Skiing Without Snow:
An Analysis of Climate Change and the Consequences for the Ski Industry in New Hampshire and Vermont

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Abstract:

The purpose of this study is to determine trends in climate variability in New Hampshire and Vermont and link these changes to ski industry performance. The impact of a consistent deterioration in winter weather has the potential to cause significant economic and lifestyle consequences in regions of the country and world that are heavily reliant on tourism and skiing in particular. State governments, ski resort areas and individual residents have a vested interest in the relationship between climate and tourism. This idea is supported by much of the recent work on this topic in North America including the work of Wall (2001) in Canada and Bloomfield and Hamburg (1997) in New England. Although a number of the climatic characteristics including temperature, snow fall in the winter months and lake ice information demonstrated a warming trend over the past 50+ years, poor correlation regarding snow pack and early season snowfall makes final conclusions uncertain. The analysis of ski area performance as measured by the number of skier days determined a statistically significant difference (P=0.02794) between the best snow years and the worst snow year. This important piece of information signals that economic viability in this industry is vulnerable to any warming or reduction in season length and is inexorably linked to the climate. This evidence also makes it clear that the United States is not impervious to the consequences of climate change. Recommendations to remedy this predicament include more proactive involvement from interested parties in the policy decisions surrounding production and emission of greenhouse gases at both the state, national and international level. In addition, coping strategies should be implemented to minimise the immediate risks of any shift in the climate. Management decisions to reduce this effect involve a combination of increased snowmaking, intensified use of the ski season, better utilisation of the resort in a year-round capacity and the purchase of geographically varied resorts. These strategies should be employed with particular attention to community, environmental and resort specific needs and concerns.

Disclaimer:

"Except otherwise stated and acknowledged I certify that this Dissertation is my sole and unaided work."

Signed:___________________________ Date:_________

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1. ***Introduction and Objectives:***

Due to New England's reliance on tourism, specifically the ski industry, the region's economy is vulnerable to alterations in weather patterns that would affect economic earnings while dramatically altering lifestyles and traditional ways of life. Employment, tax revenue, business and resort success and expansion in the New England region are all intricately connected with the continued prosperity of the ski resorts. Potential changes and losses in this economic sector would have significant consequences for the states involved, ski industry and residents of these states.

The objective of this research is:

-to examine the historical patterns for six specific climate characteristics to determine the presence of any significant climate change that may exist outside of normal variability.

-to analyse trends in the ski industry for the period of record available.

-to establish the effects that annual weather has upon a specific indicator of ski area performance, the number of skier days.

-to discuss and propose possible coping strategies that may minimize the impacts of climate change on the ski industry in New Hampshire and Vermont.

This investigation requires analysis of both historical climate records for the region and recent trends in ski area performance and activity. Integration of these two sets of data lends insight into how ski areas perform under different climatic conditions. Appropriate proactive responses from the interested parties will be examined in the area of greenhouse gas policy position and emissions regulation standards. These actions are imperative to ensure a stable and sustainable future for the people who rely on this industry for livelihood.

The paper has been divided into seven chapters that consider individual aspects of this issue and the manner in which it was researched. Chapter 2 provides a foundation of knowledge for the area of study and an explanation of climate trends in the region. Chapter 3 provides an introduction to the ski industry in New England from its inception to more recent developments. The fourth chapter describes the related research on tourism and winter recreation and its relation to the climate, specifically, winter conditions. Chapter 5 outlines the procedures utilised in this dissertation while defining the data sources and reasons for their choice. Chapter 6 goes on to present the data for each aspect of the research while providing an analysis of the result, specific data bias, and further topics to study. Chapter 7 provides conclusions about the entire set of results and presents strategies for interested and affected parties.

2. ***Background Information on New England:***

2.1. *Introduction to Location.*

Located in the northeast corner of the United States, the “New England” designation includes six states. Maine, New Hampshire and Vermont are the three northern-most states while Connecticut, Massachusetts and Rhode Island make up the southern half of the area. New York State lies to the area’s west while Canada and its province of Quebec share a common border to the north. The Atlantic Ocean is found to the east and south of this maritime influenced region.

Figure 1: New England Identification

Temperate, hard and softwood forest covers a rugged topography that is comprised of a number of small mountain ranges. Lake systems, another characteristic of New England, are found throughout interior portions while beaches and coastal habitats define parts of all states except for Vermont. A traditional set of four seasons lends a variety of weather to this part of the country. Summers in the Northern Hemisphere coincide with the earth being at its furthest orbital distance but simultaneously being tilted towards the sun.

Winters display the opposite characteristics as the sun's angle of incidence is at its lowest on December twenty-first.

The states of New Hampshire and Vermont that have been chosen for the purposes of this study are located in the northern half of New England. Vermont's 9,609 square miles lies on the western edge of this designated region while New Hampshire's 9,279 acres lies to the east of Vermont (www.vtchamber.com, 2001). The Connecticut River provides the boundary between the two states before flowing south into Massachusetts and Connecticut. New Hampshire claims the White Mountains with Mount Washington as its peak elevation of 6284 feet (Monahan, 1933). Vermont's motto "The Green Mountain State" describes the similar uneven range in the western half of the adjacent state. Vermont's highest point, Mount Mansfield reaches an elevation of 4,393 feet (www.vtchamber.com, 2001).

2.2. *New England's Variable Climate:*

Weather describes what is happening in the atmosphere at a given time while climate determines what is predicted to occur according to a known set of circumstances such as time of year and geographic location (Burroughs, 2001). This prediction is based on an average of a number of years of data and includes the possibility of extreme events. A climatic change requires a shift in the meteorological conditions lasting for a few years or longer. In discussions surrounding this issue, it is important to distinguish between climate change and climate variability. Climate variability concerns the variability that exists on an annual or daily basis and consequently may or may not accompany a shift in the climatic mean (Burroughs, 2001).

A climatic description of New England often includes the word "variable." In a speech given at the New England Society's 71st Annual Dinner in New York City, Mark Twain once described a typical New England weather forecast:

> Probably northeast to southwest winds, varying to the southward and westward and eastward and all points between, high and low barometer swapping around from place to place; probable areas of rain, snow, hail and drought succeeded or preceded by earthquakes, with thunder and lightning—But it is possible that the programme may be wholly changed in the mean time.
>
> •Mark Twain, December 22, 1876

One reason for this inconsistent climate is that no single pattern controls the weather regime in the Northeast section of the United States (www.uvm.edu/~ldupigny/sc/climate-vermont.html, 2001; Keim, 1998). Another complicating factor is that New England lies at the confluence of a number of major storm tracks. Air masses from the arctic tundra, the desert Southwest, the Gulf of Mexico and sub-polar seas can converge on the region (Ludlum, 1976). Recent focus on climate change demands that historical records be examined to determine patterns that may be present or occurring at present day. Unfortunately, applied analysis for the New England region with its high degree of variability makes it difficult to discern any historical changes or predict any modifications over the long-term.

