Cross-Regional Perspectives on Ecosystem Management in Temperate Forest Systems

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Can managing for late-successional and old-growth forest characteristics be one element of ecosystem management?

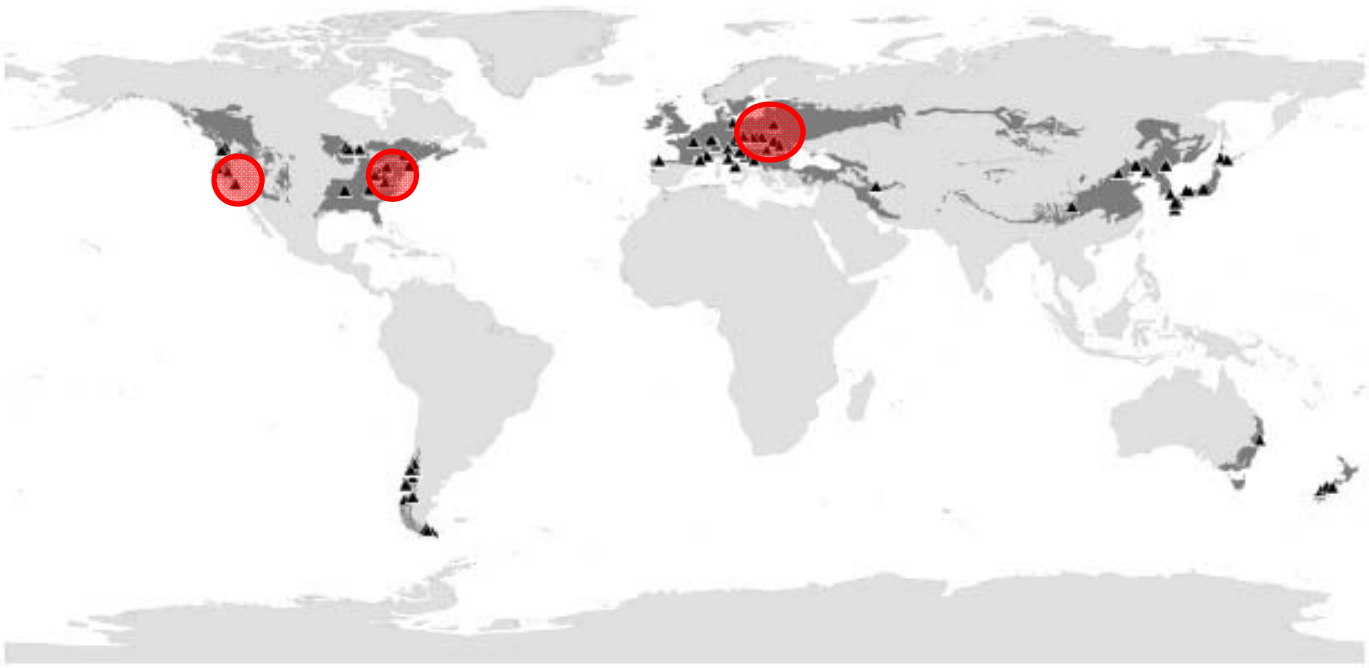
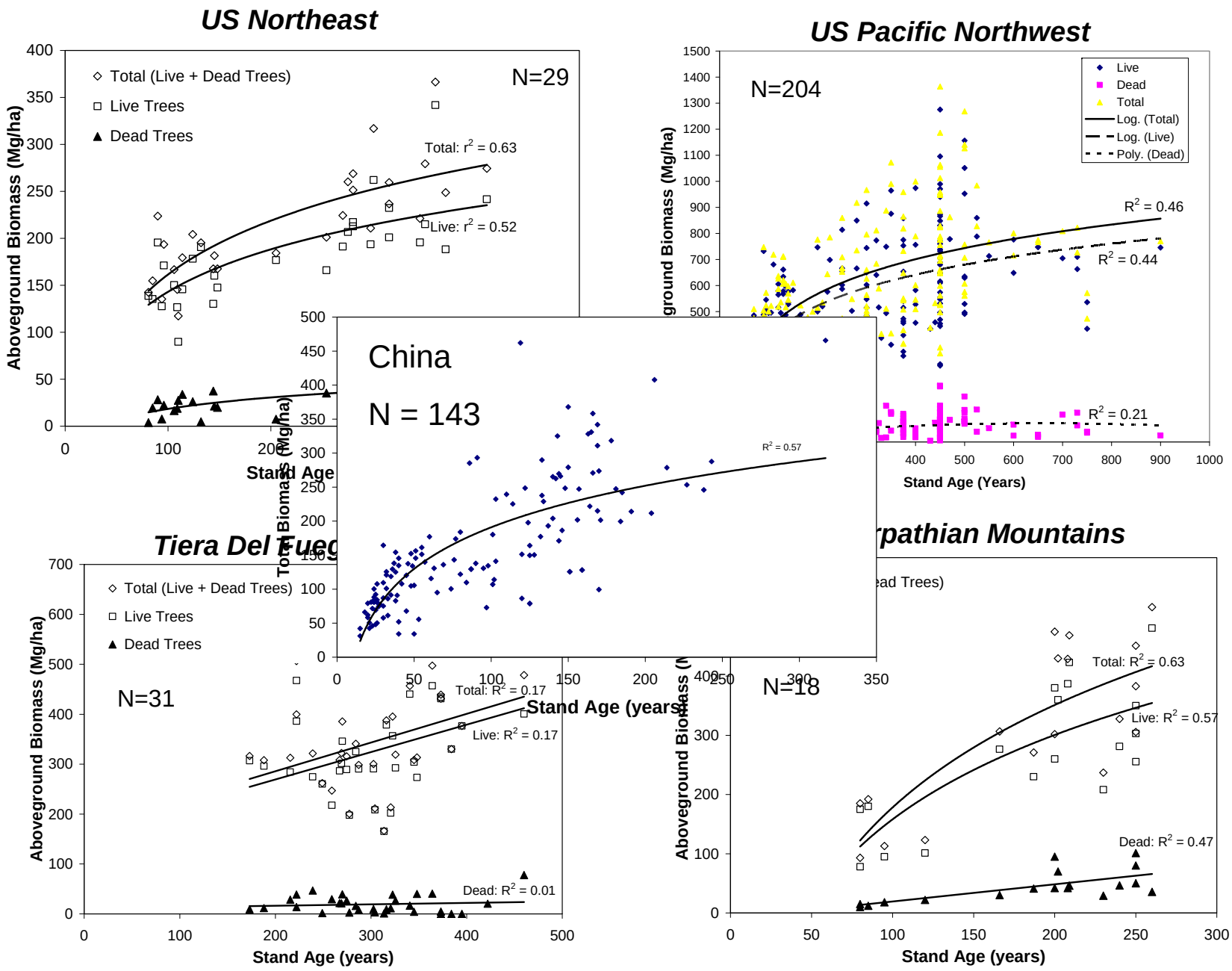


Fig. 1. World distribution of temperate forests (dark grey) within the temperate latitudinal zone according to Olson et al. (2001), and location of stands (triangles) included in the review for which detailed geographic information was available.

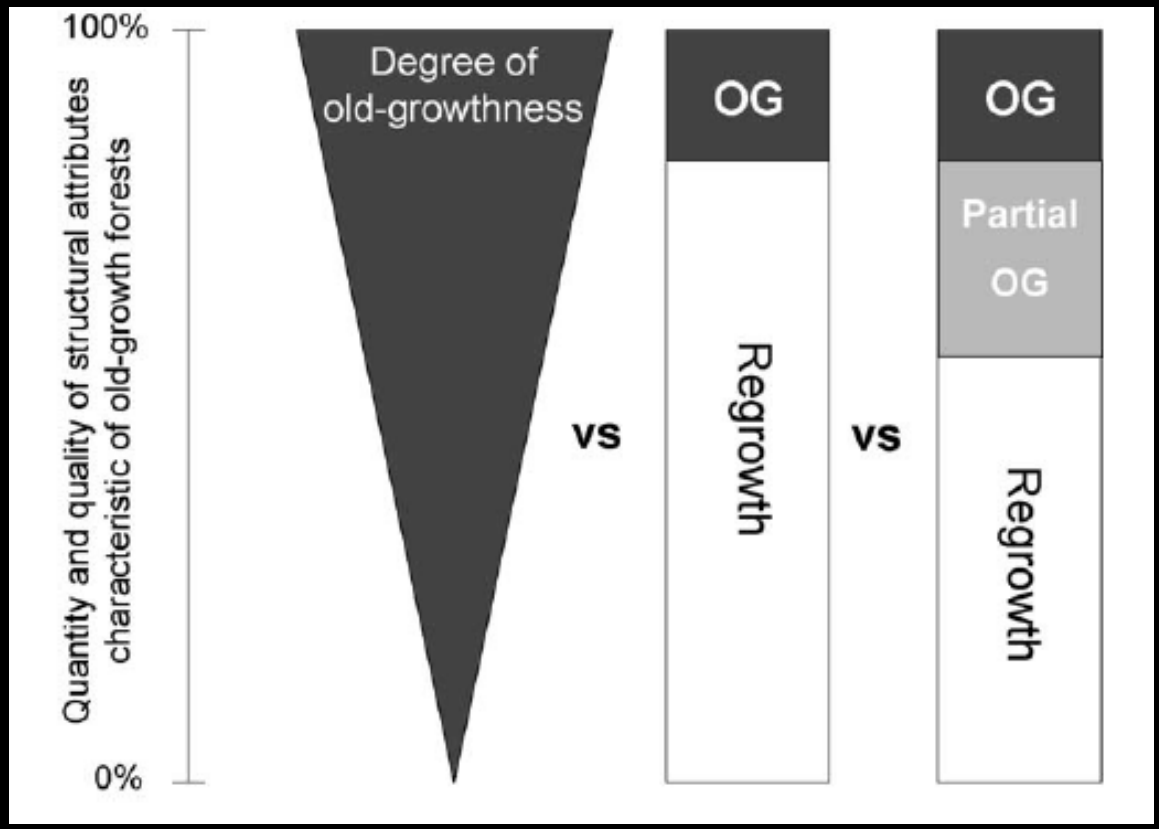
From: Burrascano, S., W.S. Keeton, F.M. Sabatini, and C. Blasi. 2013. Commonality and variability in the structural attributes of moist temperate old-growth forests: A global review. Forest Ecology and Management 291:458–479.

Aboveground Biomass vs. Stand Age

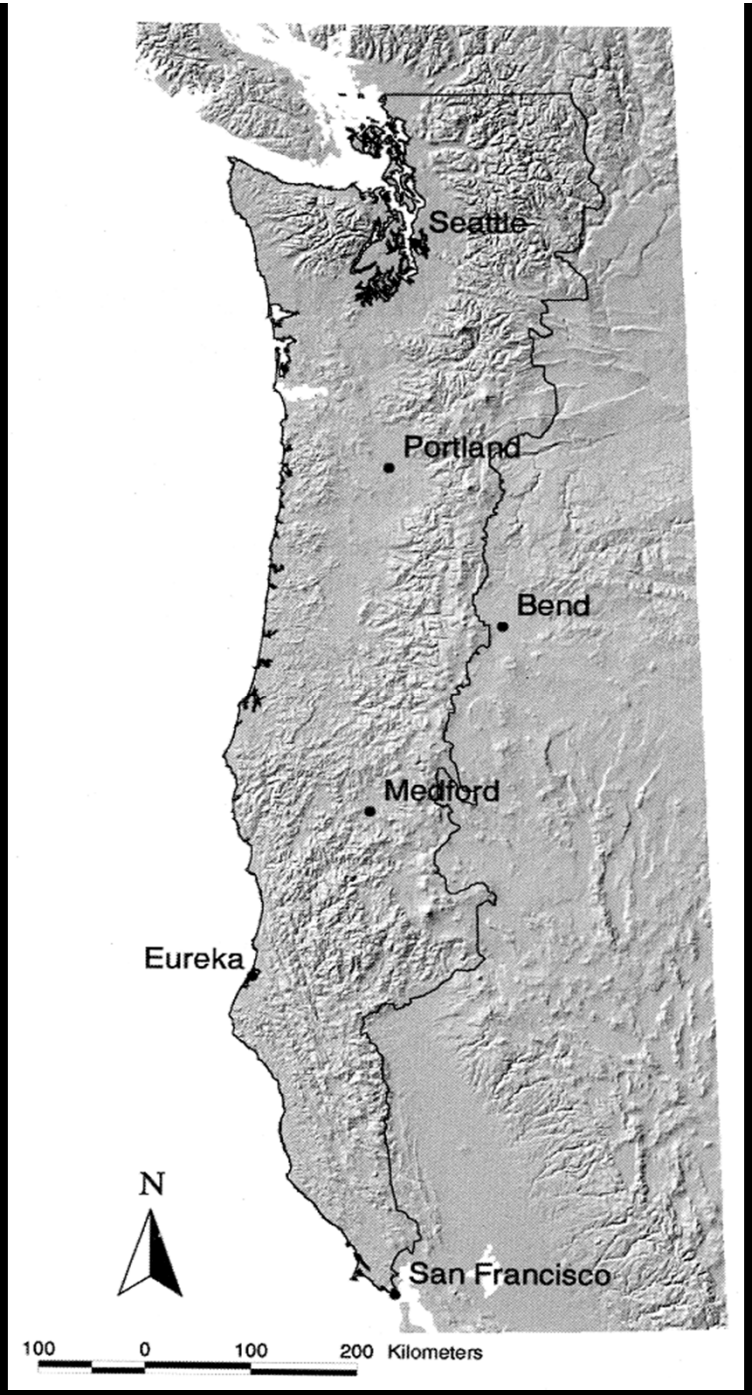


Broadening our perspective about "old-growth silviculture

- Recognizing variability
- Flexibility in OG management!
- Multiple pathways of development
- Manage as dynamic systems

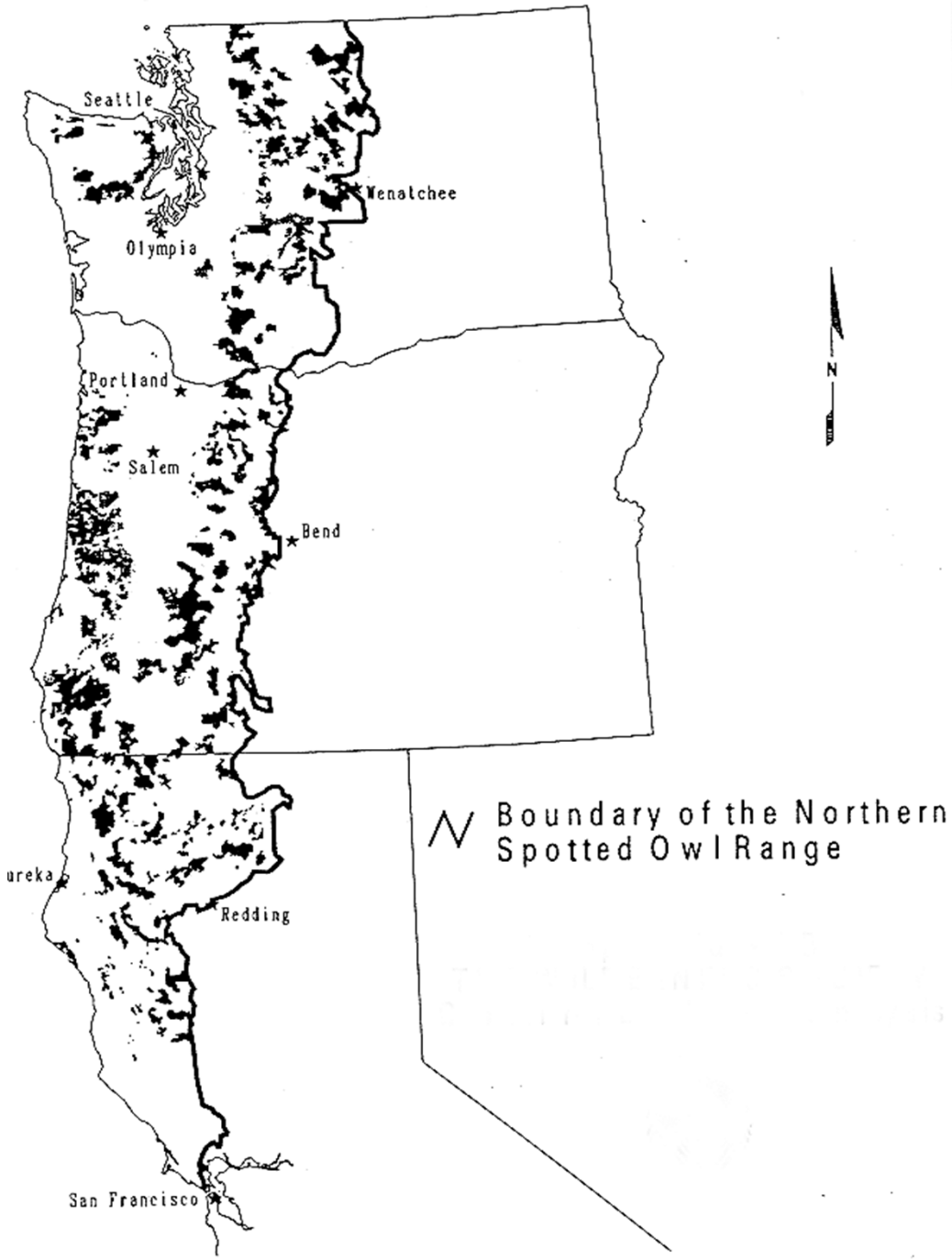


From: Bauhus, J., Puettmann, K., Messier, C., 2009. Silviculture for old-growth attributes. Forest Ecology and Management 258: 525-537.



