FACT SHEET 9: VERNAL WINDOWS

New Hampshire's Changing Climate, Land Cover, and Ecosystems

The vernal window is a period that marks the end of winter and the start of the growing season. A series of dramatic transitions occur within this window that affect ecosystem energy, water, nutrient, and carbon flows. Previous studies have shown that many of these transitions are occurring earlier in the year, such that spring arrives sooner than it has historically. Lags between transitions, such as the period between when air temperatures warm to when leaves emerge in the forest canopy, also shift with climate change.

We measured a variety of atmospheric, terrestrial and aquatic variables in 2012, 2013, and 2014 at several sites across NH. This research indicates that warmer winters with reduced snow cover result in a longer vernal window period **(Figure 1).** This lengthening carries ecological, social, and economic consequences.
A longer spring might mean a longer mud season with increased weight restrictions on roads or a shift in the duration of the sugar maple season. Outdoor recreation opportunities might also change with greater periods between ice and open water fishing and between snowmobiling and four-wheeling seasons.

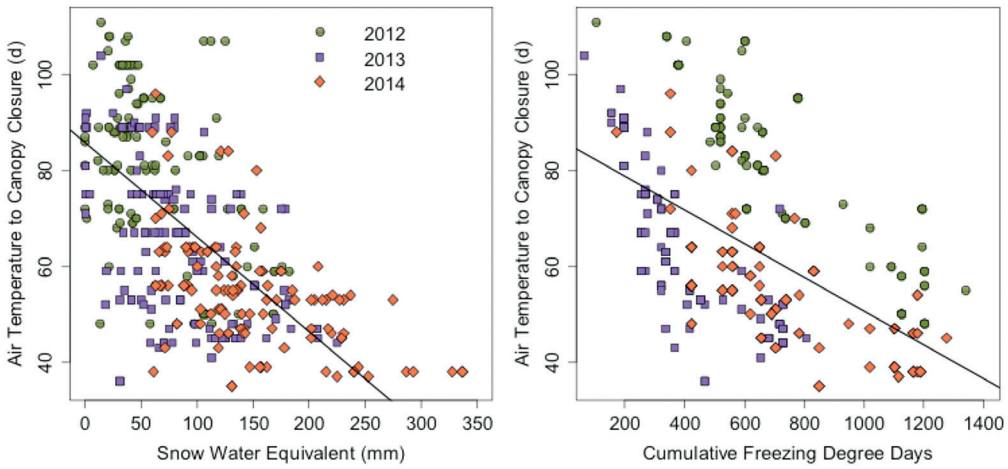


Figure 1. Number of days between air temperature warming and forest canopy closure (vernal window) as a function of winter climate (defined by snow water equivalent and cumulative freezing degree days). Different colors represent different years. The black line is the overall trend and shows shorter lags with deeper snowpacks and colder winters.

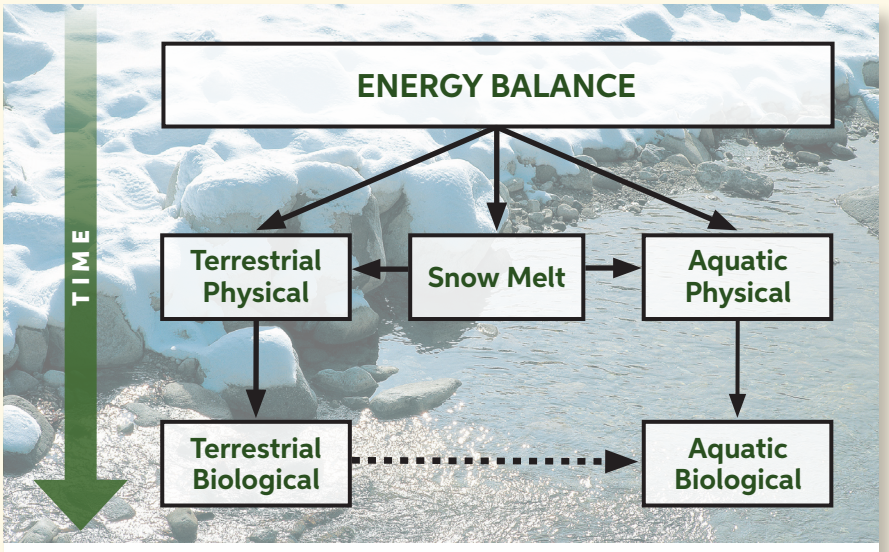


Figure 2. Conceptual model of the vernal window.