Global and regional circulation patterns have had a long recognised and significant impact on weather in the United States and specifically the northeast section of the United States. The warm and cold phases of the well-known El Niño demonstrate shifts in snowfall patterns specifically throughout the continent (Smith, 2001;

www.usatoday.com/weather/news/2001/2001-05-31-elnino.htm, 2001). As a consequence the New England region typically receives less snowfall during the cold phase while more snow falls in the Northwest and Colorado during this same period (Smith, 2001; www.usatoday.comweather/news/2001/2001-05-31-elnino.htm, 2001). The North Atlantic Oscillation (NAO) is another key component of the larger, global circulation patterns that aid in describing and predicting weather in New England (Whiteman, 2000). The NAO index describes the air pressure gradient between the low found over Greenland and Iceland and the comparable high pressure located near the Azores and Bermuda at lower latitudes. The weather on both sides of the Atlantic is affected by changes in the strength of the gradient. A positive index (determined by an abnormally low pressure in the north and a higher than average pressure in the south) will result in stronger westerlies consequently impacting the west-to-east movement of storm systems.

First discovered in the 18th century, the North Atlantic Oscillation has been associated with persistent weather patterns in Greenland, North America and Europe as well as changes in arctic sea ice (Burroughs, 2001; Lamb, 1987; Hurrell, 1995; Whiteman, 2000). The NAO has been of particular interest to climatologists in research related to winter weather as there are solid observational records that demonstrate consistency between positive and negative indexes and the snow that falls in those phases (Hartley, 1998; Bronsal, 2001). Specifically, snow cover in Southern Ontario and the Eastern United States shows a strong correlation with cycles of the NAO (Brown, 1996; Hartley, 1998). Higuchi (2000), also found similar relations with winter weather (not necessarily snow cover) in the Northeast corner of the North American continent. A strong association with winter conditions also exists in the Austrian Alps (Schoner, 2000). Climatologists are able to make reasonable predictions of upcoming winters through examination of the index in association with other global influences. Not only is snow a consequence of larger circulation patterns; it may also be determinant in affecting changes back onto existing patterns (Shukla, 1993). Snow-cover influences micro-climatic variables such as albedo, temperature and wind currents in a manner that has a strong impact on local weather. Since snow impacts surface temperatures by as much as 4.5º C per day through cooling and albedo alterations, it is thought that these changes may in turn cause changes in regional circulation patterns (Shukla, 1993).

In addition to influences from the NAO, New England weather is affected significantly by four other components (Keim, 1998; Keim, 2001). Since the region lies at approximately 45 degrees N latitude, it is at the halfway point between the equator and the North Pole. As a consequence, it is located at the critical juncture between the cold, dry, polar easterlies and the warm, moist, equatorial westerlies. The fronts denoted by these boundaries may shift by small amounts and dramatically alter the weather in New England. In general, the front, often defined by the jet stream, lies to the south of New England in the winter and to the north of the region in the summer allowing temperatures to fluctuate widely between seasons. The record high temperature in summer for the region is 107º F. This is higher than the record for Miami, FL or Atlanta, GA. The record low of –50º F is lower than that in Anchorage, AK or in International Falls, MN (Keim, 1998; www.uvm.edu/~ldupigny/sc/climate-vermont.html, 2000; Keim, 2001).

The maritime influence in New England is the next dramatic control on weather in the region. The high heat capacity of water in the Atlantic Ocean serves to moderate summer and winter temperatures making summers cooler and winters warmer (Whiteman, 2000). The effect is reduced with increasing distance from the ocean and also depends upon location on the New England coastline. Coastal location is critical since the warm Gulf Stream flows from the south while cooler water flows south from Newfoundland and Greenland. As a consequence, sea surface temperatures create more moderating results for the south-facing coasts of Connecticut, Rhode Island and southern Massachusetts and less of an effect for east-facing portions of Maine, New Hampshire and eastern Massachusetts.

The third component of New England weather is derived from the region's location on the larger continent of North America. Because it is located on the east coast, the jet stream dictates that airflow is dominated by a dry, west to east, continental movement, unlike the moist, ocean climates found at similar latitudes on the west coast. Although most storms approach from the west, some of the heaviest and most significant rain and snow events are a consequence of "nor'easters" (Keim, 2001, Rock, 2001). These storms originate in the moisture and energy rich Gulf of Mexico or Southeast coast of the United States. Tracking on an aptly determined northeast track, the storm centers pull moisture from the ocean while drawing cold air from the north. Significant rain and snowfall combined with high winds and ocean surges result from these storms.

The fourth characteristic of weather in New England is a result of the mountainous topography found primarily in the western and northern parts of the area. Particular climatic events are unique to areas with this sort of land feature. Since pressure decreases with elevation and fewer green house gases occur at higher altitudes, cooler temperatures are usually found at on the summit areas. Although the exact formula changes with geographic and global location, temperature usually decreases 3.5º F with every 1000 feet (Whiteman, 2000; Barry, 1992). Another event affecting local climate in areas of rugged terrain results from air masses converging on elevated land areas. This orographic effect results from rising and condensing air that enhances rainfall on the windward side while creating a rain shadow effect on the leeward side. The measuring and observation of trends in long-term climatic conditions are made difficult in these regions for the same reasons that makes them popular destinations for recreation. The rugged, remote access often associated with these regions has resulted in very few recording stations with significant data. Better information often comes from the valley bottoms that are more likely monitored by such meteorological sites (Barry, 1992; Beniston, 1994). Compounding the lack of data in mountain regions are problems that are common to most data collected over a historical period. These include changes in instrumentation or monitoring techniques over the duration of observation.

2.3. *General Trends and Historical Patterns:*

Generalisations in weather patterns for New England must be recognised as insufficient in predicting daily and long-term trends since even over small geographic space within the region, considerable differences may be observed. These differences can result from elevation changes, terrain variation and distance from large bodies of water such as Lake Champlain and the Atlantic Ocean (www.uvm.edu/~ldupigny/sc/climate-vermont.html, 2001). For example, the growing season in Northern Vermont and New Hampshire is often less than 100 days while it is more than 150 days in parts of northern Massachusetts, southern New Hampshire and the southern Connecticut River valley (www.fairbanksmuseum.com/htm/weather_roundhere.shtml, 2001). Once these variations are considered, it is important to obtain a baseline of climatic conditions for the region.

