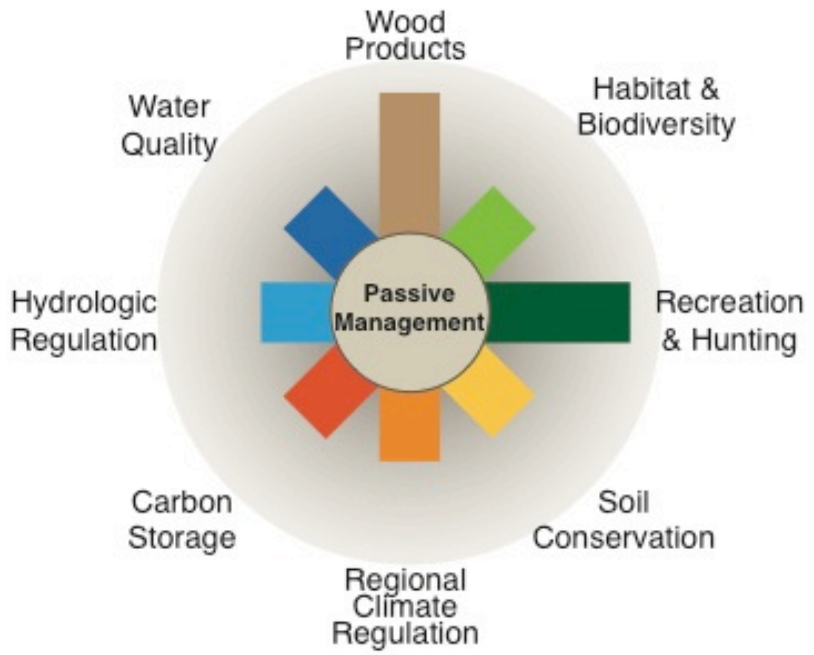
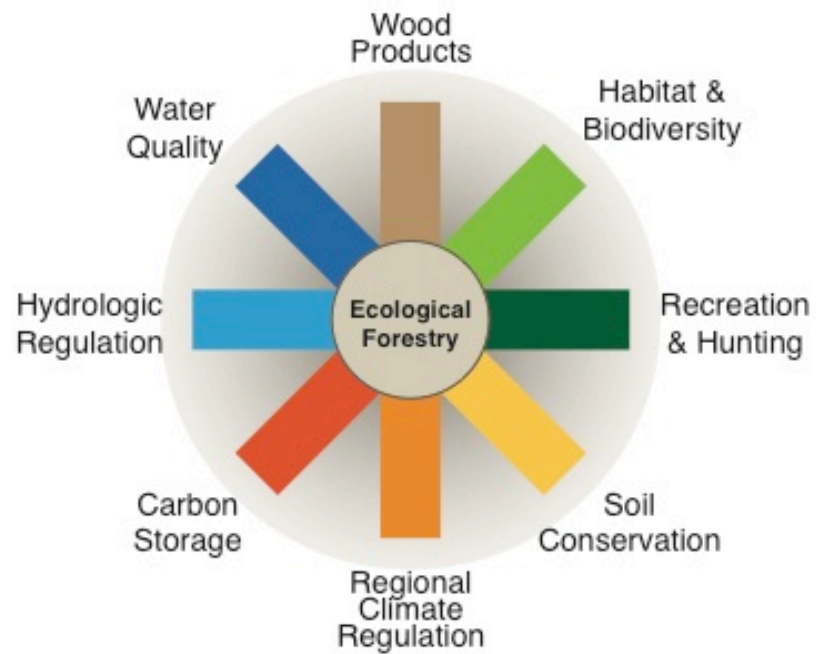
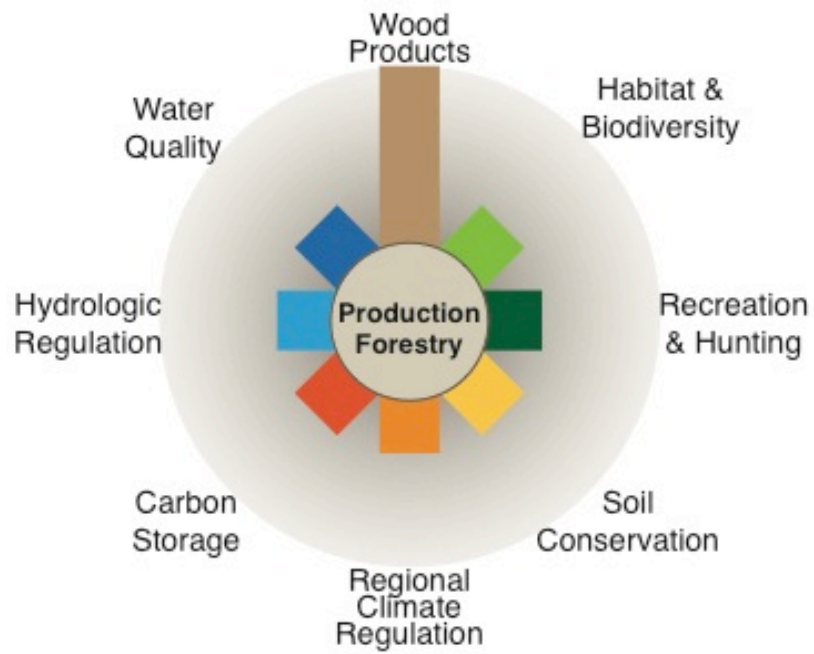
Ecological Forestry Uses ecological principles to balance wood production with habitat and ecosystem services