Northwest Forest Plan

- U.S. Forest Service
- Bureau of Land Management
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- National Park Service



Late-Successional Reserves Established by the Northwest Forest Plan

From: Vogt, K.A…W.S. Keeton et al. 1997. Ecosystems: Balancing Science with Management. Springer-Verlag, New York, N.Y. 4

Restoration Treatments to Accelerate Succession

- Thinning from below the canopy
- Under-planting of shade tolerant conifers

Photo credit: Jerry F. Franklin, University of Washington

Intermediate Treatments:

e.g. Variable Density Thinning

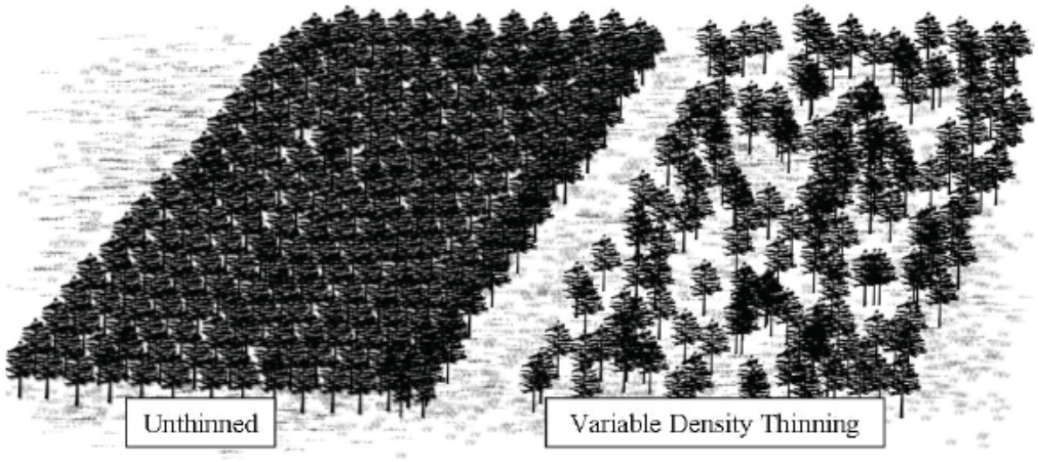


Figure 29.—Stylized representation of variable density thinning: (a) unthinned stand; (b) thinned stand displaying horizontal variation in stand density including gaps, skips (unthinned areas), and lightly thinned matrix.

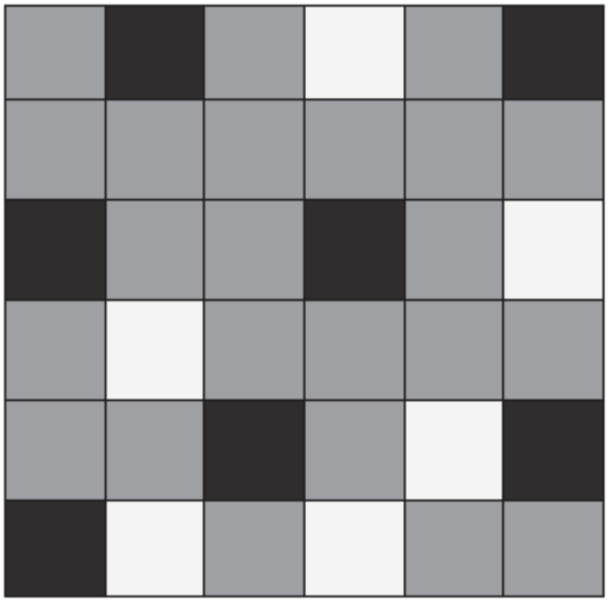
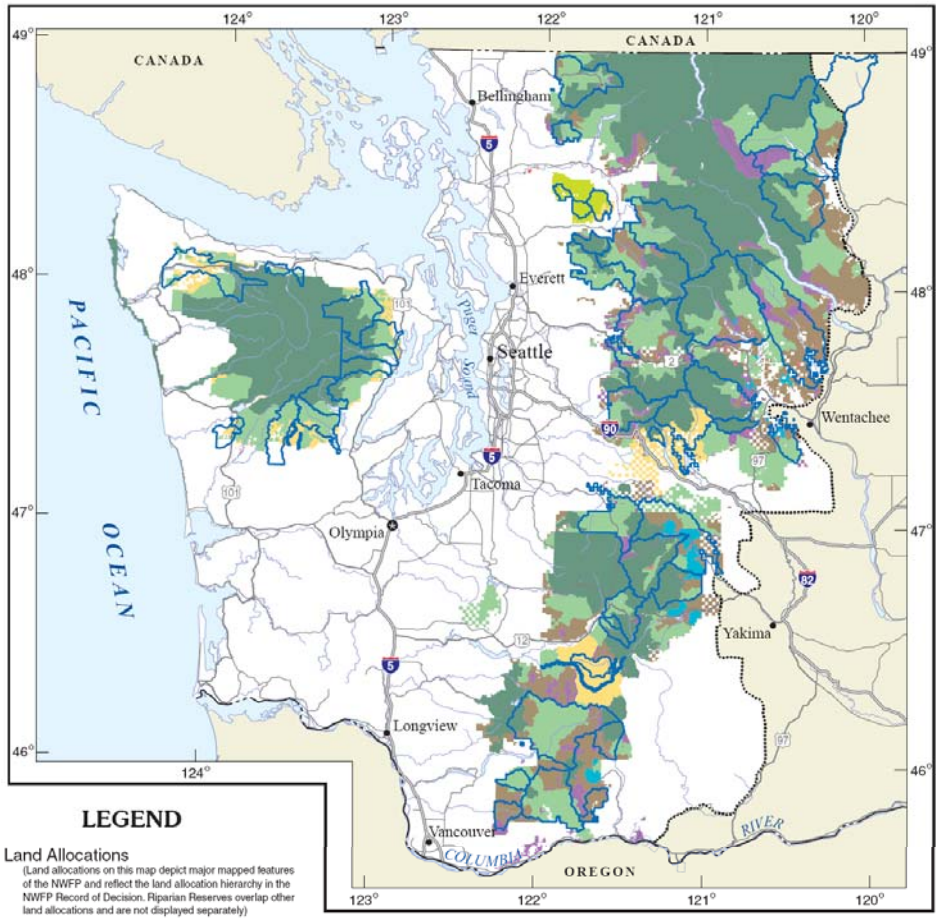


Figure 28.—Grid approach for implementing variable density thinning.

Figures from Franklin, Mitchell, and Palik (2007). US. Forest Service GTR NRS-19

Northwest Forest Plan Land Allocations

Western Washington - 2002



LEGEND

Land Allocations

(Land allocations on this map depict major mapped features of the NWFP and reflect the land allocation hierarchy in the NWFP Record of Decision. Riparian Reserves overlap other land allocations and are not displayed separately)

- Congressionally Reserved Area
- Late-Successional Reserve (LSR)
  (Not shown: LSRs associated with some species sites)
- Adaptive Management Reserve
  (Category depicts LSRs within Adaptive Management Areas)
- Adaptive Management Area
- Managed Late-Successional Area
- Administratively Withdrawn Area
  (Only major categories are shown)
- Other Area
  (Category depicts a mix of Matrix, Riparian Reserves, and other unmapped land allocations)
- No NWFP Designation

Boundaries

- Key Watershed
- Northwest Forest Plan Boundary

LOCATION MAP

N
W
E
S

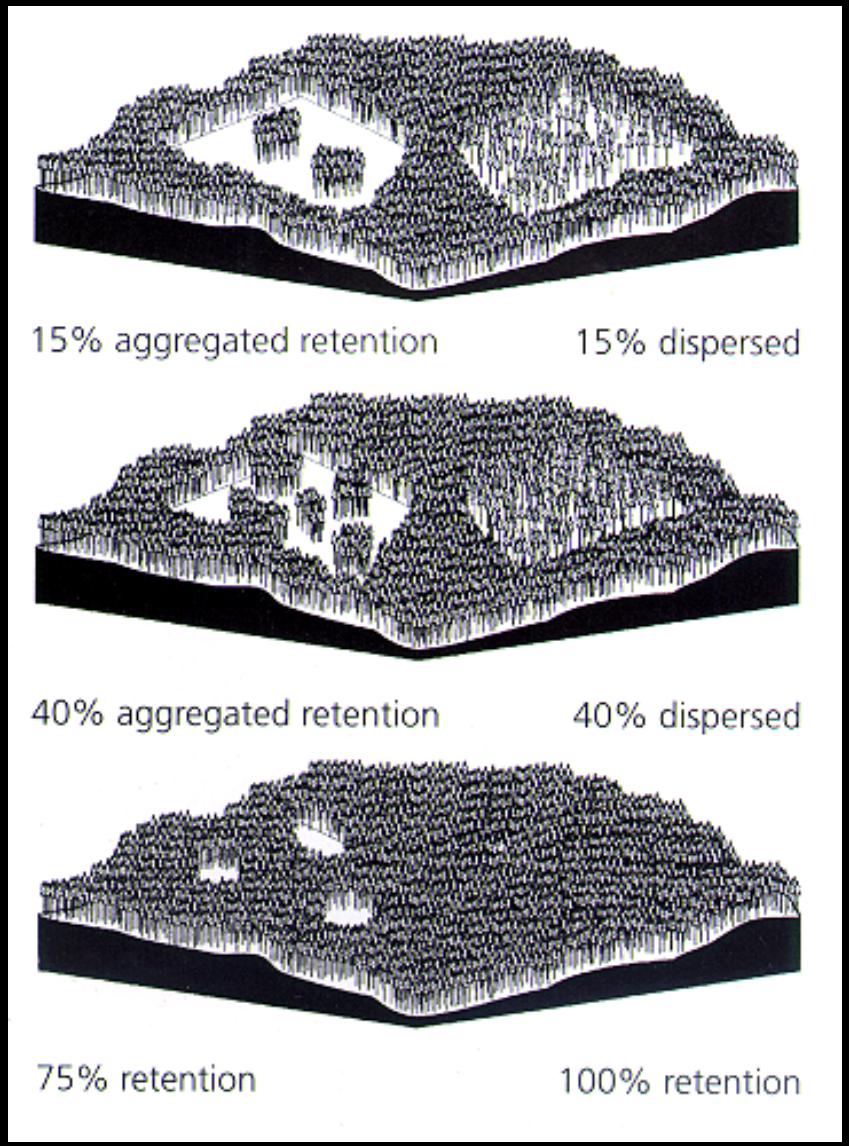
20 0 20 40 Miles

20 0 20 40 Kilometers

U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
U.S. DEPARTMENT OF THE AGRICULTURE
Forest Service
2004

M04-09-13 : JR

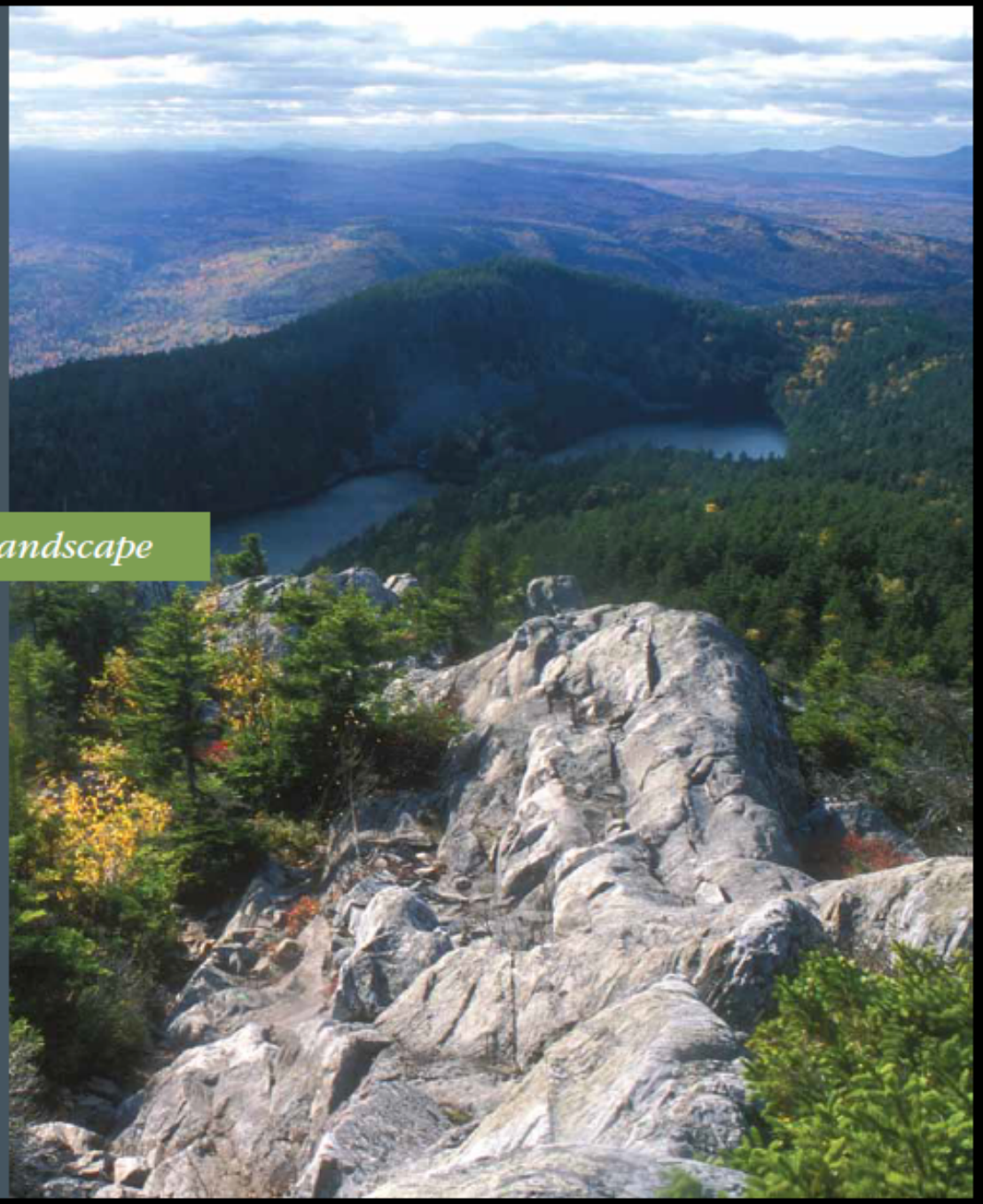
"Demonstration of Ecosystem Management Options"

