



THE **GLOBE** PROGRAM

Tracking the Vernal Window Using GLOBE protocols



Elizabeth Burakowski, University of New Hampshire
GLOBE Annual Meeting, Detroit, MI – July 15-17, 2019



THE **GLOBE** PROGRAM

US Forest Service Vernal Window Partners



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Burakowski – Tracking the "Vernal Window"



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Macrosystems Bio
#1802726

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Burakowski – Tracking the "Vernal Window"

Teacher Collaborators:

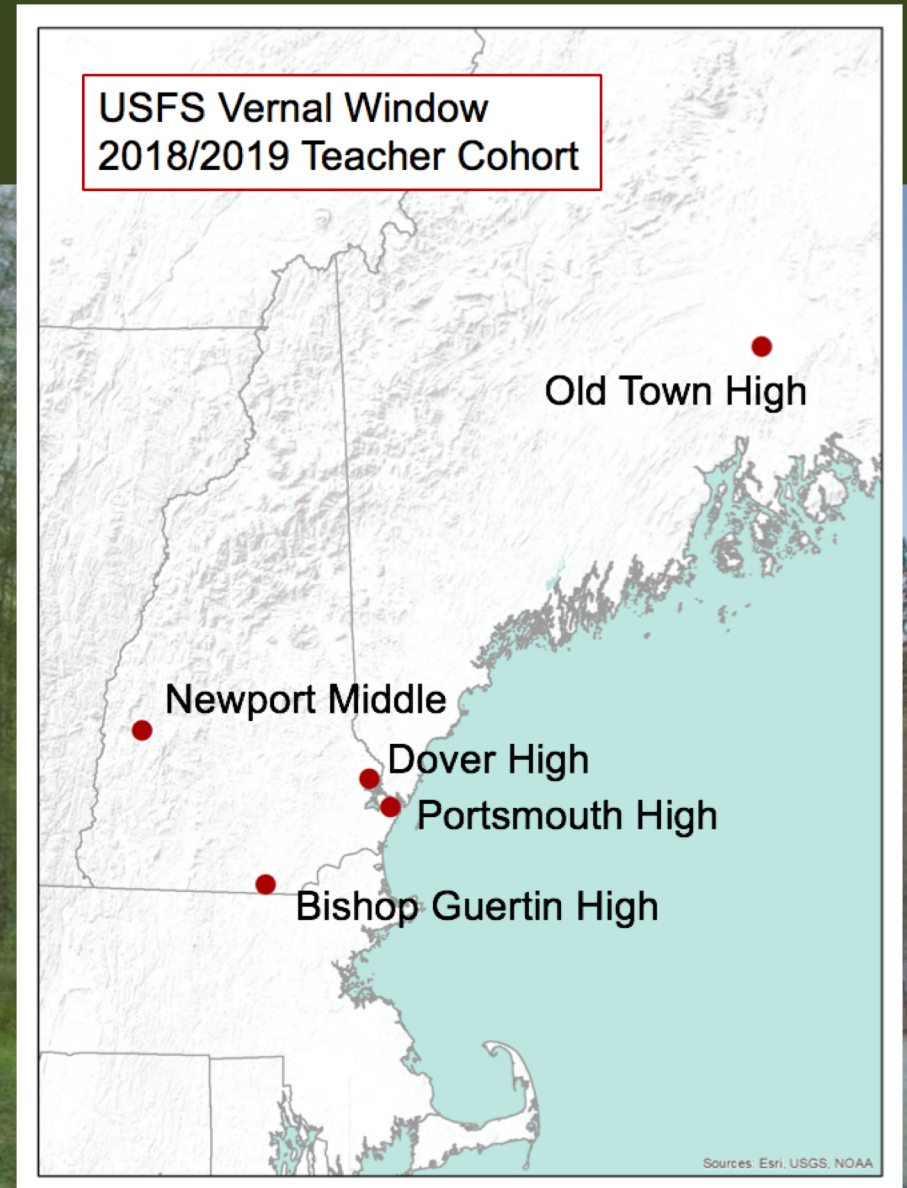
Dee Barrett
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Ed Lindsey
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What is the Vernal Window?



Burakowski – Tracking the "Vernal Window"

