COMPUTATIONAL BIOLOGY - FINAL PRESENTATION

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Title: Adaptive forest management across diverse forest ownerships in southeastern Vermont, USA

- PRESENTATION OUTLINE:
  - Research Objectives
  - Introduction
  - Research Questions
  - Study Area
  - Methods
  - Use of R in landscape initialization
  - Questions & Discussion

RESEARCH OBJECTIVES

- Simulate forest change over time in response to projected climate change and under alternative forest management regimes.
- Use forest landscape simulation modeling (LANDIS-II) to evaluate forest management decisions within a 10,000-acre forested landscape of mixed-ownership in southeastern Vermont, USA.

INTRODUCTION

- GLOBAL CHANGE: represents a major challenge for forest resources managers
- Climate change impacts – Increased temp., precip., drought, extreme weather event,
- Shifting disturbance regimes
- Shifts in suitable habitat
- Increased threats from pest/pathogen and invasive species
- Economic uncertainty
- Societal drivers – land use

INTRODUCTION

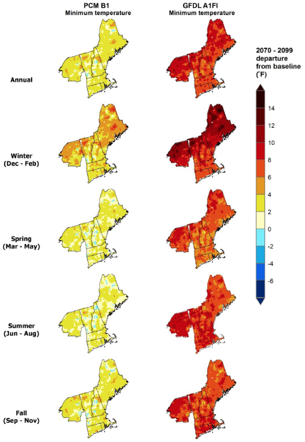


Figure 4.3 — Projected difference in minimum daily temperature (°F) at the end of the century (2070 through 2099) compared to baseline (1971 through 2000) for two climate model-emissions scenario combinations.

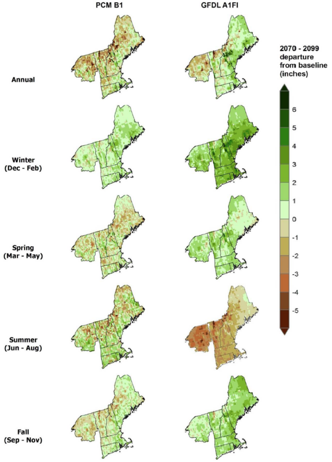


Figure 4.6 — Projected difference in mean precipitation (inches) at the end of the century (2070 through 2099) compared to baseline (1971 through 2000) for two climate model-emissions scenario combinations.

INTRODUCTION

- Increasing uncertainty around future impacts on forest ecosystems
- Tool-box approach
    - Use of traditional and novel approaches employ an iterative and adaptive process
- *Utilize new tools*: Landscape simulation models

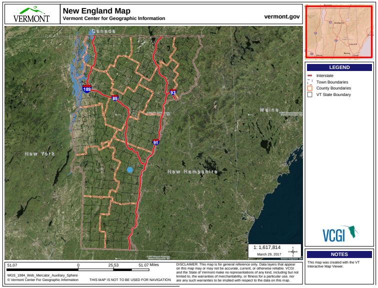
RESEARCH QUESTIONS

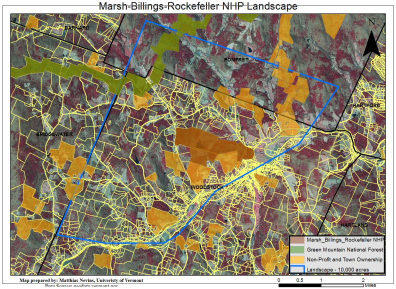
1. How does species composition change within the landscape over time under two climate scenarios and three management regimes?
2. How do differences in landowner behavior in regards to application of adaptive measures influence landscape-level resilience to climate change?