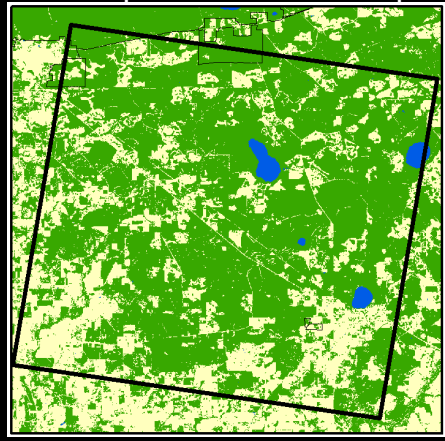
Source: OR BLM

Photo: Oregon BLM

Becknell et al., Bioscience, 2015



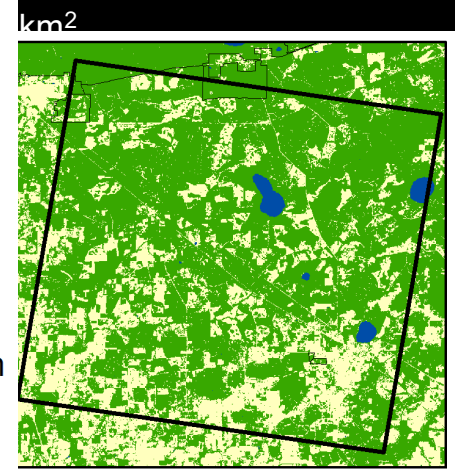
Private plantation landscape –



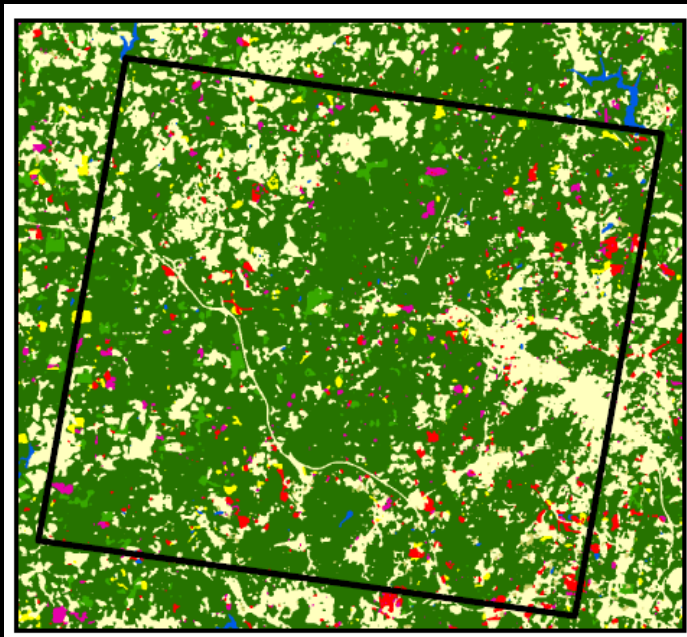
2000

Forest Trajectories

- N - N - N Non - forest
- N - N - F Recent regroth
- N - F - F Forest regrowth
- F - N - N Deforestation
- F - N - F Harvest regrowth
- F - F - N Recent harvest
- F - F - F Stable forest



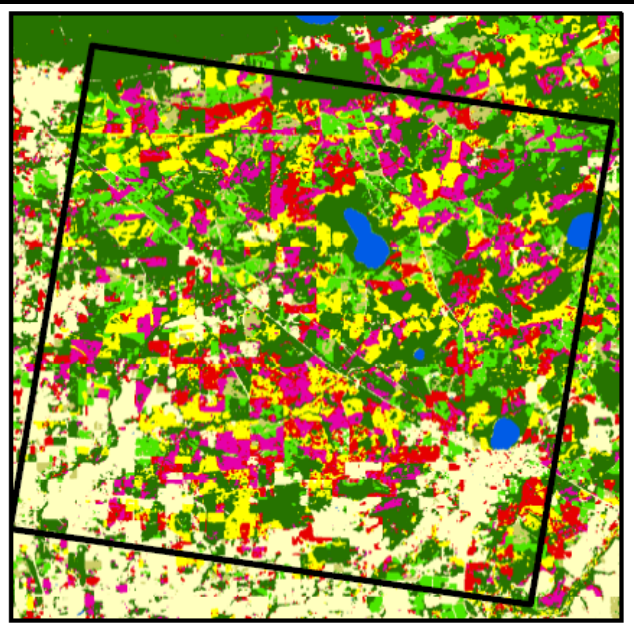
2010 All January



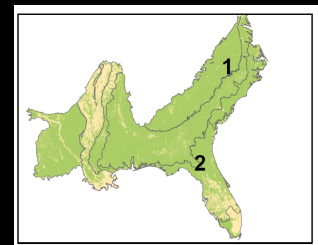
Central North Carolina

Forest Trajectories

- Non-forest
- Recent regrowth
- Forest regrowth
- Deforestation
- Harvest-regrowth
- Recent harvest
- Stable Vegetation
- Water