The temperate conditions for the region result in a moderate average of 44º F (Keim, 1998). Areas in the north may average more than 10 degrees cooler than sections in the south. Mount Washington, the highest point in New England, demonstrates the effects of both elevation and location as it averages only 26º F (Whiteman, 2000). Since total wet precipitation contributes nearly 50 inches per annum in the southern states and 35 inches in Northern Vermont and New Hampshire, the area is not considered water limited (Keim, 1998). Despite the significant precipitation, periods of drought do occur and may impact the growing season. Snowfall is considered a highly variable entity in the region with the exception of consistent 55-65 inch totals in the lower Connecticut River Valley (www.uvm.edu/~ldupigny/sc/climate-vermont.html, 2001; Keim, 2001; Hartley, 1998). Regions in the White and Green Mountains and northern Adirondack Range receive totals of greater than 100 inches per year (Keim, 2001). Totals above 200 inches are common above elevations of 2000 feet (www.fairbanksmuseum.com/htm/weather_roundhere.shtml, 2001). These amounts are impacted dramatically by single event “nor’easters” or blizzards as evidenced by the 77 inches that fell in Pinkham Notch, NH from February 22-28, 1969 (Keim, 2001; www.fairbanksmuseum.com/htm/weather_roundhere.shtml, 2001). Other extreme events including ice storms (1998-notable regional damage), tornadoes (1953-Worcester, killed 90 and caused $52 million in damage), hurricanes (1938-Great New England Hurricane) and blizzards (1977-notable) frequent the region and add to the variability and rapid changes that New England is known for (Ludlum, 1976). Since climate is defined as the “average of a series of weather events,” (Burroughs, 2001) the events and the inter-daily and inter-annual variability that describe New England weather, make it difficult to assess climate change.

3. ***Skiing in New England***

3.1. *The History of New England Skiing:*

The history of skiing in New England is significant when compared to many modern-day sports. Scandinavian immigrants first introduced the concept to the area in the late part of the 1800's (Ski NH, 1993). Dartmouth College's Outing Club, founded in 1909 helped to engender and develop the sport's popularity which in turn led to the opening of other clubs and some of the region's first ski areas (www.skimuseum.org, 2001). Snow trains run by the Boston and Maine Railroad increased the sport's accessibility and allowed skiers to return to developing resort areas year after year. A support network of lodging facilities and restaurants began to associate themselves with particular areas and helped to further increase the popularity. Since the first trail on Cannon Mountain in New Hampshire in 1933 and the first downhill slalom race in 1934, the industry's economic and cultural importance has grown (www.skimuseum.com, 2001). Not only does it provide a key magnet to attract and maintain the younger sector of the population, it also creates an important outdoor activity for the long months between the summers (Figure 2). Today, Vermont claims 18 areas with 984 trails and 5,175 skiable acres that are covered by 67% snowmaking (http://nature.snr.uvm.edu, 2001). As New Hampshire's Official State Sport, the alpine industry is comprised of 19 areas claiming 89% snowmaking coverage on 2,676 acres (Ski NH Report, 2001).

Figure 2: Skiing at Cannon Mountain, NH

3.2. *Recent Changes and Modern Developments:*

The New England Ski Museum and the New England Lost Ski Areas Project record ski industry changes in New England. Specific patterns have evolved as the industry has continued to develop and expand in an ever more competitive market. The idea that skiing is no longer recreation and is indeed a business has helped to change the requirements of the areas and the demands of the skiers. An intensification of the season is a strategy that has been developed in an attempt to gain more from each day the resorts are open. This approach results in more lifts, wider trails, more frequent and thorough grooming and night lighting to allow for a longer ski day. These improvements are often accompanied by better amenities in the form of better lodging and restaurant services. This sort of expansion requires a return on the investment and as a result advertising is more rigorous both on and off the Internet. A specific form of the technological advance in this area is the high-speed-detachable quad, first introduced in 1987. This advance allows for more customers to ski more runs each day. At a cost of nearly $300 per chair, this demonstrates the increasing necessary capital required for successful resort performance (Davis, 1998).

Snowmaking improvements and expansion describe another trend that has recently added to the significant capital expenditures within the ski industry in New England. As the ski industry continued to evolve, snowmaking was first utilised in the late 1950’s to help cope with the inconsistent winters (Davis, 1998, www.skimuseum.org, 2001). The more consistent snow conditions provided by this technology enables resorts to guarantee snow even for early season holidays (Wall, 2001; Bloomfield, 1997). Unfortunately this technology has its own constraints due to the expense of the equipment and running costs that consume large quantities of water, electricity and/or diesel. Attitash, a ski resort in New Hampshire, spends about $750,000 per year on snow making which accounts for approximately 20% of their operating costs (Bloomfield, 1997). Despite establishing the ability to produce snow in a larger temperature window, snow making still has climatic constraints that must be considered, making it impracticable outside of specific ranges (Wall, 2001). Even with such constraints, its benefits are recognised widely within the industry. Between 1984 and 2000, 15 areas in New Hampshire saw an increase in the number of acres covered by snowmaking from 1,093 to 2,382 and the percent of trails covered by snowmaking increased from 71.4% to 89% (Goss,2001: Ski NH, 2001). The cost of snowmaking enhancement for these areas from 1990-2000 was $24.2 million (Ski NH, 2001). The coverage of snowmaking in Vermont also increased from 53% to 67% between 1988 and 2001 (Skivermont.com reports).

These changes in the industry mean tremendous initial expenditures as competition for customers increase. As an example of these cost outlays, Attitash has spent $32 million since 1995, the Dartmouth Skiway built a 1,600 square foot base lodge in 2000, Sunapee invested $11 million over the past three seasons and finally the American Skiing Company spent $28 million on snowmaking and new lifts at Sugarbush during the 1995-1996 season (Davis, 1998; Winter Guide, 2001). In addition to this attempt to intensify winter season usage, a trend of the 1990's shows that resorts are marketing themselves more and more as year-round attractions. The recreational resort destination combines skiing with summer and fall activities such as golf, alpine slides, hiking, mountain biking and water recreation. Some areas have even gone as far as to eliminate the word "ski" from their resort name (Wall, 2001). Another separate trend in the mid and late 1990's saw larger ski resort conglomerates buying a number of local resorts. Companies such as Intrawest and the American Skiing Company now own areas in Canada and on both coasts of the United States (Binkley, 2001; Davis, 1998). Interestingly, this management strategy has inadvertently served to dilute the economic consequences of a bad winter in one region of the country.