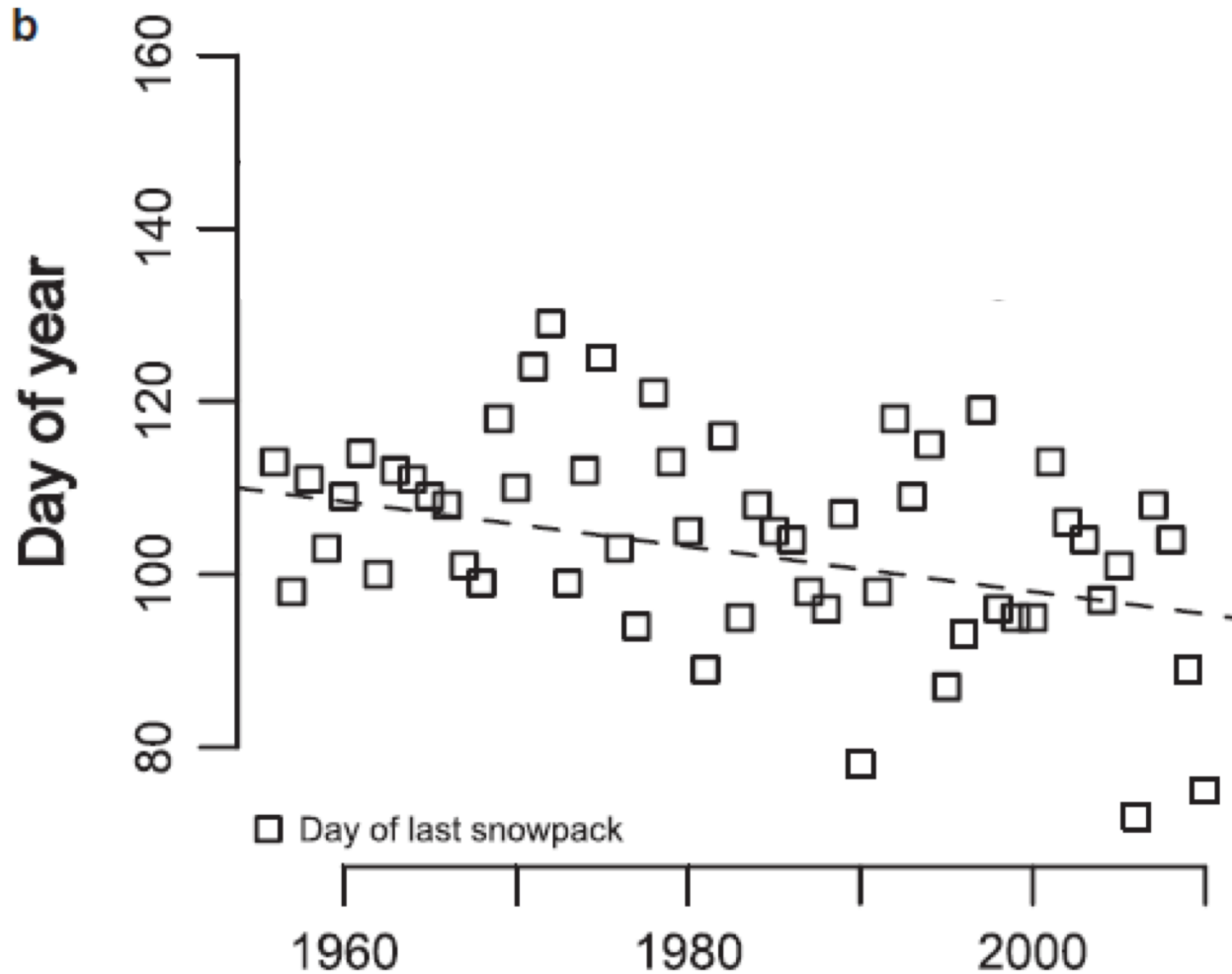
Snowmelt to Canopy Closure

Creed et al. 2015
Contosta et al. 2017



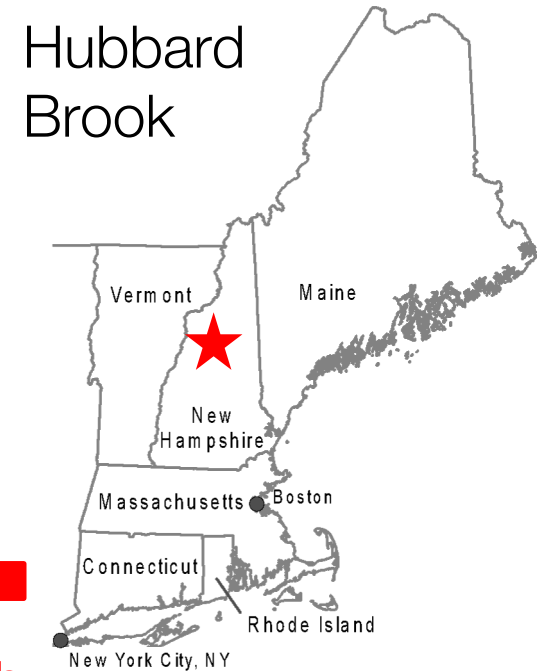
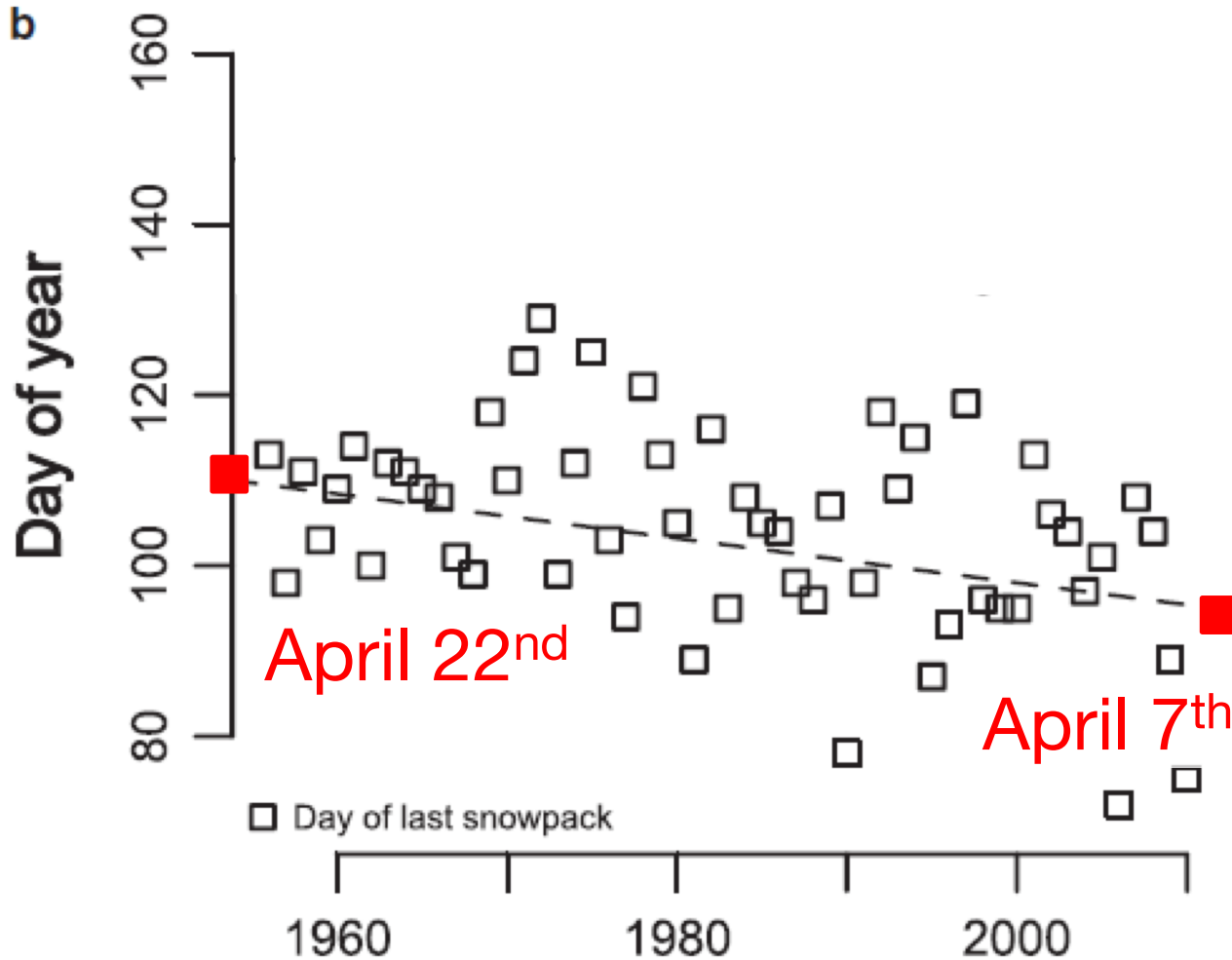
Burakowski – Tracking the "Vernal Window"

The date of snowpack disappearance at Hubbard Brook NH, 1956-2010.