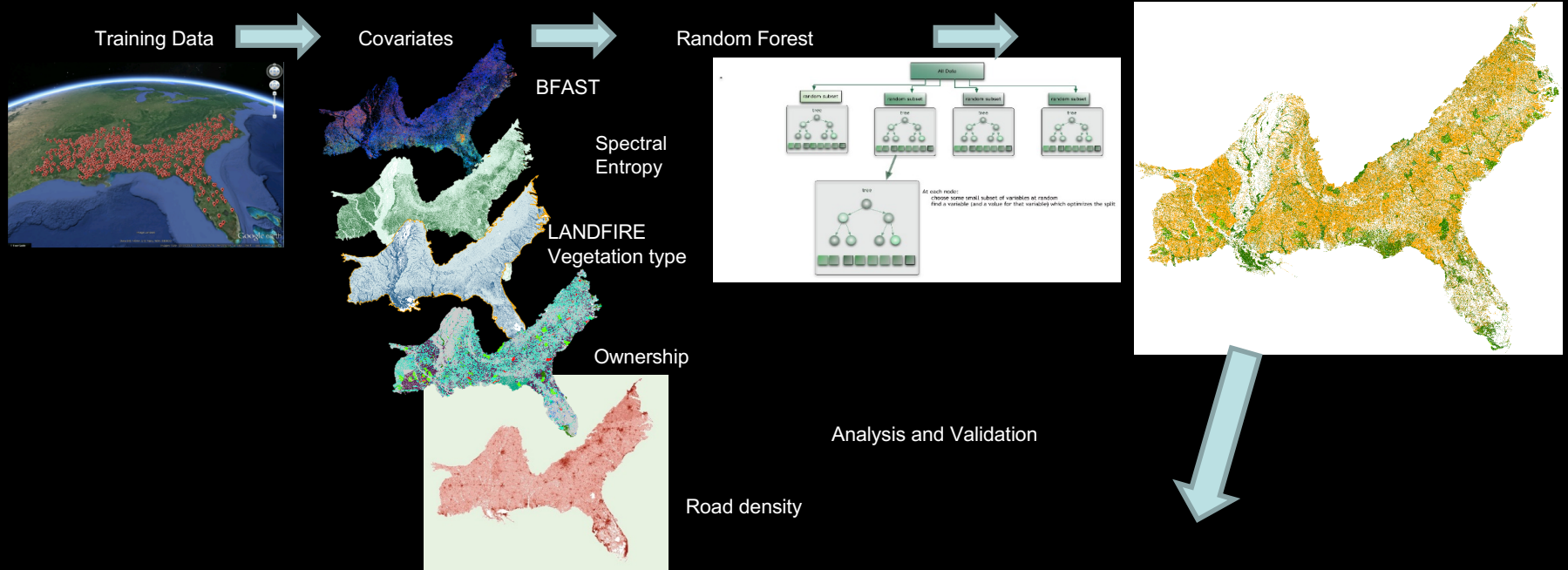


North Florida



M. Binford

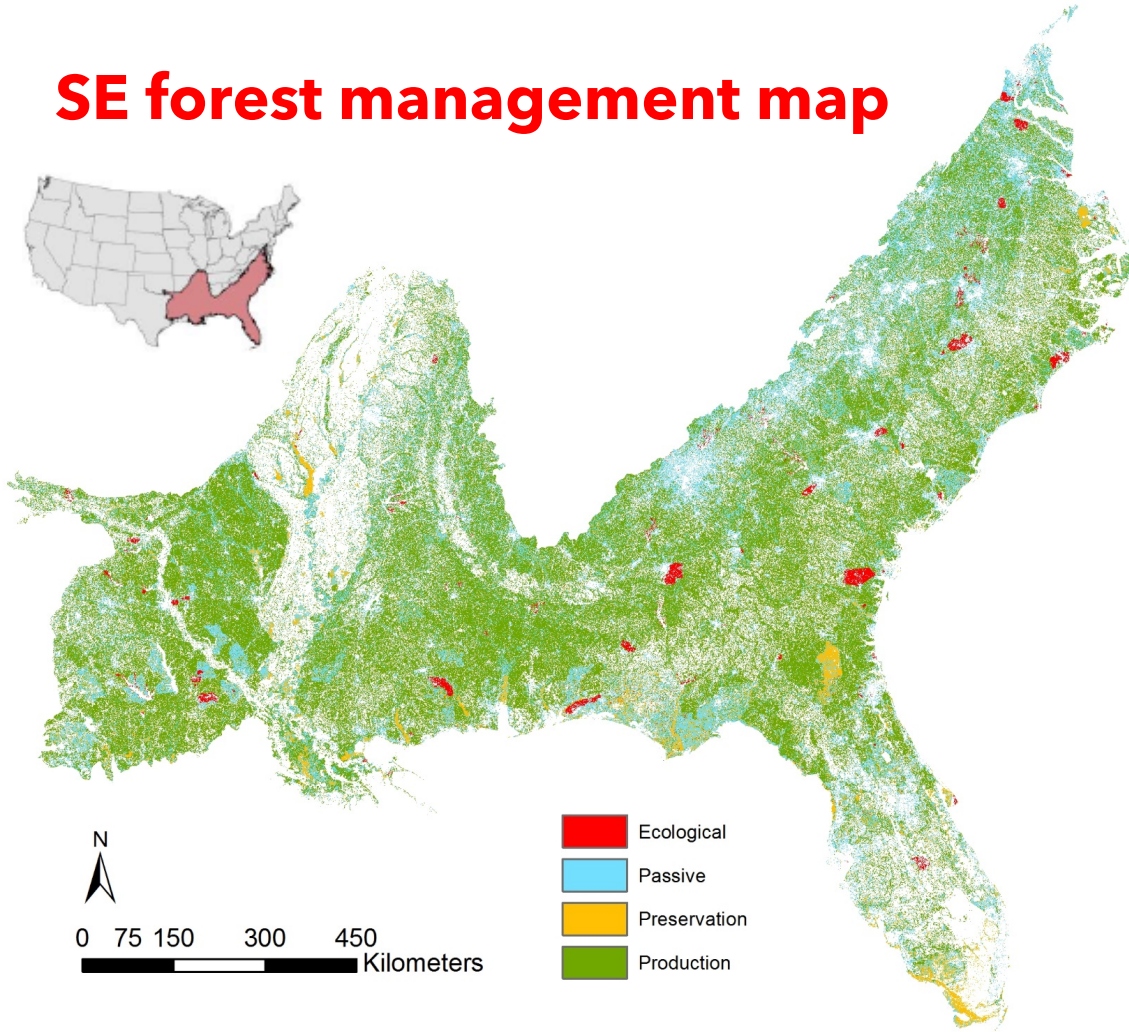
Mapping procedure (Binford)



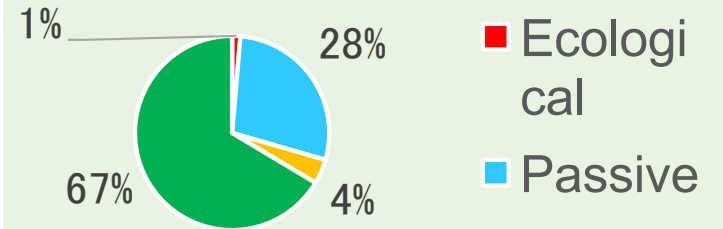
MODIS time-series: Enhanced Vegetation Index
 Normalized Spectral Entropy of VI
 BFAST (Breaks For Additive Season and Trend)
 Ownership, Forest Type, other ancillary data
 overlay and zonal analysis

Cross Validation						
	Ecological	Passive	Preservation	Production	Wetlands	Accuracy
Ecological	23	1	0	0	1	0.92
Passive	1	47	0	0	3	0.92
Preservation	0	0	50	0	2	0.96
Production	1	1	0	23	2	0.85
Wetlands	0	1	0	2	17	0.85
					Total Accuracy	0.91

