Forest adaptation impacts on microclimates in lowland spruce-fir ecosystems

Grace Smith, University of Vermont
Anthony W. D'Amato, University of Vermont
Carol Adair, University of Vermont
Sarah Nelson, Appalachian Mountain Club
Alexandra Contosta, University of New Hampshire

University of Vermont

NECASC
Northeast Climate Adaptation Science Center

INSPIRES

BE OUTDOORS
APPALACHIAN MTN CLUB

University of New Hampshire

U.S. FISH & WILDLIFE SERVICE

The future of forests in the face of climate change

Northern forest winters have lost cold, snowy conditions that are important for ecosystems and human communities

Alexandra R. Contosta,[1,18] Nora J. Casson,[2] Sarah Garlick,[3] Sarah J. Nelson,[4] Matthew P. Ayres,[5] Elizabeth A. Burakowski,[1] John Campbell,[6] Irena Creed,[7] Catherine Eimers,[8] Celia Evans,[9] Ivan Fernandez,[10] Colin Fuss,[11] Thomas Huntington,[12] Kaizad Patel,[4,13] Rebecca Sanders-DeMott,[1] Kyongho Son,[14] Pamela Templer,[15] and Casey Thornbrugh[16,17]

Consequences of climate change for biotic disturbances in North American forests

Aaron S. Weed,[1,3] Matthew P. Ayres,[1] and Jeffrey A. Hicke[2]

[1]*Department of Biological Sciences, Dartmouth College, Hanover, New Hampshire 03755 USA*
[2]*Department of Geography, University of Idaho, Moscow, Idaho 83844 USA*

The future of forests in the face of c

Northern
im

Alexandra R. Con
Elizabeth A.
Ivan Fernandez,[1]

Consequer

A

[1]Department
[2]De

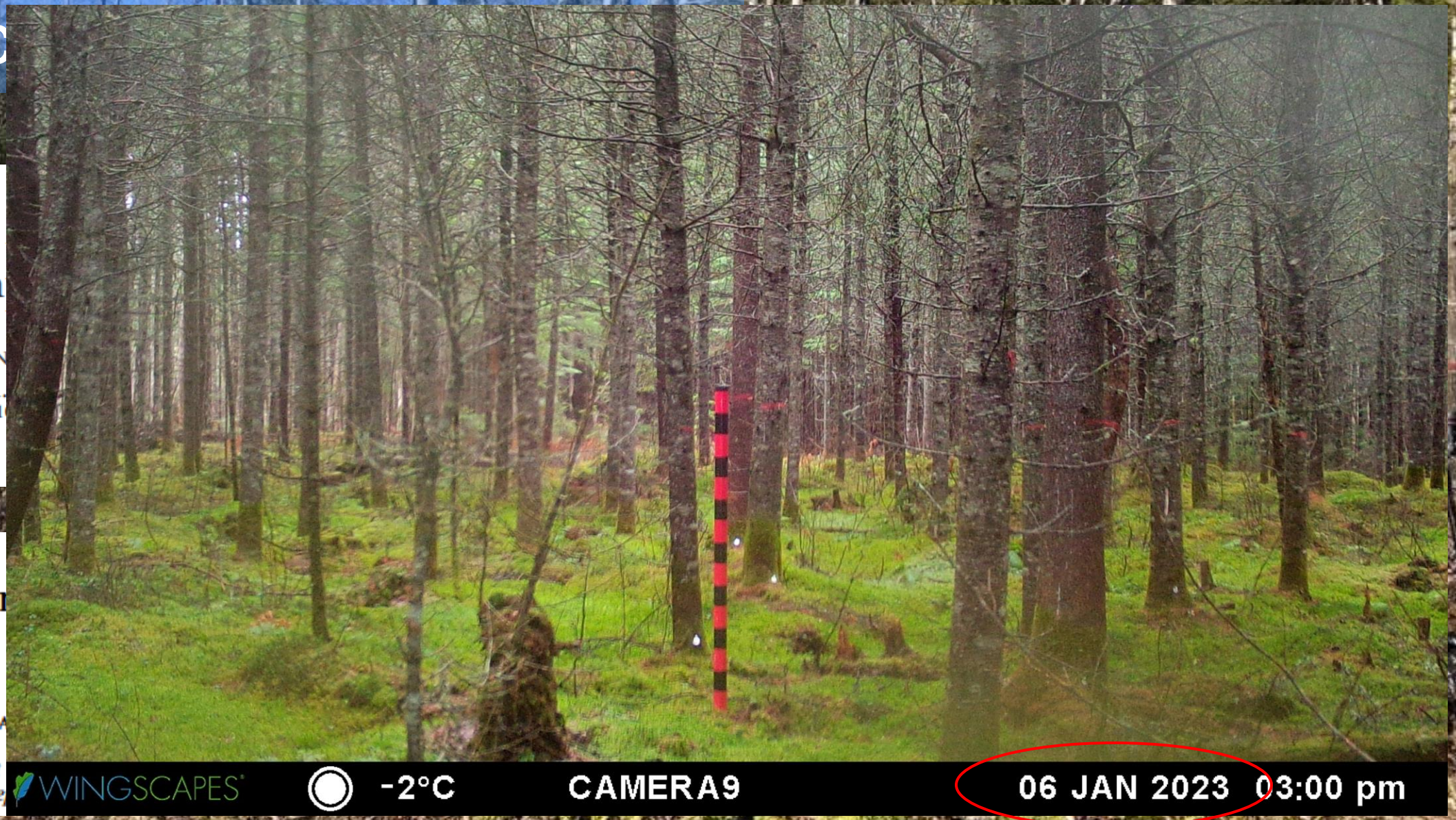


Photo credit: USFWS

Local climate determines vulnerability to camouflage mismatch in snowshoe hares

Marketa Zimova[1] | Alexej P. K. Sirén[2,3] | Joshua J. Nowak[1] |
Alexander M. Bryan[3,4] | Jacob S. Ivan[5] | Toni Lyn Morelli[2,3] |
Skyler L. Suhrer[1] | Jesse Whittington[6] | L. Scott Mills[1,7]

Changes in winter conditions impact forest management in north temperate forests

Chadwick D. Rittenhouse [a, b, *], Adena R. Rissman [a]

[a] Department of Forest and Wildlife Ecology, University of Wisconsin–Madison, 1630 Linden Drive, Madison, WI 53706, USA
[b] Wildlife and Fisheries Conservation Center, Department of Natural Resources and the Environment, University of Connecticut, 1376 Storrs Road Unit 4087, Storrs, CT 06269-4087, USA

Photo credit: Tony D'Amato

Managing for the Cold Project Team

Melissa A. Pastore, Northern Research Station, USDA Forest Service

Sarah J. Nelson, Appalachian Mountain Club

Elizabeth A. Burakowski, Alexandra R. Contosta, Alexej P. K. Sirén, University of New Hampshire

Anthony W. D'Amato, Grace A. Smith, University of Vermont

Sarah Garlick, The Nature Conservancy

Edward Lindsey, Old Town High School

David A. Lutz, Dartmouth College, Colby-Sawyer College

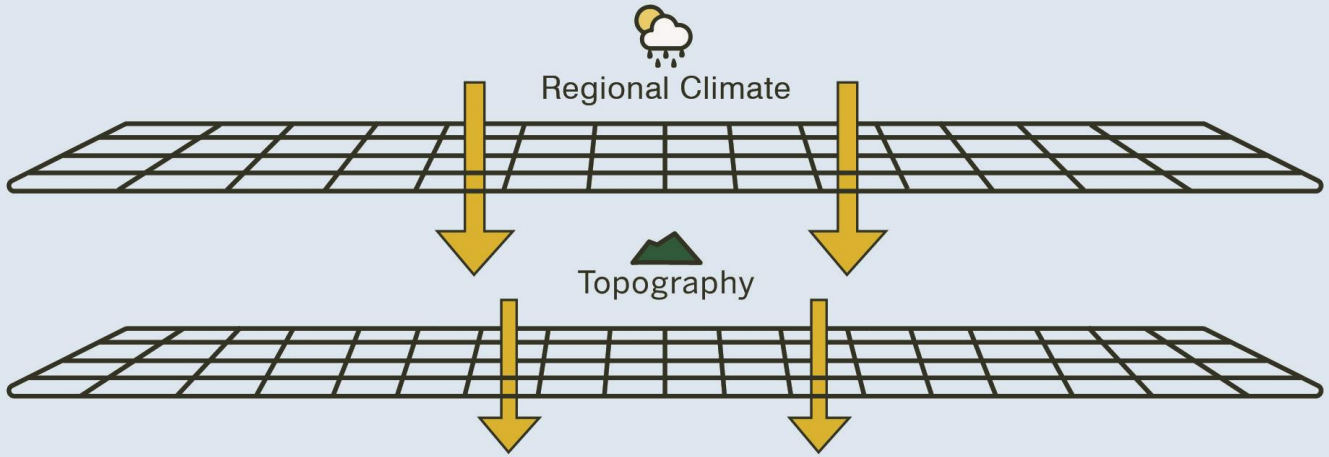
Toni Lyn Morelli, Northeast Climate Adaptation Science Center, USGS

Aaron Weiskittel, University of Maine

MACROFILTERS

Red = leads to shallower snowpack

Blue = leads to deeper snowpack

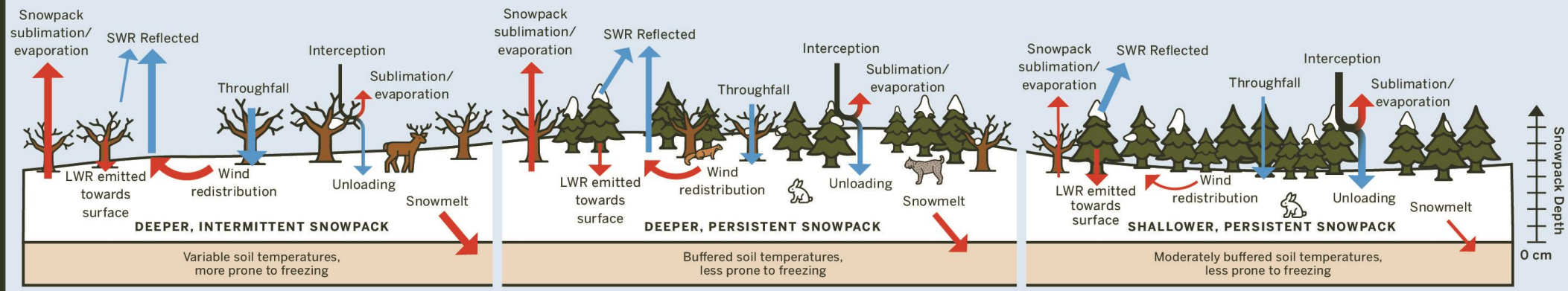


MESOFILTER

a. Sunny clearing or sub-canopy with highly variable air temperatures

b. Shady sub-canopy with variable air temperatures

c. Very Shady sub-canopy with buffered air temperatures



DORMANT SEASON CANOPY COVER

a. Low

More snow makes it to the ground, however sunny, open conditions lead to larger diurnal temperature fluctuations, causing higher maximum air temperatures and thus more melting and sublimation/evaporation of snowpack. **Peak snowpack is deep but snowpack over time is intermittent**, leading to highly variable soil temperatures and more frequent soil freeze-thaw cycles.