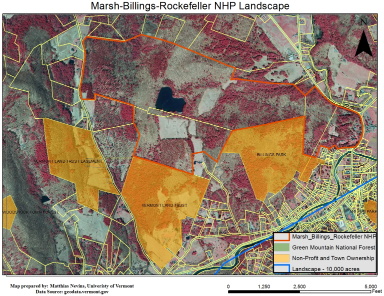
STUDY AREA

- Southeastern Vermont, USA
- 10,000 Acre (4,047 Hectare) Landscape
- Centered on Marsh-Billings-Rockefeller National Historical Park – 500 acres

STUDY AREA


New England Map
Vermont Center for Geographic Information
vermont.gov
VERMONT
Canada
Maine
New York
New Hampshire
LEGEND
Interstate
Town Boundaries
County Boundaries
VT State Boundary
VCGI
NOTES
This map was created with the VT Interactive Map Viewer.
1: 1,617,814
March 29, 2017
51.07
0
25.53
51.07 Miles
WGS_1984_Web_Mercator_Auxiliary_Sphere
© Vermont Center For Geographic Information
THIS MAP IS NOT TO BE USED FOR NAVIGATION
DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. VCGI and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.


Marsh-Billings-Rockefeller NHP Landscape
BARNARD
POMFRET
HARTFORD
BRIDGEWATER
WOODSTOCK
HARTLAND
N
Marsh_Billings_Rockefeller NHP
Green Mountain National Forest
Non-Profit and Town Ownership
Landscape - 10,000 acres
Map prepared by: Matthias Nevins, Univeristy of Vermont
0
0.5
1
2
Miles


Marsh-Billings-Rockefeller NHP Landscape
N
BILLINGS PARK
VERMONT LAND TRUST EASEMENT
VERMONT LAND TRUST
WOODSTOCK TOWN FOREST
Marsh_Billings_Rockefeller NHP
Green Mountain National Forest
Non-Profit and Town Ownership
Landscape - 10,000 acres
Map prepared by: Matthias Nevins, Univeristy of Vermont
Data Source: geodata.vermont.gov
0
1,250
2,500
5,000
Feet

METHODS

- Use landscape simulation model to analyze change in species composition over time under two climate change scenarios and three management regimes
- LANDIS-II (v6.0) is a spatially explicit forest landscape + simulation model
  - simulates successional dynamics, seed dispersal, regeneration, and response to disturbances such as windthrow and harvesting
  - 100 year simulation at 30x30m resolution
- LANDIS -> Output:
  - Total above ground biomass (AGB)/species at each time step
  - From AGB ->
    - Relative importance (Curtis)
    - Spp. diversity
    - Functional diversity

LANDIS-II is a forest landscape simulation model. It simulates how ecological processes including succession, seed dispersal, disturbances, and climate change affect a forested landscape over time (Figure 1).

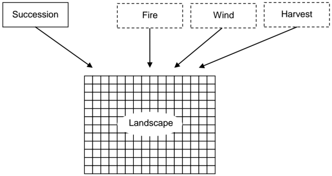


Figure 1 – Ecological processes modify landscape.

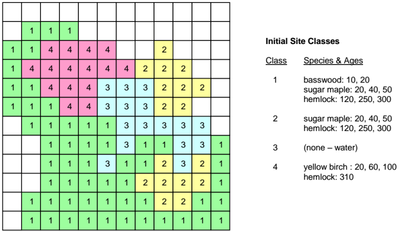
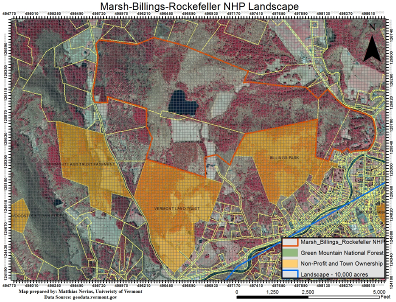


Figure 5 – Example of a site initialization map.