The intensive on-mountain improvements and increased money spent on marketing has been particularly rigorous in the ski industry because the number of participants peaked in the 1960's and has remained relatively level nationwide at approximately 50 million skier visits each year (Binkley, 2001; Davis 1998). Snowboarding's recent surge in popularity has helped to boost what could have even been a decline in total visits over the past 20 years. In fact, snowboarding has a higher percentage of participation than alpine skiing for ages 7-24 (www.snowlink.com, 2001). Despite the increased competition for participants, the cost of skiing has increased dramatically, particularly since the 1980's. Daily lift tickets at some areas are nearing $70 per person at some resorts (Binkley, 2001). Equipment necessary for the sport is also expensive. Packages including skis, boots, binding and poles range from $300-$1,500 depending on the needs and desires of the individuals (http://shopping.yahoo.com, 2001). In addition to these core items, necessary ski clothing also includes jackets, ski pants, gloves, hat and goggles. Travel, lodging and eating requirements incur more expenses that when totaled; combine for a significant monetary fee. These high costs may have significant impact on participant decisions to either enter the sport for the first time or go for a simple weekend trip especially if the snow conditions are uncertain.

Figure 3: Vermont Ski |Areas and Location in the State

(www.newengland skiresorts.com/statemap.cfm/VT.htm, 2001)

Figure 4: New Hampshire Ski Areas and Location in the State

(www.newengland skiresorts.com/statemap.cfm/NH.htm, 2001)

4. ***Related Research***

4.1. *Cold Weather and Mountain Research:*

Snowfall history, specifically changes in snow depth, glaciation and snow pack season length have been researched in many parts of the world including the European and Australian Alps, Scotland, North America and New Zealand. The high elevation stations located in the Austrian Alps display some of the best geographically specific, long-term records with important information on coinciding glacial movement (Barry, 1992; Beniston, 1994). At these stations, significant warming during the winter months has been observed (Beniston, 1994). The recording station at Sonnblick, Austria (altitude 3,106 m), averaged 82 days of snow from 1910-1925 and only 53 days for the period of time between 1955-1970 (Beniston, 1994). The Hubbard Brook Experimental Forest, in

New Hampshire, recorded a number of low snow years in the 1980's and 1990's and predicted that another 2º C increase in temperature would dramatically impact the depth and duration of the snow pack (Federer, 2001). Another study in North American detected two decades of decreasing snow cover in the winter months of December through February (Karl, 1993). As with much of this type of research, certain limitations must be considered. Harrison et al. (1999) discovered tremendous regional variation even over small scales when analysing climate variability in the Scottish highlands. In addition, many of the recording sites only measured information at lower elevations. Those that did measure snowfall and snow pack were found to have had a lack of consistent methodology from year to year (Harrison, 1999; www.scotland/gov.uk/cru/kd01/lightgreen/ccsnow.htm, 2001).

Similar studies examining climate change impacts on snow cover include methodologies that use modeling to predict future scenarios in the Australian Alps. Using input from five Global Climate Models in conjunction with historical data, predictions for 2030 and 2070 demonstrated declines of up to 50% snow cover for sites above 1700 m by 2030 and near 100% losses by 2070, while sites at lower elevations responded with even greater sensitivity (Whetton, 1996). Another study by Bultot (1994) in the Broye Catchment area in Switzerland showed similar responses for low altitude areas. Even under moderate climate change scenarios, the first and last month of the snow season were affected so dramatically that sport resorts below 1500 meters could expect economically difficult conditions (Bultot, 1994). Beniston (1998) also noted marked impacts at lower altitudes in Europe.

4.2. *Climate and Tourism Research:*

Tourism and associated economic gains and losses provide a lens through which climate change and climate variability may be examined. Despite this perceived need, more attention should be given to outdoor recreation in its relation to climate change. A 900-page report by the National Academy of Sciences included only two pages that were dedicated to the potential problem (Mendelsohn, 1999). In a seeming contradiction to this realisation, the report went on to note "outdoor recreation is more sensitive to climate change than any other sector of the economy due to recreation's close link to natural resources" (Mendelsohn, 1999). Tourism is influenced by climate through two different mechanisms. Changes in precipitation and temperature will directly impact the participant's desire and marginal utility while it will indirectly affect the demand through alterations in quantity and quality of the natural resource to be used (Mendelsohn, 1999). Applying these designations, the choices surrounding skiing opportunities will be affected by changes in skier enjoyment due to changes in climate as well as alterations in the amount of snow that will impact variables such as the length of season.

Since specific activities will become economically impractical while others will benefit from increases in temperature, predicted changes in the New England region "will fundamentally change both the character and quality of life" (Rock, 2001). Although warmer days may increase demand for activities such as beach recreation and hiking, similar changes would shorten the length of the ski season. New England's year-round tourism industry demonstrated the responsiveness of the tourist between the 1999 and 2000 summer seasons. New Hampshire's outdoor summer revenue fell by 10% between the warm, dry summer of 1999 and the cool, wet summer of 2000 (Goss, 2001). During the same period of time, revenue from indoor activities grew by 25% (Goss, 2001). The case of climatic impact on the tourism industry is not so narrow as to simply include changes in temperature and precipitation. In Sri Lanka, the Maldives, Australia and the Seychelles high water temperatures resulting from ocean circulation alterations can cause significant coral bleaching and mortality which will in turn adversely alter the number of visitors (Wilkenson, 1996). Another indirectly impacted industry is that one that benefits from the fall foliage visits that take place each autumn in New England. This sector shows 3-5% increases in "spectacular" years (Goss, 2001). The IPCC remarked that North America's coastal and mountain tourism industry could be affected by "decreased snow cover and duration" (McCarthy, 2001). The report went on to admit that future changes would have uncertain impacts on recreational opportunities (McCarthy, 2001). While recognising each of these various impacts, a focus on specific geographic vulnerability indicates that the impending threat of changes in climate is of particular importance in those regions that dedicate a higher proportion of their work force to the tourism and service industries (Wall, 2001).

In the example of a region specific study, researchers examined the Scottish tourist industry and how the impact of climate alterations would threaten the industry's financial viability and affect the amount of visitor activity. The observed and predicted warmer, drier winters with subsequent lower snowfall and frost days saw a 10% decline in the number of days that ski lifts were open since 1962 (Harrison, 1999). The Scottish Executive Report also noted a marked decrease in snow cover since the 1970's. The authors used the 1991-1992 ski season to demonstrate the impacts on a larger economic scale as they found that the industry realised only 20% of what is economically viable for continued sustainable function. The European Alps saw a decrease of 54% in the number of over-night stays during the past 20 years with an associated decrease in the number of skier days (Beniston, 1994). Beniston (1994) goes on to argue that a “100 day rule” demands a requisite 100 days of operation in order for the ski industry to see profits. Those areas operating for fewer days saw lost revenue and were forced to operate at a loss in the years of the study. Some impacts of climate change may bring about greater opportunities for recreation and consequent tourism. In the normally cold and wet Scotland, climate change produced warmer and drier summers would allow more opportunities for outdoor activities (Harrison, 1999). A paper by Najjar et al. (2000) recognises warmer, longer summers in Delaware and other mid-Atlantic states could mean increases in tourism related to beach and boating activities.