b. Medium

A moderate amount of snow makes it to the ground and is less prone to melting and loss because of the shadier conditions and lower maximum air temperatures reached. **Peak snowpack is deepest and snowpack is more persistent**, thereby buffering soil temperatures and helping to prevent soils from freezing. Conditions favor snow-loving wildlife like the Canada lynx.

c. High

Less snow makes it to the ground but is less prone to melting and loss. The closed canopy creates very shady conditions and acts as a thermal buffer, limiting the maximum air temperatures reached. **Snowpack is shallower but more persistent**, helping to buffer soil temperatures but allowing for periodic soil freezing.

Pastore and Nelson et. al, in review

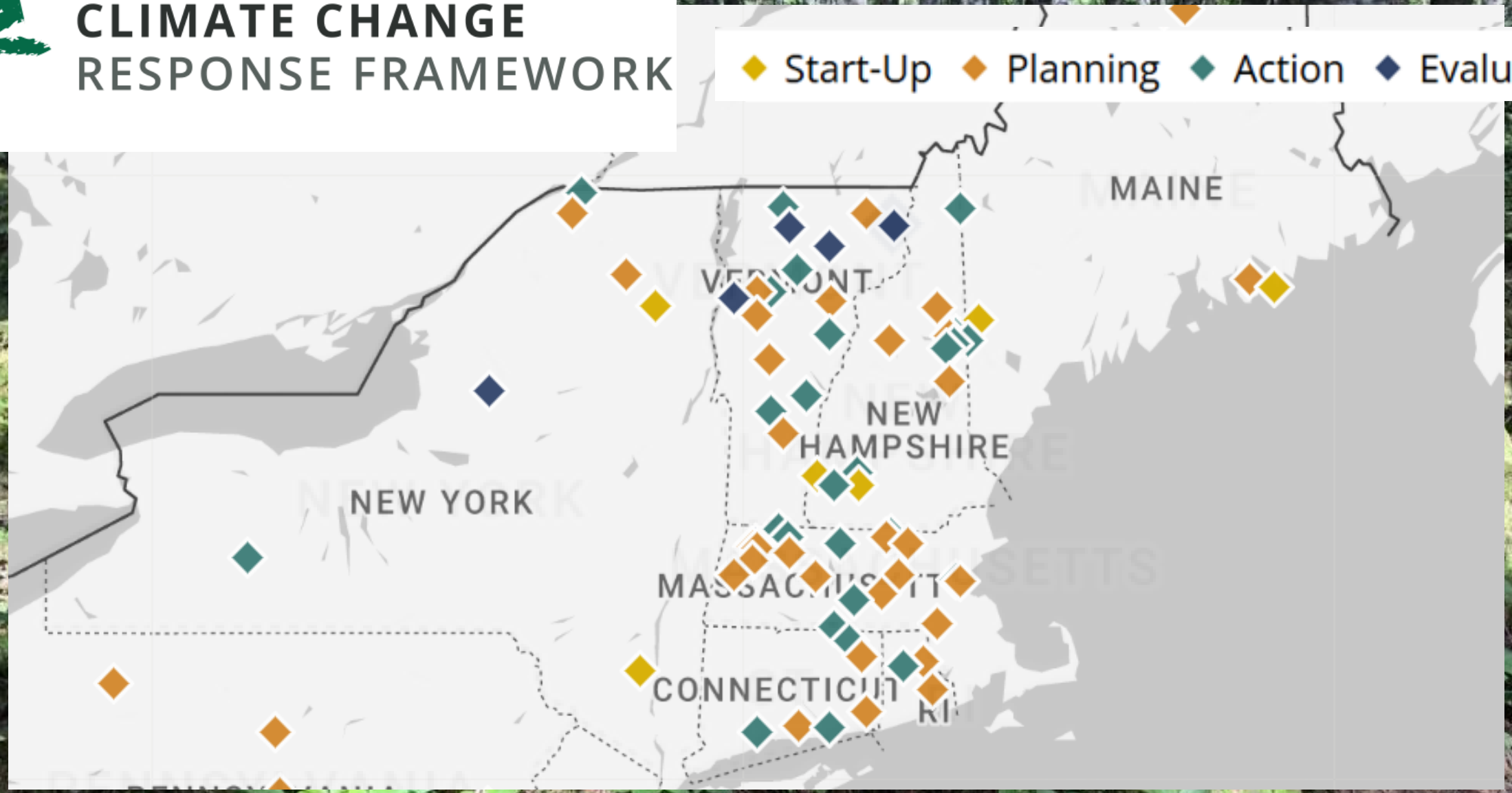
Case Study – Nulhegan Basin

- 10,500 ha USFWS Refuge containing mix of soft- and hardwood- forests developing following history of intensive, industrial management
- Designated an Important Bird Area by the National Audubon Society
- One of the coldest lowland areas in the northeast (2.5m snow, 100 frost-free days)