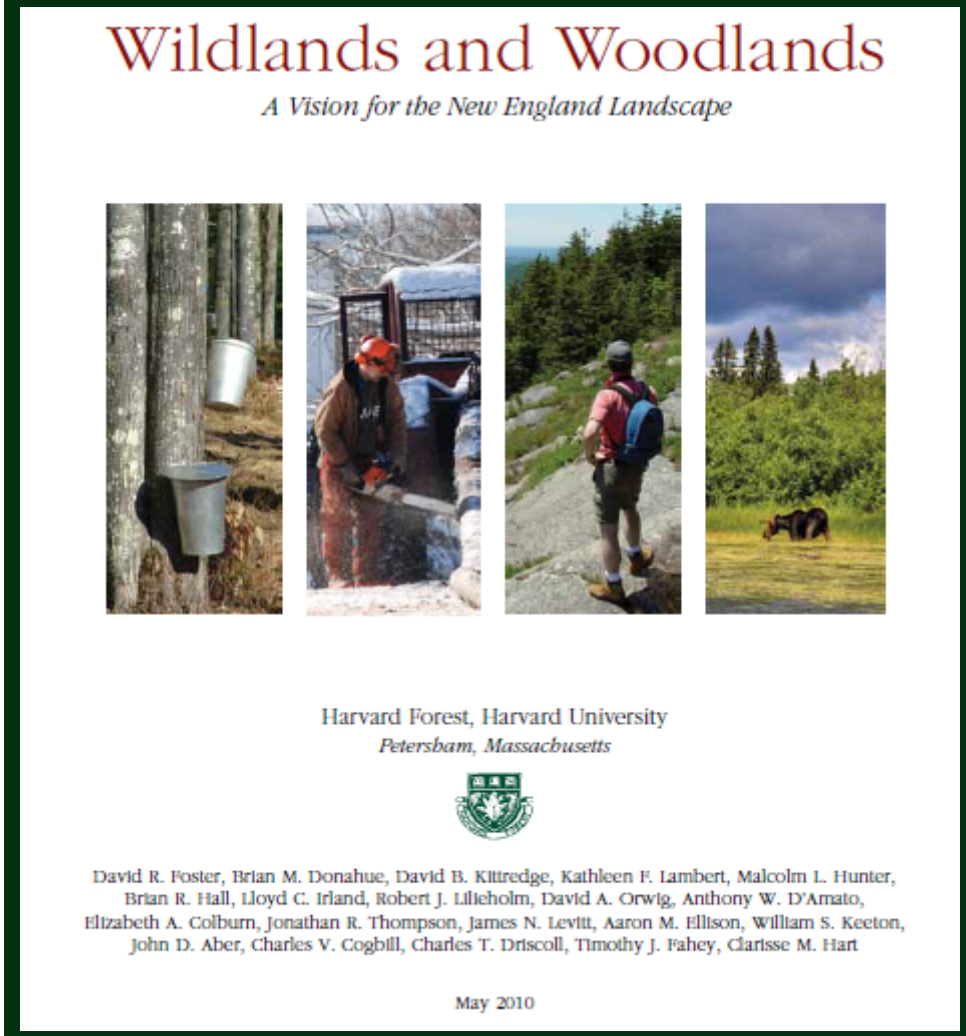


Variable Retention Harvesting

Wildlands and Woodlands

A Vision for the New England Landscape



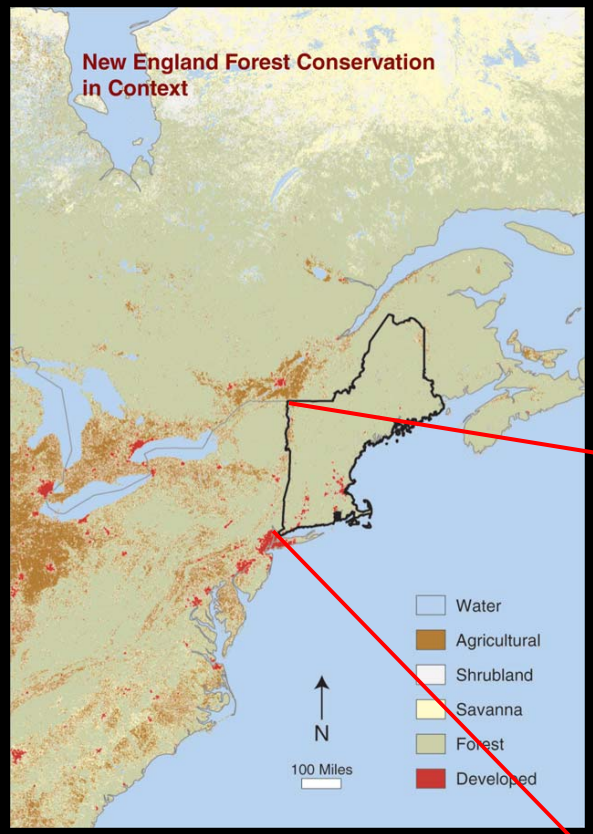


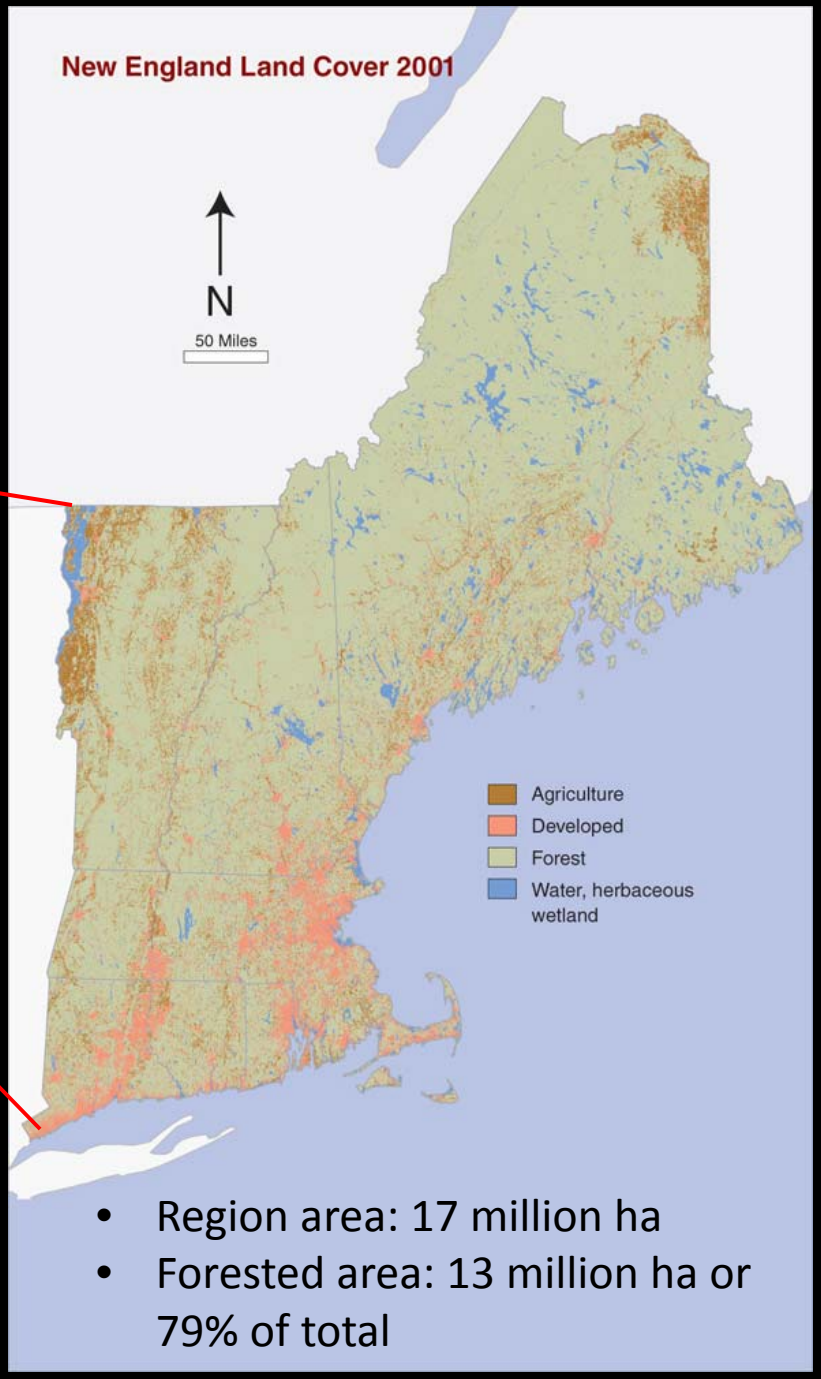
Science:

- Multi-disciplinary team of 20 scientists and communications specialists
- Compilation of historic and contemporary data sources
- Use of remotely sensed National Land Cover Database
- Variety of projection methods for future scenarios
- Integration of empirical and modeling studies to interpret trends

Application:

- Unprecedented effort to develop policy recommendations
- Expert opinion process
- Major multi-media campaign
- Down-scaling through stakeholder based processes



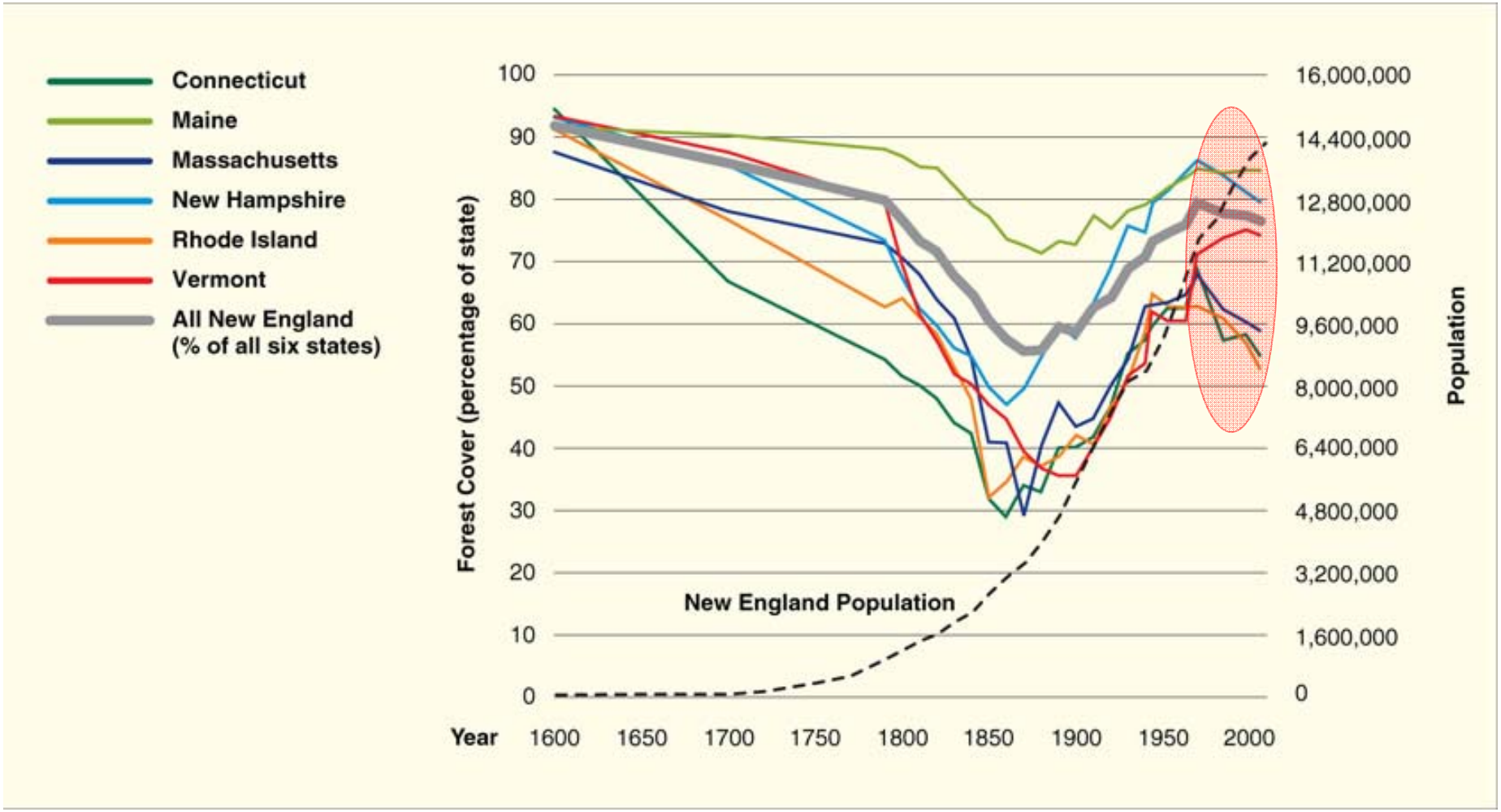


Modified from National Land Cover Database (2001):

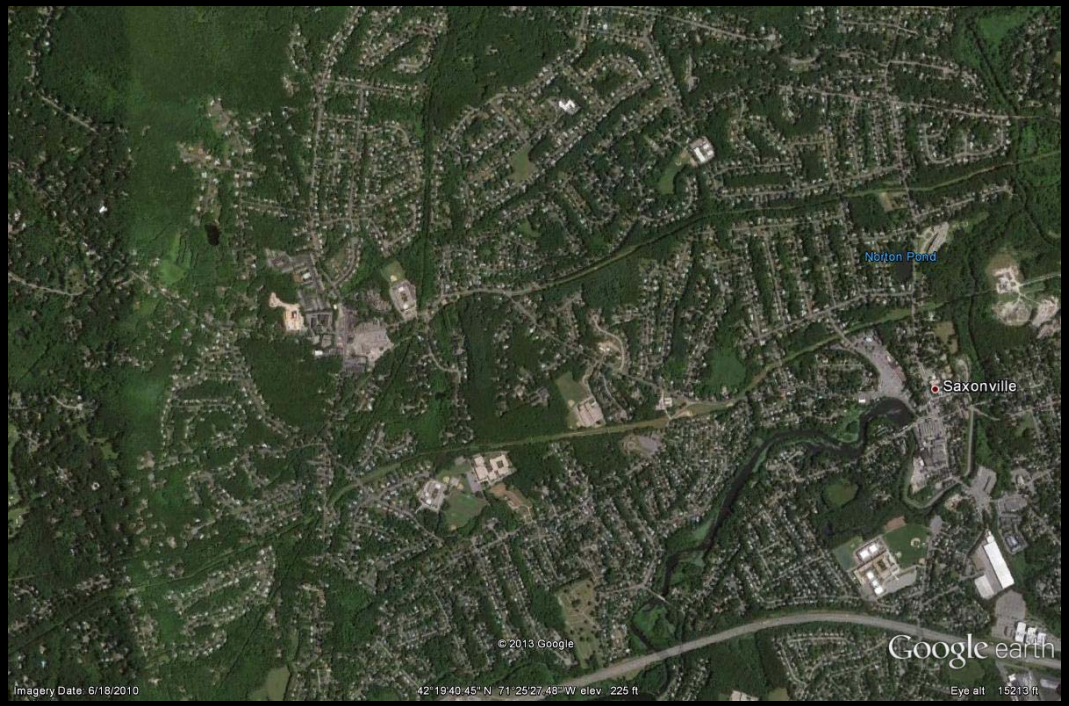
- 16-class land cover classification
- Spatial resolution = 30 meters.
- Based primarily on unsupervised classification of Landsat Enhanced Thematic Mapper+ circa 2001 satellite data.
- Three elements: *land cover, percent developed impervious surface, and percent tree canopy density.*

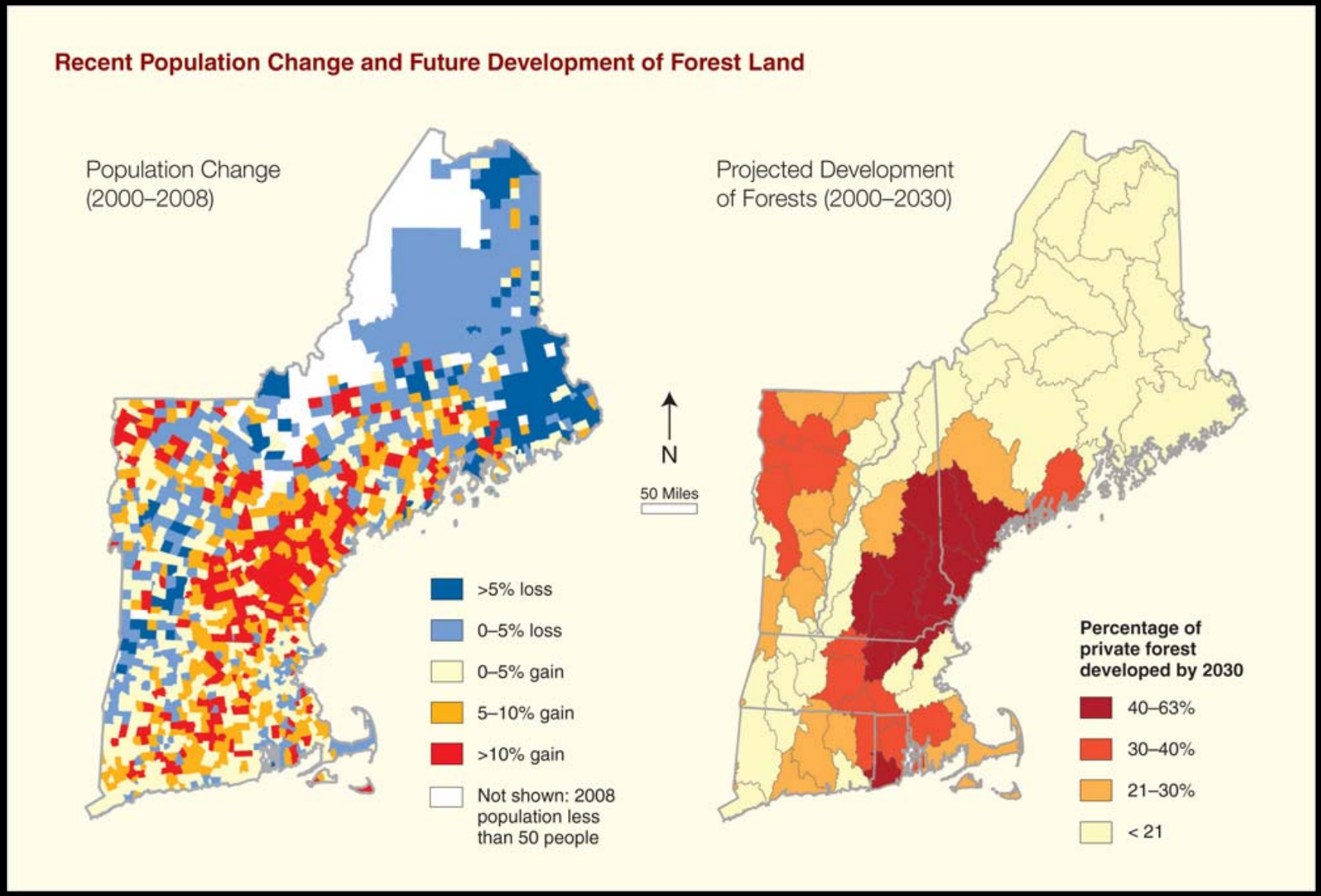
- Region area: 17 million ha
- Forested area: 13 million ha or 79% of total