Due to the revenue generated and jobs created from recreational opportunities in mountain regions, its particular sensitivity to climate change is critical to understand (Parish, 1998). Fitzharris, et al. (1997) recognises that the tourism industry’s reliance on snow and glaciers in mountain regions of New Zealand make the economy at risk especially because of the high level of sensitivity in the input/output systems of glacial formation. In Canada, it is predicted that the number of suitable skiing days will decrease by 40-70% as a consequence of the benchmark double of CO2 predicted by the 1990 IPCC report (Cline, 1992). This alteration in the industry would result in a loss of nearly $1.7 billion based on the 1988 skier visit numbers (Cline, 1992). In another project on

Quebec's ski industry, Lamothe and Périard (1998) predicted that with a 4-5º C increase in temperature the region would see a 50-70% loss in ski days.

Since many outdoor activities are site specific or dependent upon a small subset of particular topographical or geographic features, any alteration in climate for those areas will not necessarily see a concurrent shift to other equally viable regions. This is especially true of the skiing industry in New England's mountainous terrain. The concept of site-specific recreational activities is examined by Morey (1981) in a review of the ski industry. Increases in snowfall often see strong increases on the intermediate and novice skiers (Morey, 1981). The case of desire is not simple. It is based on a number of other determining factors including ability, familiarity with the resort, physical characteristics specific to the resort, and resort attributes such as lift capacity and lodging. Mountain resort accessibility and skiing popularity as an outdoor activity is dependent upon numerous variables. Wall (2001) describes the ability to travel to a resort as a significant determining aspect that may contradict the idea that more snow brings about more skiers. In fact, he argues that more snow may limit road access to the resort making the initial journey impossible. Not only is the form of precipitation (i.e. snow, rain, and ice) important at the resort, it is also important on the travel routes.

Another complicating factor in determining the consequence of a shift in climatic conditions involves the restricted time period or the length of season that is critical in determining the success or failure of the industry (Wall, 2001; Bloomfield, 1997; Beniston, 1994). The most crucial time periods for the ski industry are holidays and weekends. The December break accounts for a significant amount of total revenue with this 10-day period earning 20-30% of seasonal sales (Wall, 2001). Because there is a limited number of weekends and holidays from December through February the areas must have sufficient snow on the ground for a maximum number of these time periods. Wall (2001) goes on to predict that Canada's ski areas will have shorter winter recreation seasons in coming years and that although they may be able to withstand a single bad season, a number of them in close proximity, may be detrimental. The warm season in 1979 in Ontario saw the industry claim losses of 40%, or up to $10 million compared to average seasonal sales (Wall, 2001; Bloomfield, 1997). The American Skiing Company claimed $400 million in debt after the first quarter of 2001 with losses of over $52 million suffered during the poor winter of 1999-2000 (Golden, 2001). Perhaps even more interesting, the company realised losses of $32 million in the first quarter of 2001 despite a big snow year in the East (www.eagletribune.com/news/stories/20010329/Bu_002.htm, 2001). In order to restructure their debt, the company has recently decided to sell Steamboat (one of their resort holdings in Colorado) and cut 70 jobs (www.eagletribune.com/news/stories/20010329/Bu_002.htm, 2001).

The ski industry's interest in environmental issues has been increasing in recent years as it realises the intricate ties between economic success and the climate. This point is evidenced by the issuance of the Sustainable Slopes Charter that was created by the National Ski Areas Association in 1999 and 2000 and has been endorsed by 10 resorts in New Hampshire and 8 in Vermont. This charter recognises the environment as "their number one asset" and commits to good environmental stewardship (www.nsaa.org, 2001). In an effort to work towards this end, the charter outlines resort practices that would demonstrate the sound use of water and energy. Reductions are also suggested in the area of waste management. Specifically citing the issue of climate change and the industry's reliance on weather, the NSAA commits to "reducing its own emissions of greenhouse gases and educating its customers and other stakeholders about this issue" (www.nsaa.org, 2001). The report goes on to add that "The ski industry has an opportunity to be leaders among the outdoor recreation providers and all other businesses in promoting environmental awareness and striving to be a model of sustainable development" (www.nsaa.org, 2001).

4.3. *Tourism and Skiing in New England:*

On an international scale, tourism is only exceeded by oil in the magnitude of its contribution to world trade. It is predicted to be the largest industry in the world in the 21st century (Wall, 2001). In the United States alone, over nine billion visitor days are recorded each year (Mendelsohn, 1999). Based on the topography and climate of the New England region, an economy reliant on tourism has developed to take advantage of the recreational opportunities provided by the four distinct seasons. The diurnal variations in spring temperature provide unique opportunities for maple sugaring while the warm summers allow for boating, hiking, camping and swimming. As days become shorter and temperatures dip, a blend of various, deciduous hardwood vegetation with coniferous softwood provide for a foliage-viewing season that brings visitors from around the world. From the earliest days of skiing at associated outing clubs and colleges, the ski industry is a tremendously important facet to the economies of both

Vermont and New Hampshire during the winter months (http://nature.snr.uvm.edu, 2001; Ski NH Report, 2001).

As an economic activity, tourism has a number of other industries that are embedded in it and reliant upon it. These include: eating and drinking, hotel and lodging, amusements and recreation, and transportation (www.visitnh.gov, 2001; Norris, 2001). Both New Hampshire and Vermont are recognised as tourism dependent. Ranking as the fastest growing industry in Vermont and the second largest industry in both states, the region is highly dependent upon the influx of out-of-state visitors (www.govtn.com, 2001; www.discovernewengland.com, 2001; www.visitnh.gov, 2001). 15% of Vermont's Gross State Income (GSI) is derived from this industry (http://nature.snr.uvm.edu, 2001) Although classification and inclusion of sectors varies in analysis at the state agency level, New Hampshire claims $8.6 billion in total tourist spending and employment of 65,000 individuals in 2000 (www.visithn.gov, 2001). Of this, $566 million is skiing related spending while employment includes 16,324 residents or 10.2% of the total employment in the state during winter months (www.visitnh.gov, 2001; Ski NH Report, 2001). This is impressive considering a general population consisting of 1,235,786 (www.census.gov, 2001). Furthermore, both states rank in the top 7 (out of 50) with regards to their reliance on tourism and travel (www.visitnh.gov, 2001; www.vtchamber.com, 2001). In fact, more than 7.5 % of the total visitor spending in New Hampshire is generated through this industry (Ski NH Report, 2001).