Photo credit: Ryan Hagerty: USFWS

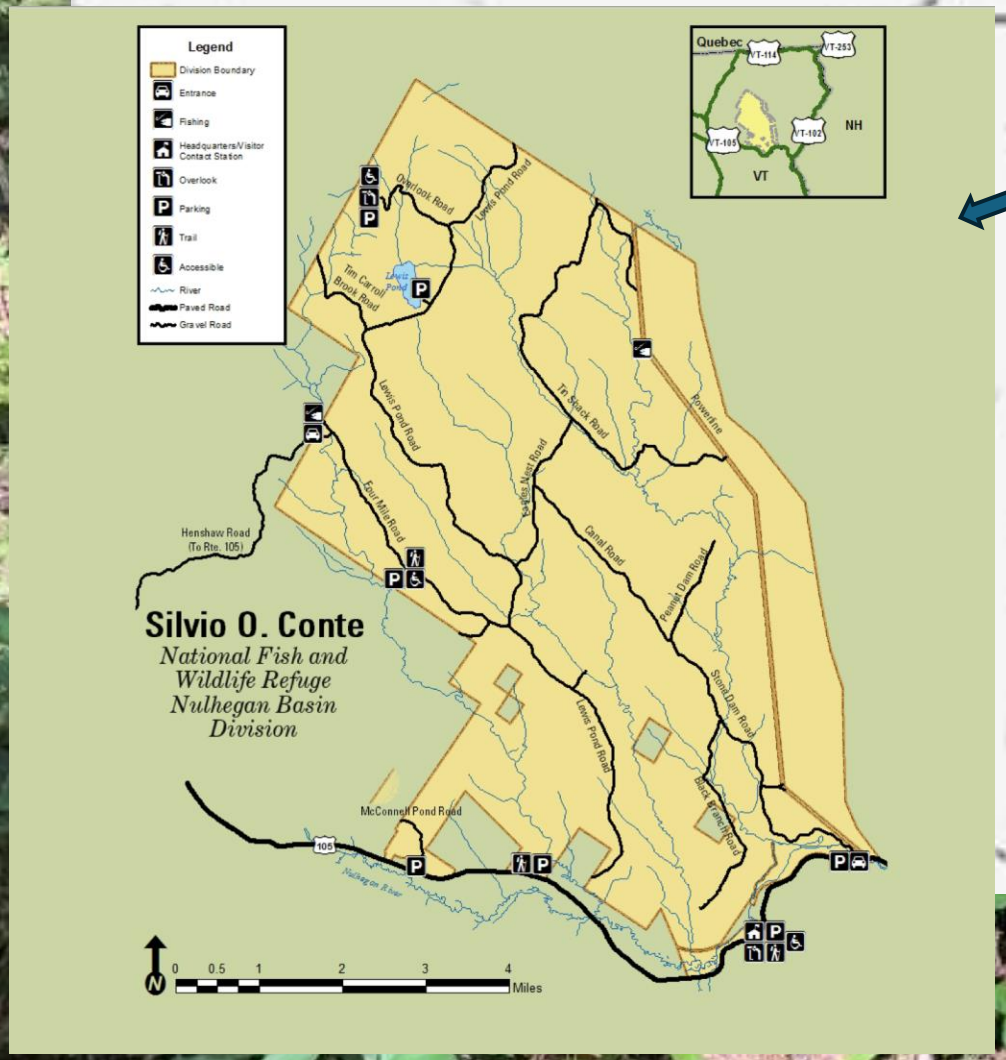
Photo credit: Ryan Hagerty: USFWS

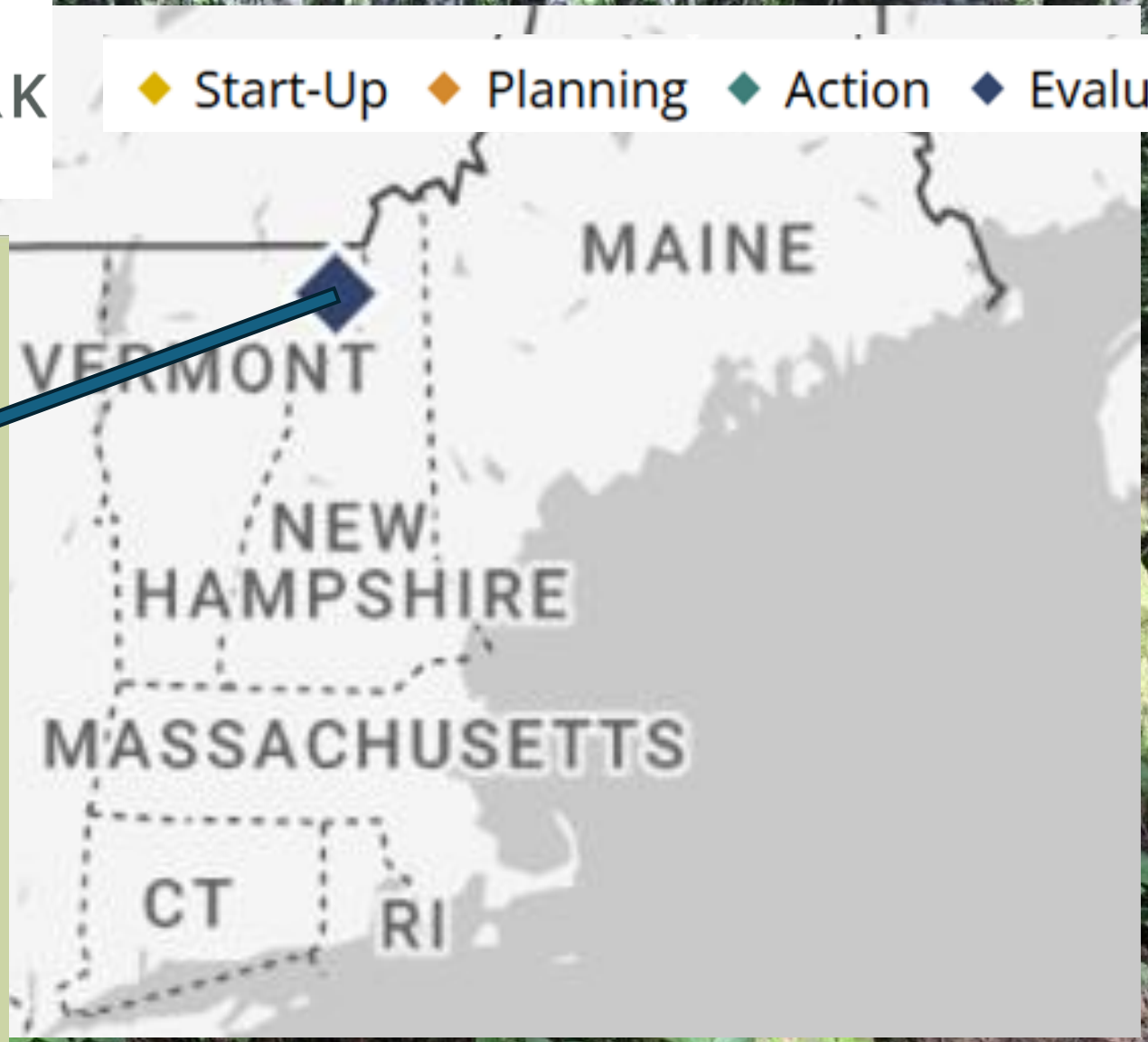
CLIMATE CHANGE
RESPONSE FRAMEWORK

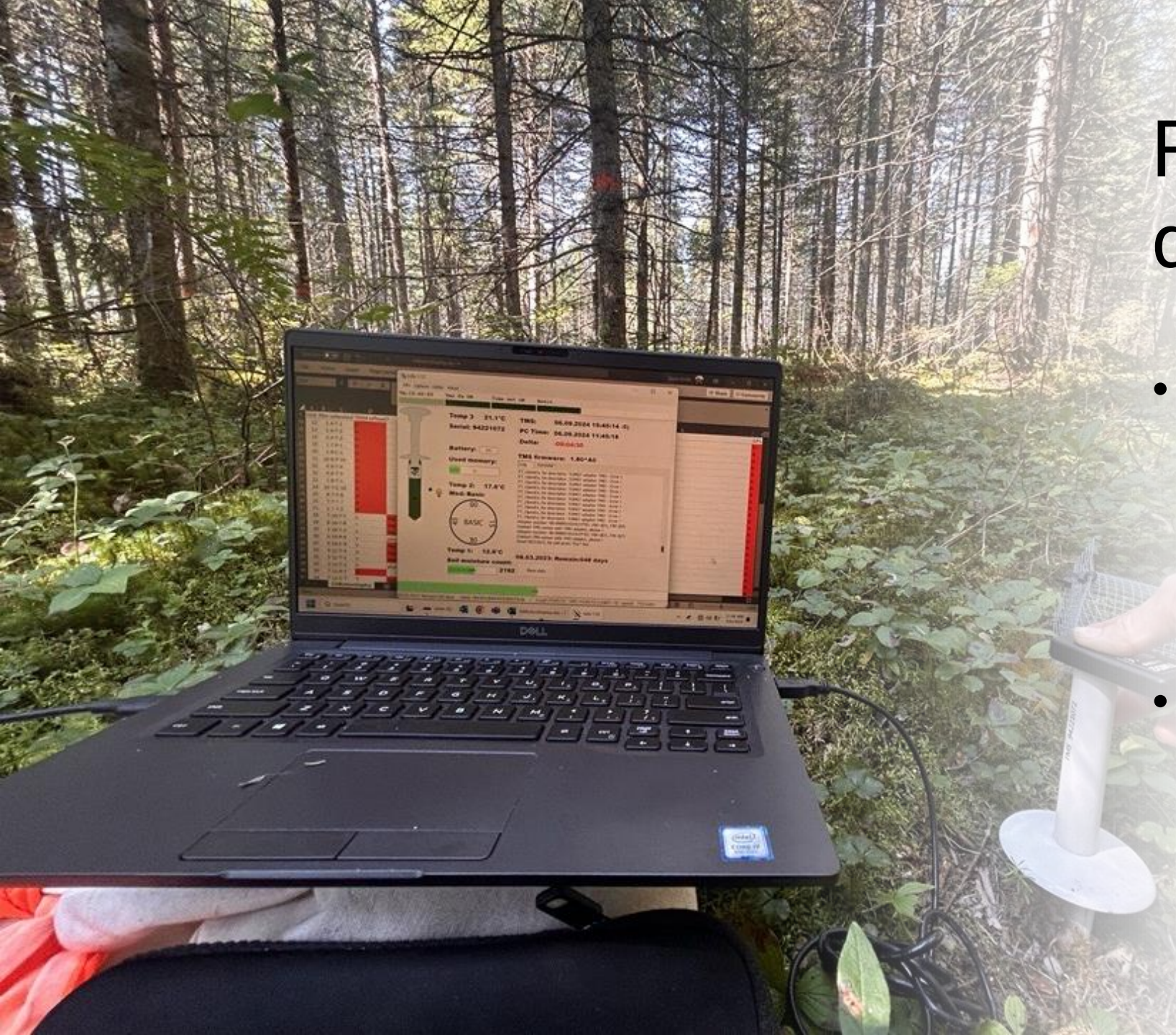


CLIMATE CHANGE
RESPONSE FRAMEWORK

Start-Up Planning Action Evaluation



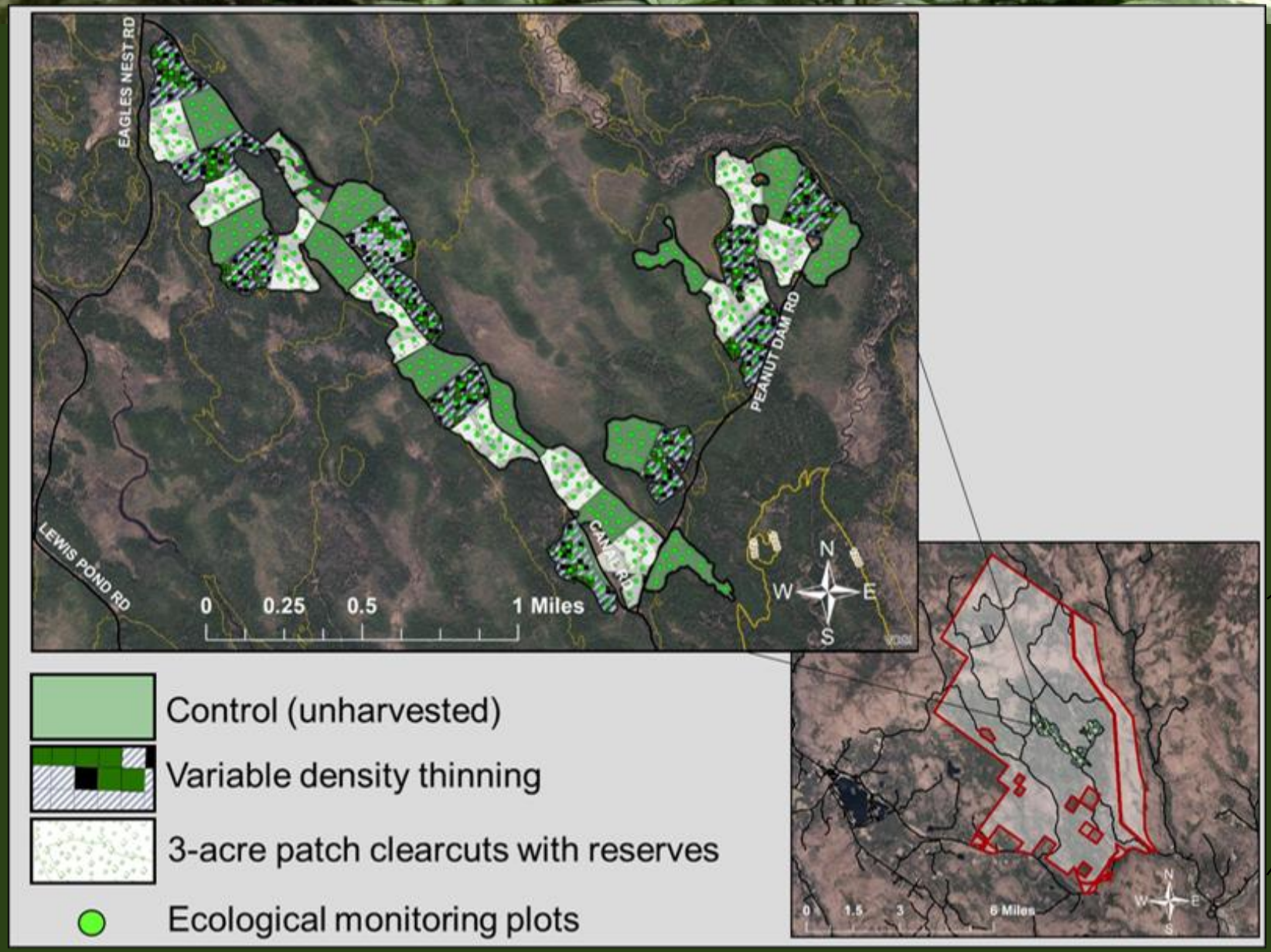