Estimated forest cover change since the early 1600s



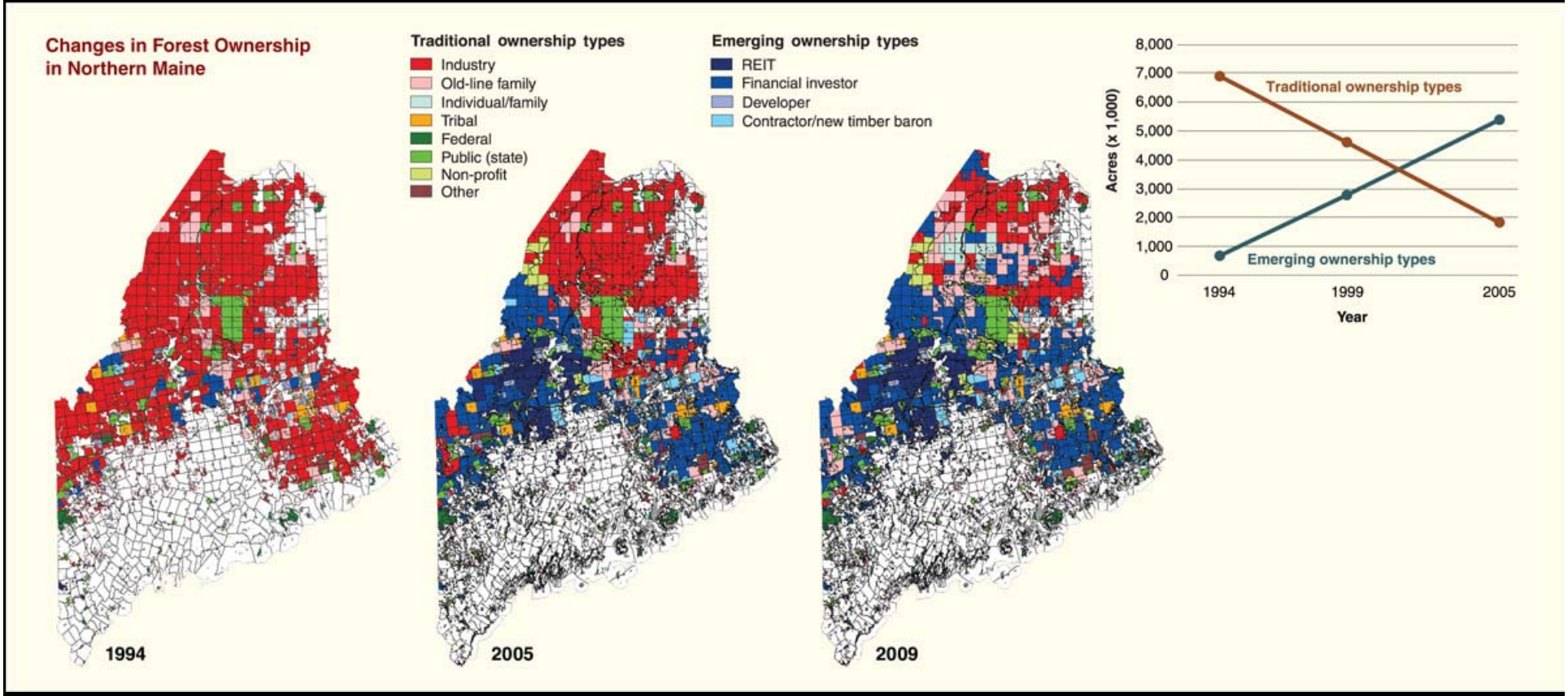
Data sources compiled in: Foster, D. R., and J. Aber (eds). 2004. Forests in time: the environmental consequences of 1,000 years of change in New England. Yale University Press, New Haven, CT


Norton Pond
Saxonville
© 2013 Google
Google earth
Imagery Date: 6/18/2010
42°19'40.45" N 71°25'27.48" W elev 225 ft
Eye alt 15213 ft

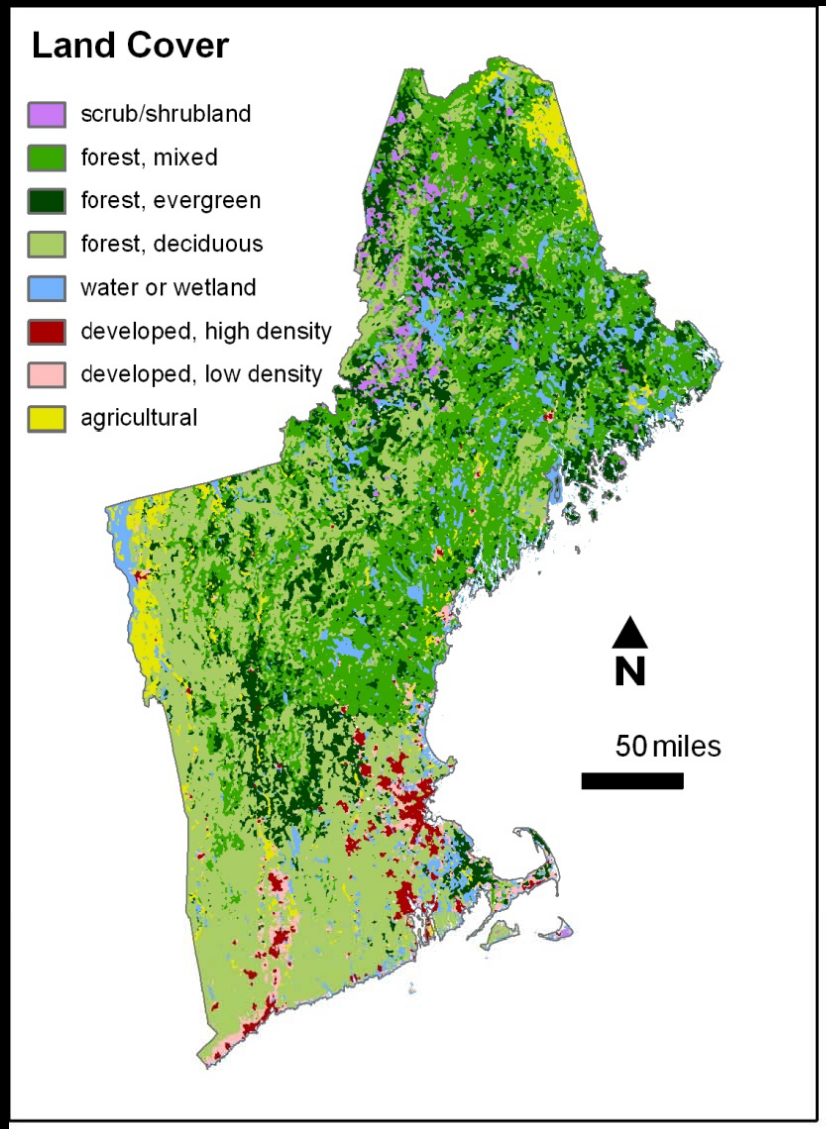


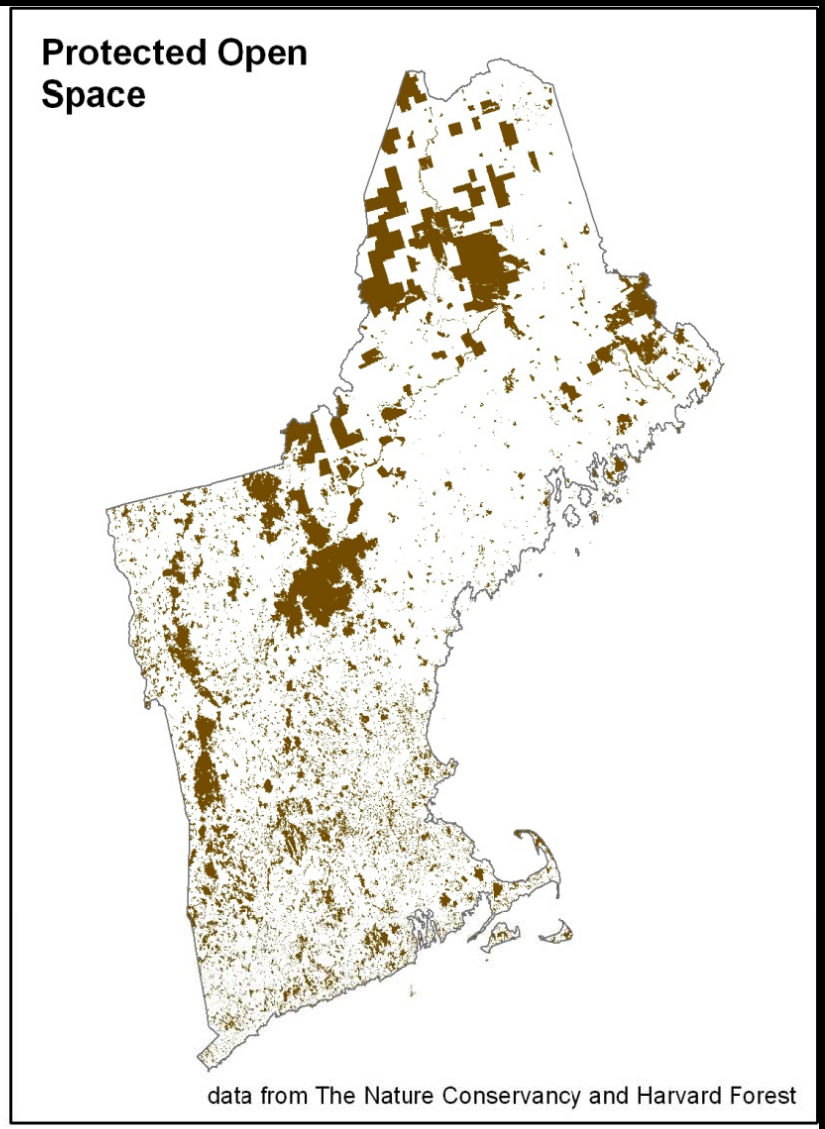
- Sources: Population map based on data from the U.S. Census Bureau. To represent meaningful changes, only sub-county areas with a 2008 population of 50 people or more are shown.
- The projected forest development map is reprinted from the *Forests on the Edge* research project, sponsored by the U.S. Forest Service (Stein et al. 2005, 2010).

Changing ownership patterns are influencing forest loss and fragmentation…



Sources: Maps reprinted from Lilieholm et al. (2010) with data from the James W. Sewall Company. Line graph reprinted from Hagan et al. (2005)





Land use/land cover and protected open space in New England. Landcover data comes from the National Land Cover Data (NLCD), 2001. A majority filter was applied using a 1km-radius window to smooth the image and reveal regional-scale patterns. The protected open space data came from state GIS agencies, The Nature Conservancy, and the Harvard Forest.

WILDLANDS AND WOODLANDS: AT A GLANCE

OBJECTIVE: Permanently retain 70% of the New England landscape in forests that will benefit current and future generations.

Managed Woodlands: 63% of New England (27 million acres)

Woodlands vary in both ownership and management types. They strive to accomplish five objectives:

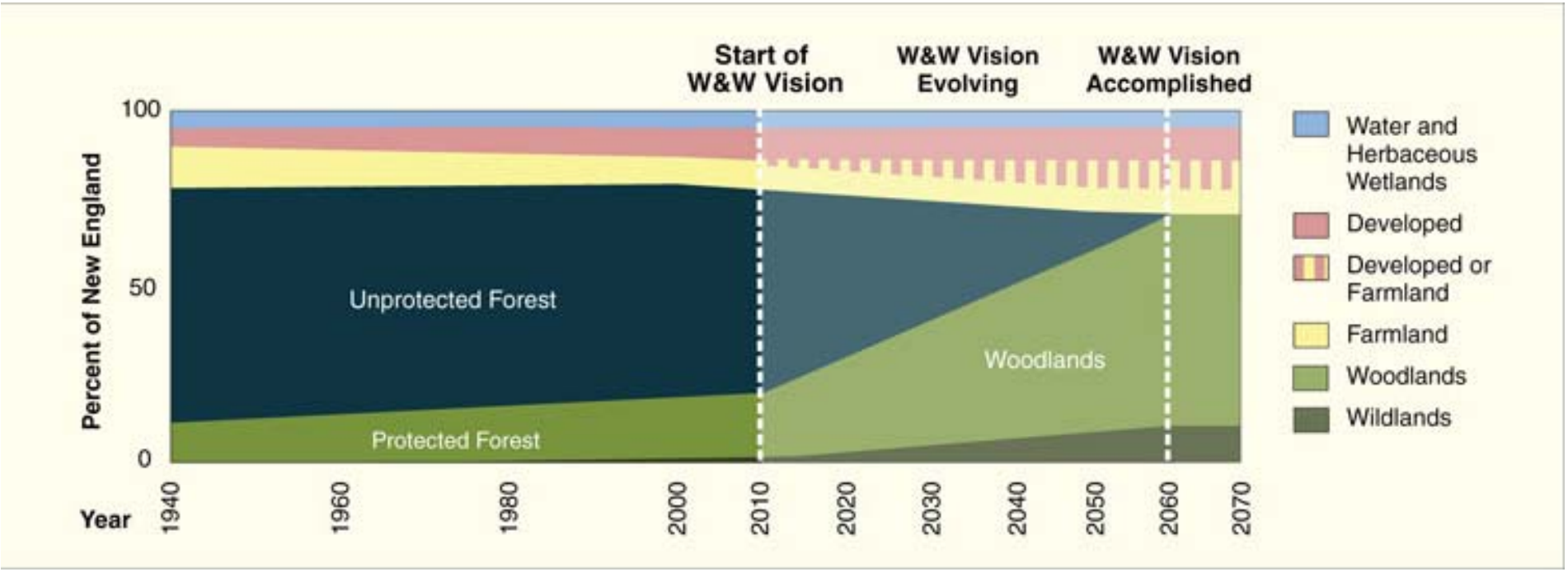
- Bolster New England's economy by providing a dependable local resource base for sustainable wood products and future ecosystem-service mitigation markets;
- Enhance the natural benefits that forests provide: clean water and air, flood and erosion control, and carbon sequestration to combat climate change;
- Maintain access to continuous landscapes for nature-based tourism, recreation, and enjoyment;
- Provide extensive connected forest habitats for plants and animals pressured by development, natural disturbance, and climate change; and
- Expand the cover of trees in and around town centers, suburbs, and cities.

Wildland reserves: 7% of New England (3 million acres)

Wildlands, protected based on local considerations and ranging in size from 5,000 to 1 million acres. They strive to accomplish four objectives:

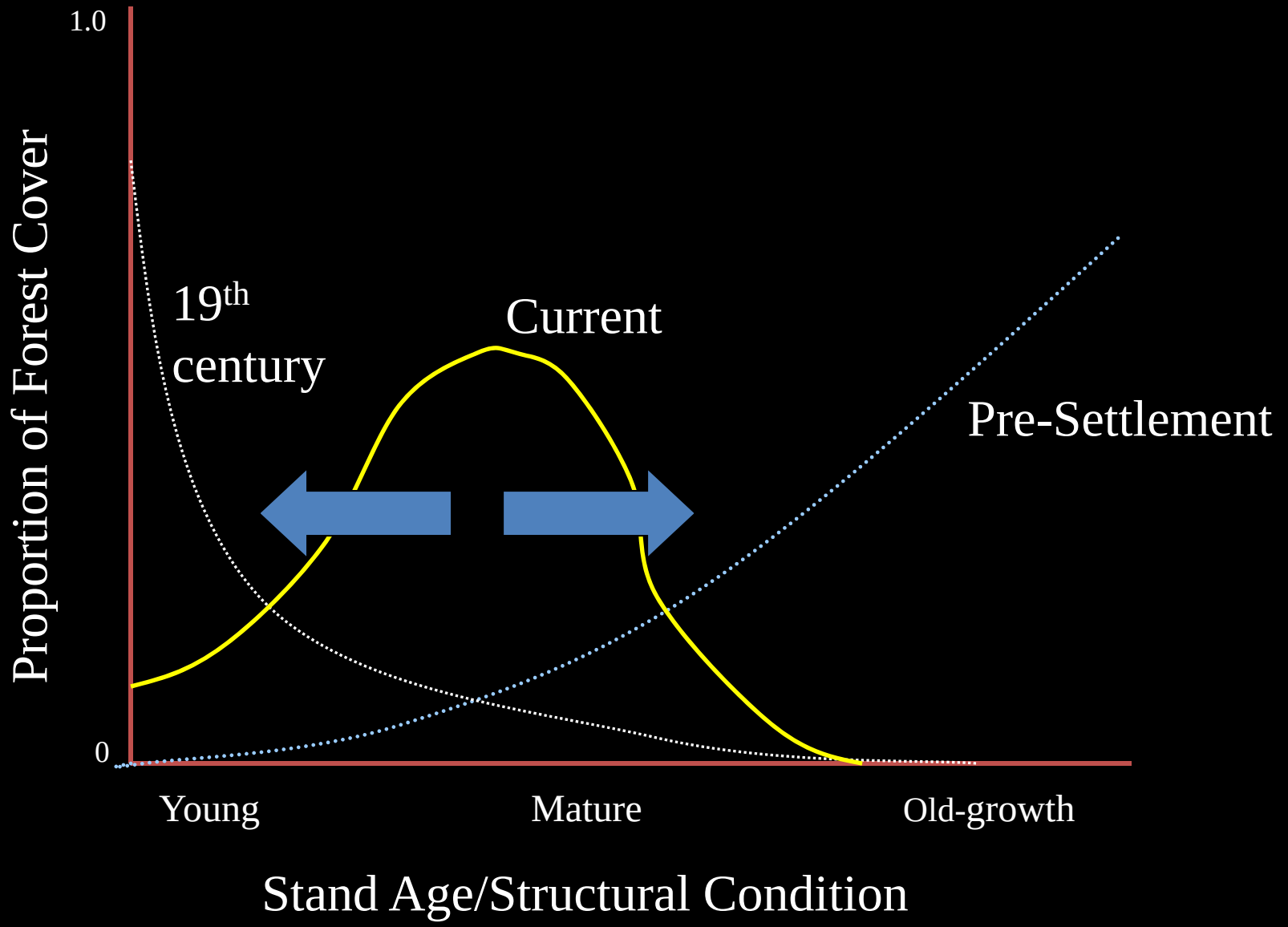
- Slow the pace of climate change by supporting complex, aging forests that can store twice as much carbon as young forests;
- Provide rare habitats for a diverse array of plants, animals, and micro-organisms;
- Safeguard lands of natural, cultural, and spiritual significance; and
- Serve as unique scientific reference points for evaluation and improvement of management practices elsewhere.