Groffman et al. 2012

Snowpack disappears ~ 15 days earlier.



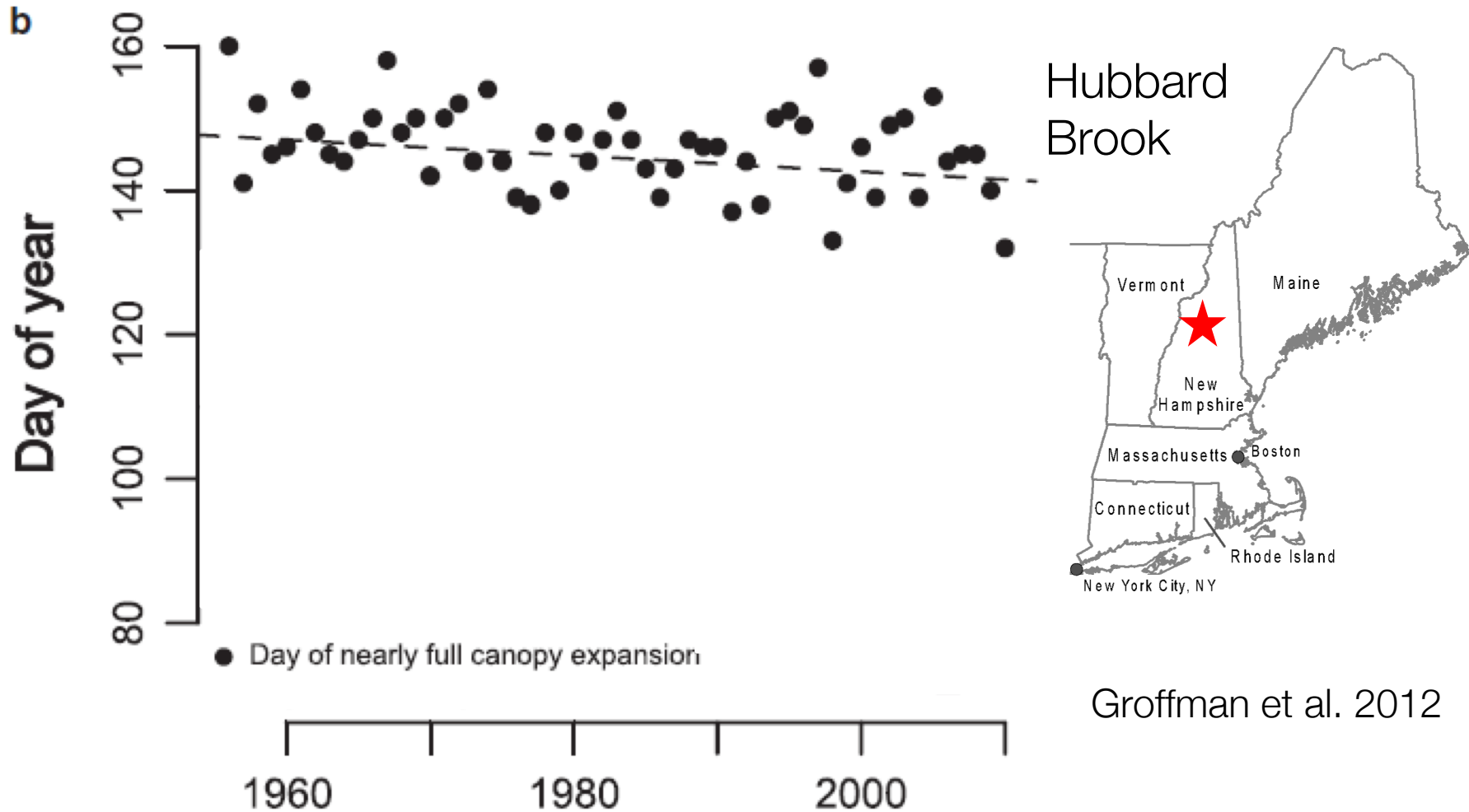
Groffman et al. 2012

Earlier snowmelt lengthens the vernal window.