Research questions

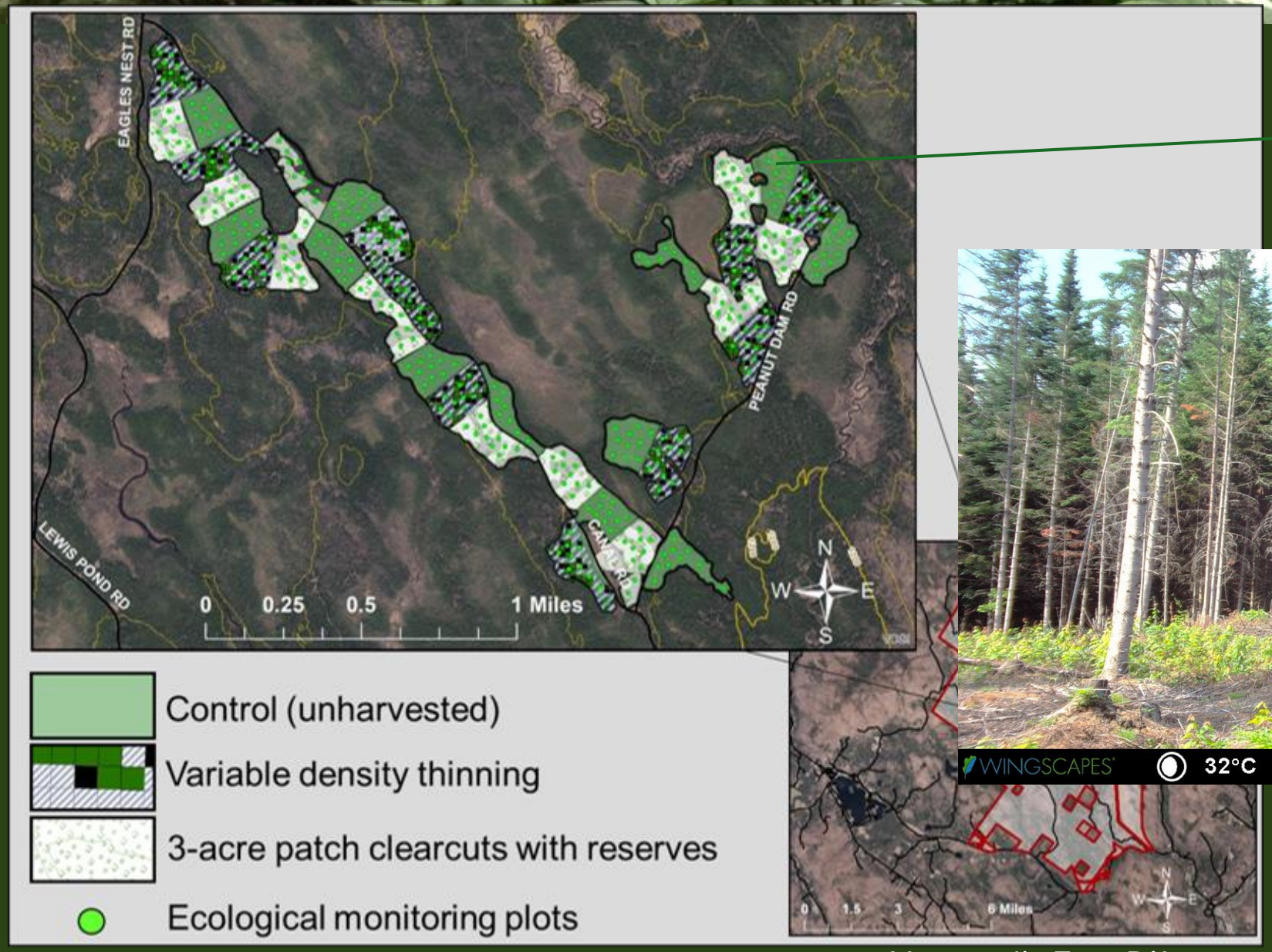
- How do forest structural conditions, as generated by different adaptive management strategies, influence microclimate conditions within lowland spruce-fir forests?
- How do adaptive forest management practices modify microclimatic processes? How do these processes vary seasonally?