SE forest management map

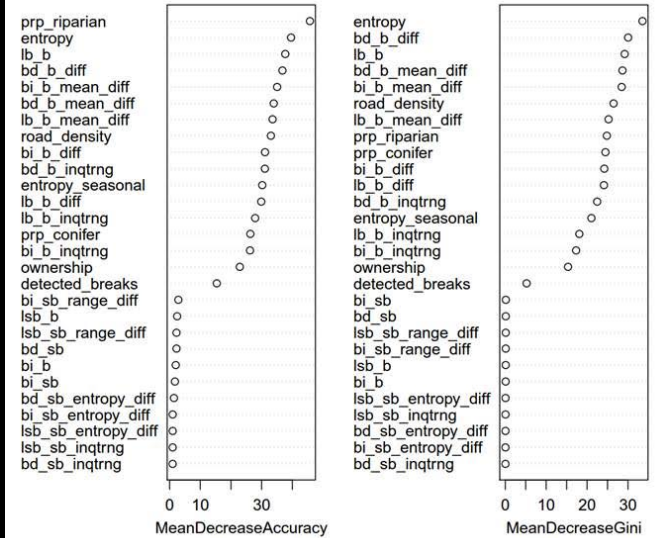


Area of forest classes by percentage

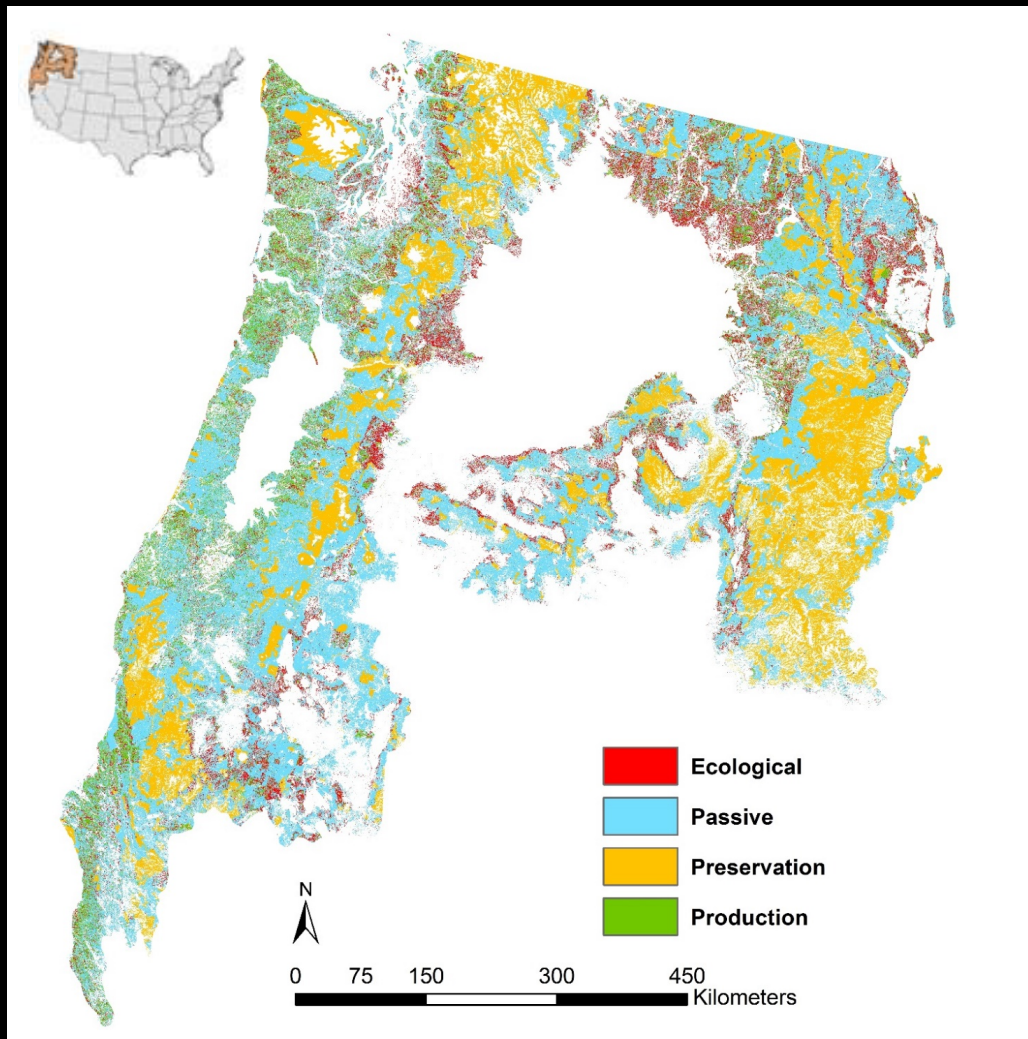


Total forest area: 61,345,169 ha

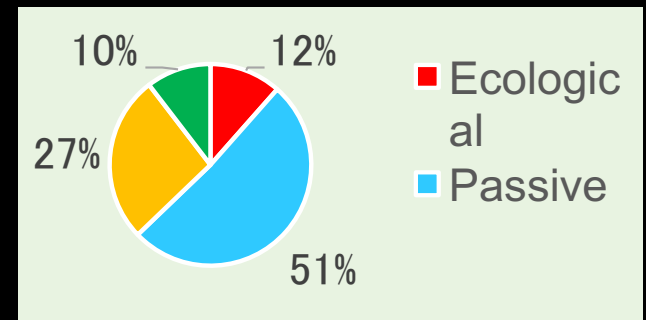
Variable Importance for Random Forest Classification