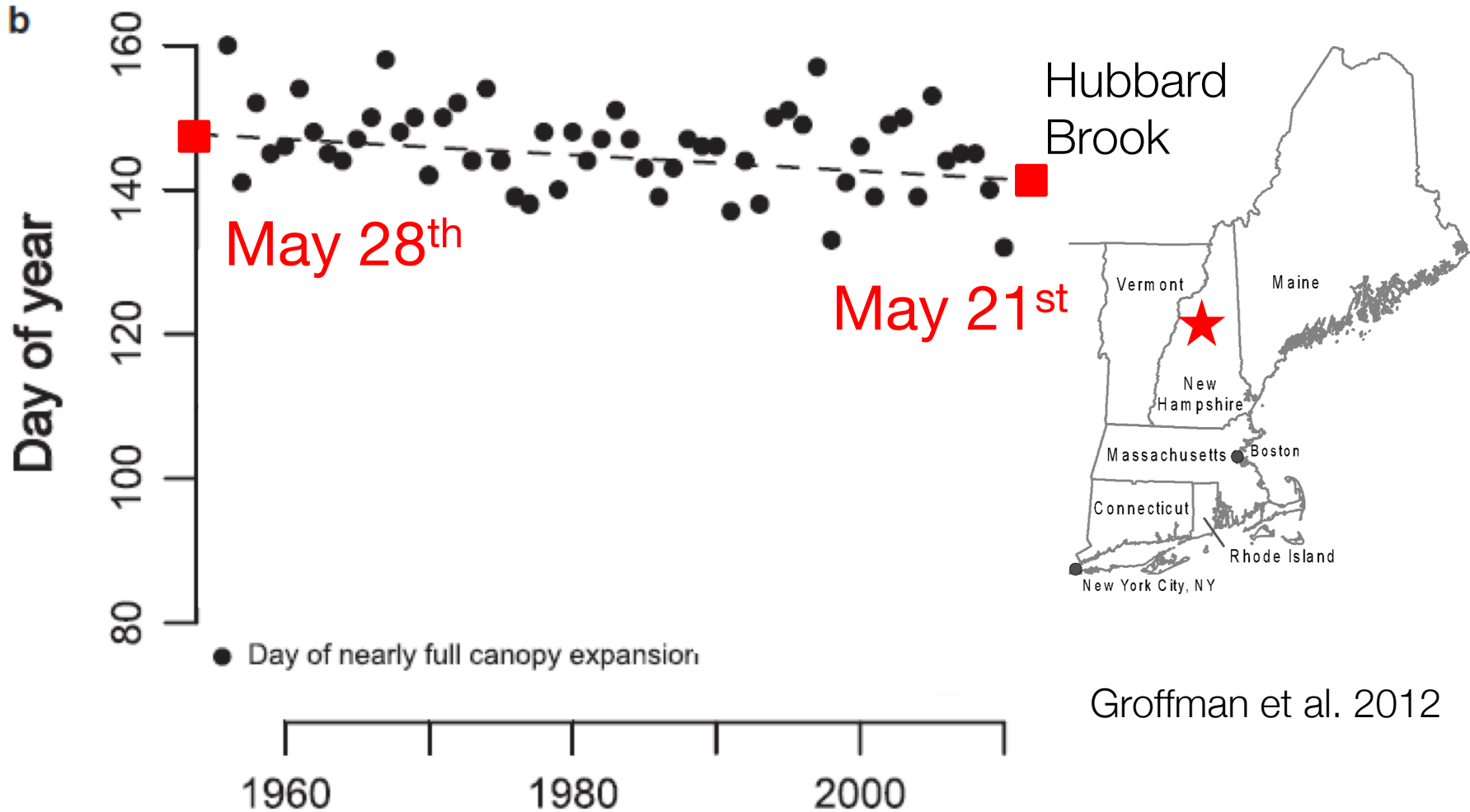


Burakowski – Tracking the "Vernal Window"

The date of canopy closure at Hubbard Brook NH, 1956-2010.

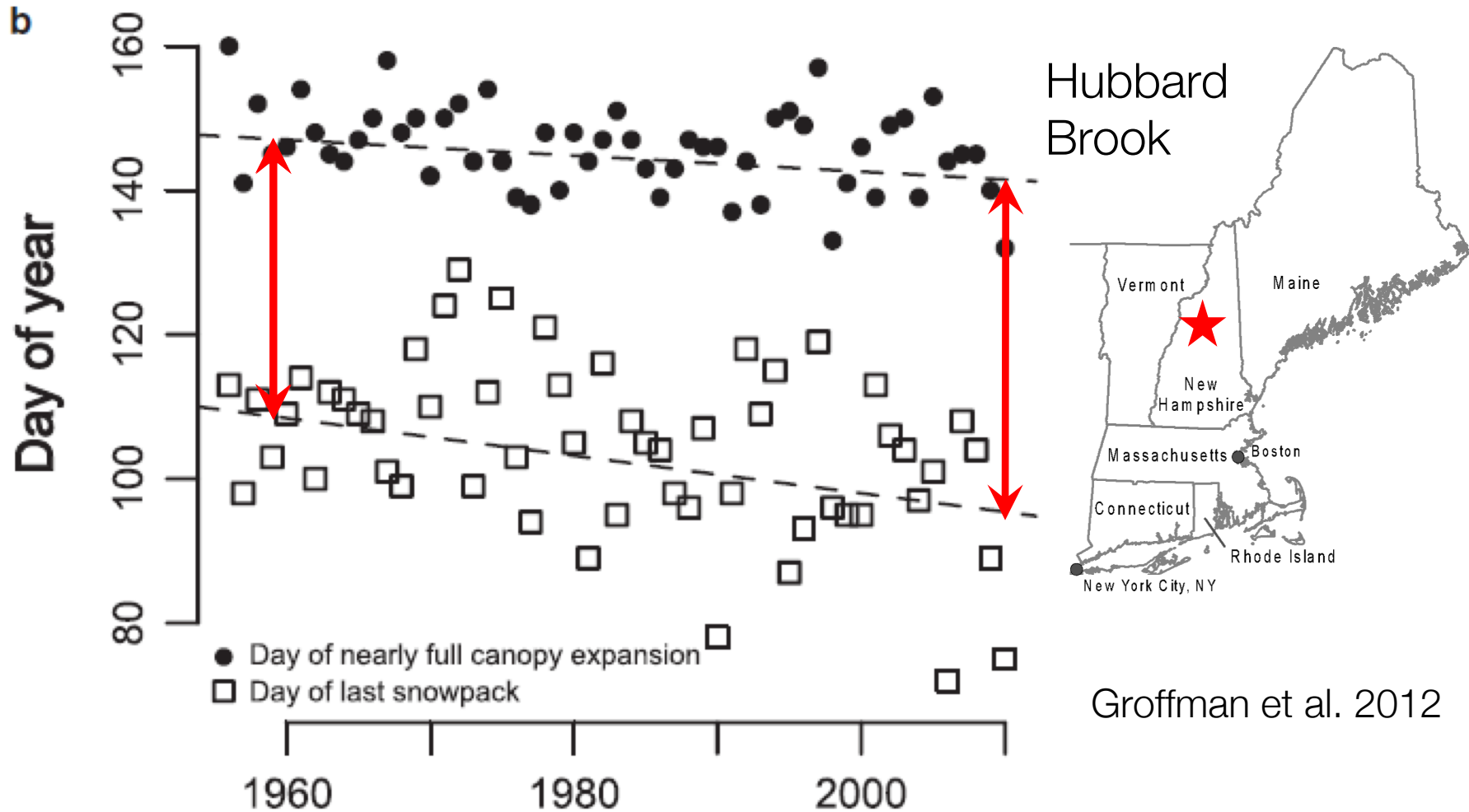


Canopy closes ~ 7 days earlier.



Groffman et al. 2012

An overall lengthening of the vernal window, by ~8 days.




A longer vernal window could lead to phenological mismatches in timing of key energy, carbon, and water related ecosystem processes.



Energy: Snowmelt → Snow-free

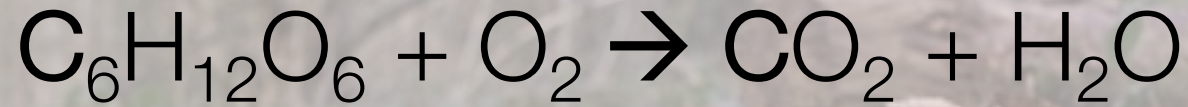


 picture post
picturepost.unh.edu

Carbon: Snow-free → Budburst

During the snow-free period, soils warm up and microbes start respiring organic matter.

Respiration:



Carbon: Snow-free → Budburst

Once budburst begins, ecosystem begins to take up carbon through photosynthesis.

Photosynthesis



Water:
Snowmelt → Peak streamflow



Burakowski – Tracking the "Vernal Window"

What will the vernal window look like in the future?