Study area

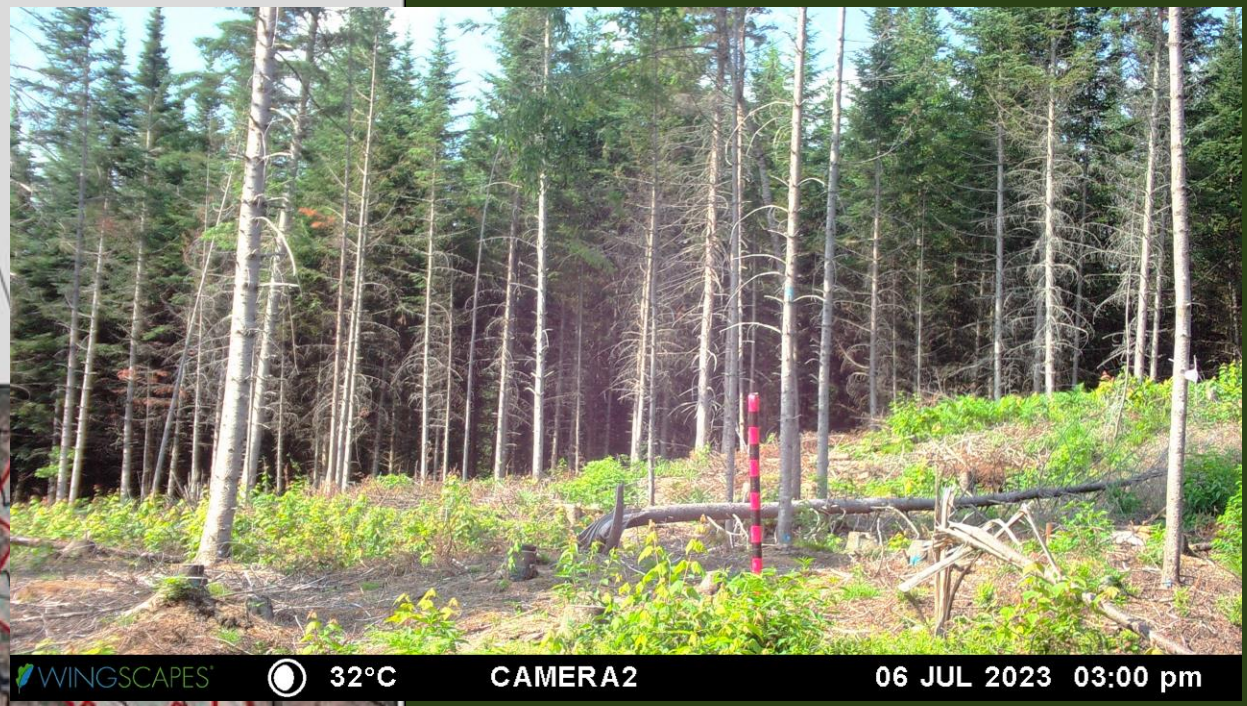


Map credit: Tony D'Amato

Study area

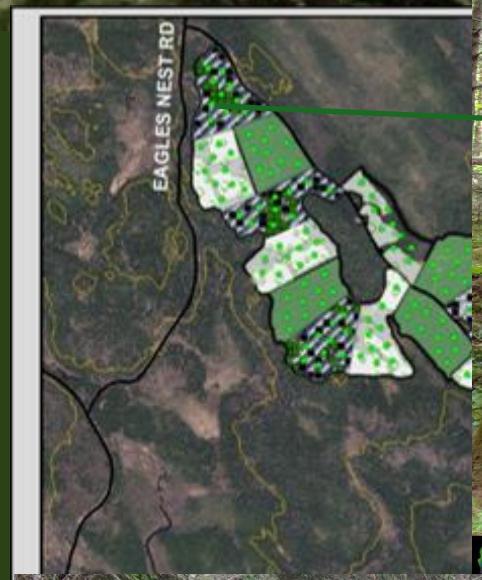


Patch clearcuts with reserves



Map credit: Tony D'Amato

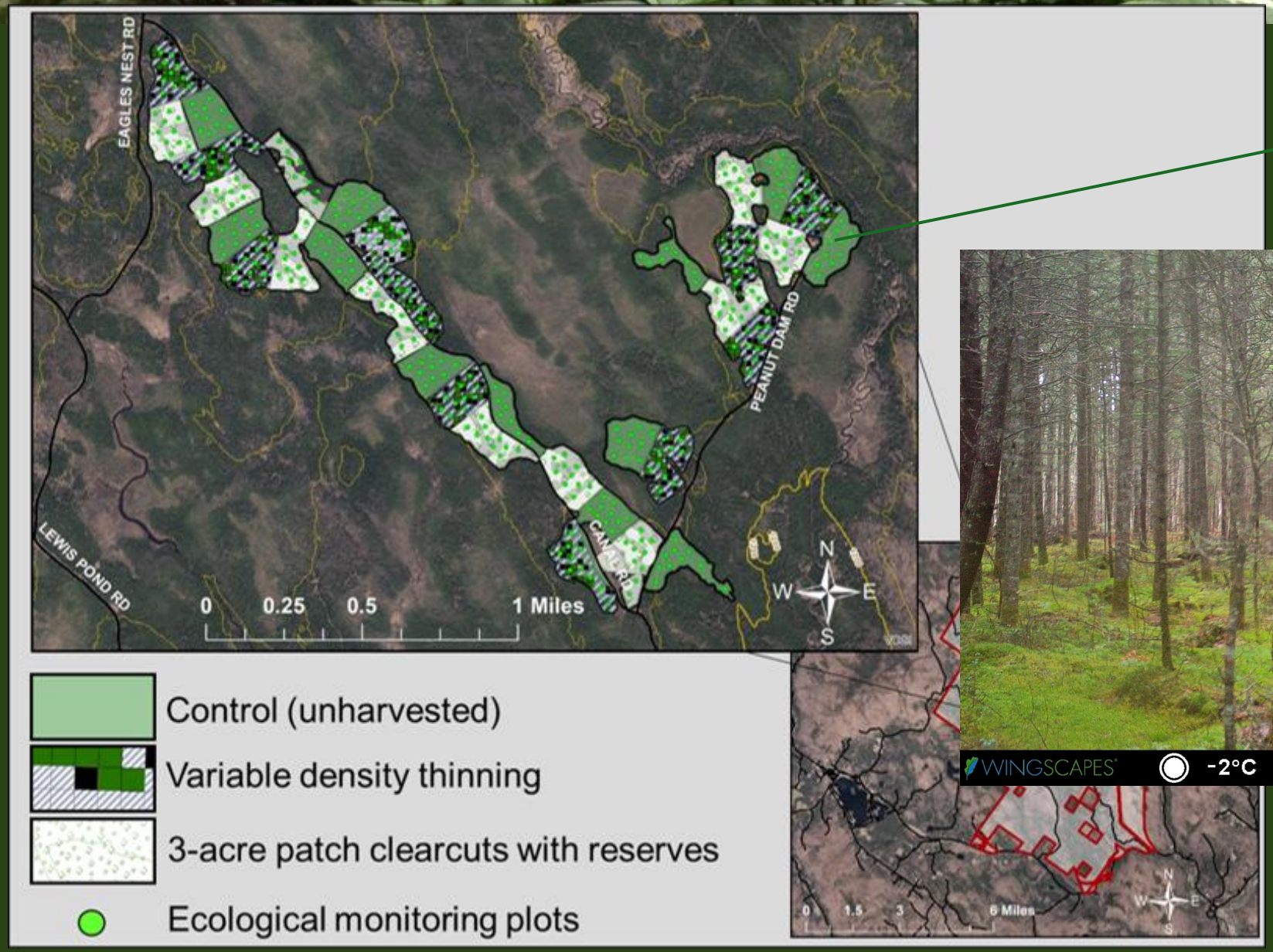
Study area



Variable density thinning

Map credit: Tony D'Amato

Study area



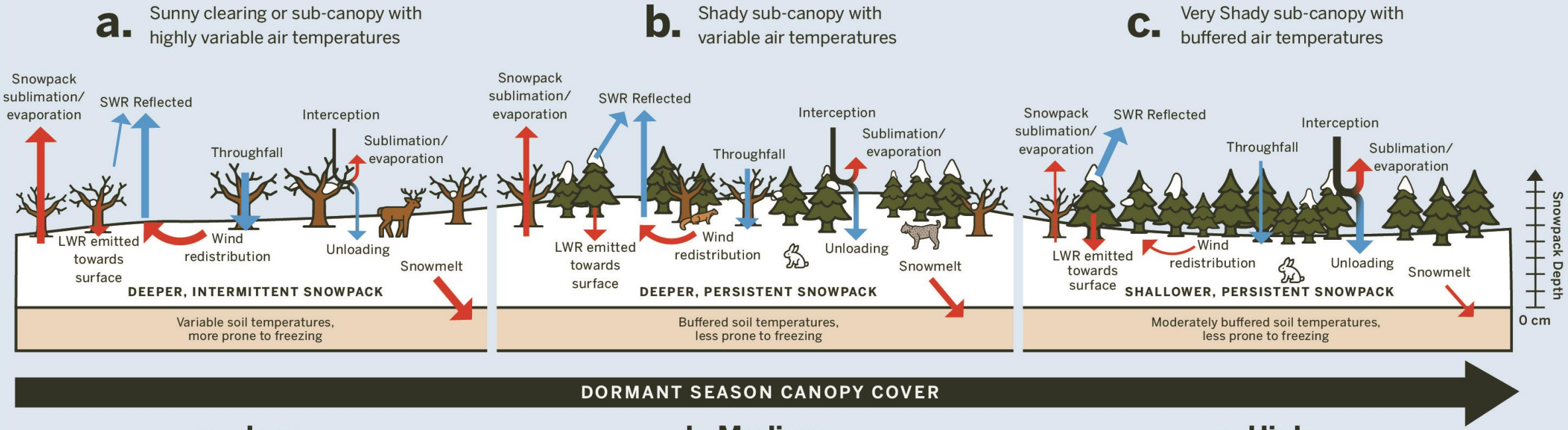
Unharvested control units

Map credit: Tony D'Amato

Experimental design

higher openness ← Canopy openness → lower openness

Patch clearcut | VDT-Gap | VDT-Thin | VDT-Skip | Control



a. Low

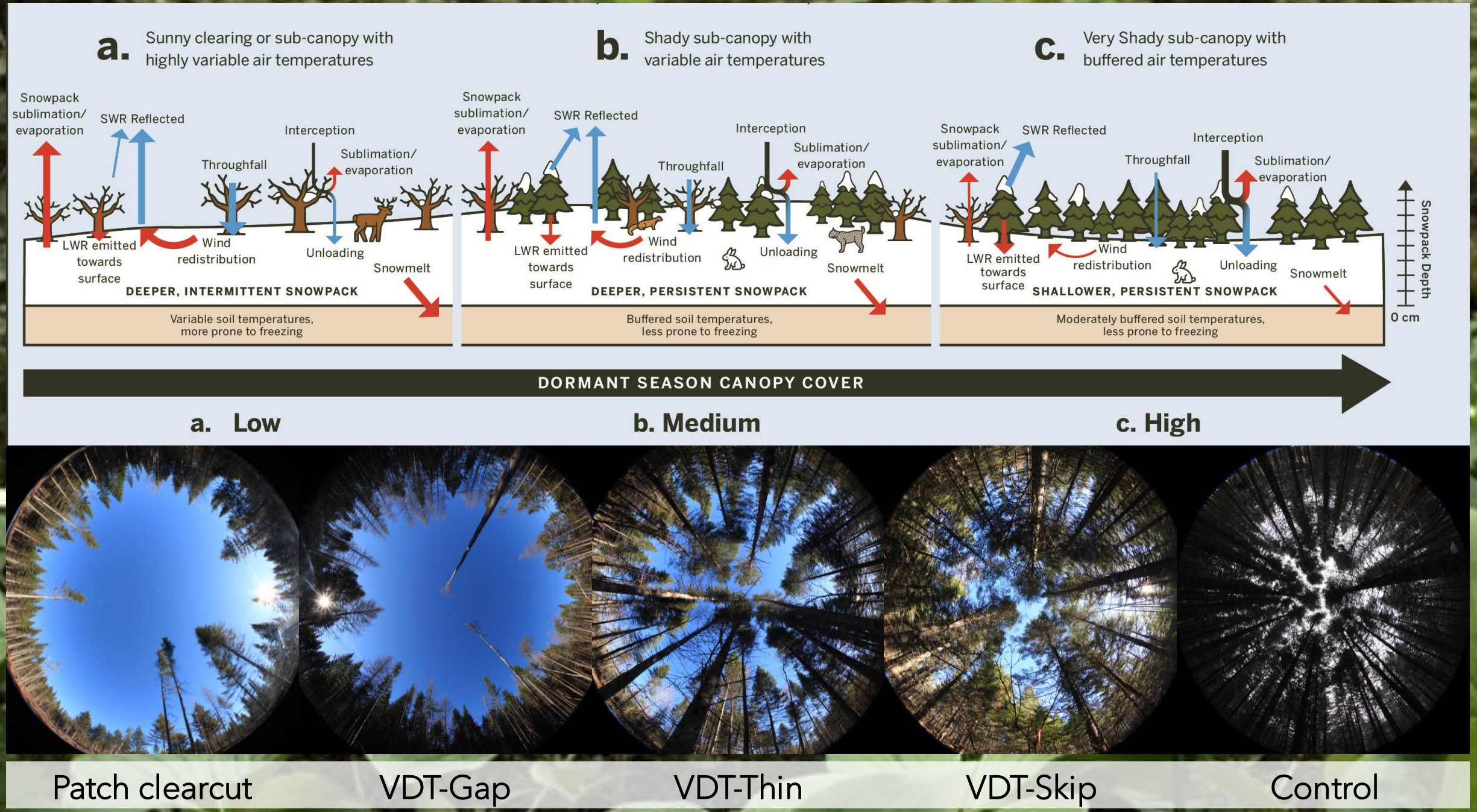
More snow makes it to the ground, however sunny, open conditions lead to larger diurnal temperature fluctuations, causing higher maximum air temperatures and thus more melting and sublimation/evaporation of snowpack. **Peak snowpack is deep but snowpack over time is intermittent**, leading to highly variable soil temperatures and more frequent soil freeze-thaw cycles.

b. Medium

A moderate amount of snow makes it to the ground and is less prone to melting and loss because of the shadier conditions and lower maximum air temperatures reached. **Peak snowpack is deepest and snowpack is more persistent**, thereby buffering soil temperatures and helping to prevent soils from freezing. Conditions favor snow-loving wildlife like the Canada lynx.