PNW forest management map

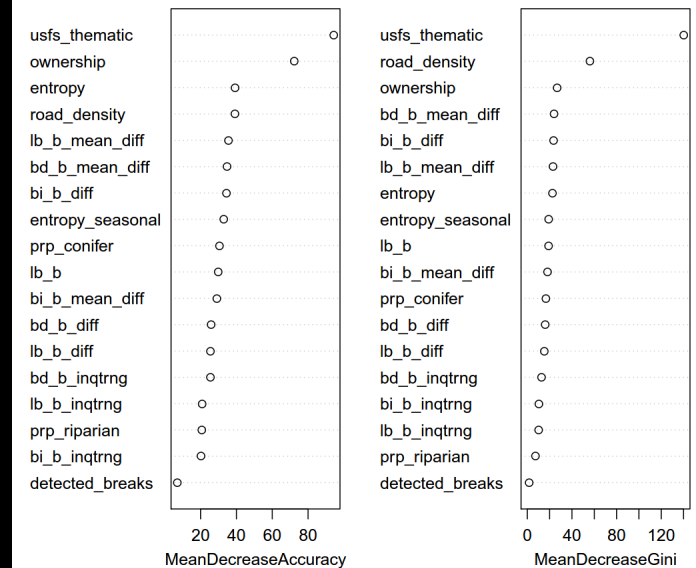


Area of forest classes by percentage

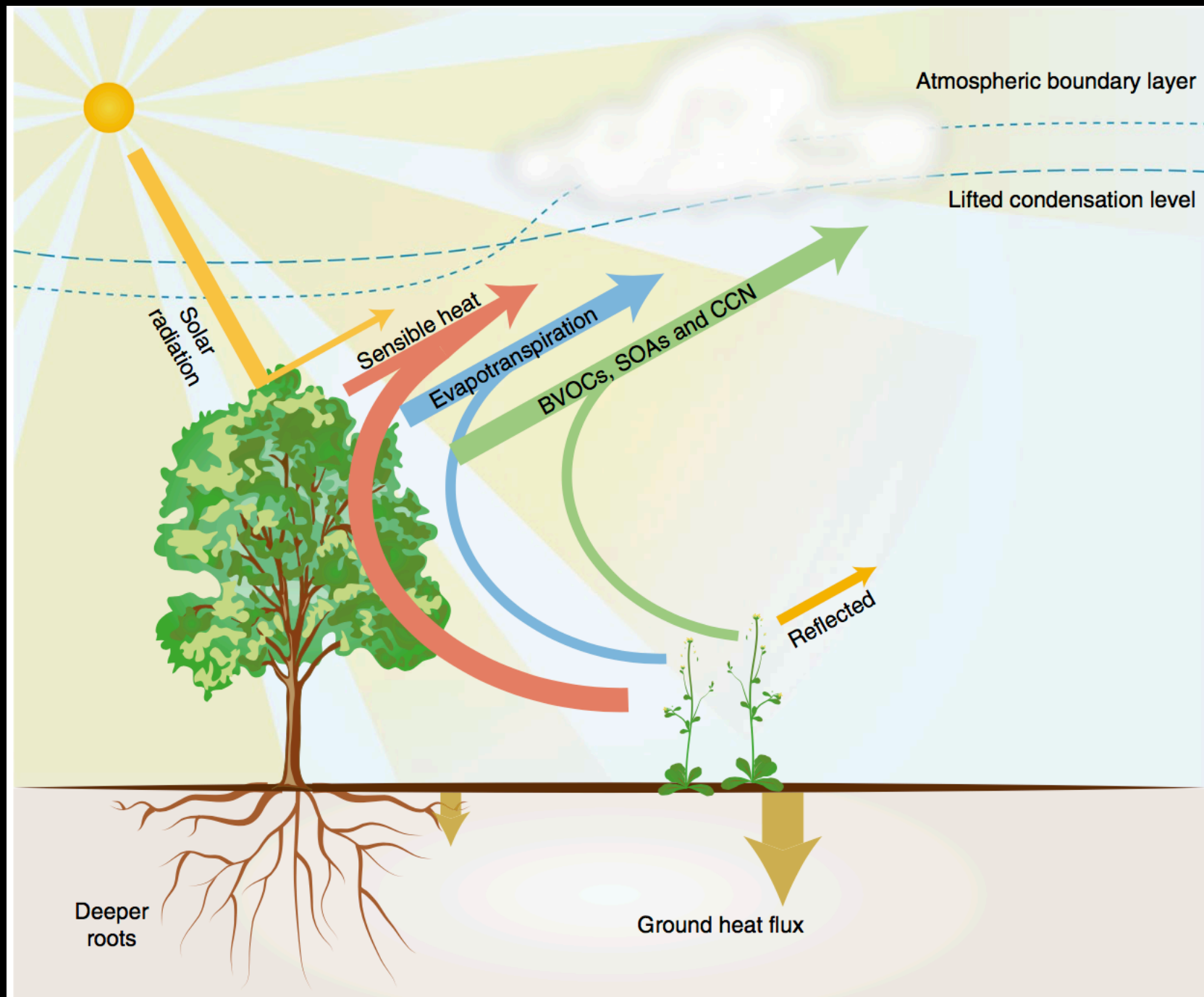


Total forest area: 28,988,131 ha

Variable Importance for Random Forest Classification

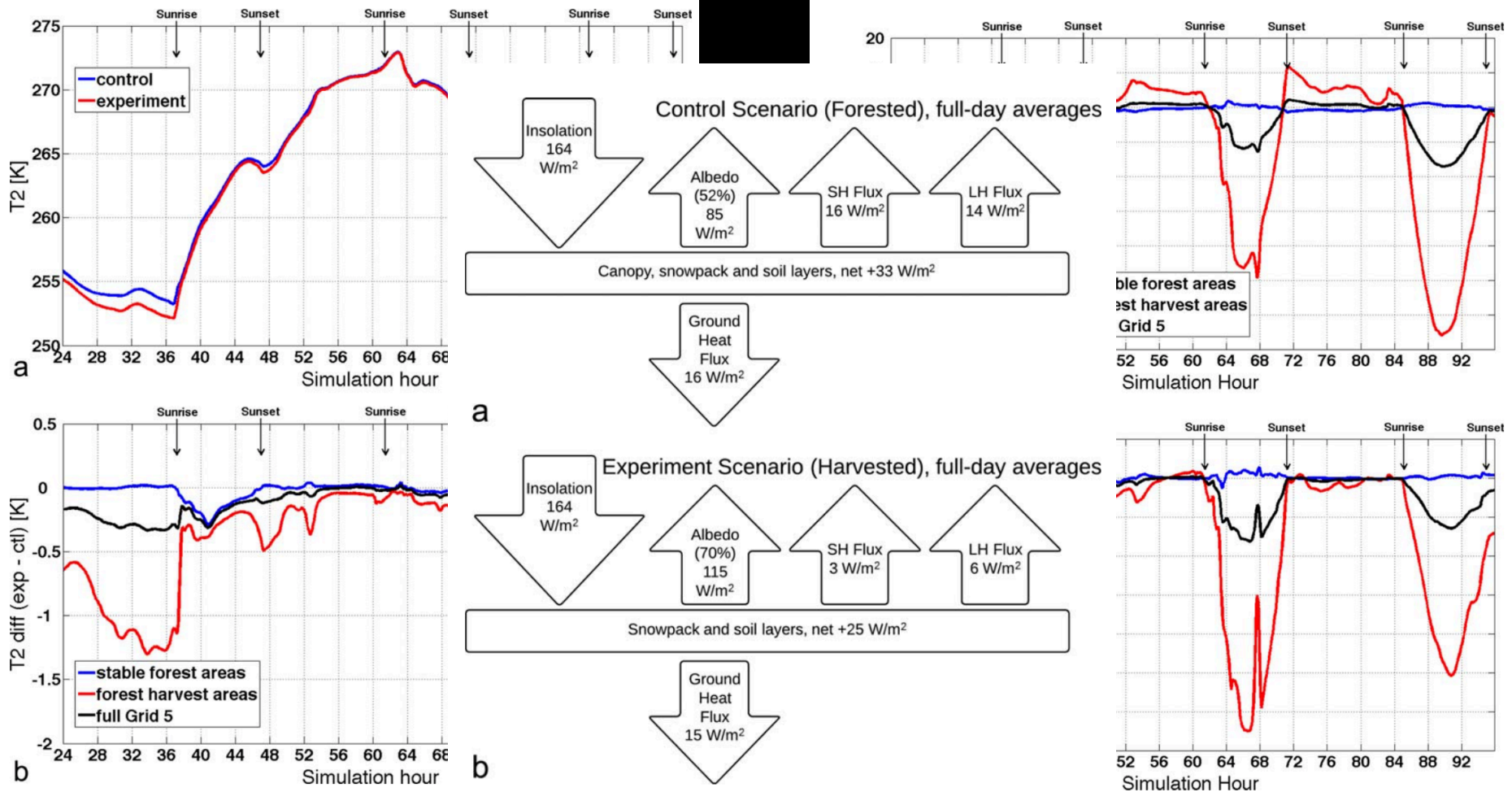


What are the effects of