Burakowski – Tracking the "Vernal Window"

What will the vernal window look like in the future?

February 26, 2017
Kingman Farm, Durham, NH

This is the warmest February day ever recorded in Boston. *Boston Globe*



Tracking the vernal window using low-cost instrumentation.

Snow depth



Soil frost depth



Canopy Green-Up

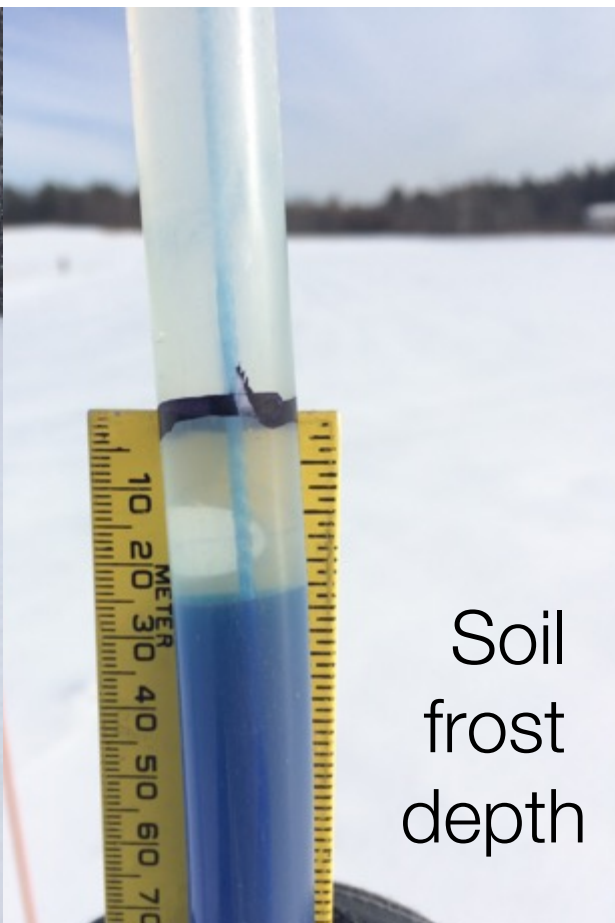


Soil respiration





Global Learning and Observations to Benefit the Environment (GLOBE) Protocols



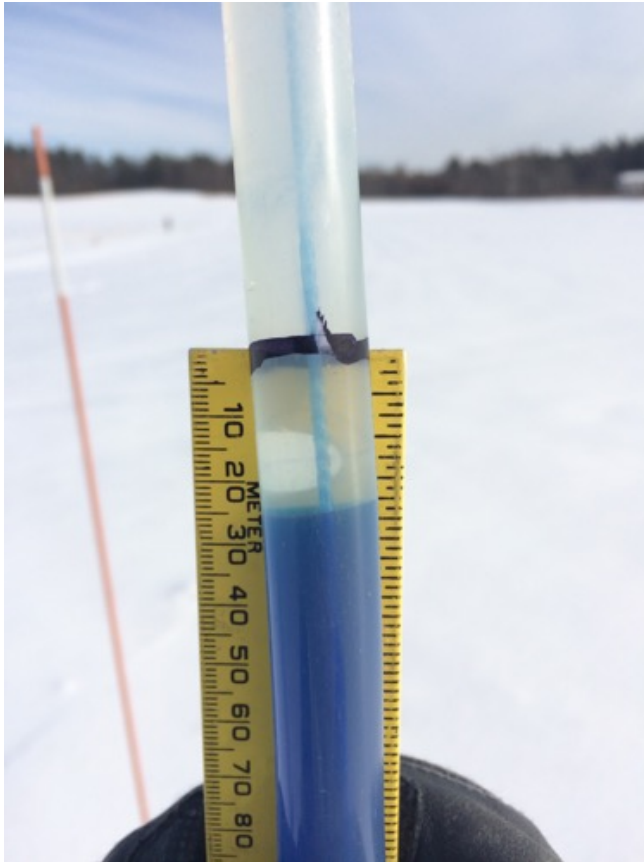
Soil Frost Depth



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- measure frozen soil depth throughout the winter.



Photos: Elizabeth Burakowski



- Students assist with siting & installation
- Daily to weekly measurements through until soil is completely thawed

Snow Depth



THE GLOBE PROGRAM

www.globe.gov

- measure how deep the insulative snow pack is.



Photo: Elizabeth Burakowski

- Snow depth measured alongside soil frost depth
- Daily to weekly measurements until the snowpack melted completely
- Hardwood and softwood comparison



Canopy Green-Up

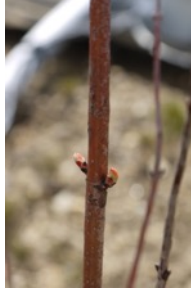
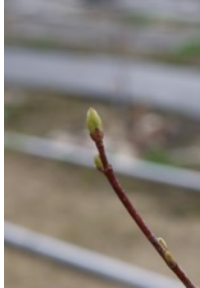

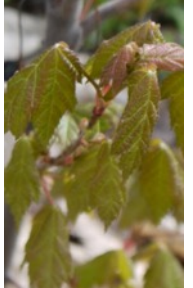
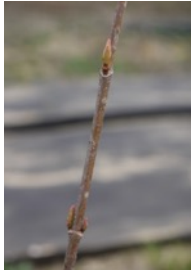
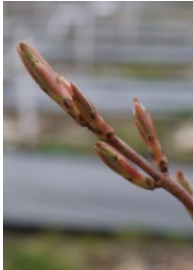
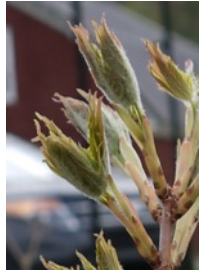



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- measure canopy phenophase

- Chose dominant species for each site.
- Daily to weekly measurements from dormant to canopy closure (full expansion)

	1 Dormant	2 Bud Swelling	3 Bud Burst	4 Expansion
Red Maple				
Sugar Maple				

Soda Lime Base Trap



- measures dormant season soil respiration.