The larger industry of tourism is based upon numerous types of attractions that entice people to come to the New England region. From boating and camping in the summer, foliage in the fall to skiing in the winter, New Hampshire and Vermont have year-round and seasonal appeal. A Vermont study demonstrated that 26% of all visits occur in the winter months and nearly 50% of these visitors come just to ski (http://nature.snr.uvm.com, 2001). The regional economic importance of this industry is further underscored by the high rate of spender return per skier. The average tourist has a multiplier effect of 1.69, meaning that for each dollar spent on their visit, they are likely to spend another 69 cents on that visit. The average skier has a multiplier effect of 1.94 meaning that a "skier-tourist" is more profitable to the region's economy than an "average-tourist" (www.vtchamber.com, 2001). In 2000, Vermont businesses took in an estimated $722 million from direct/indirect spending within the ski industry (http://nature.snr.uvm.edu, 2001). An important byproduct of this is the economic gains that the state earns in the form of associated tax revenue. The fiscal year 1999 produced $43 million in tax revenue for Vermont from ski related expenditures and $58 million in 2000 for NH tax earnings (http://nature.snr.uvm.edu, 2001; Ski NH Report, 2001).

5. ***Methodolgy***

5.1. *Choice of Study Area:*

Skiing has a cultural and economic importance throughout the world, yet globally, there is a lack of research examining climate change impacts and its relation to the economic sector, specifically the tourism industry. The issue of economic loses resulting from climate change in this region is made even more interesting since the United States is the largest producer of green house gases. Recent and upcoming policy decisions on energy sources and its uses may have a detrimental impact on various tourism sectors such as fall foliage viewing, maple sugaring and skiing. Vermont and New Hampshire are both extremely reliant on the tourism industry and skiing in particular. The 38 alpine areas found in the two states demonstrate a high concentration of downhill skiing in the relatively small land area of 18,900 acres. The large proportion of residents employed in this industry and in supporting businesses combined with the significant tax revenue gained by the states from visitor spending makes these states' economic well-being vulnerable to any reduction in skier visits. The highly variable weather in the New England region adds to the level of susceptibility especially when considered in the context of the poor snow seasons in the 1980's and 1990's.

5.2. *Data Collection:*

The different data types were collected from a number of different sources. Data sources and ski area information was obtained through a network of individuals specialising in climatology and/or the ski industry. Traditional library research revealed a number of additional resources.

5.2.1. Climate Data:

The paper requires data on a number of different climatological characteristics and because of this, the sources and original format demonstrate significant variety.

5.2.1.1. Temperature and Snowfall:

The National Climatic Data Center produces collated data in the form of daily summaries for weather collecting stations throughout the country. Annual collection of data is currently released in CD-ROM format. Data for this paper was from the NCDC Summary of the Day-East Hydrosphere 2001, Vol.12.2. Although it would have been ideal to have recording locations from the highest elevations, not all of these stations had lengthy and continuous records of the information. High elevation records are important in an examination of skiing in New England because unlike resorts in the European Alps and the Rocky Mountains, skiing activities extend to the summits of even the highest peaks. As a result of the limited lengths of records at many places, four recording stations in both Vermont and New Hampshire were selected over a broad range of elevations from this data source. This inclusion is actually more representative because skiing occurs from the summit tops to the valley bottoms. Each site had more than 40 years of data, was still collecting data at present and had a minimal number of missing data points.

Vermont:

- Searburg station (ID# 7152) has recorded monthly total snowfall data from 1948-1998. The site is located at an elevation of 1560 feet, at 42:52:00 N, 072:55:00 W.

- Mansfield station (ID# 5416) has recorded monthly total snowfall and average temperature data from 1954-1999. The site is located at an elevation of 3950 feet, at 44:31:00 N, 072:48:00 W.
- Chittenden-snowfall, station (ID# 5416) has recorded monthly total snowfall and average temperature data from 1954-1999. The site is located at an elevation of 3950 feet, at 44:31:00 N, 072:48:00 W
- West Burke station (ID# 9099) has recorded monthly total snowfall and average temperature data from 1948-1998. The site is located at an elevation of 900 feet, at 44:38:00 N, 071:59:00 W.

New Hampshire:

- First Connecticut Lake station (ID# 2999) has recorded monthly total snowfall and average temperature data from 1948-1999. The site is located at an elevation of 1660 feet, at 45:05:00 N, 071:17:00 W.
- Mount Washington station (ID# 5639) has recorded monthly total snowfall and average temperature data from 1948-1999. The site is located at an elevation of 6262 feet, at 44:16:00 N, 071:18:00 W.
- Hanover station (ID# 3850) has recorded monthly total snowfall and average temperature data from 1926-1999. The site is located at an elevation of 603 feet, at 43:42:00 N, 072:17:00 W.
- Pinkham Notch station (ID# 6818) has recorded monthly total snowfall and average temperature data from 1948-1999. The site is located at an elevation of 2009 feet, at 44:16:00 N, 071:15:00 W.

In order to improve the robustness of the snowfall data, the National Weather Service also has climatological data for specific Vermont sites on line at www.nws.noaa.gov/er/bvt/climo/snow. Although there were slightly fewer years included in each of these records, this information was used in conjunction with the NCDC information to reduce bias of either site.

The three Vermont stations utilised and the data at each site were:

- Chittenden II station is located just north of Rutland on the western border of the state and has recorded monthly total snowfall data from 1948-1997.
- Waitsfield station is found near both Mad River Glen and Sugarbush in the west/central part of the state and has recorded monthly total snowfall data from 1955-1997.
- Morrisville station is located north of Stowe in the Northeast Kingdom has recorded monthly total snowfall data from 1962-1997.

Another recording station used to augment the climatologic history in the area is located in Durham, New Hampshire. Durham is located in the southeast corner of New Hampshire near the seacoast. The substantial, long-term information for this recording site includes continuous snowfall data from 1896 through 1995. This material is found at www.unh.edu/geography/climate/snowdur.txt.

At each of these stations, the cumulative snowfall totals from the winter months of December, January and February were recorded for each skiing season (i.e. the continuous set of months December through February). These annual totals were placed into an Excel spreadsheet and graphed in conjunction with each of the other stations. The slope for each of these lines was calculated, demonstrating increasing or decreasing snowfall over the examined period of time.

Pre-January totals for snowfall were also recorded for the sites in an effort to display the early season base and December vacation skiing opportunities. These annual totals were again displayed in an Excel Spreadsheet and the slope of the best-fit line was calculated.

In an analysis of the stations with temperature data, an average of the winter months temperatures were obtained by finding the sum of the three continuous months' (December, January, February) temperatures and then dividing by 3. This result was added to an Excel spreadsheet and graphed in conjunction with the other stations. Calculation of the slope determines warming or cooling trends over the recorded period of time.