management on the
atmosphere?



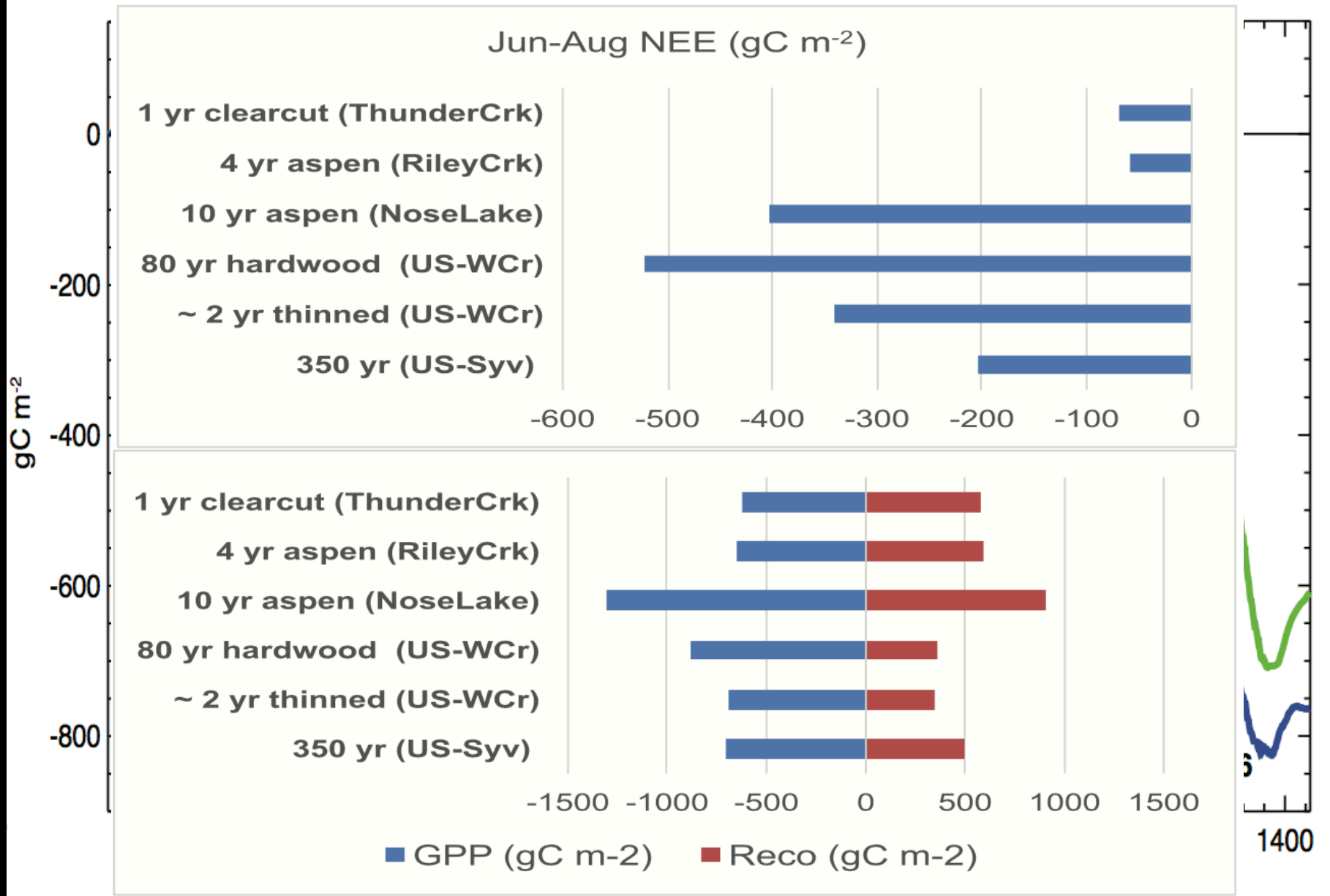
Impacts of forest harvest on cold season land surface conditions and land-atmosphere interactions in northern Great Lakes states

Matthew Garcia¹, Mutlu Özdoğan¹, and Philip A. Townsend¹



Let's thin a forest!