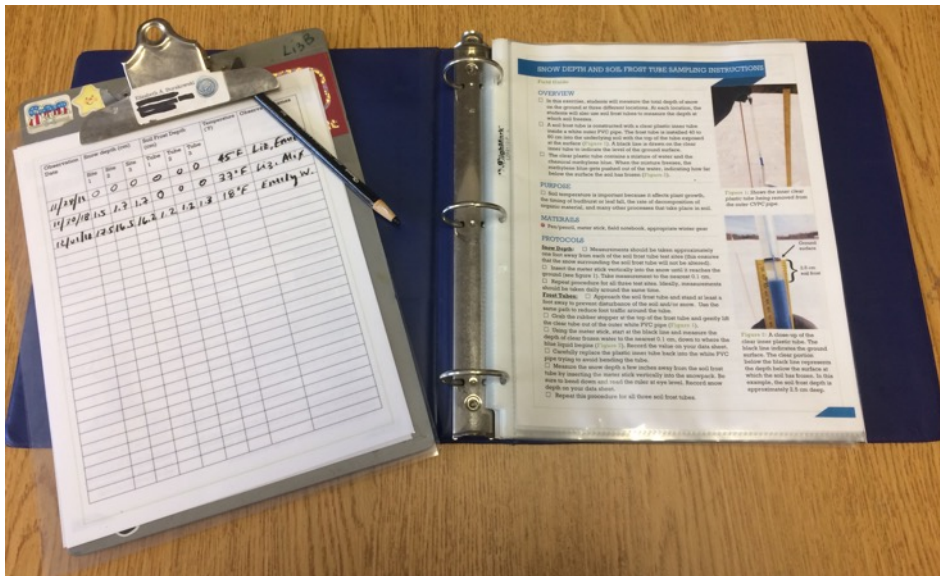
Photo: Elizabeth Burakowski

- Cost ~\$50 per chamber
- Set it and forget it until leaf out.
- Soda lime absorbs CO_2 as it is slowly released from the soil over the winter, so it 'gains weight'. Weight gained is proportional to CO_2 released from the soil.

Iteratively Constructed Teacher Kit



- Hard copy laminated datasheets, one-page protocols, GLOBE site set-up and data entry instructions, shopping list and recipes for low-cost instrument assembly
- Digital pdfs of all hard copy materials



- Feedback encouraged and solicited from teachers throughout the program.
- Co-production of learning activities

The Vernal Window Timeline Activity



Students are given a set of eight cards describing different vernal window events:

1. Snowmelt initiation
2. Snow disappearance
3. Peak streamflow
4. Stream temperature
5. River, lake, stream ice-out
6. Soil thaw
7. Budburst
8. Canopy closure

Hypothesis generation & discussion

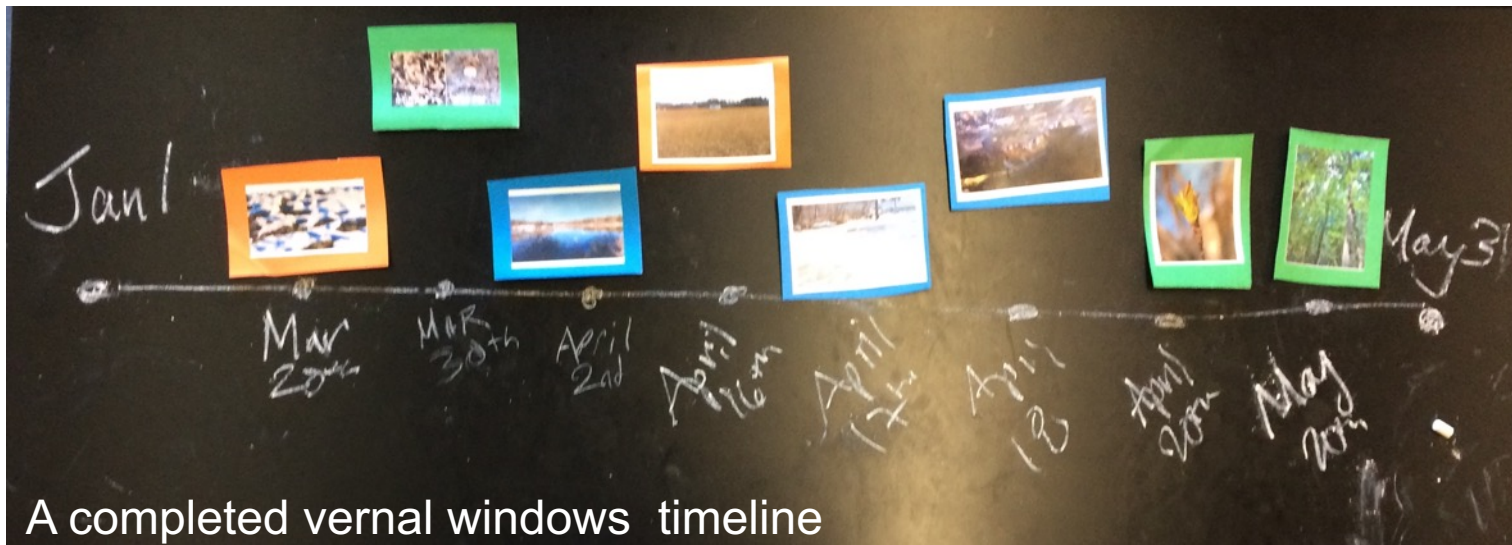


- Ask students to arrange the cards into a hypothesized order of events and assign a timeline.
- Prompt students to discuss how each event is related to energy, water, and/or carbon.
- Throughout vernal window, compare hypothesized sequence and timing to actual observations

Hypothesis testing through investigation



- Use GLOBE protocols and other publicly available data (e.g., US Geological Survey stream data) to test their hypothesized sequence of events and timeline.



"I ran the activity with some of my classes and they were very engaged in the types of discussions I believe it is meant to incite."