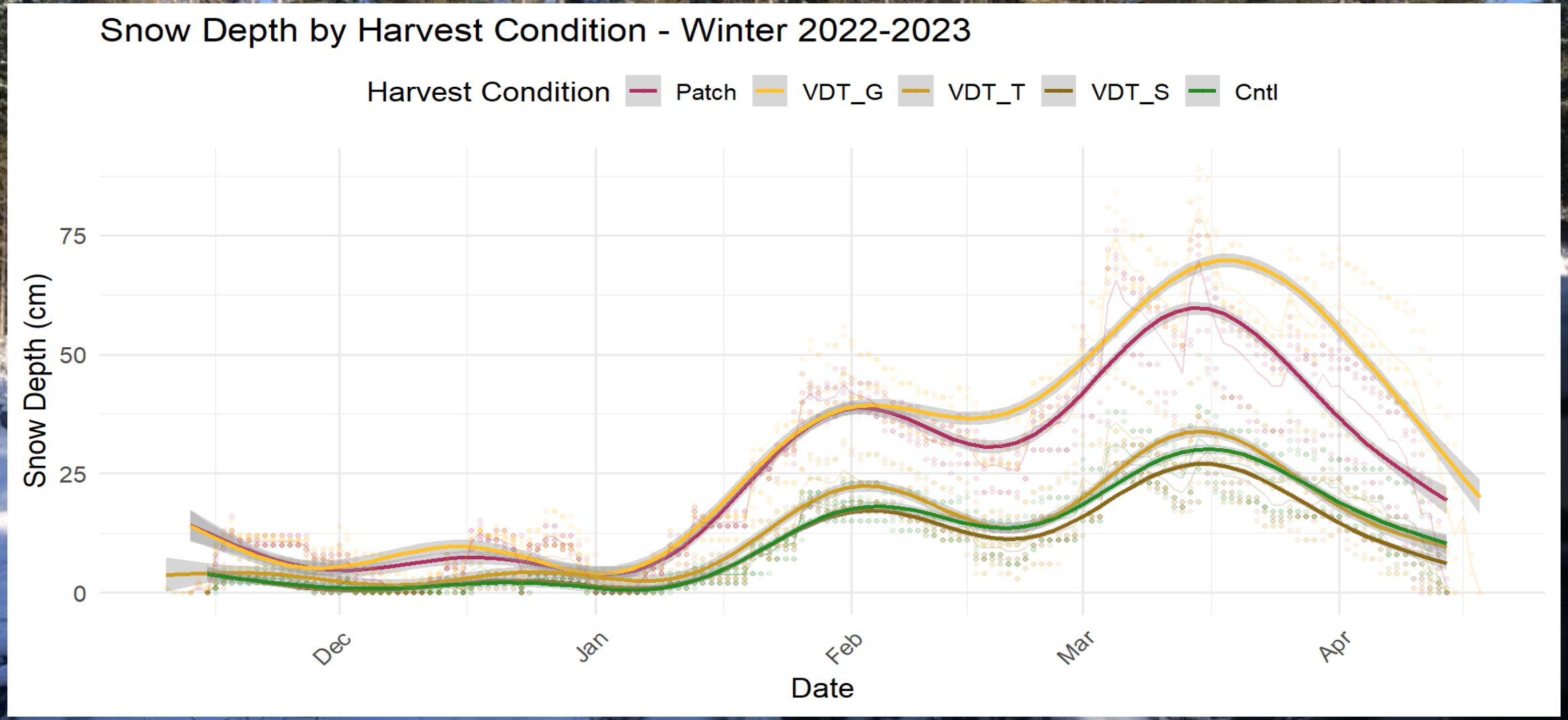
c. High

Less snow makes it to the ground but is less prone to melting and loss. The closed canopy creates very shady conditions and acts as a thermal buffer, limiting the maximum air temperatures reached. **Snowpack is shallower but more persistent**, helping to buffer soil temperatures but allowing for periodic soil freezing.

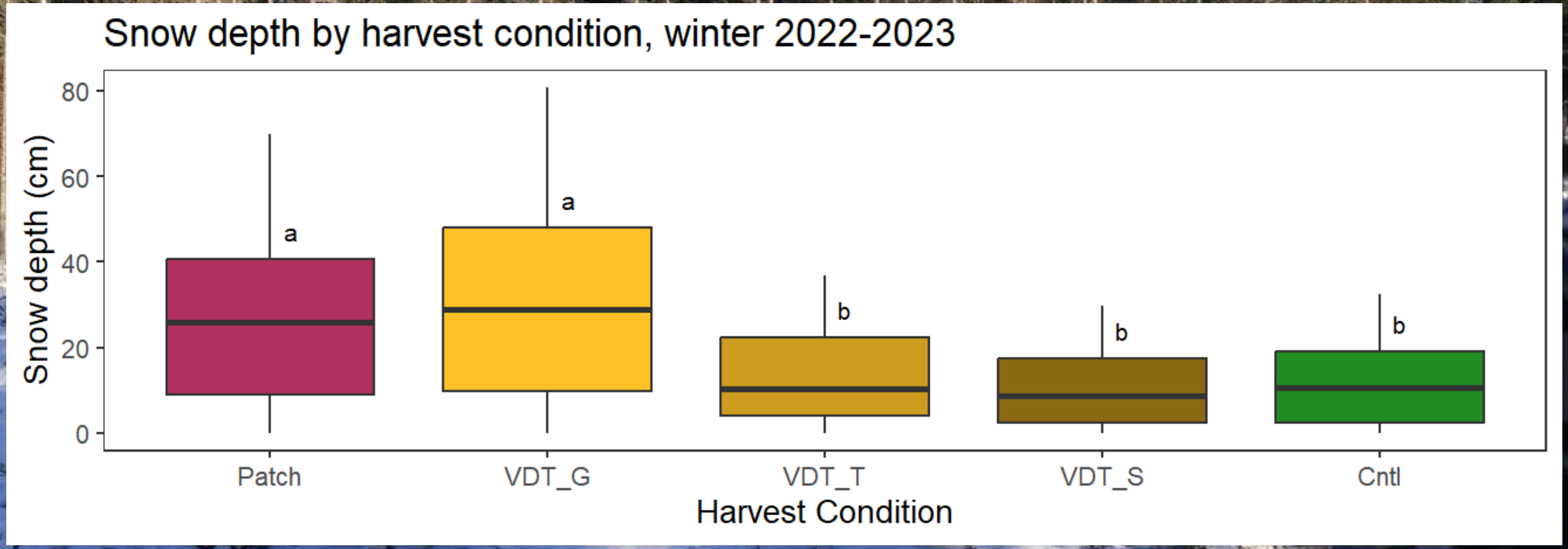

a. Sunny clearing or sub-canopy with highly variable air temperatures
b. Shady sub-canopy with variable air temperatures
c. Very Shady sub-canopy with buffered air temperatures
Snowpack sublimation/ evaporation
SWR Reflected
Interception
Throughfall
Sublimation/ evaporation
LWR emitted towards surface
Wind redistribution
Unloading
Snowmelt
DEEPER, INTERMITTENT SNOWPACK
Variable soil temperatures, more prone to freezing
DEEPER, PERSISTENT SNOWPACK
Buffered soil temperatures, less prone to freezing
SHALLOWER, PERSISTENT SNOWPACK
Moderately buffered soil temperatures, less prone to freezing
Snowpack Depth
0 cm
DORMANT SEASON CANOPY COVER
a. Low
b. Medium
c. High
Patch clearcut
VDT-Gap
VDT-Thin
VDT-Skip
Control

PRELIMINARY RESULTS

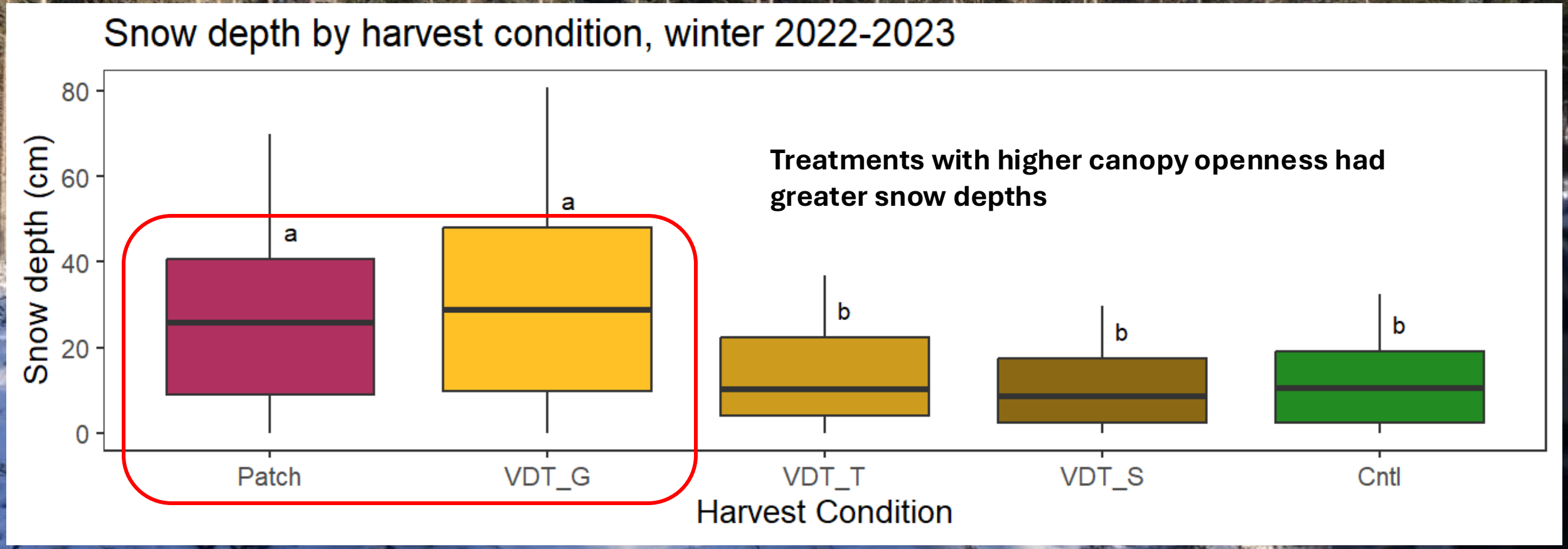
Results – Snow Depth by Harvest Condition