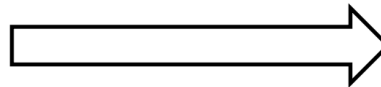
New studies in the tropics

C. Deshmukh
APRIL

Pristine peatswamp forest



Land use change



Plantation forestry

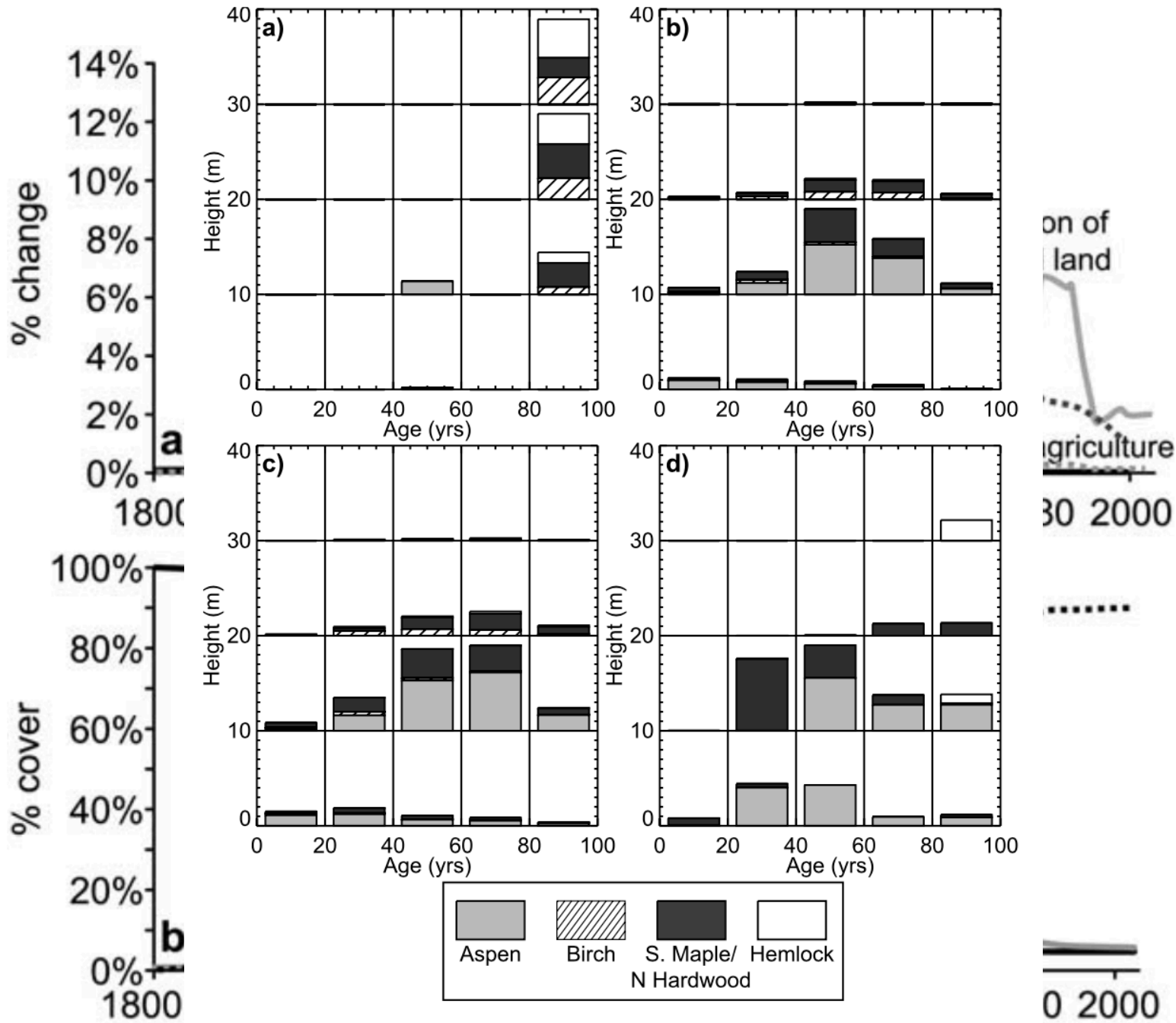


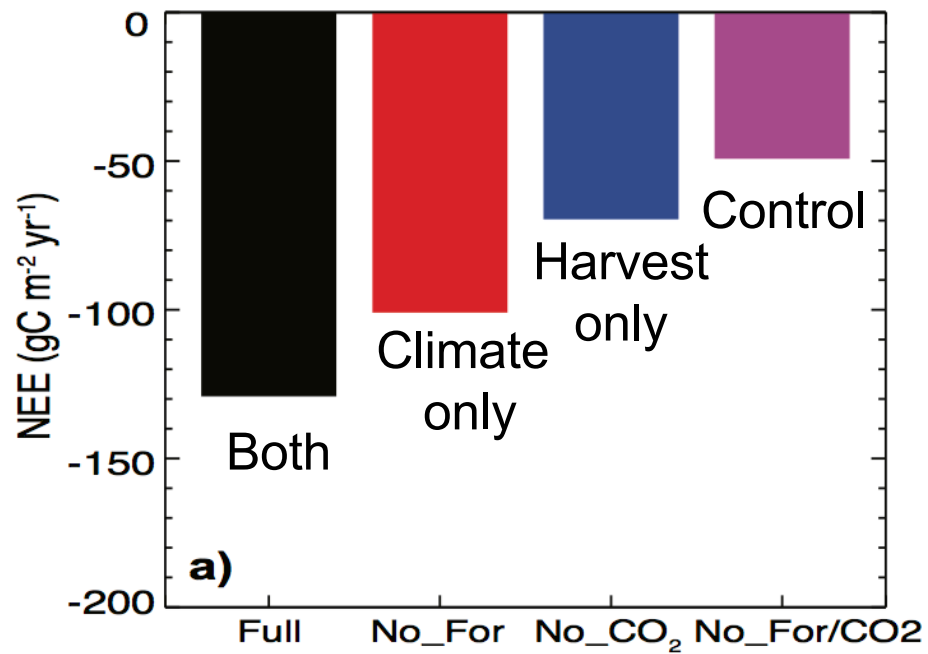
Mixed land cover



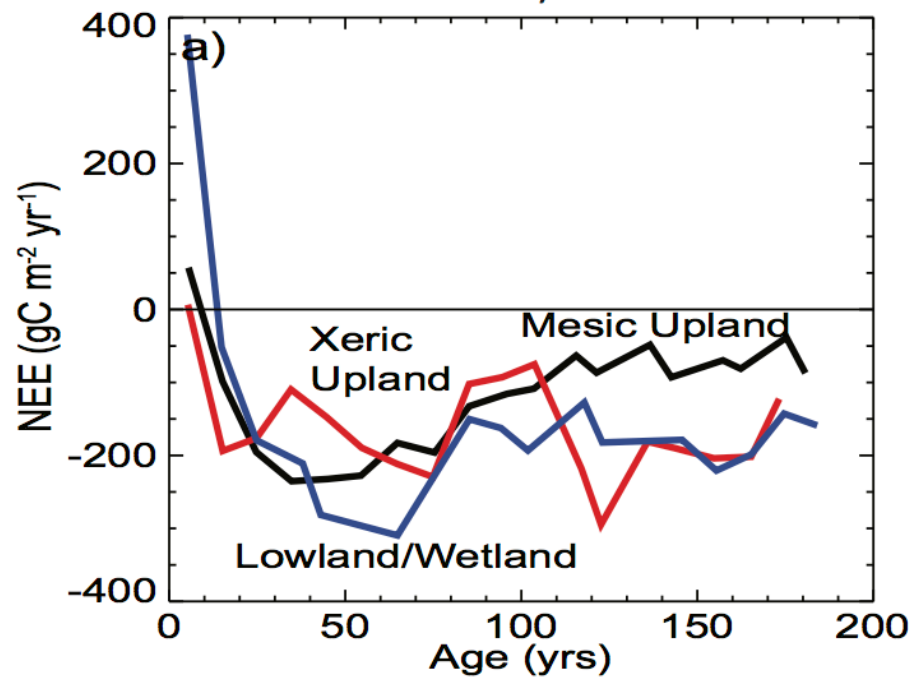
- National/global importance

So how do we model forest
management?

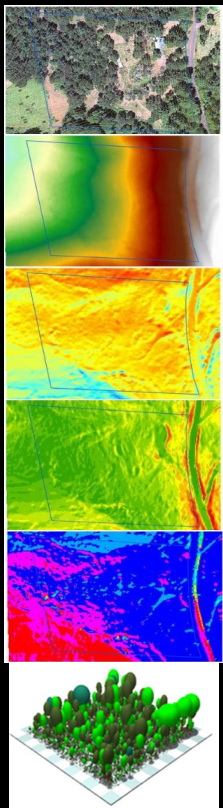




Desai *et al.*, 2007



Ecosystem Demography 2 Model Preliminary Results



Reality

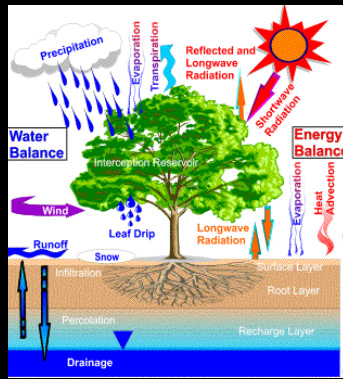
Elevation

Slope

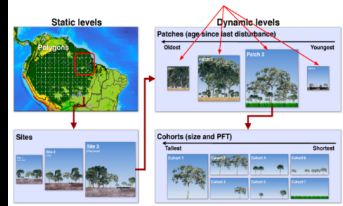
Aspect

TCI

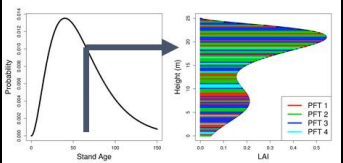
ED2 Model



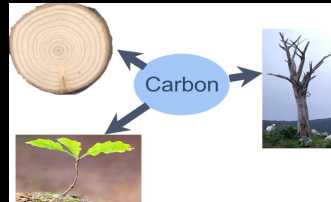
But within each grid-cell, exist numerous patches
*Patch physics processes are essentially independent



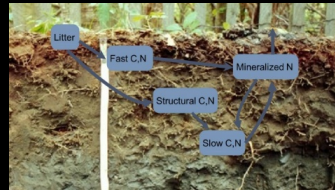
Size & Age Structured Approximation



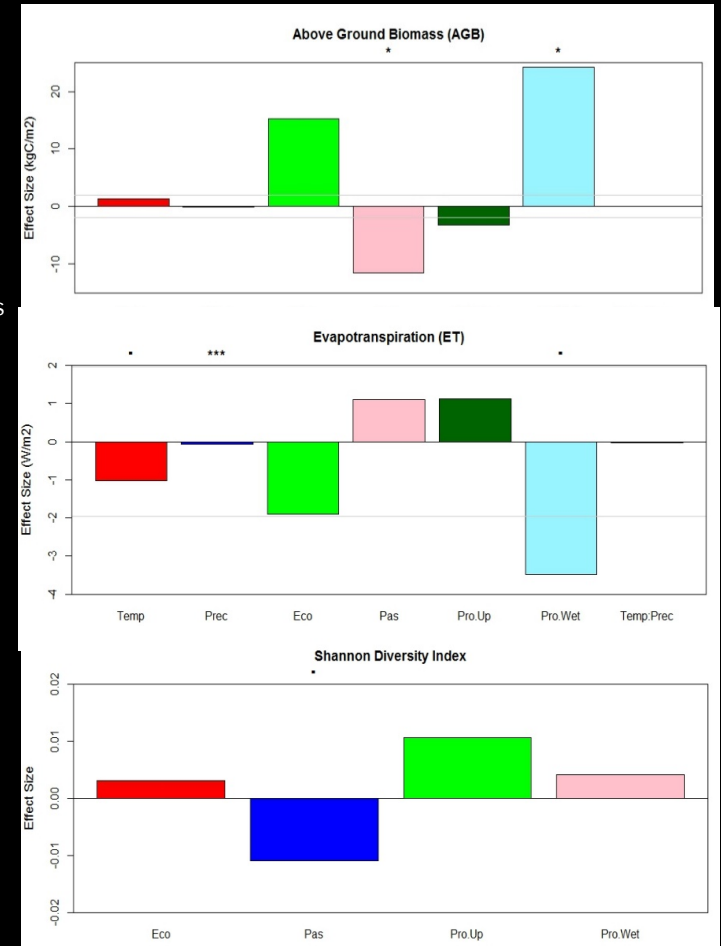
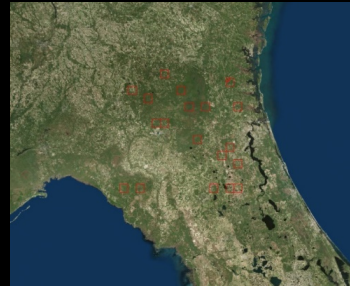
Cohort: Demography