Wildlands and Woodlands: The Long-Term Alternative



- Will require a doubling in the rate of forest conservation over current levels to achieve the vision within 50 years.

Changes in Age-Class Distributions



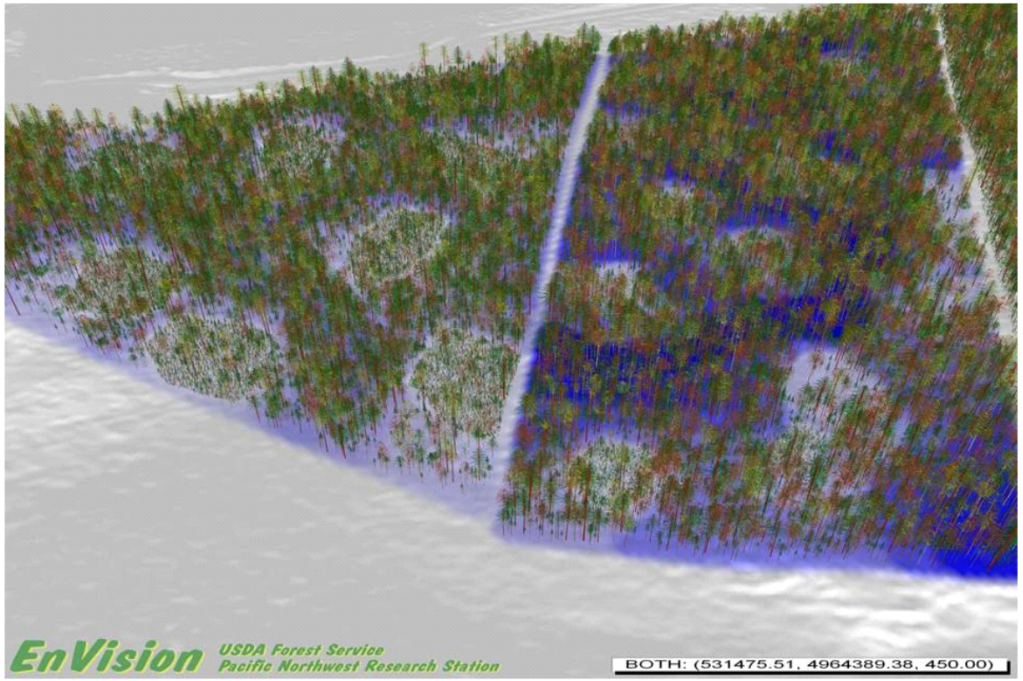
Managing for Early-Successional Habitat

Patch Cutting:

- Used increasingly
- Sometimes with retention, dispersed and aggregated
- Proportion of landscape is key
- Long term implications -> increased abundance of stem exclusion stage stands?

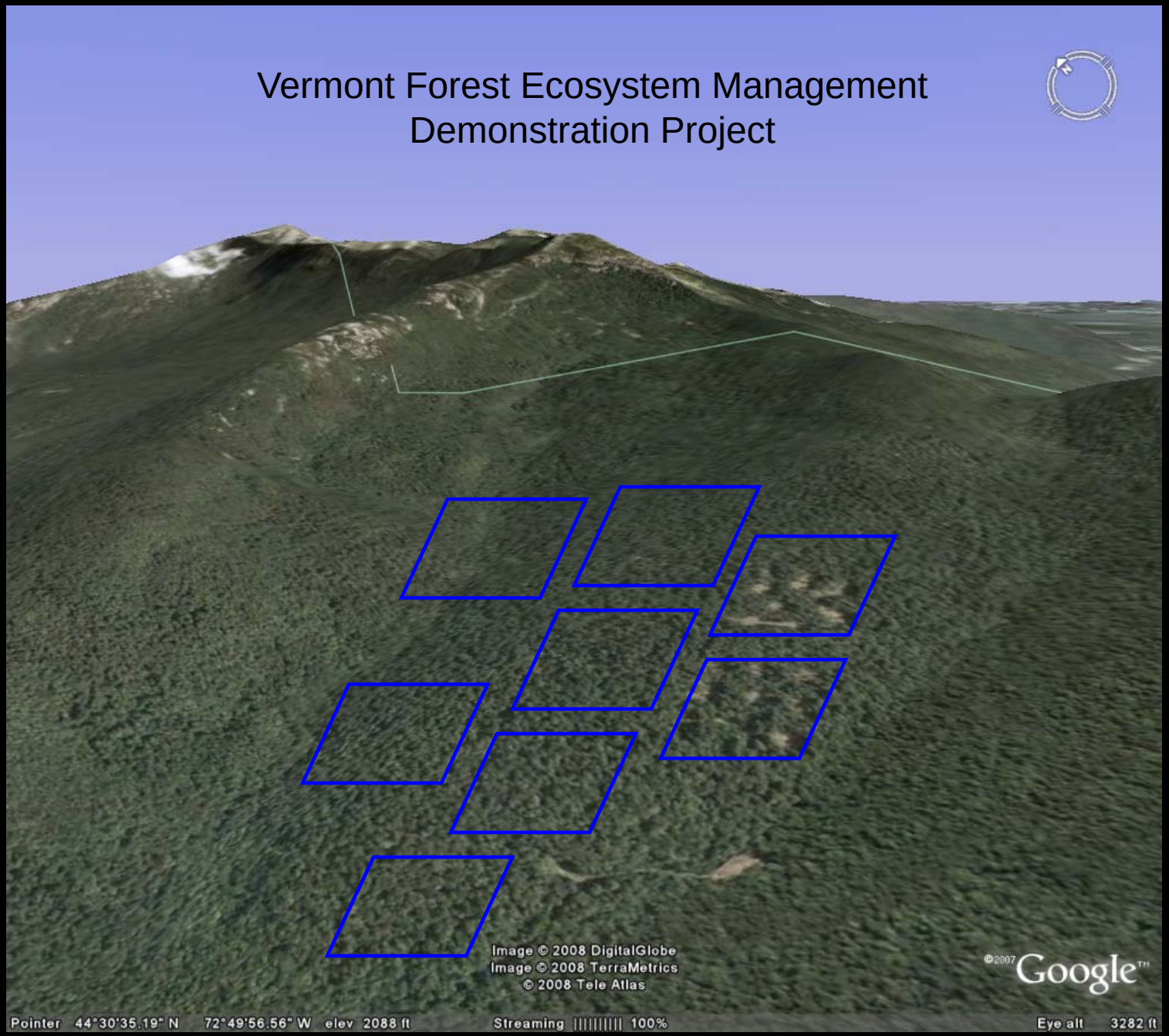
"Expanding Gap" Study. Univ. of Maine.

- Expanding group selection with retention
- Entry cycle and area in openings mimic disturbance frequency and intensity



(From North and Keeton 2008; as modified from Seymour 2005)

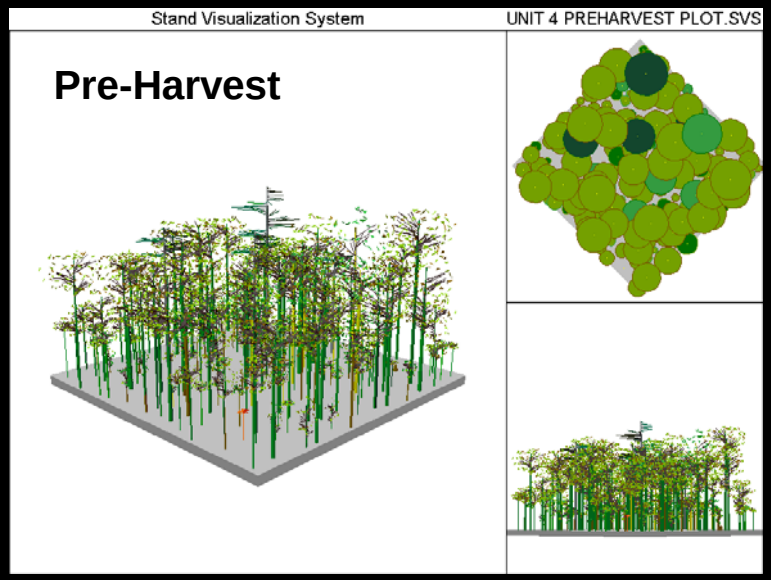
Vermont Forest Ecosystem Management Demonstration Project

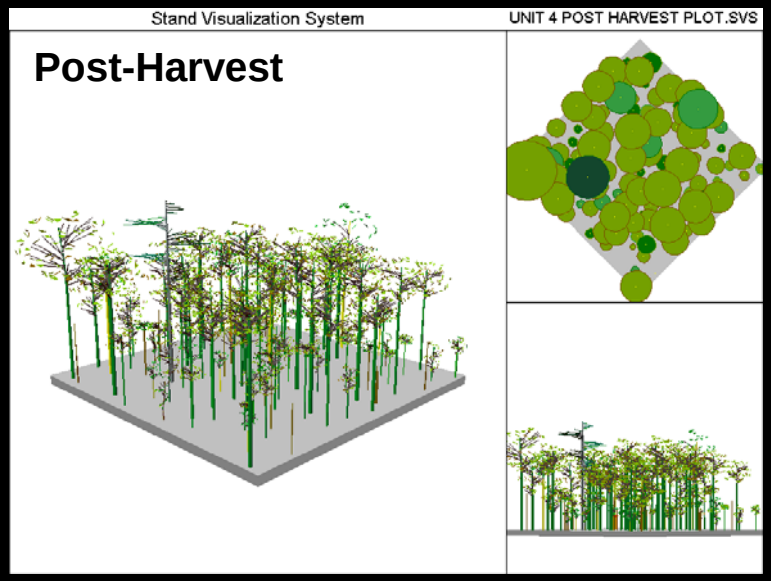


Structural Complexity Enhancement (SCE)

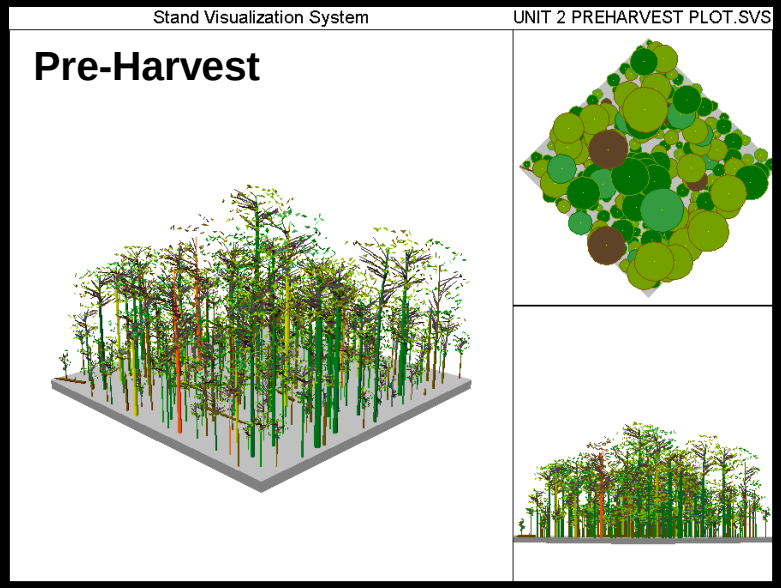
Structural Objective	Silvicultural Technique
Multi-layered canopy	• Single tree selection using a target diameter distribution • Release advanced regeneration • Establish new cohort
Elevated large snag densities	• Girdling of selected medium to large sized, low vigor trees
Elevated downed woody debris densities and volume	• Felling and leaving, or • Pulling over and leaving
Variable horizontal density	• Harvest trees clustered around “release trees” • Variable density marking
Re-allocation of basal area to larger diameter classes	• Rotated sigmoid diameter distribution • High target basal area • Maximum target tree size set at 90 cm dbh
Accelerated growth in largest trees	• Full and partial crown release of largest, healthiest trees

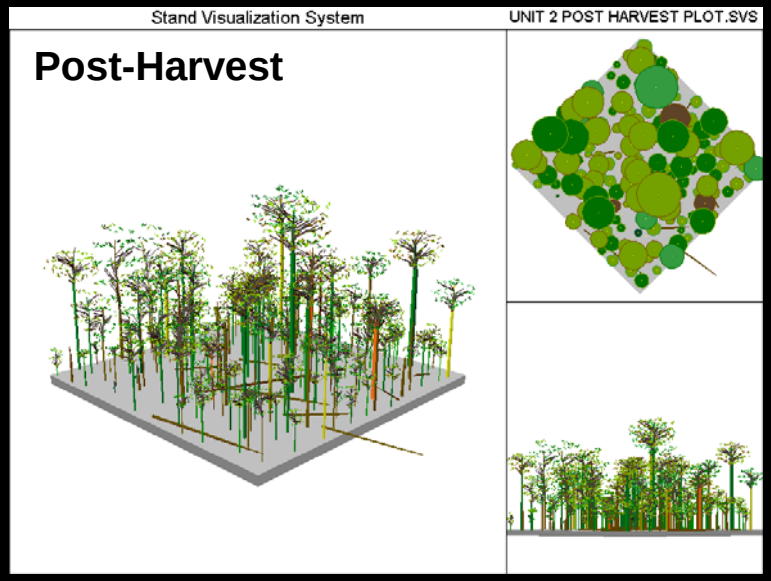
Single-Tree Selection Unit





Structural Complexity Enhancement Unit





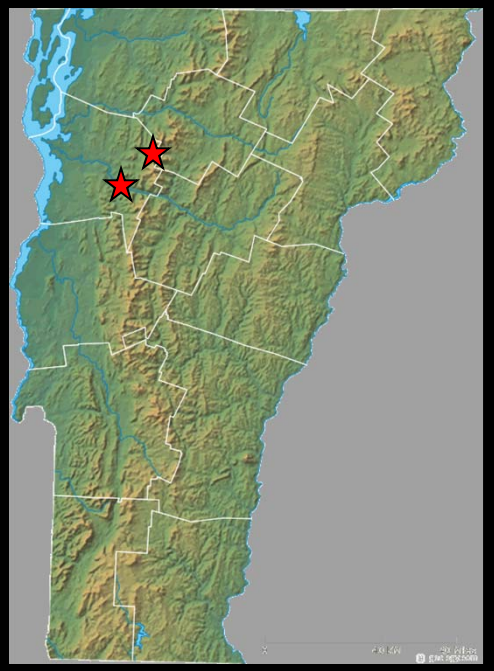
Methods

Study Areas:

Mount Mansfield State Forest

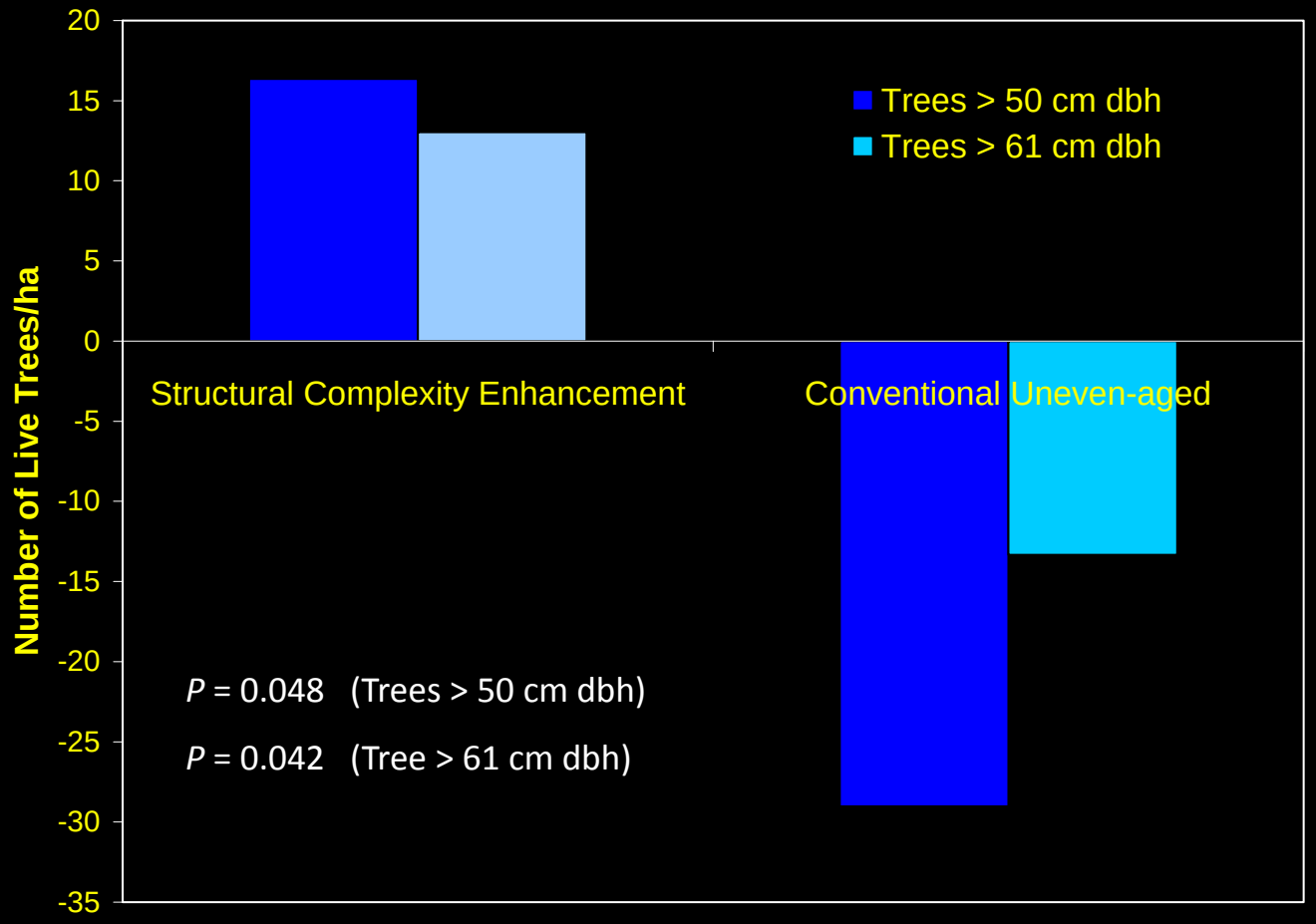
Jericho Research Forest

Paul Smith's College (via cooperation)



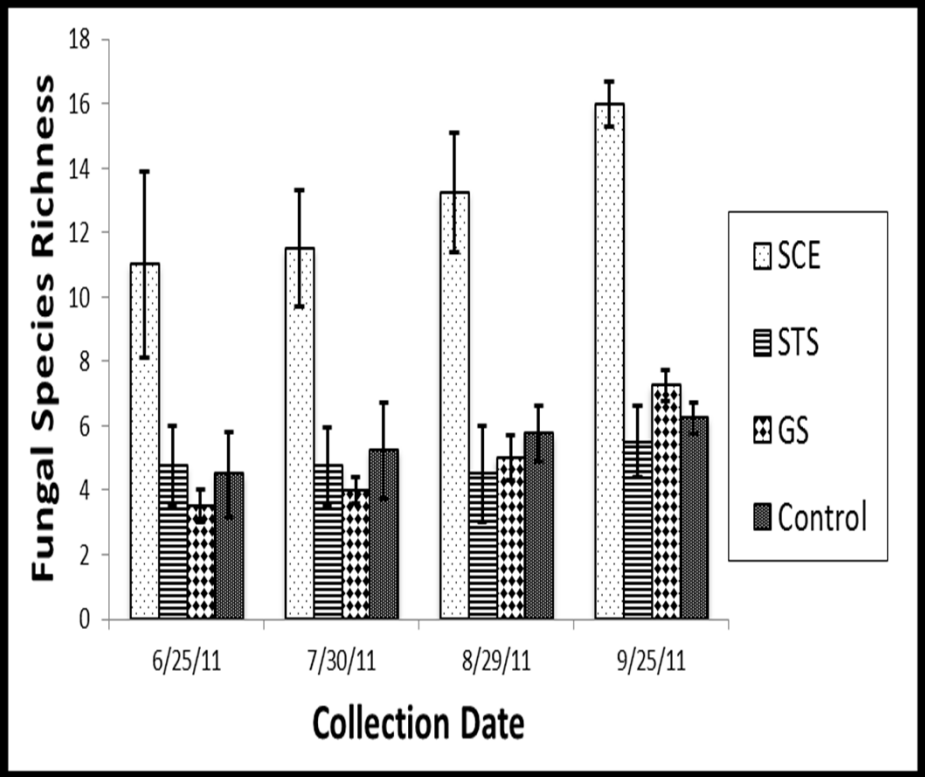
- Mature, multi-aged northern hardwoods
- History of thinning and selection harvesting
- Mid-elevation, moderate productivity

FVS projected change in large tree densities after 50 years



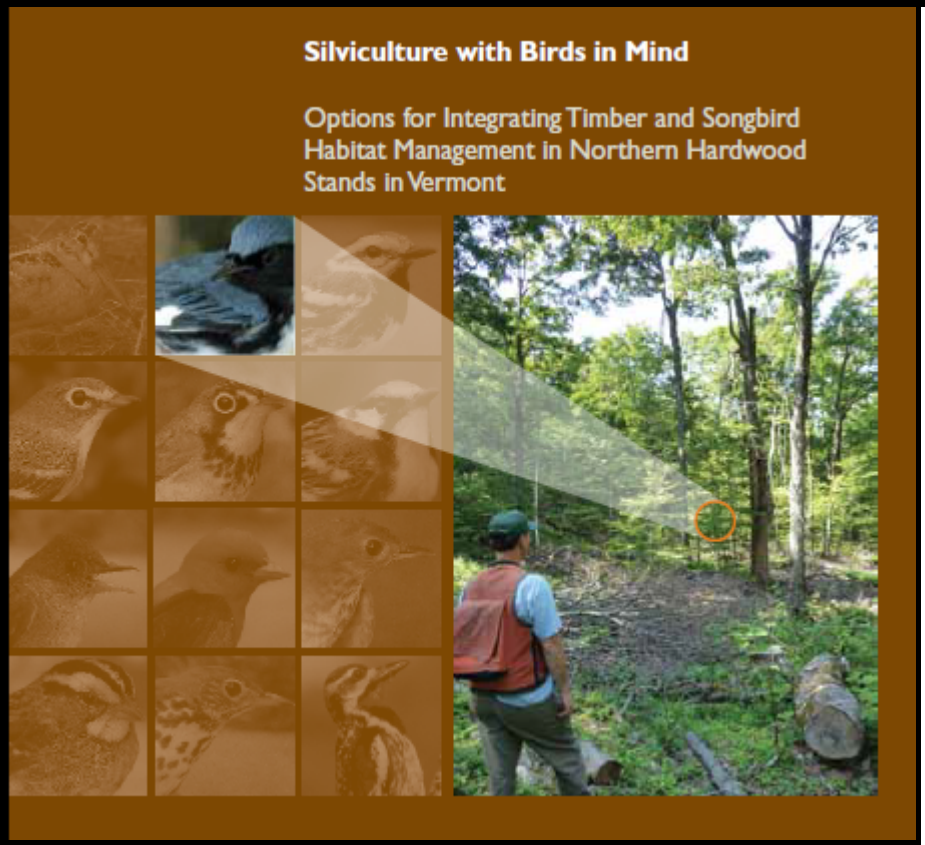
Keeton , W.S. 2006. Forest Ecology and Management

Fungi Responses to Experimental Disturbance-based Treatments



Dove and Keeton. In Review

National Audubon's Silviculture with Bird's in Mind



http://vt.audubon.org/foresters-birds

Stand Condition 2 *Silvicultural Option 2A*

Expanding-Gap Group Shelterwood

Use successive cuttings with long 20+ year or indefinite regeneration periods to establish new cohorts or release advance regeneration in groups and/or patches (0.1ac – 0.25 ac) which are gradually expanded at each successive entry. Use crop tree release in stand matrix between groups to increase growth and quality and initiate advance regeneration.

GAPS CREATED DURING FIRST ENTRY WILL BE GRADUALLY EXPANDED AT EACH SUCCESSIVE ENTRY.

Notes & Considerations

Particularly applicable in degraded stands as transition strategy to more complex structure and composition.

May appear similar to group selection but only after first entry; thereafter new cohorts are established immediately adjacent to previous ones.

At each entry, harvest no more than 1% of the stand for each year between entries.

Dominant cover must contain an adequate quantity and distribution of seed trees of desirable species, vigor, and quality.

Stand must be relatively wind firm.

Retain groups of acceptable growing stock.

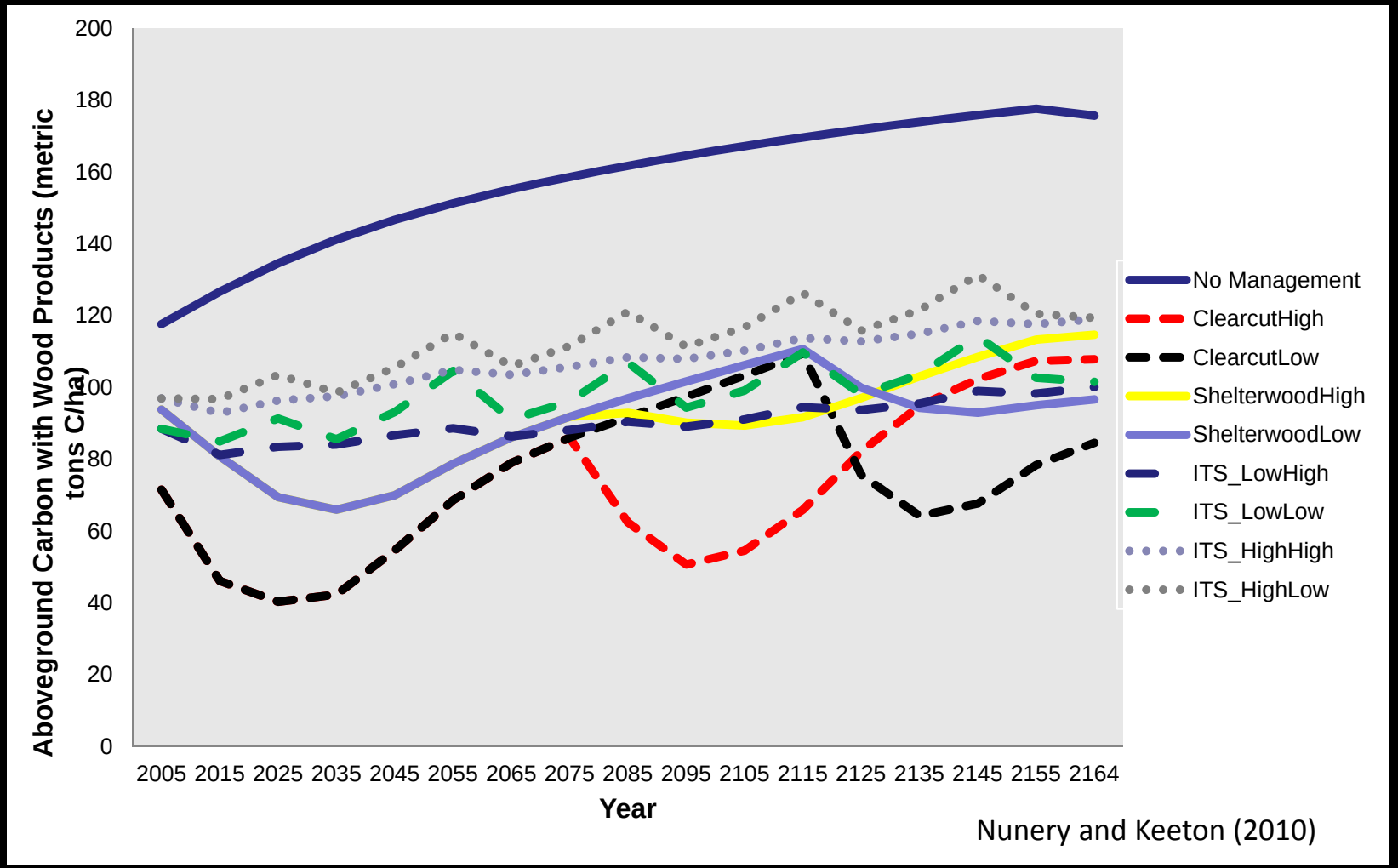
Locate and create gaps/patches through removal of clusters of high-risk, low-vigor, low-value trees, to release advance regeneration, and to avoid sensitive sites.

Offers increased opportunity to regenerate mix of species including less shade tolerant species.

Recruit snags by girdling some poor-quality dominants; leave worst-quality cut stems in woods as coarse woody debris.

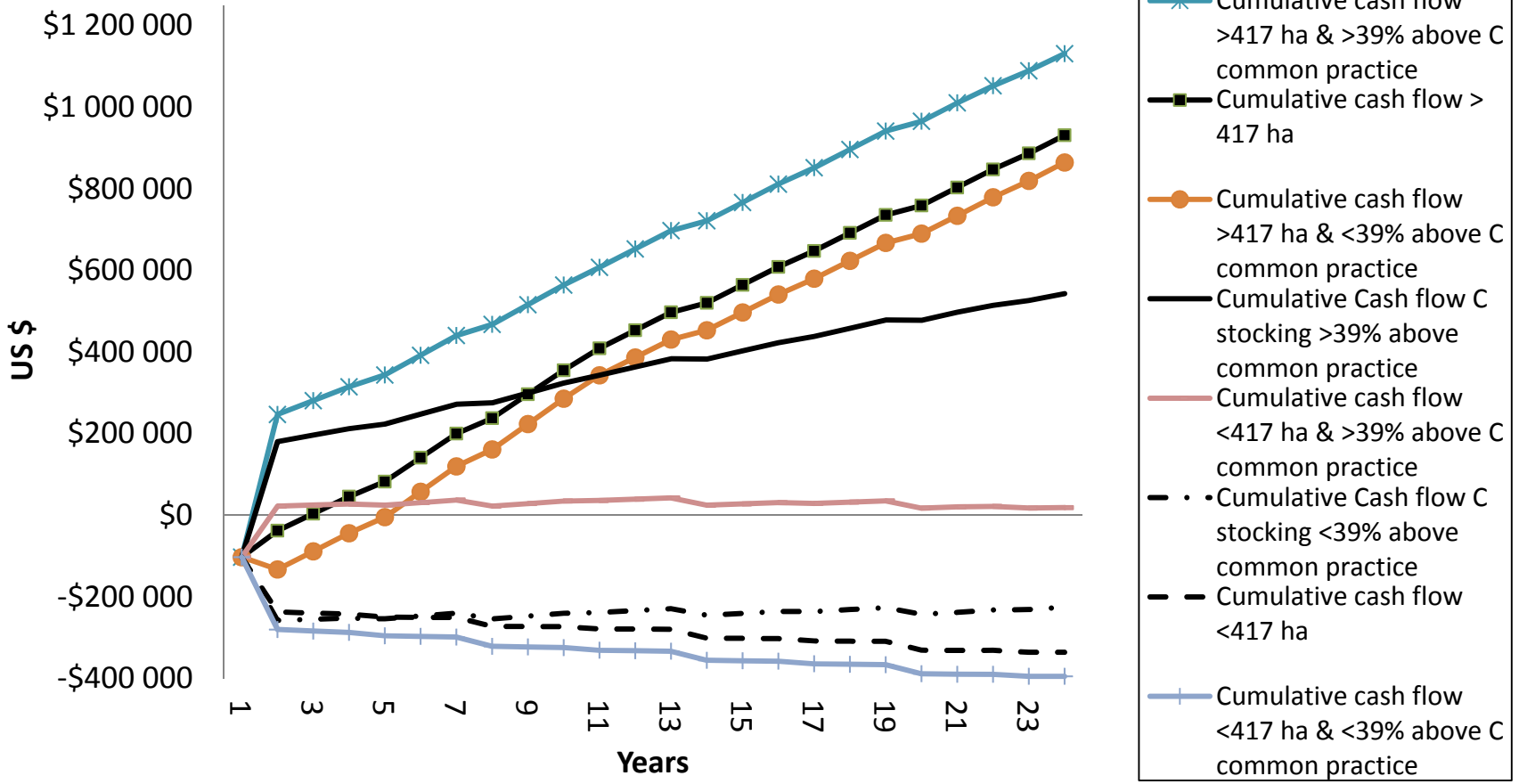
Supporting carbon market participation with the "best available science"…