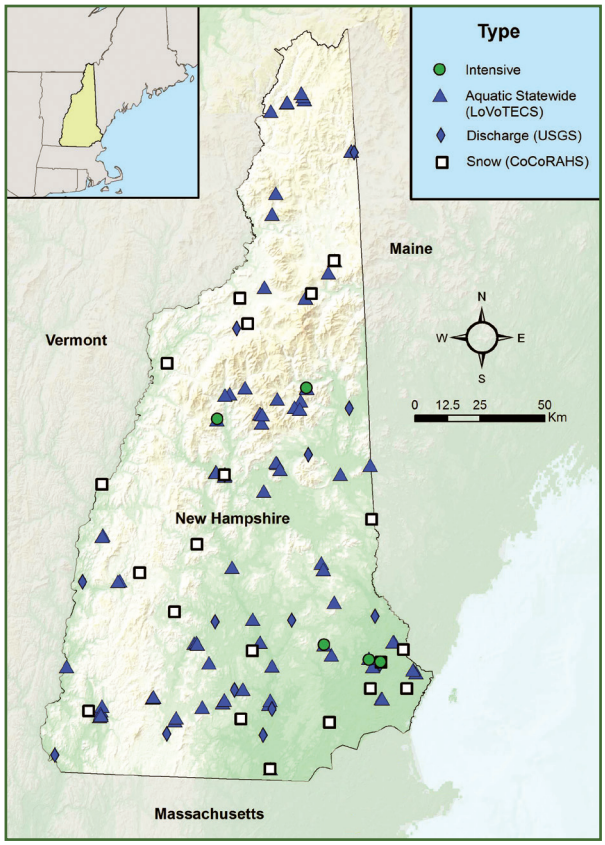
CONCEPTUAL MODEL

Our conceptual model of the vernal window emphasizes the role that winter coldness and snowpack play in driving the duration of the spring season. (**Figure 2**).

This model highlights ecosystem energy balance as the dominant control on the timing of the start of spring, which is heavily influenced by snow depth and winter air temperatures.

DATA SOURCES

The NH EPSCoR statewide sensor network provided much of the data for our analysis of the vernal window period (**Figure 3**). This network consists of citizen science networks such as the Community Collaborative Rain, Albedo, Hail, and Snow (CoCoRAHS) network, the Lotic Volunteer Network for sensing Temperature, Electrical Conductivity, and Stage (LoVoTECS), and coupled climate, soil, and aquatic data at four intensively monitored terrestrial and aquatic sites.



DATA SOURCE	VARIABLE
CoCoRAHS	Air Temperature
	Snow Albedo
	Snow Depth
	Snow Water Equivalent
Terrestrial Intensive	Air Temperature
	Soil Temperature
	Soil Moisture
	Specific Conductance
Aquatic Intensive	Aquatic Temperature
	Discharge
	Specific Conductance
	Nitrate
	Dissolved Organic Matter
	Dissolved Oxygen
LoVoTECS	Aquatic Temperature
	Specific Conductance

Figure 3. The NH EPSCoR statewide sensor network.

REFERENCES

Contosta, AR and others (2015) The Vernal Window Flow Path: a Cascade of Ecological Transitions Delineated at Scales from Points to Pixels. American Geophysical Union Annual Meeting, San Francisco, CA.

Contosta, AR and others (2016) A longer vernal window: the role of winter coldness and snowpack in driving spring transitions and lags. Global Change Biology. doi: 10.1111/gcb.13517

A second companion paper will describe the ecological, social, and economic impacts of a longer vernal window.

ACCESS TO DATA: ddc.unh.edu

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Reports and additional information available at *Climate Solutions New England:* **www.climatesolutionsne.org**

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