Long-term climate data at a statewide level is kept by the NCDC and the National Oceanic and Atmospheric Administration (NOAA). This information is found in electronic format on-line at www.ncdc.noaa.gov/cgi-bin/cag3/hr_display3.pl. State averages for temperature are kept in continuous format and broken down on a seasonal basis. The information was loaded into Excel and Vermont and New Hampshire historical records were graphed from 1960-1999.

5.2.1.2. Snow Pack:

Snow pack data was obtained from 4 sites spread geographically throughout New Hampshire and Vermont.

- Mount Mansfield, VT- measured "at the stake" at approximately 3900 feet in elevation. Data for daily snow records from 1955 to present. Data found at www.nws.noaa.gov/er/btv.
- Burlington, VT- from the Collection of Local Climatological Data taken by the U.S. Department of Commerce and NOAA. Located at the eastern edge of Lake Champlain.
- Mount Washington Observatory, Gorham, NH- from the Collection of Local Climatological Data taken by the U.S. Department of Commerce and NOAA. Elevation of 6262 feet, near the Summit. While the data set was considerable, only the years 1980 to present were used for the research.
- Concord, NH- from the Collection of Local Climatological Data taken by the U.S. Department of Commerce and NOAA. Elevation of 300 feet on the edge of the Merrimack River. While the data set was considerable, only the years 1980 to present were used for the research.

Although resorts may open somewhat earlier than November 1^{st} and may extend their closing date past April 15^{th}, these dates were used to designate a maximum number of ski season days and consequently the number of days that a resort would have benefited from sufficient snow pack. As specific guidelines, in order to be included in the ski season, the day must fall within the previously mentioned date restriction and it must also have had a snow pack depth greater than 5 inches. The number of days that met the following criteria were tallied and recorded to determine the ski season length for each year.

5.2.1.3. Ice Information:

The ices out records are kept by a number of different associations and individuals throughout the two states. The date of "ice out" or "ice in" demands that ice must be covering or absent from certain stretches in each lake. These criteria are set by independent and unrelated organisations at each lake.

- Lake Champlain is located in the northwest corner of Vermont and is Vermont's largest body of water. The annual record indicates the date when the lake is shut down to boat traffic each winter. Information is found at www.nws.noaa.gov/er/btv//climo/lakeclose.html and includes data from 1816 to present.
- Lake Winnipesaukee, New Hampshire's largest fresh water body is located in the central part of the state. The date recorded each year signals the time at which the Mount Washington Cruise ship may pass to all of its ports of call and an end of the winter ice season. Information is found at www.winnipesaukee.com/icoout.htm#Ice-Outs, and includes data from 1887 to present.
- Lake Sunapee is found in the west/central section of New Hampshire. Records are kept by the Sunapee Lakes Association and may be obtained through phone inquiry. Information records the date of ice out on the lake and includes data from 1887 to present.
- Squam Lake is located just north of Meredith and is New Hampshire's second largest lake. The Squam Lakes Association records the date each spring when an individual

can “drive a boat from covered bridge in Ashland to Sandwich Town Beach.” Information includes data from 1978 to present.

The Lake Champlain record is unlike the data found for the three New Hampshire lakes. Instead of keeping a record of the day that the ice leaves the lake in the spring, the data reveals the dates of “ice in.” Since all of these events historically occurred after December 31st, the day of year was recorded. As the lake does not always freeze, a designation of “90 days” was used so that the data was not skewed. In an examination of the data and a determination of the severity of the winter, a larger number meant a warmer year while a smaller number signaled a colder year. This is in direct contrast to how the determination was made for the New Hampshire bodies of water.

Figure 5: Map of Station Locations in Vermont:

(http://www.lib.utexas.edu/maps/united_states/vermont_90.jpg, 2001)

Figure 6: Map of Station Locations in New Hampshire

(http://www.lib.utexas.edu/maps/united_states/newhampshire_90.jpg, 2001)

5.2.2. Ski Area Information:

5.2.2.1. Skier Days:

A skier day is equal to one skier visiting a resort for a single day. The number of skier days are recorded by each individual ski area and then reported to a state agency, in this case, Ski Vermont or Ski NH. These two organisations keep industry records and are in charge of some information dissemination and advertising for the areas.

- Ski NH has annual records for all member areas since 1984.
- Ski Vermont has annual records for all member areas since 1971.

5.2.2.2. Snowmaking:

Snowmaking percent coverage is a measure of the total number of skiable acres compared to the number of acres that is covered by snowmaking technology and equipment. The final number is calculated by taking the acres with snowmaking and dividing it by the number of total acres. This number is then multiplied by 100 to obtain a percentage.

- Ski NH has spotty data included in their bi-annual reports that began in 1993. Because they were comparing historical trends, the coverage goes back to 1984 but is better in the mid to late 1990's.
- Ski Vermont has a record of all years from 1988 to present with the exception of 1999.

5.2.3. Analysis of Skier Visits in Different Climate Conditions:

Skier visit information only exists for both states from 1984-present. Although Vermont's record is considerably longer, many of the data point in the 1970's were estimated. As a consequence of this limited historical data, climatological data during this same period of time was examined in order to determine the three best winters and the three worst winters in terms of climate. The following characteristics were considered in an appraisal of the snow and ski conditions:

- Station Temperature Data
- Station Snowfall Data
- Pre-January Station Snowfall Data
- Lake Ice information
- State Temperature Data
- Season Length

The temperature data from all of the monitoring sites were added together and divided by the number of stations to obtain an average temperature for each year during the winter months. Average snowfall for each year was obtained by calculating the sum from each station and then dividing it by the number of total stations. Average pre-January snowfall and lake ice data includes information that is in a comparable format and was manipulated in the same manner. The average temperatures for both Vermont and New Hampshire were totaled and divided by two to give a statewide value. The data for the four monitoring sites measuring season length consisted of a total number of days for each year with more than five inches of snow. Once all of the stations annual information was totaled, this value was divided by four to find the average length of season.

Each of these pieces of information was ranked and assigned a number that coincided with the relative magnitude. The coldest, snowiest or longest seasons received a value of "1." The warmest, least snowy or shortest seasons received a value of "18." The numbers "1" through "18" represent the most recent 18 years of joint climatological and ski resort data that were examined in this section. New Hampshire's skier history limited the scope of the comparison to this period of time. The ranking numbers for each of the six climatic characteristics were then totaled for each year. The sum of the ranked numbers for each characteristic, in each year, was evaluated and a final ranking assigned to determine the winter weather severity. The three best and three worst winters were then compared in terms of the number of skier days that were recorded in each of those years. A t-test was performed to evaluate if there was a statistically significant difference.