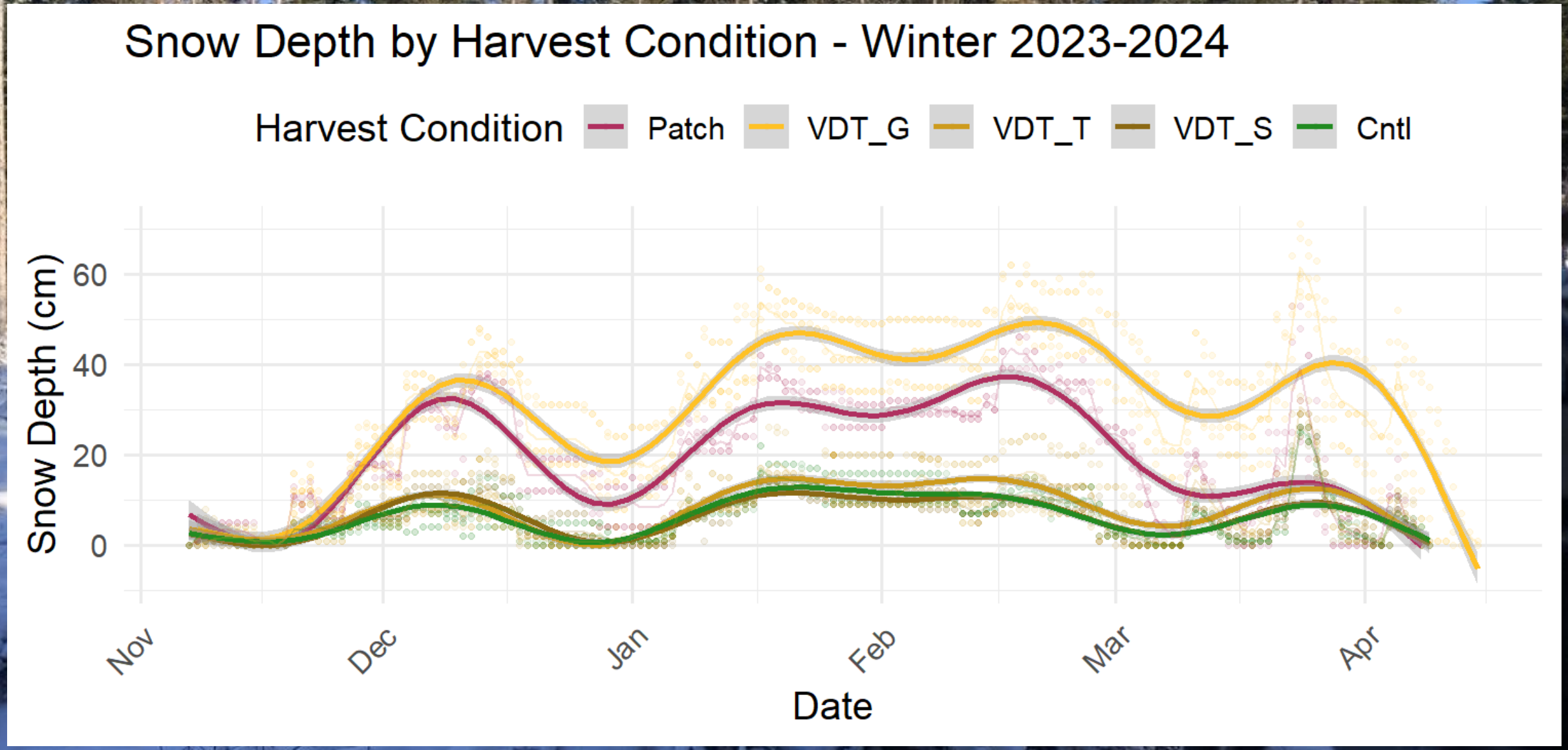
Results – Snow Depth by Harvest Condition



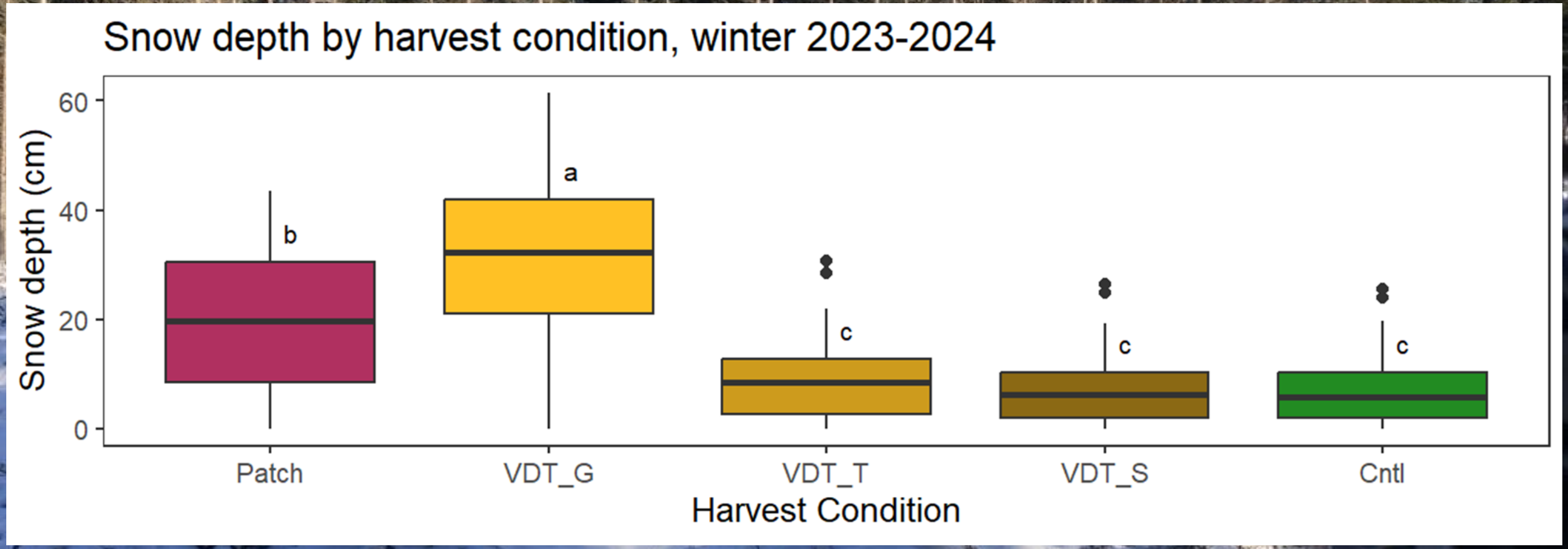
Results – Snow Depth by Harvest Condition



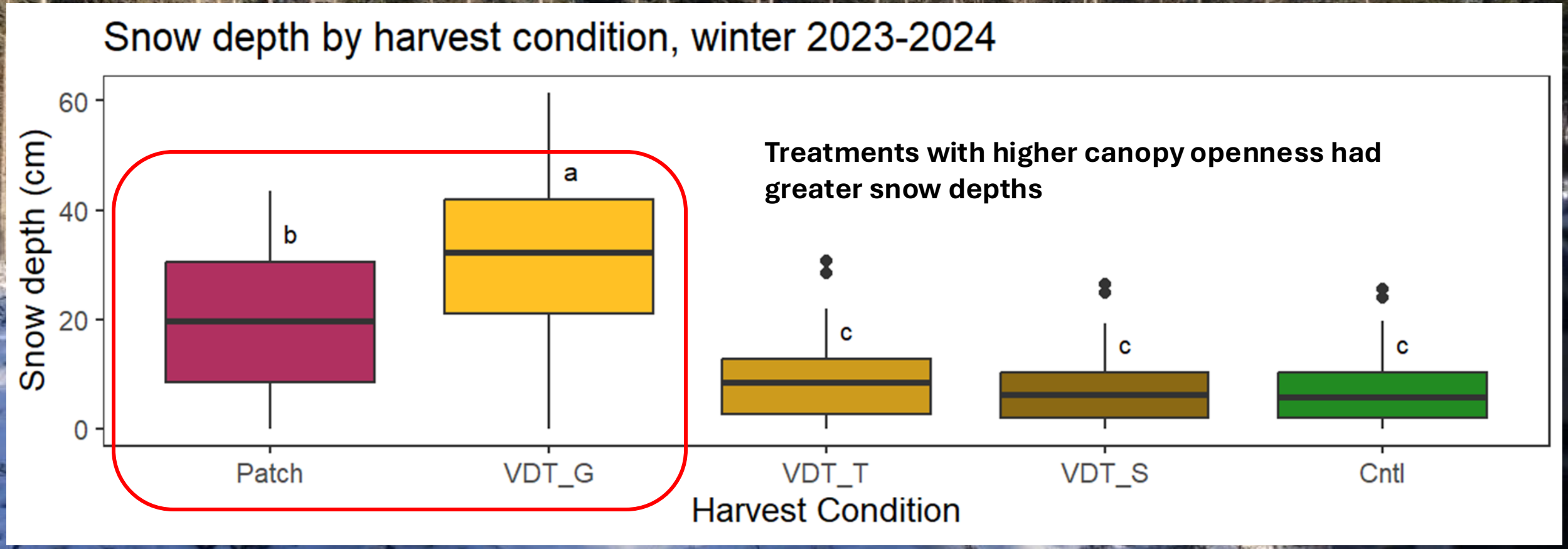
Results – Snow Depth by Harvest Condition



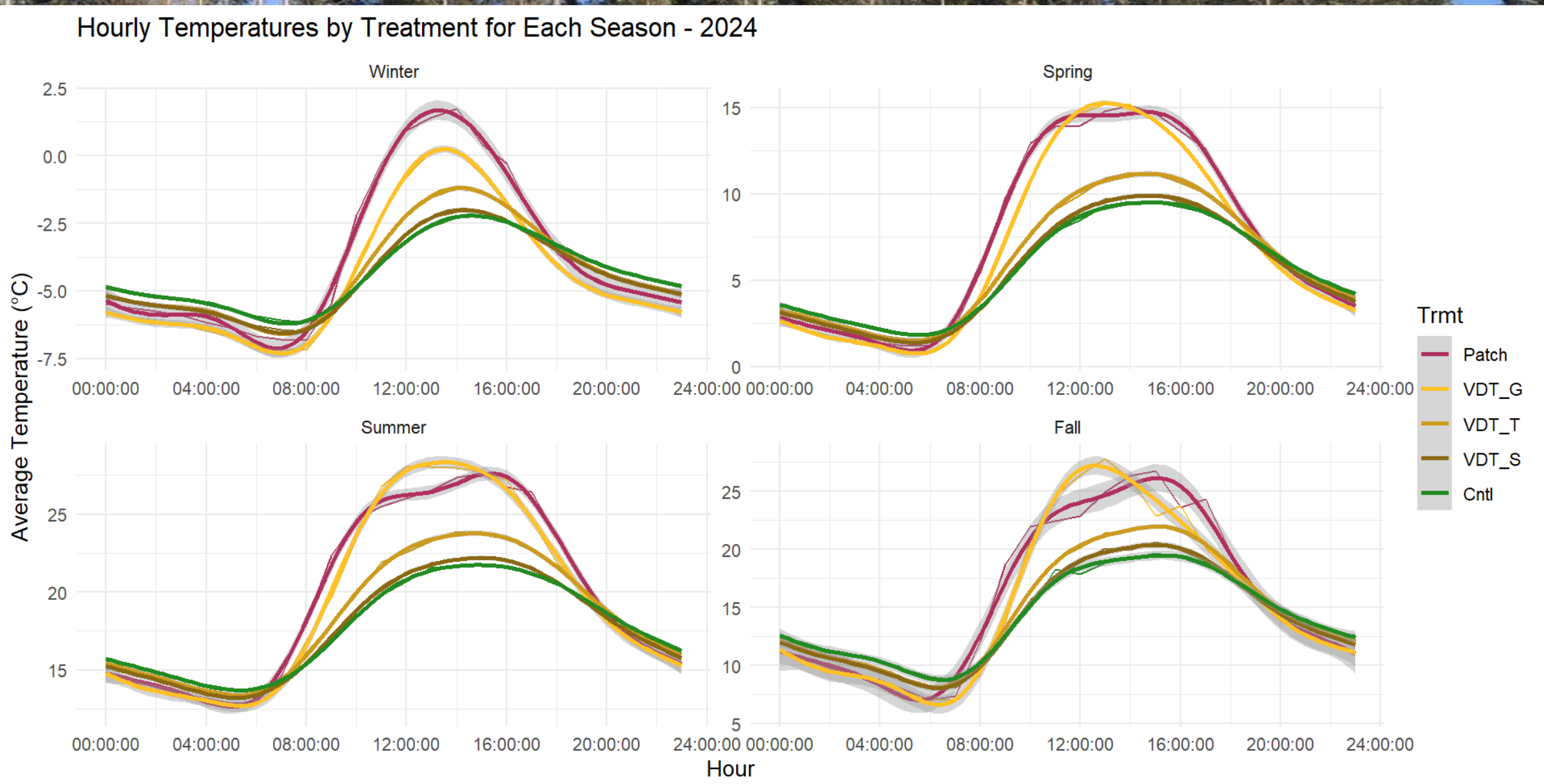
Results – Snow Depth by Harvest Condition