Ken Akiha, Old Town High School

Hypothesis testing through investigation

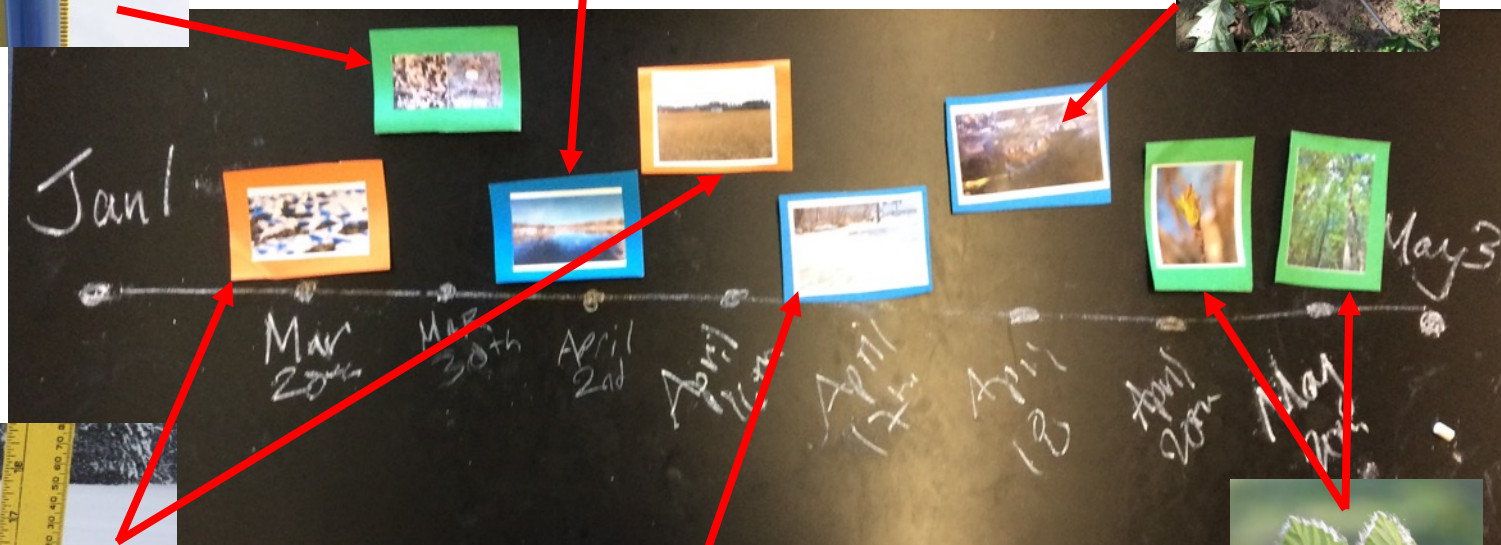


Soil frost

Stream
Flow



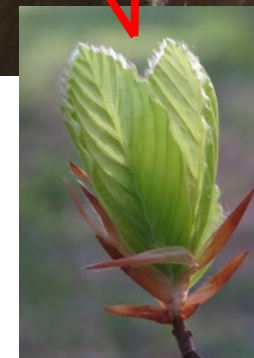
Soil
Temperature



Snow
depth



Water
temperature



Canopy
Green-Up

Analyzing and interpreting data, constructing explanations, communication



2019 Northeast Regional Student Research Symposium



Amanda Oertell,
Old Town High School
**recognized for Research
Process & Use of GLOBE
Protocols*

What Does the Vernal Window Look Like at a Softwood and a Hardwood Site?
Amanda Oertell -- Old Town High School Alternative Education
Old Town, Maine

Introduction

It is widely recognized that Earth's climate is changing. In Maine, the climate is getting better. This affects the vernal window. The vernal window is a period of time in a forested ecosystem that begins when the reflective snow melts and opens the soil up to the sun's radiation. The window ends when the leaves burst and absorb water and nutrients from the soil. (Contosta et al.) The vernal window in Maine and New Hampshire is getting longer, with a recorded increase of 3.9 days per decade at Hubbard Brook Experimental Forest (Griffman et al.). The vernal window's increase is due to the snow melting sooner, but the time that leaves burst isn't changing as fast. Our research group has been monitoring the vernal window in the University of Maine research forest connected to Old Town High School.

It's important to recognize, however, that we have collected data from two different forest types. The first neighborhood was the softwood site, which is full of Hemlock trees that offer a dense tree canopy over the surface. The second neighborhood was the hardwood site, full of beech trees, which have very little tree canopy in the winter. According to Griffman et al., the vernal window should start later in softwood sites than in hardwood sites because of the lack of tree canopy which exposes the snow to the sun's radiation.

The data we collected shows that the snowmelt and the warm-up in the soil temperature happened sooner in the softwood site than in the hardwood site. This is because the hardwood site has a large tree canopy that causes less snow to fall on the soil, and 2) the snow that does fall gets sprinkled with hemlock needles, which insulates the soil. The hardwood site has very little tree canopy, meaning that more snow falls onto the site but less dark

Data/Graphs/Results

Softwood Site

This graph shows the soil temperature measured at 5 cm in comparison to the average snow depth (taken in mm) in the softwood site over the course of winter 2018-2019.

Hardwood Site

This graph shows the soil temperature measured at 5 cm in comparison to the average snow depth (taken in mm) in the hardwood site over the course of winter 2018-2019.

Acknowledgements

O.T. Public Works, Dr. Alex Contosta, Dr. Lar Burakowski, April Perry, Dr. Ivan Fernandez, Dr. Sarah Nelson, Keith Kanott, Danielle Grogan, and Tyson Potter.