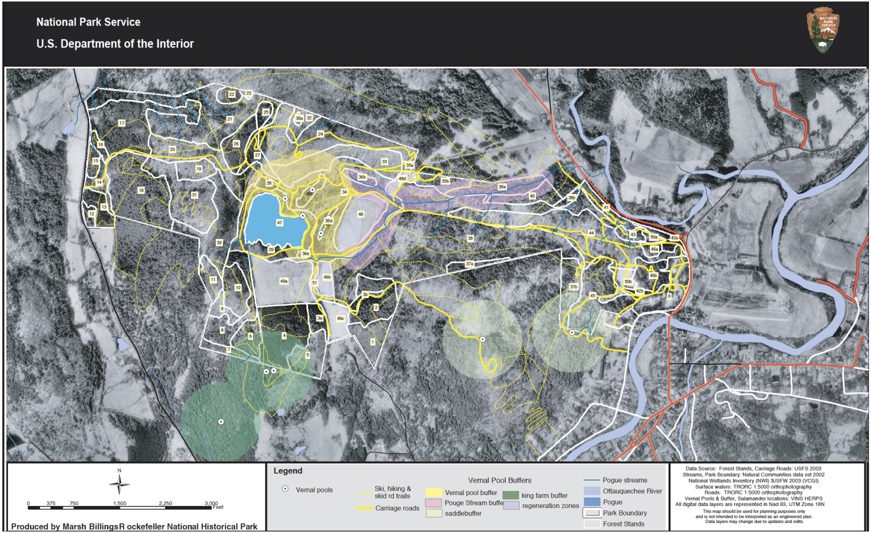
MODEL ADVANTAGES AND LIMITATIONS

- ADVANTAGES
  - Simulate forest succession overtime under user defined disturbance regimes (wind, fire, harvest)
  - User defines species specific attributes
  - Works well at larger scale and with long lived organisms (TREES)
- LIMITATIONS
  - Limited by base assumptions about sucession etc.
  - Limited by scale
  - Designed for landscapes dominated by woody vegetation
  - Should not be used as a prediction -> instead a range of possible outcomes
  - Highly random and stochastic

LANDSCAPE INITIALIZATION

- Populating the landscape of grid cells with info about scecies composition.
  - Tracks "cohorts" of tree species
  - EXAMPLE: cell 1
    - Sugar Maple: (10,50,100)
    - White Pine: (130)
- Use forest inventory data
  - Use of R to summarize inventory data

FOREST INVENTORY



FOREST INVENTORY

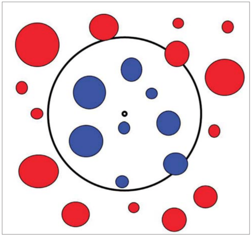


Figure 4-2: A schematic of a fixed area plot. "In" (sample) trees are identified in blue, and "out" trees are shown in red. Trees that fall along the plot boundary are determined as "in" or "out" based on whether the center of the tree falls within the plot.

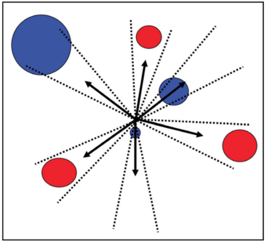


Figure 5-1: A schematic of a variable plot, where an angle gauge is applied in several different directions (indicated by the arrows). Trees intersected by the angle (indicated by the dotted lines) are considered "in" trees (shown in blue).

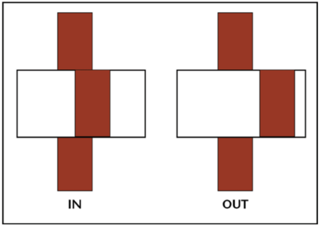


Figure 5-2: Looking at the stem of the tree (at breast height) through a prism will shift the image of the tree. If the shifted image overlaps (example on the left), the tree is "in." If the shifted image is completely separated (example on the right), the tree is "out."