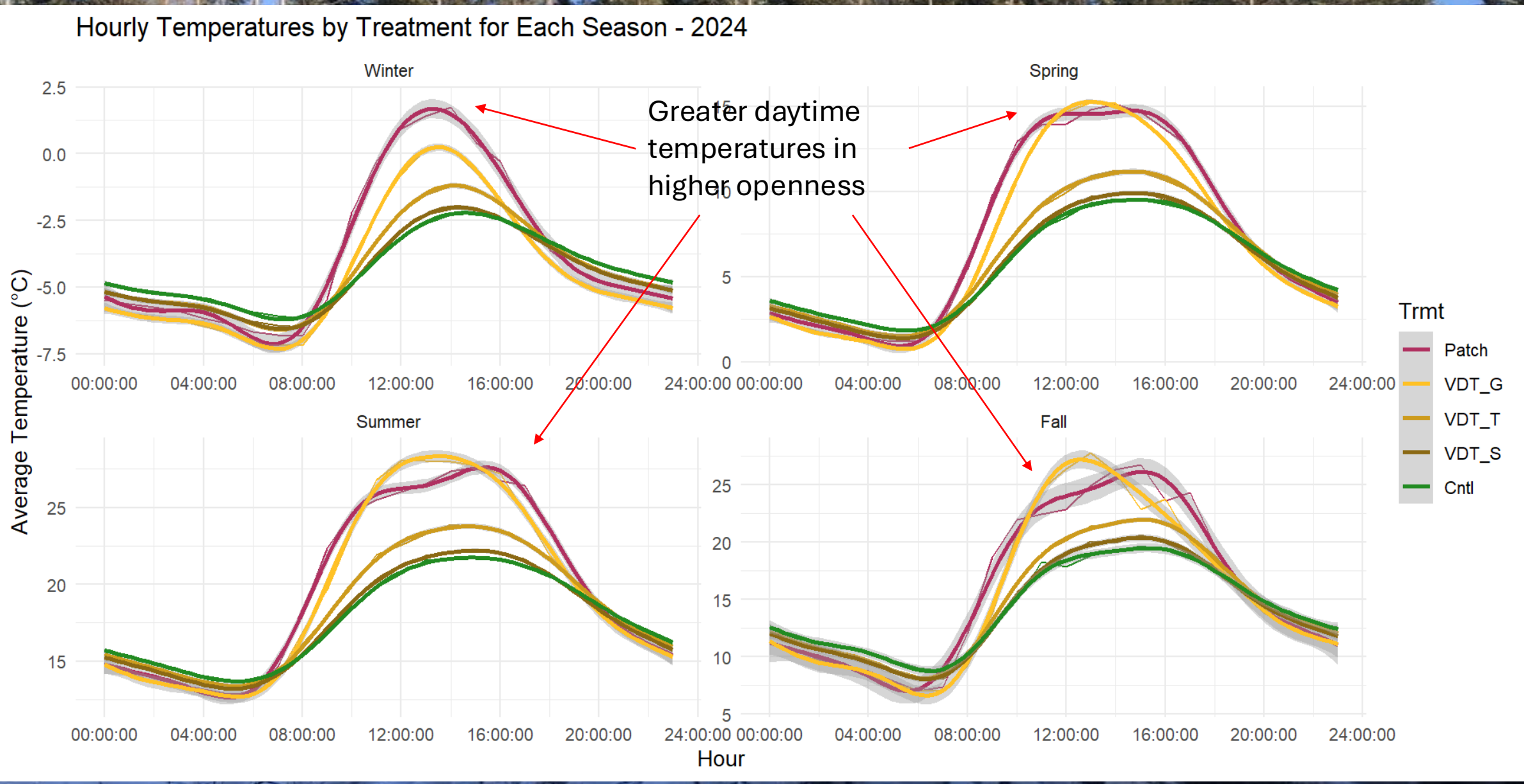
Results – Snow Depth by Harvest Condition



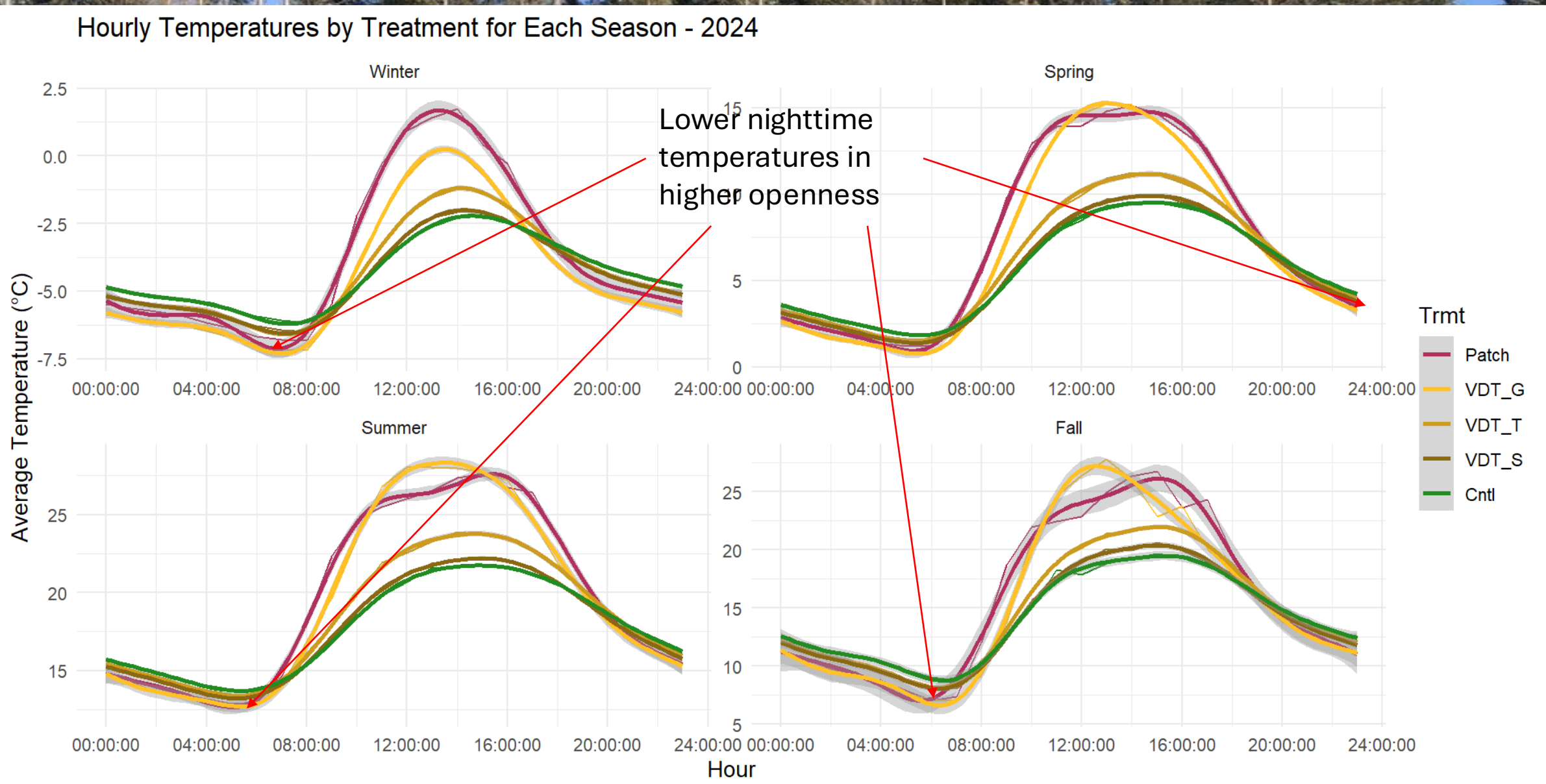
Results – Diurnal Temperature Range by Harvest Condition



Results – Diurnal Temperature Range by Harvest Condition



Results – Diurnal Temperature Range by Harvest Condition



Conclusions and next steps

- Early results suggest influence from canopy cover on microclimate conditions
  - Greater canopy openness results in greater snow depth and increased variability
  - Greater canopy openness results in greater daily temperature fluctuation

- Investigate relationships across continuous canopy cover scale (hemispherical canopy photos), soil and ground temperature, soil moisture relationship to canopy cover

- 1 more winter of data collection

Acknowledgements

Advisor: Tony D'Amato

Committee: Carol Adair, Beverley Wemple, Shelly Rayback

Nulhegan Refuge Staff: Jeremy Goetz, Rachel Cliche, Steve Agius

Managing for the Cold Project Team

Silviculture and Applied Forest Ecology Lab Group

K. Rand, A. Contosta, S. Nelson, M. Pastore, M. English, M. Olson

Funding: Northeast Climate Science Adaptation Center, NSF INSPIRES, USDA NIFA McIntire-Stennis Cooperative Forestry Program


Questions?
WINGSCAPES
-6°C
CAMERA11
27 FEB 2024 09:00 am