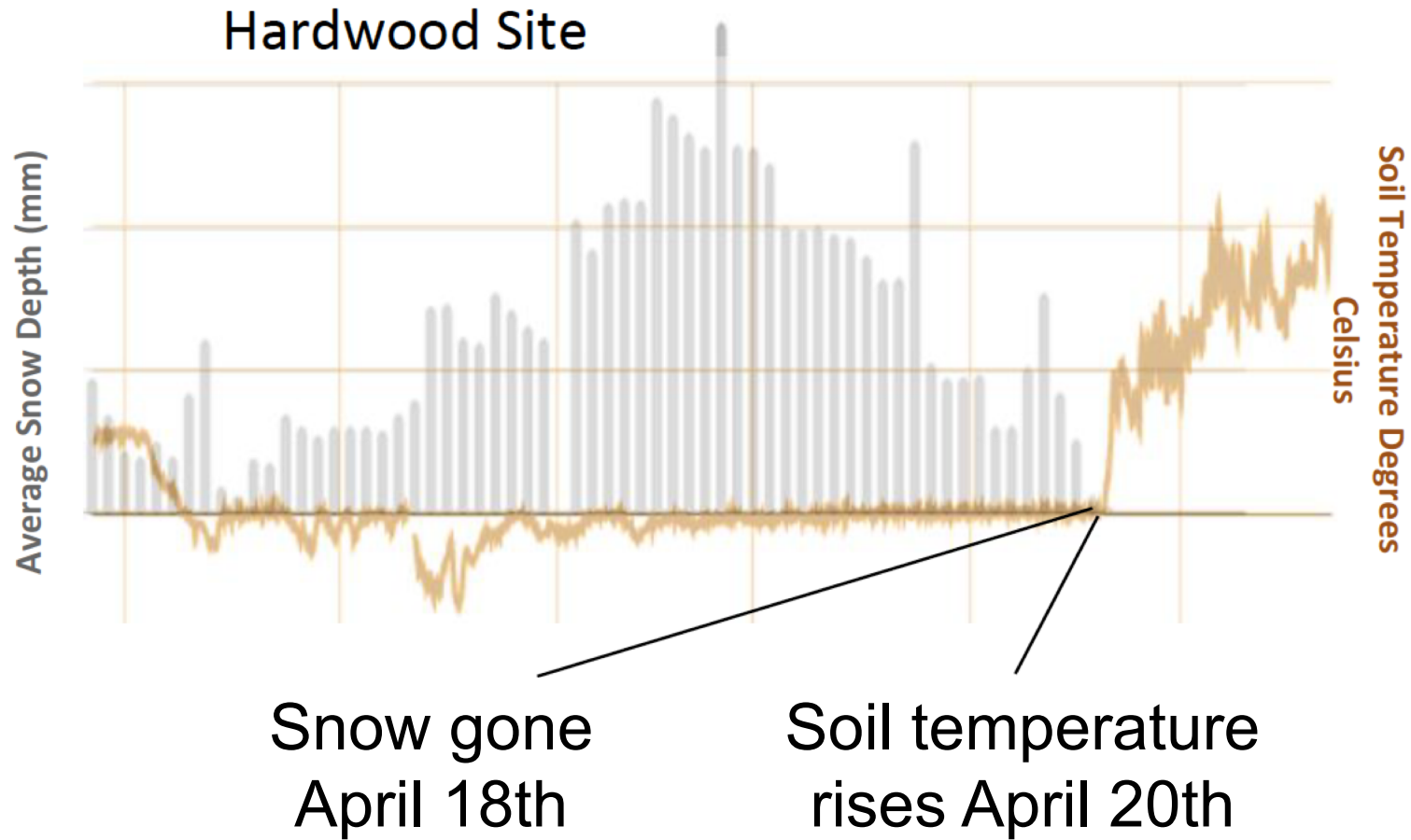
Contributors

Students: Adeline Chabe, Jacob Burns, Bradley Frizzell, Chase Kerr, Emily Nason, Amanda Oertell, Janiya Mitchell Sappell, Zakary Scuderie
Staff: Edward Lindsey, Bryan Murphy, Whyne Craibree

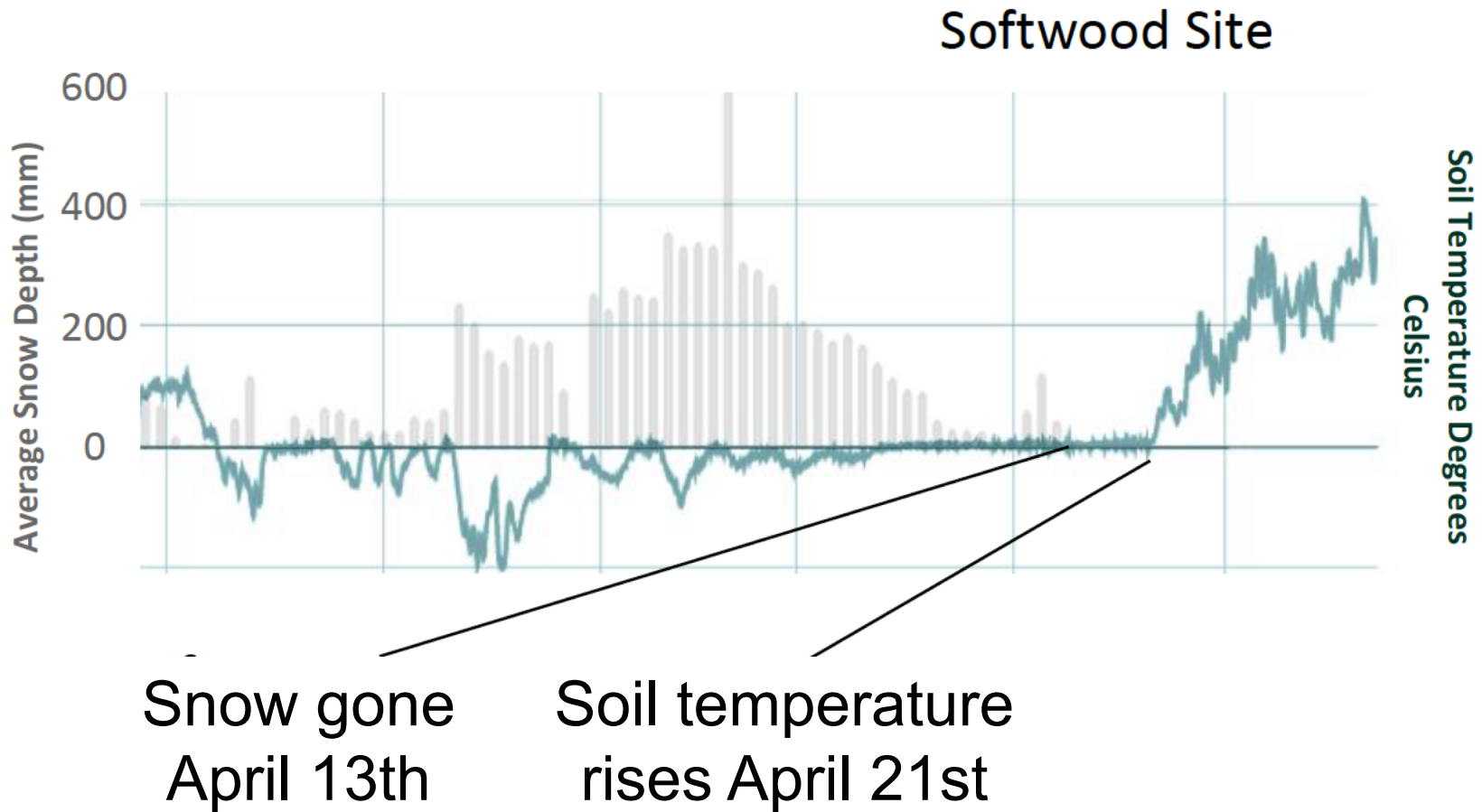
Questioning prevailing theory: an earlier vernal window at hardwood sites?



Groffman et al. 2012



...Or an earlier vernal window at softwood sites?



Constructing explanations: hemlock canopy intercepts snow & needle litter lowers albedo



Softwood Canopy



Hardwood Canopy



- Less snow (~10 cm) accumulates under the softwood canopy
- Needle debris darkens snowpack, accelerating melt.


Bundled GLOBE protocols enhance understanding of processes that link Earth's spheres during the vernal window



“Through the physical intimacy of collecting data, students have learned about snow and snowmelt in two real places in the forest. They have been tuned to seasonality. Through crafting posters, they have learned about some regional consequences of global climate change.”

Ed Lindsey, high school teacher
Old Town High School



Thanks and Questions
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