Predicted Carbon Storage using the Forest Vegetation Simulator



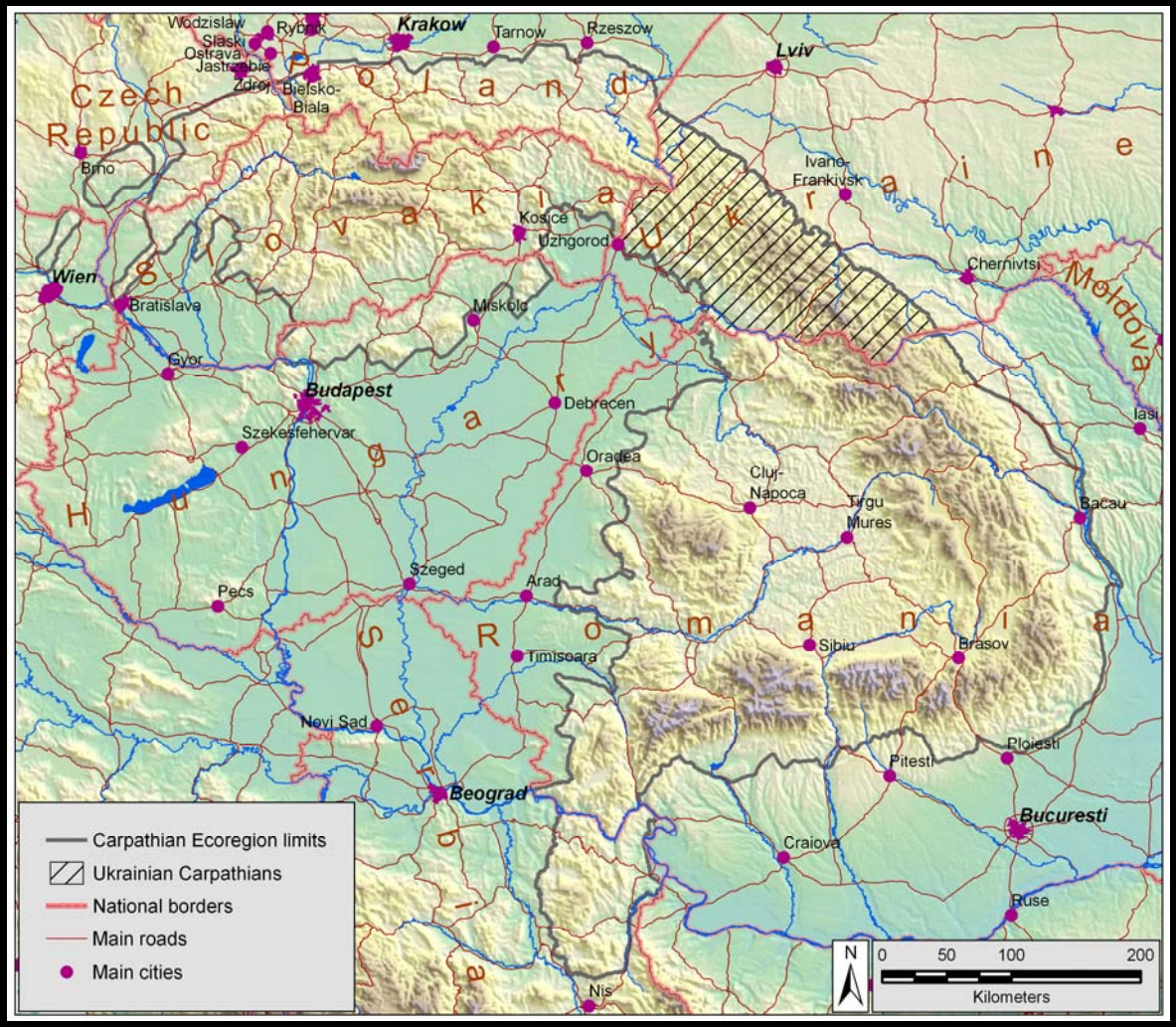
Nunery and Keeton (2010)

Cash Flows For Carbon Market Participation (ARB) by Predictor of Financial Viability



Kerchner and Keeton. Forest Policy and Economics. In Review

The Carpathian Mountain Region – Central and Eastern Europe

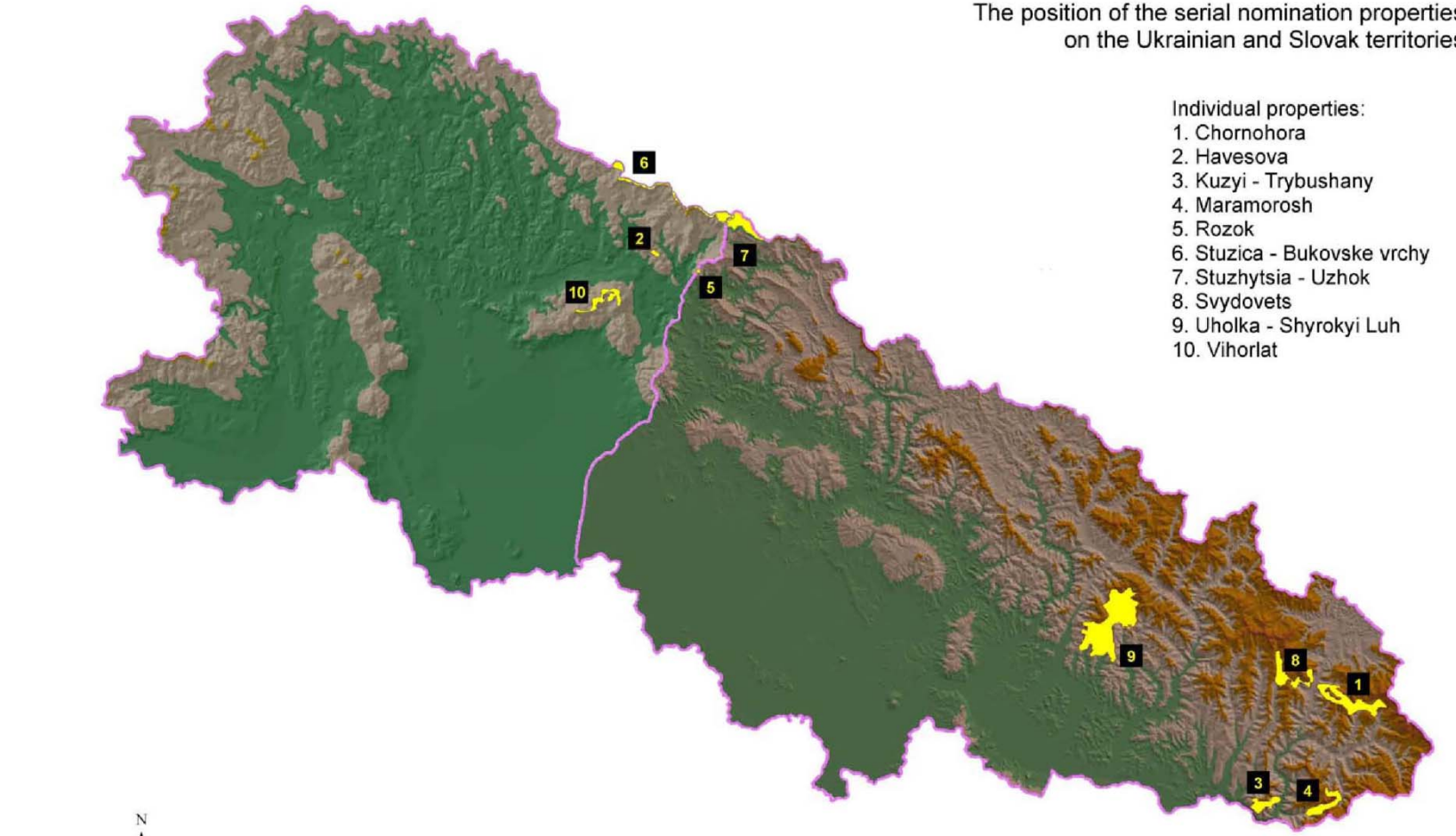


From Keeton et al. 2013. Springer Verlag

BEECH PRIMEVAL FORESTS OF THE CARPATHIANS

Map annex 2

The position of the serial nomination properties
on the Ukrainian and Slovak territories



Individual properties:
1. Chornohora
2. Havesova
3. Kuzyi - Trybushany
4. Maramorosh
5. Rozok
6. Stuzica - Bukovske vrchy
7. Stuzhytsia - Uzhok
8. Svydovets
9. Uholka - Shyrokyi Luh
10. Vihorlat

N

1:800 000

0 10 20 40 60 80 Kilometer

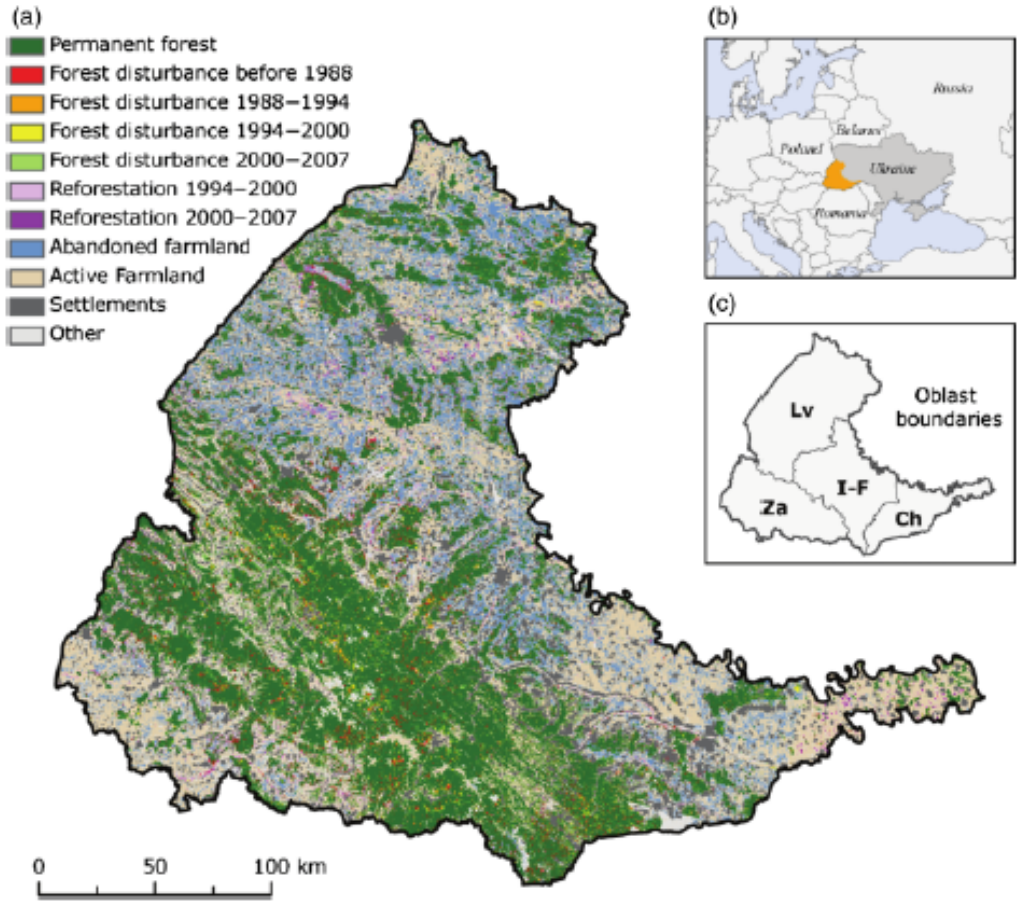
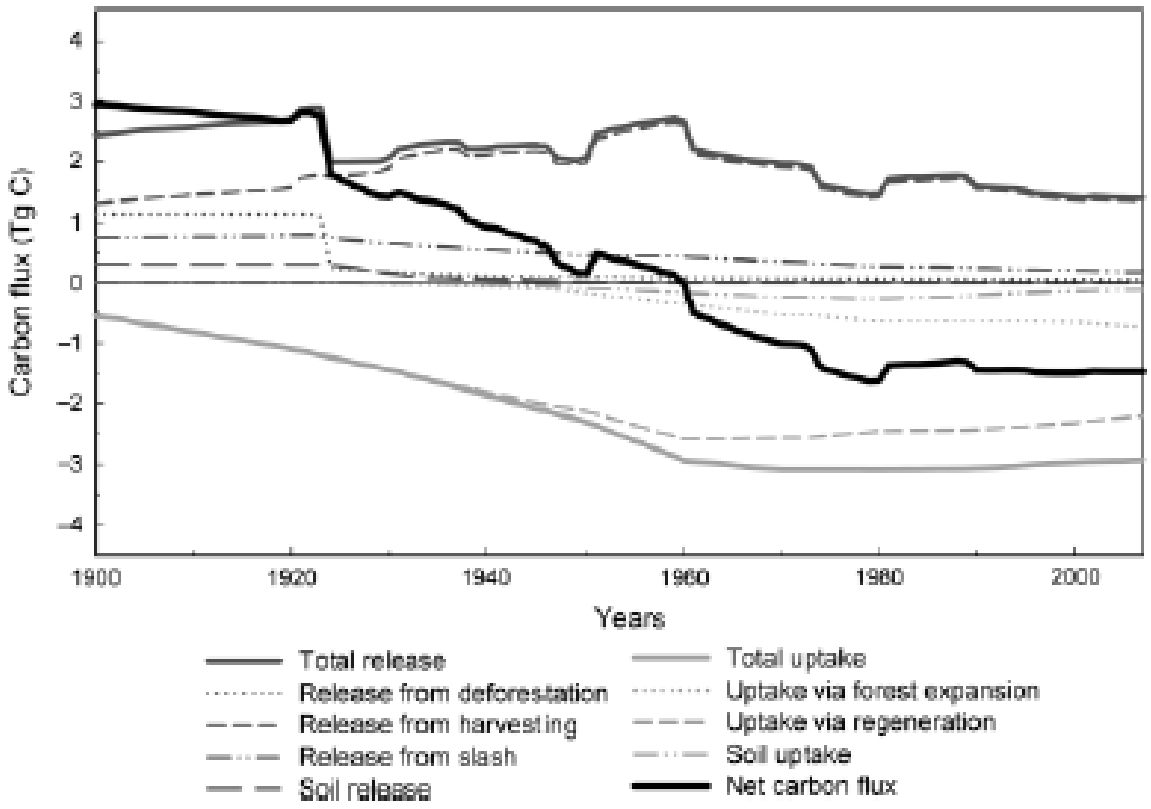


Fig. 1 (a) Forest cover changes and farmland abandonment patters between 1988 and 2007 in the study region. Land cover changes were mapped from Landsat TM and ETM + images. (b) Location of the study region in Eastern Europe. The study region (highlighted in orange) consists if four Ukrainian Oblasts (equivalent to states) (c) Administrative boundaries of Lvivska Oblast (Lv), Ivano-Frankivska Oblast (I-F), Zakarpatska Oblast (Za), and Chernivetska Oblast (Ch).

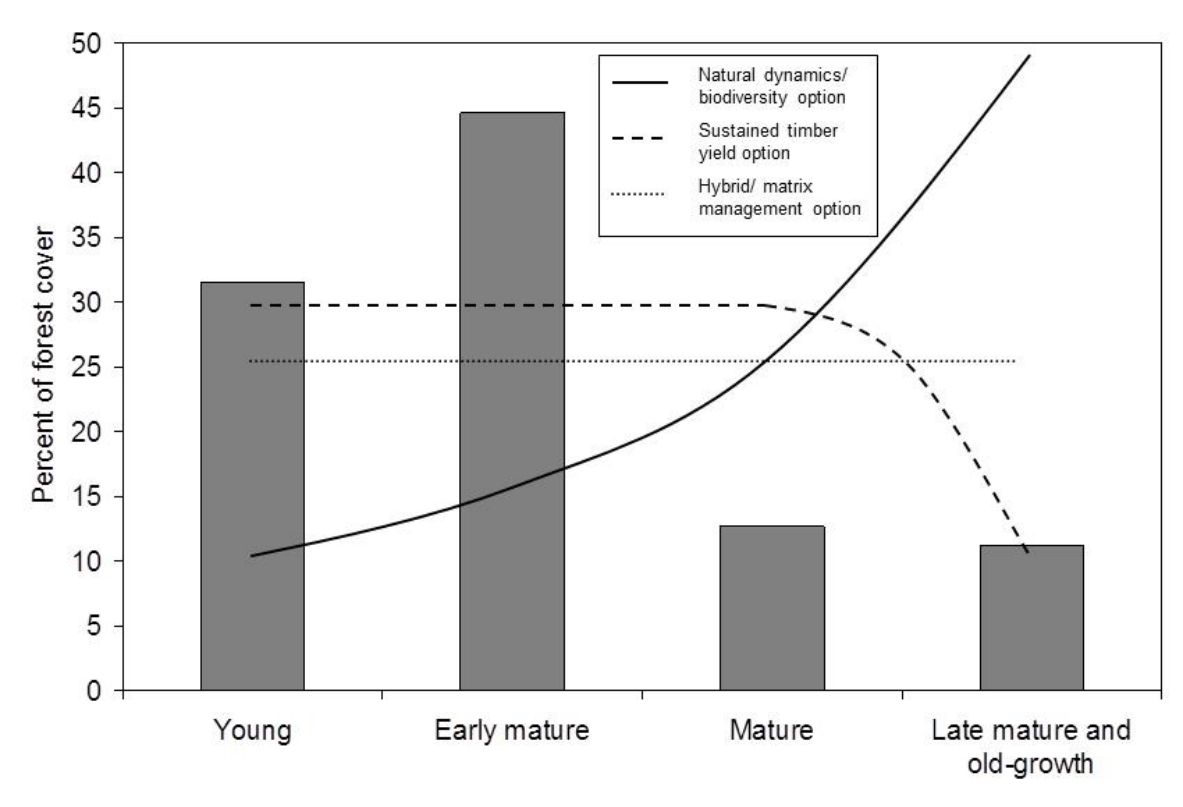
From: Kuemmerle, T., P. Olofsson, O. Chaskovskyy, M. Baumann, K. Ostapowicz, C.E. Woodcok, R. Houghton, P. Hostert, W.S. Keeton, and V.C. Radeloff. 2011. Post-Soviet farmland abandonment, forest recovery, and carbon sequestration in western Ukraine. Global Change Biology 17:1335–1349.

