



Earth Gauge

A National Environmental Education Foundation Program

Climate and Winter Recreation



Irwin, Colo., 1883. Skiing in the U.S. began as a recreational activity in snowed-in Western mining towns. Image: National Park Service.

Skiing in America: Skiing first became popular in the United States in the latter-half of the 19th century, although it was not until after World War II that ski resorts became common winter tourist destinations. Many of the early facilities were started by members of the 10th Mountain Division, who fought in Italy's mountains near the end of the war. Today, there are hundreds of resorts as part of a ski industry valued at around \$66 billion. About 15.5 million Americans hit the slopes or trails each year, supporting close to 600,000 jobs. One-quarter of these jobs are in Colorado. In New Hampshire, an estimated 12 percent of jobs are related to skiing and the industry accounts for seven percent of the state's economy. In Vermont, skiing generates \$750 million in tax revenue annually. Many mountain areas rely on winter sports as the largest source of income for their economies.

The number of people that participate in skiing has been climbing over the last 30 years. Yet climate trends, such as less snow and shorter snow seasons, are affecting how this industry operates.

Ski Industry and Weather: Whether a ski resort can profitably operate is dependent upon several climatic factors. Resorts must be in operation for a certain number of days per year in order to generate enough revenue to pay for operating costs. In the Northeast between 1990 and 2005, there were about 124 skiing days each year. The number of skiing days is determined primarily by temperature, which determines when precipitation changes from rain to snow. Changes in precipitation levels also have effects on snowpack. The ski industry can adapt to less snowfall through production of artificial snow, but this leads to increased costs for equipment, maintenance, water supplies and energy. In order to produce snow, cold and dry conditions are required. It is possible to manufacture poor quality snow when temperatures are above freezing, but only if humidity is low. Inputs of cold water into the machines are also required; water typically comes from nearby ponds and lakes. Learn more about snow production: http://www.snowathome.com/snowmaking_science.php.

Snowmobiling: In North America, there are close to 2.5 million registered snowmobiles and over 110,000 machines were sold in 2009. Unlike the alpine ski industry, snowmobiling as a recreational activity is almost entirely dependent on natural snowfall, as it is simply not feasible to line snowmobile trails with artificial snow. This makes the snowmobiling industry arguably more vulnerable to climate change than the skiing industry.

Recent Climate Trends Relevant to Winter Recreation

Noticeable climate trends/patterns impact winter recreation in New England and the Western United States.

New England:

- New England's average wintertime temperature has risen by five degrees Fahrenheit since the 1970s.
- Between 1949 and 2000, the annual percentage of precipitation falling as snow declined from 30 percent to 23 percent.
- Since 1950, the average extent of March snow cover has declined by eight percent.
- Between 1926 and 2004, average snowpack in northern New Hampshire/southern Maine decreased by 16 percent. Over this same period, snow density increased by 11 percent due to warmer temperatures and more rain falling on snow. When this occurs, layers of ice can form between layers of snow, or a heavier layer of high water content snow can overlay a less dense layer, increasing the likelihood of avalanches and risk to skiers.
- While there has been no trend in the frequency of Nor'easters – the winter storms that move up the East Coast and bring snowfall to New England – these storms have become slightly more intense and the Gulf Stream waters that ultimately power these storms have become warmer.

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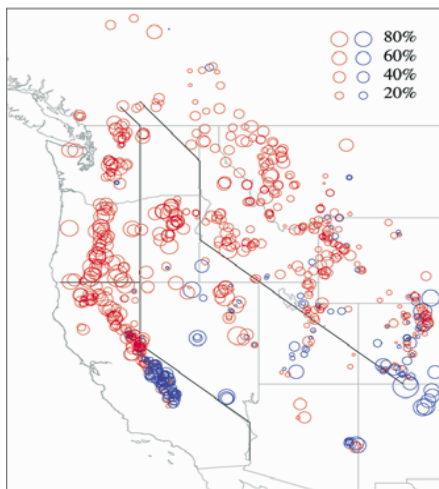


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The West:

- Across the West, there has been an 11 percent decline in overall snowpack over the last 50 years.
- In the Pacific Northwest, average November through March temperatures rose by 4.5 degrees Fahrenheit between 1950 and 1998. This was accompanied by a nine percent decline in March snow cover. The average date when there ceases to be snow on the ground has advanced by 16 days.



1950 – 1997 trends in water content of snowpack for April 1. Red circles indicate negative trends; blue circles positive trends. Image: AMS (Mote, 2004)

- In the Rocky Mountain region over the same period, there was 17 percent decline in average March snow cover. The average date when there ceases to be snow on the ground advanced by four days.

Interannual climate variability also affects snowfall/snowpack in the West:

- Precipitation is reduced throughout the West when the North Atlantic is in a warm phase (it moves between warm and cool phases on periods of 60 years, a cycle known as the Atlantic Multidecadal Oscillation).
- Pacific Ocean sea surface temperatures appear to largely control Pacific Northwest snowpack. Warm phases of the Pacific Decadal Oscillation, which occurred between 1920 and 1945 and from 1977 until a few years ago, correspond to warmer temperatures in the Pacific Northwest and less snowpack.
- The El Niño-Southern Oscillation affects the trajectory of winter storms that move over the Pacific and bring rainfall/snowfall to the West. During warm phases (El Niño), storm tracks shift to the south and the southwest gets more precipitation. During cool (La Niña) phases, storm tracks move to the north and the Pacific Northwest gets more precipitation.

CASE STUDY: New Hampshire

Skiing became popular in New Hampshire in the 1920s and was recently named the state's official sport. New Hampshire's mean temperature warmed by 3.8 degrees Fahrenheit over the 20th century and average annual snowfall fell by about 20 inches between 1950 and the early 2000s. This latter trend largely coincided with a switch from a predominately negative to a predominately positive phase of the North Atlantic Oscillation (NAO), the index based on pressure differences between Atlantic high and low pressure centers. Positive NAO phases help block cold arctic air from reaching the region, keeping winters relatively wet and mild. The state has a variety of climate regimes, spanning elevations from sea level up to 6,288 feet (Mt. Washington). This heterogeneity helps to make the impacts of climate change on the ski industry plainly visible, as it allows for comparisons to be made amongst resorts of similar size and history that are located in different microclimates.



Above: Skiers on New Hampshire's Cannon Mountain. Image: State of New Hampshire.

From 1950 to the 1970s, when winters were cold and snowfall was steadier than it is today, downhill ski areas flourished across all parts of the state, even in relatively low elevation areas near the coast. The number of both small operations and bigger chairlift-based operations expanded until the early 1970s, when the NAO began its shift to a predominately positive phase and winters warmed. Beginning in 1970s, the number of smaller operations plummeted while the number of larger operations declined at a less rapid rate. While the general social trend of industry consolidation was a significant factor behind the decline in small operations and the merging of a number of larger operations, these declines occurred during a period of sustained warming. Operations of all scales positioned at lower elevations and in the more southerly parts of the state went out of business more readily than those situated in higher elevation locations. Today, the majority of ski areas are located in the state's northern mountains and almost all of these operations use chair lifts and manufacture snow. The additional capital required for chair lifts and snow manufacturing, coupled with the longer distances these resorts are from the regional population centers, have likely contributed to ski trips being relatively more expensive today than they were in the 1950s and 1960s.

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