1. Introduction

Climate change is expected to have severe negative impacts on the winter tourism industry, as states around the country experience inconsistent snowfall and rising temperatures.

New Hampshire relies on winter tourism. Snow is currency and climate change is expected to contribute to warmer winters, reduced snowfall, and shorter snow seasons. (Burakowski and Magnusson, 2012).

Map shows the measurement locations:
1. First Connecticut Lake
2. Errol
3. York Pond
4. Gorham
5. Bethlehem
6. Mount Washington
7. Pinkham Notch
8. Hubbard Brook (Stations 2 and 17)

Map created using Google My Maps.

Five National Weather Service (NWS) snow monitoring stations from New Hampshire (Mount Washington, Pinkham Notch, First Connecticut, York Pond and Bethlehem) with records spanning at least 60 years through 2015 were tested for changes in snow season and depth.

Average snow depth for three USGS (Errol, Gorham, and Pinkham) and two Hubbard Brook Research Station (Stations 2 and 17) sites were also included for the months of February and March.

2. Methodology

- Parameters examined were first and last days of snow, continuous snow cover, and snowpack depth following the methodology described in Seidel et al. (2009).
- Snow season was defined using the year associated with January (Ex.: the season of 1 July 2014 – 30 June 2015 is winter 2015)
- First and last days of snow. The first variable was calculated using simply the first and last dates during a season that a snowfall, including trace amounts, was reported.
- Start and end of snow pack are the dates after which and before which there was a continuous cover of at least 2.54 cm, allowing a "thaw" period of no more than 4 days.
- Season length was calculated for both start and end of snow pack and first, and last day of snow.
- Sen’s slope and the Mann Kendall non-parametric tests were used to examine trends in snow cover, first and last day of snow and season length.

3. Snowfall and Snow Depth

All snowfall and snow depth trends are shown in Table 1. The stations that showed significant trends are:

- The first day of snow at Mount Washington occurs 4 days/decade later in autumn and the last day of snow occurs 2 days/decade earlier in the spring.
- At Pinkham Notch the last day of snow occurs 1.8 days/decade earlier.
- At First Connecticut Lake the first snow occurs 1.2 days/decade later and the last snow ends 2 days/decade earlier.
- At York Pond the first snow occurs 2 days/decade later, and the last snow ends 3 days/decade earlier.
- At Bethlehem the first snow snow occurs 6 days/decade later, and the last snow ends 3 days/decade earlier.

4. Change in Season

Changes in snowfall season are shown for the 3 sites that had significant trends, Figure 2.

- The first snow starts on average 2.7 days /decade later (Mann-Kendall test, p< 0.1) and it ends 2.3 days /decade sooner.
- Mount Washington lost 6 days/decade from the snowfall season, while First Connecticut lost 3 days/decade and York Pond, 8 days/decade.

5. Snow Depth for the Months of February and March

Errol, Gorham, and Pinkham USGS sites, as well as Hubbard Brook (Station 2 and 17) were tested for change over time in snowpack depth for the months of February and March. Four out of five had a significant decrease (on average 1.34 inches, decade, p<0.05) in snowpack over time, Table 2.

6. Conclusions

Long term snow records from northern New Hampshire show significant trends largely indicating shorter snow cover, shorter overall snow season and less snow depth. This supports concerns that climate change is altering winter in a region that relies on snow.

7. References and Data Sources

8. Acknowledgements

Thanks to the staff of the Mount Washington Observatory for their steadfast efforts in hourly weather observations since 1932.

Contacts: mplopeanu@plymouth.edu and gmurray@outlook.org