STAND	PLOT	tree_no	tree_spp	tree_dbh	tree_alive	tree_stems_per	tree_ba	tree_rel_dens	tree_timber	tree_product	tree_saw_ht	tree_pulp_ht	tree_merch_	tree_bdft_vc	source_tree_	tree_net_bd
1	144	3	LARIX	18.7	TRUE	5.243115172	1.90726308	0.924104218	AGS	sawlog	70	0	70	442.224834	4	442.224834
1	144	4	ACSA3	12.3	TRUE	12.11887728	0.82515895	0.66688201	AGS	sawlog	32	24	56	100.621649	4	100.621649
1	144	5	ACSA3	8.8	TRUE	23.67594195	0.42236968	0.36079266	AGS	pulpwood	0	16	16	0	4	0
1	144	6	LARIX	24.1	TRUE	3.156737908	3.16782713	1.344835282	AGS	sawlog	80	12	92	907.9801	4	907.9801
1	144	9	ACSA3	13.7	TRUE	9.768580875	1.02369015	0.81571503	AGS	sawlog	10	40	50	57.4512035	4	57.4512035
1	144	12	ACSA3	7.1	TRUE	36.37105623	0.2749439	0.24613701	AGS	pulpwood	0	16	16	0	4	0
1	144	13	LARIX	15.4	TRUE	7.73091982	1.29350714	0.696338152	UGS	sawlog	56	16	72	240.093465	4	240.093465
1	144	15	LARIX	15.6	TRUE	7.533961803	1.3273229	0.709508392	AGS	sawlog	68	12	80	251.587711	4	251.587711
1	144	16	ACSA3	8.2	TRUE	27.26747389	0.36673731	0.31778628	AGS	pulpwood	0	32	32	0	4	0
1	144	17	LARIX	13.9	TRUE	9.48949301	1.05379708	0.600167962	AGS	sawlog	48	32	80	186.367623	4	186.367623
1	144	18	LARIX	9.5	FALSE	20.31540105	0.49223739	0	UGS	cull	0	0	0	0	4	0
1	144	19	FRAM2	17.9	TRUE	5.722246323	1.74756546	0.58360491	AGS	sawlog	16	40	56	150.080923	4	150.080923
1	144	20	LARIX	17.4	TRUE	6.055836122	1.65129964	0.831720472	AGS	sawlog	64	16	80	376.978862	4	376.978862
1	144	21	FRAM2	19.6	TRUE	4.772659685	2.09526777	0.66539956	AGS	sawlog	28	32	60	250.808042	4	250.808042
1	144	22	LARIX	16.5	TRUE	6.734490154	1.4848934	0.76978645	AGS	sawlog	68	12	80	328.96834	4	328.96834
1	144	23	ACSA3	11.3	TRUE	14.3587199	0.69644091	0.56980791	UGS	pulpwood	0	40	40	0	4	0
1	144	24	LARIX	18.6	TRUE	5.299644307	1.88691909	0.916875112	AGS	sawlog	70	16	86	436.27391	4	436.27391
1	145	3	LARIX	18.1	TRUE	5.596486507	1.78683536	0.881036242	AGS	sawlog	68	12	80	407.130614	4	407.130614
1	145	4	QURU	11.7	TRUE	13.39370987	0.74661913	0.67246654	AGS	sawlog	32	16	48	55.6372416	4	55.6372416
1	145	5	ACSA3	6.5	TRUE	43.39561999	0.230438	0.21098055	AGS	pulpwood	0	24	24	0	4	0
1	145	6	LARIX	21.4	TRUE	4.003548223	2.49778433	1.127017912	UGS	sawlog	40	20	60	433.640188	4	433.640188
1	145	7	LARIX	17.2	TRUE	6.197488319	1.61355689	0.817814248	AGS	sawlog	60	0	60	335.579738	4	335.579738
1	145	8	QURU	17.8	TRUE	5.786721829	1.72809413	1.49502714	AGS	sawlog	40	16	56	287.63646	4	287.63646
1	145	12	LARIX	15.1	TRUE	8.041160232	1.24360163	0.676736122	AGS	sawlog	68	12	80	232.261519	4	232.261519
1	145	13	LARIX	21.5	TRUE	3.966392524	2.52118265	1.13481945	AGS	sawlog	60	12	72	559.21807	4	559.21807
1	145	15	LARIX	15.1	FALSE	8.041160232	1.24360163	0	UGS	cull	0	0	0	0	4	0
1	145	17	QURU	10.5	TRUE	16.63006752	0.60132047	0.5485033	AGS	pulpwood	0	28	28	0	4	0
1	145	18	LARIX	21.7	TRUE	3.893616225	2.56830654	1.150483858	AGS	sawlog	68	12	80	625.960942	4	625.960942
1	145	19	QURU	9.5	TRUE	20.31540105	0.49223739	0.4547068	AGS	pulpwood	0	28	28	0	4	0
1	145	21	LARIX	19	TRUE	5.078850262	1.96894956	0.9459142	AGS	sawlog	68	12	80	460.32214	4	460.32214
1	146	1	LARIX	19.8	TRUE	4.676729274	2.1382465	1.004973688	AGS	sawlog	80	12	92	510.37485	4	510.37485

R: Summary Statistics