Net carbon fluxes due to land-use change in western Ukraine, 1900 to 2007



From: Kuemmerle, T., P. Olofsson, O. Chaskovskyy, M. Baumann, K. Ostapowicz, C.E. Woodcok, R. Houghton, P. Hostert, W.S. Keeton, and V.C. Radeloff. 2011. Post-Soviet farmland abandonment, forest recovery, and carbon sequestration in western Ukraine. Global Change Biology 17:1335–1349.

- Landscape-scale conversion to genetically non-endemic Norway spruce (*Picea abies*)
- Forest health decline
- Age class imbalance



From Keeton et al. 2013. Springer Verlag

Restoration forestry in the Carpathians: spruce to mixed species conversion

- Rapid approach – patch cutting replanting
- Phased approach – group selection, retention, release of advanced regeneration

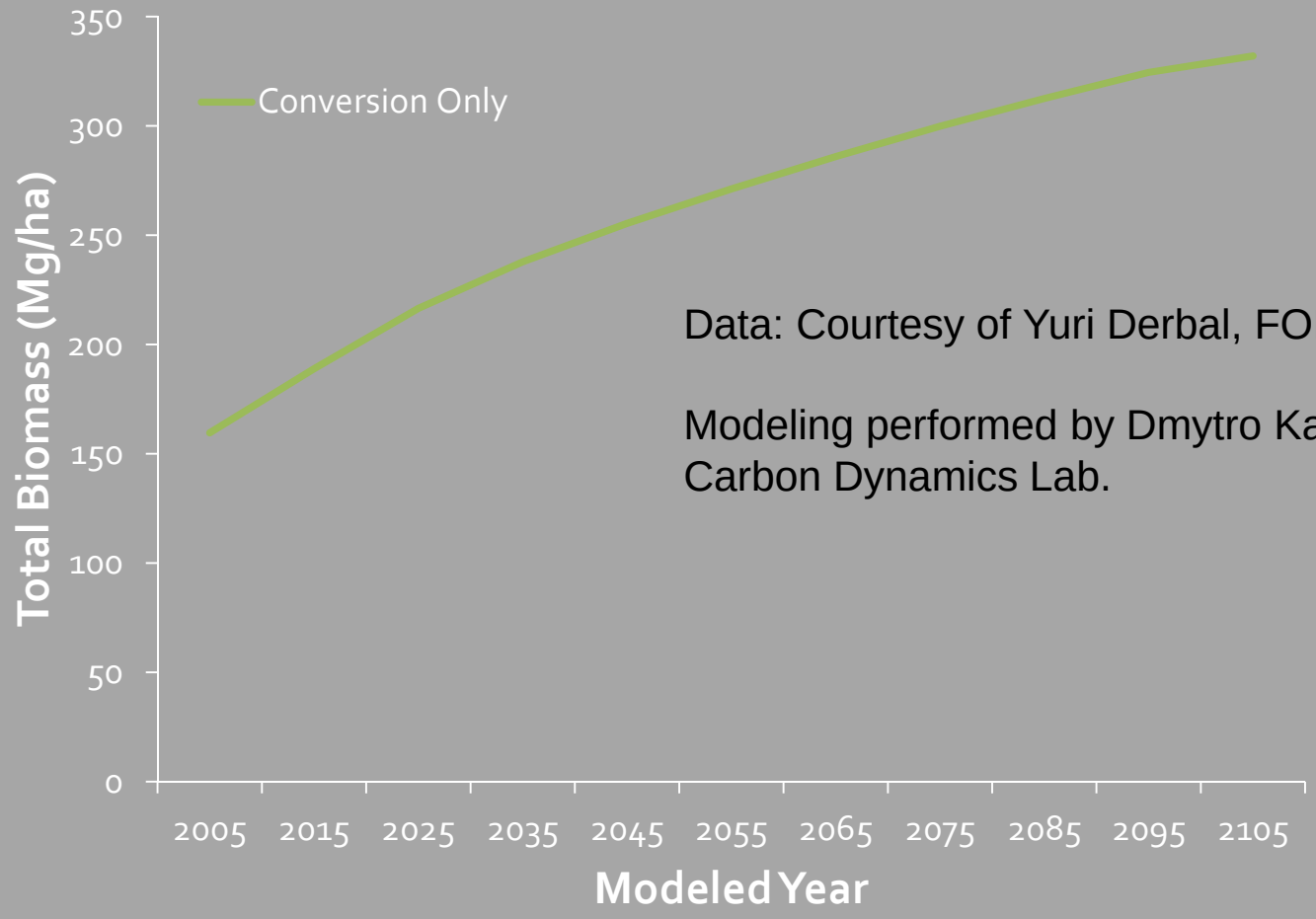
Photo Credits: William Keeton

“Close to Nature Silviculture” – FORZA’s Demonstration in Western Ukraine

- Demonstrated economic profitability of conversion cutting in Norway spruce plantations
- Developed a “close-to-nature” silvicultural system
- Established 126 demonstration sites for close-to-nature silviculture on State Forestry Enterprises in Transcarpathia.
- Close-to-nature silviculture trials conducted in 36 forest types

Photo credit:
W. Keeton

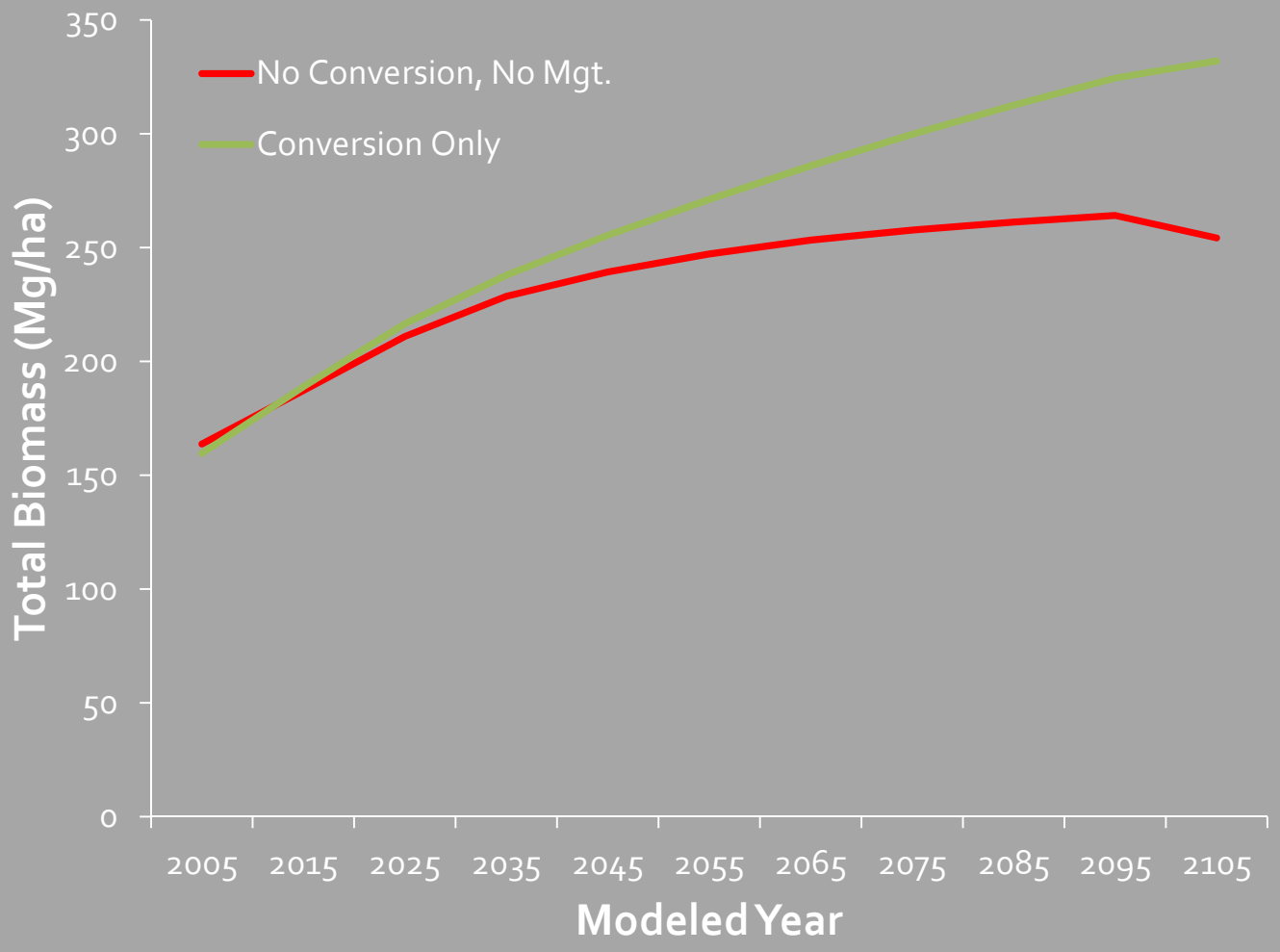
Ukraine: Modeling using the Forest Vegetation Simulator



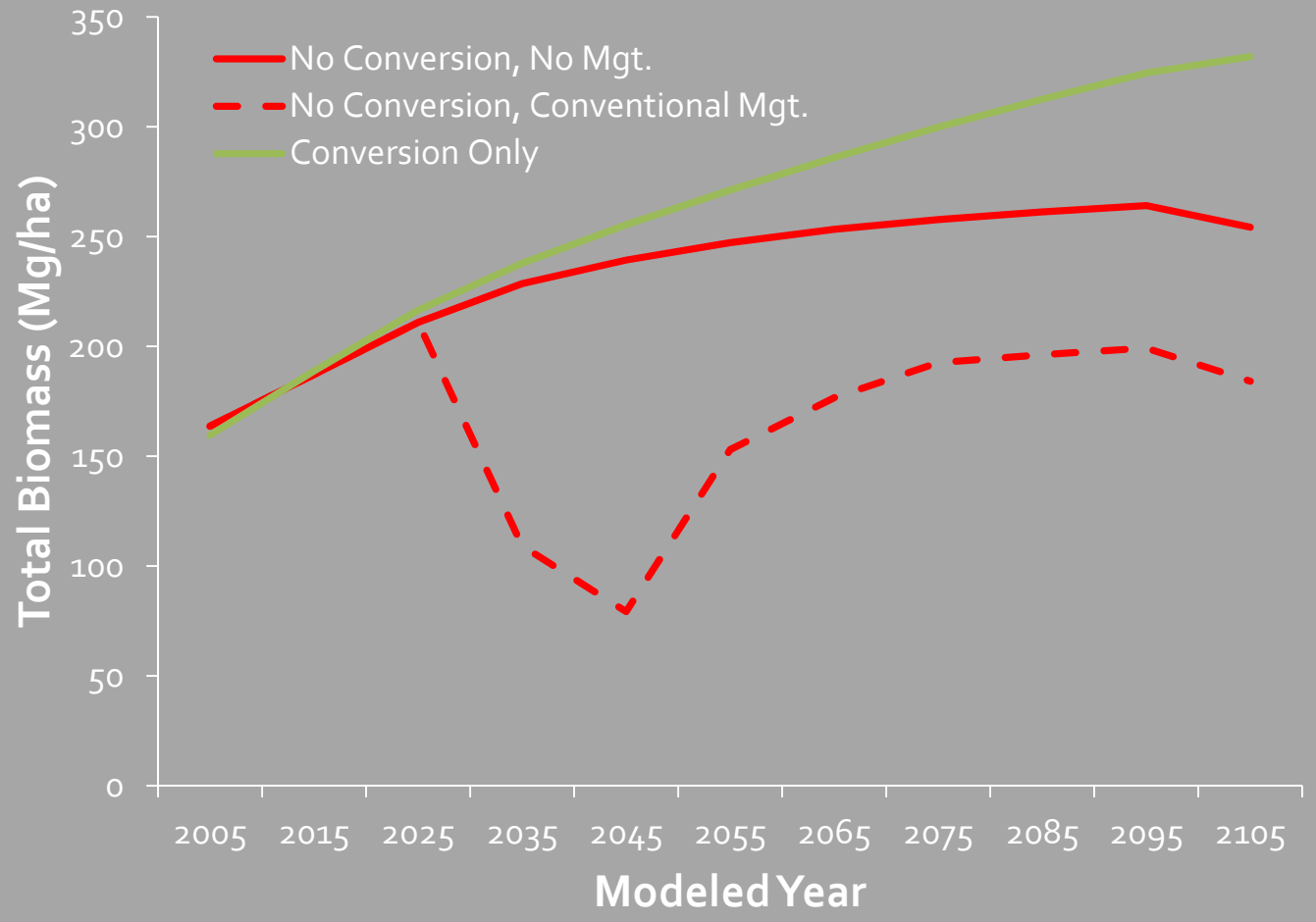
Data: Courtesy of Yuri Derbal, FORZA

Modeling performed by Dmytro Karabchuk, Carbon Dynamics Lab.

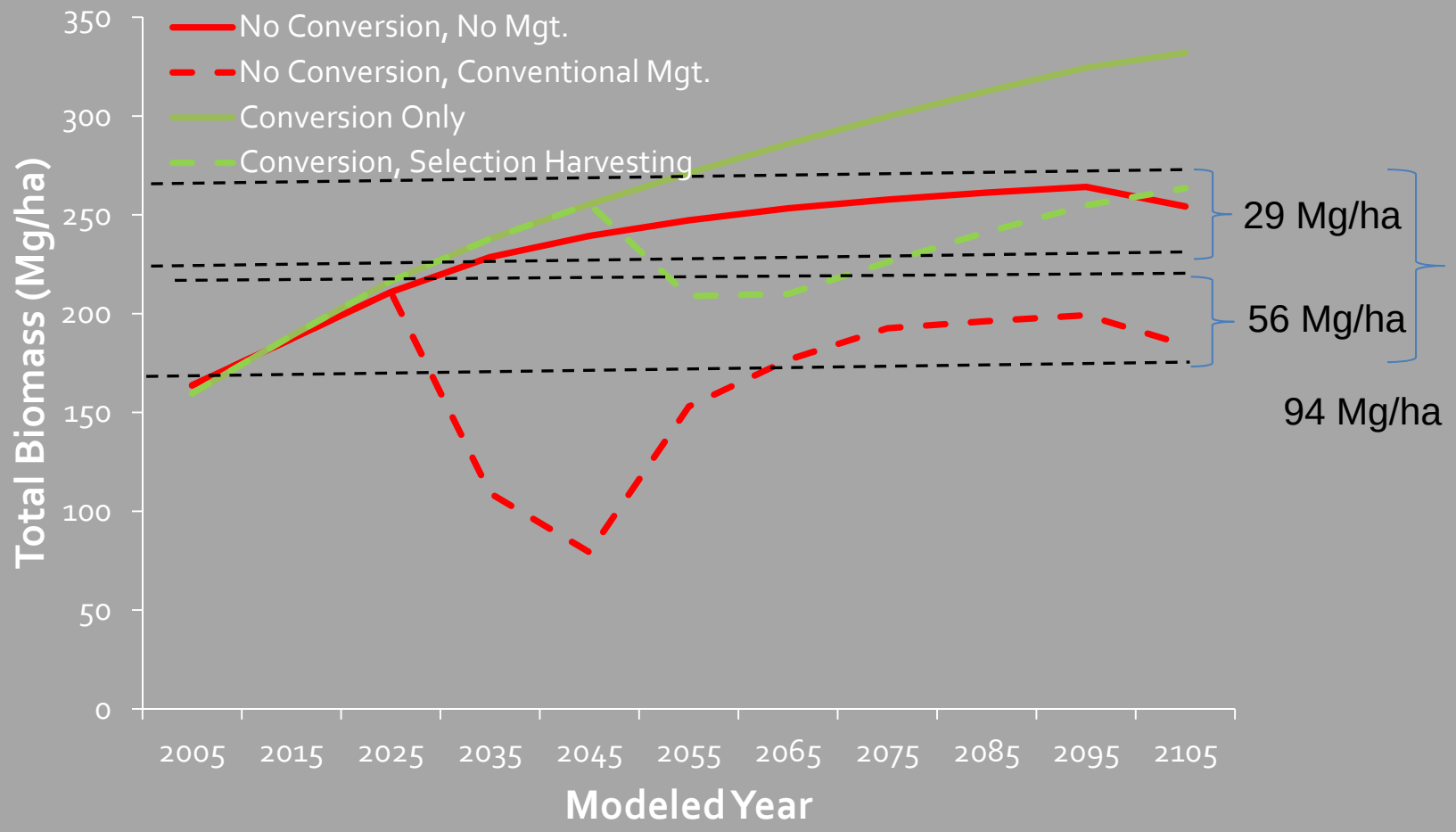
Ukraine: Modeling using the Forest Vegetation Simulator



Ukraine: Modeling using the Forest Vegetation Simulator



Ukraine: Modeling using the Forest Vegetation Simulator



Closing Thoughts

- Silviculture promoting late-successional characteristics is an element of ecosystem in many different regions
- There is no “one-size-fits all” approach; must be adapted to regional context
- Co-benefits such as biodiversty and carbon
- Integration with multiple objectives and values
- Part of adaptive management?

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