Patch: Land Surface Biophysics

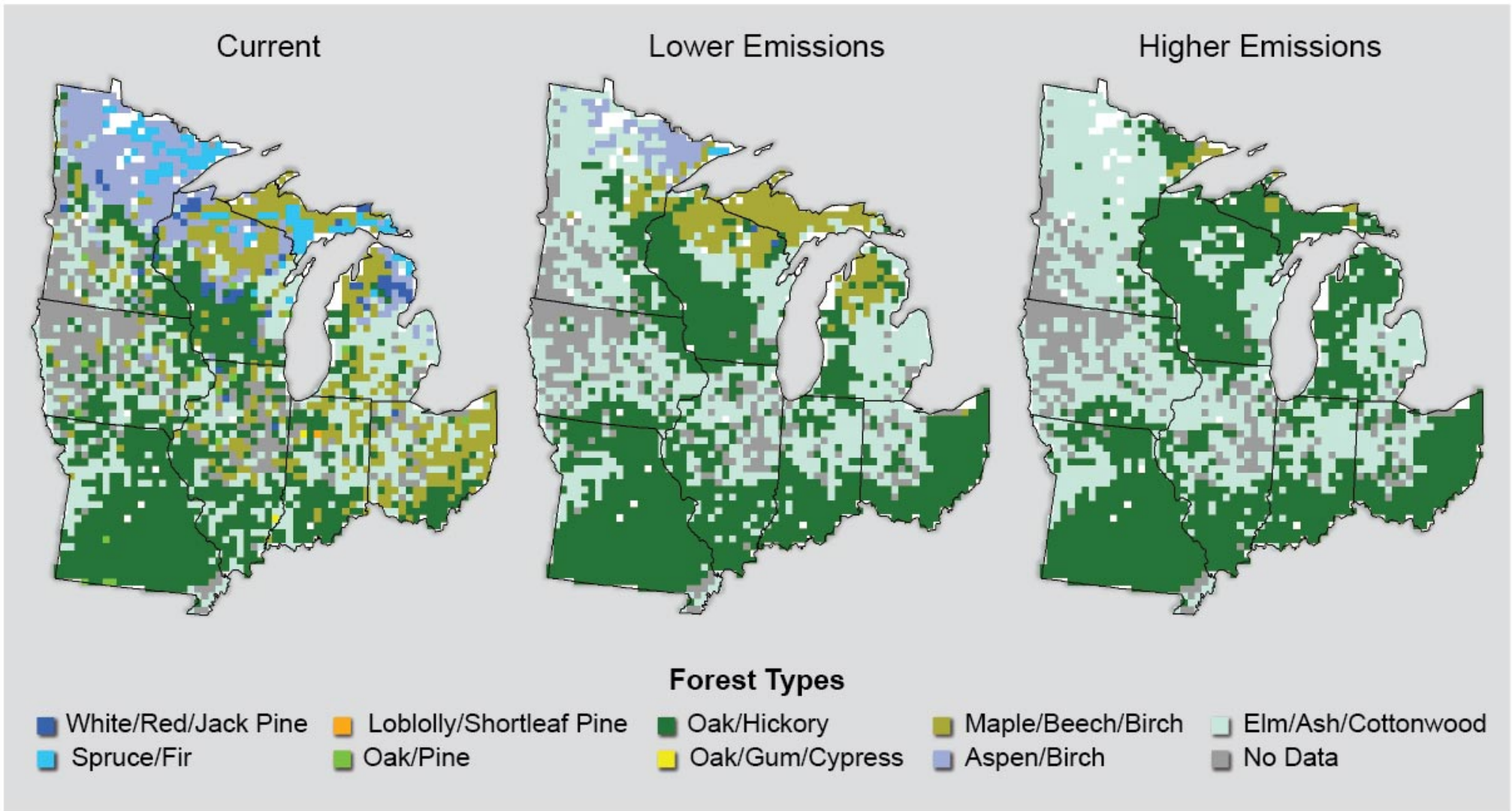


Prototype sites

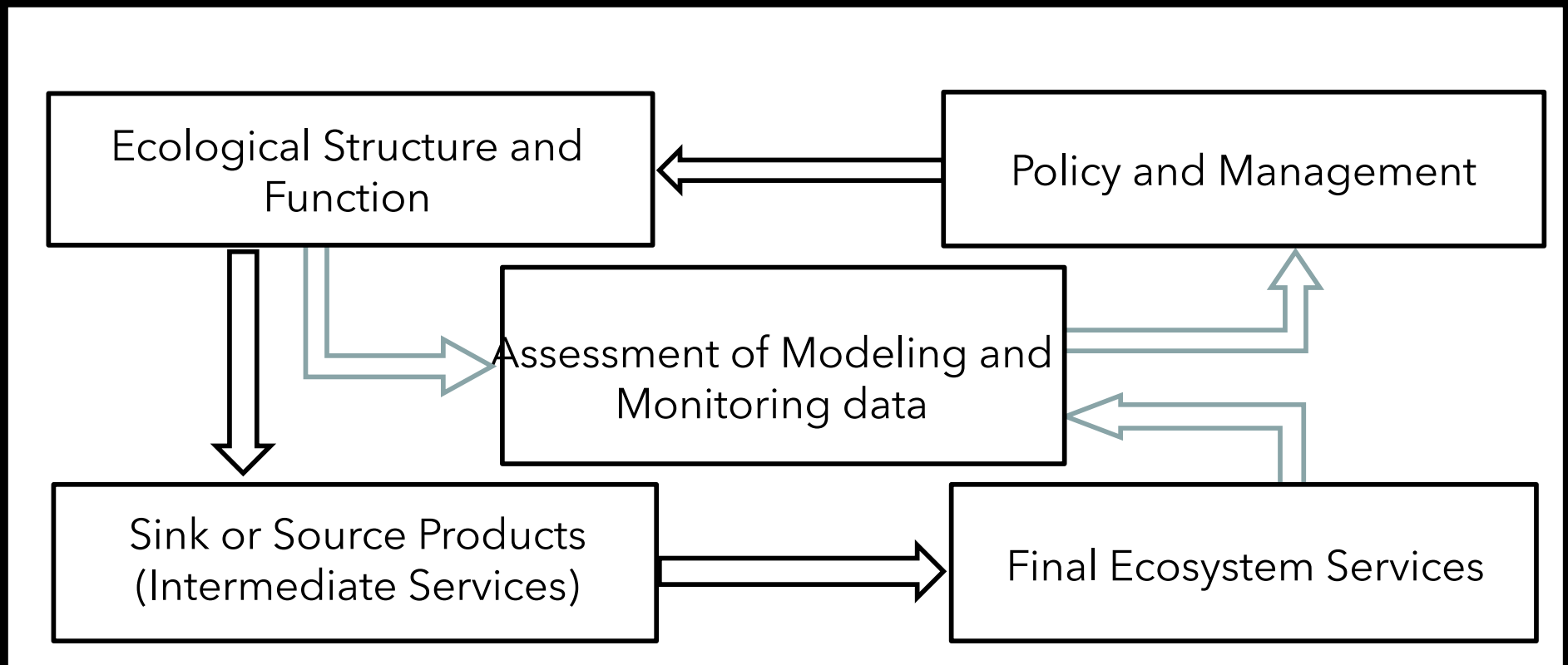


Implications and paths forward

Forest Composition Shifts



Socioecological Linkages



Final thoughts

- Forest management is more than clear-cutting
- We can map it
- We can define management function in a relatively simple manner
- We are incorporating into ecosystem models
- And comparing it to real world experiments with alternative harvesting practices
- And testing hypotheses on ecological scaling and atmospheric feedbacks
- Thanks!