6. ***Results and Analysis:***

6.1. *Climate Trends in New Hampshire and Vermont*

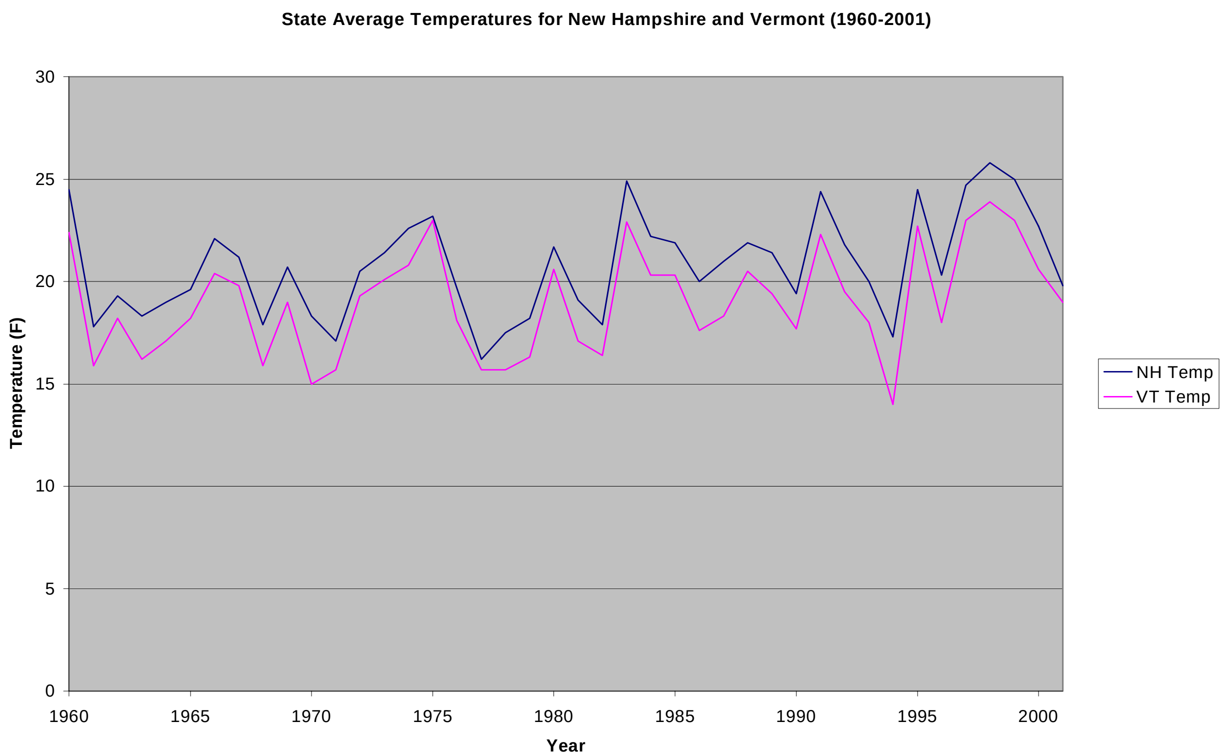
6.1.1. Average State Temperatures:

Examination of the statewide average temperature trends demonstrates only a small change throughout the area. Specific signals that may be present in smaller regions of each state or at a single location may be lost in a data set such as this. This data serves the general purpose of indicating that certain states may be more susceptible. The following table displays the equations of the best-fit lines for the temperature data from New Hampshire and Vermont in the winter months (December, January and February) in the years 1960-2001. Graph 1 demonstrates these annual trends. Numeric data for this analysis can be found in Appendix 1.

Table 1:

New Hampshire	y = 0.078x - 132.896
Vermont	y = 0.069x - 116.689

Graph 1:



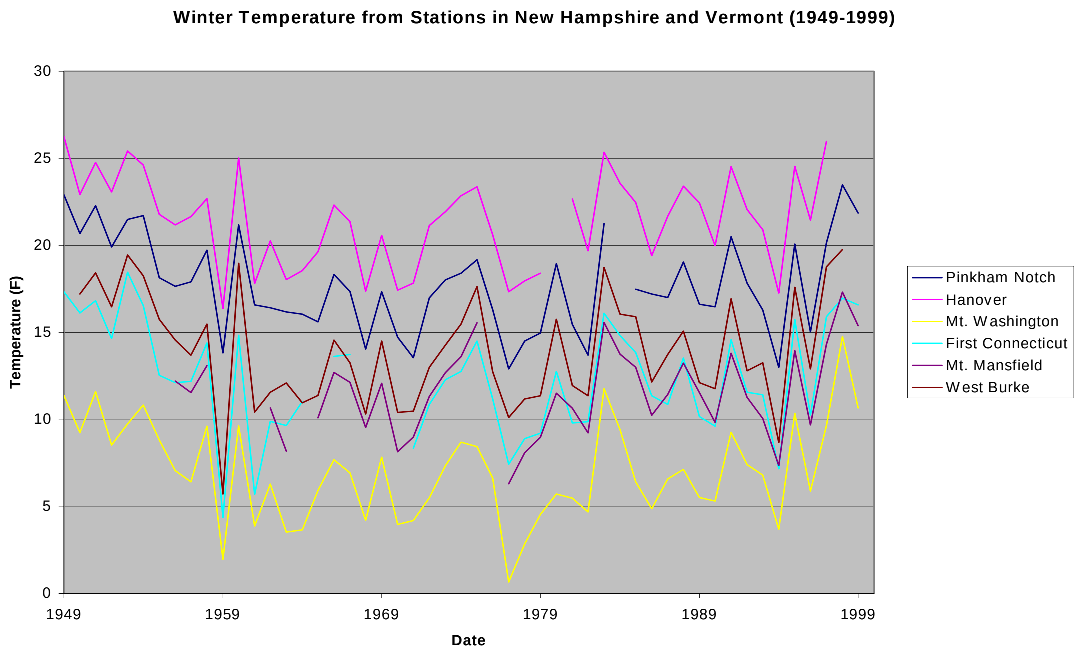
The correlation between the state data sets has an r-squared value of 0.945. This high correlation reveals that the state's temperatures responded similarly to the weather patterns each year. Despite the good correlation between this states data, each record set had a low r-squared value when the temperatures were compared to the years. This means that there is high annual variability and a weak correlation between the changes and the passage of time. New Hampshire's value of 0.1456 is shows slightly better correlation than Vermont's value of 0.1065. Over the 42 years of observation, New Hampshire demonstrated a .078º F increase each year or 1º F of warming every 12.82 years. During the same time, Vermont demonstrated a .069º F increase each year or 1º F of warming every 14.49 years. A problem that may exist for each analysis involving any temperature records involves the issue that the monthly averages may not be specific enough to determine the impact on snowfall and snow cover. Variables such as daily extremes, or daily variability may have been more representative of the effects on snow. Another and possibly better analysis may have considered the number of days each season that had a maximum temperature below some specified value.

For more specific information on the trends at a particular site, station records throughout the two-state area demonstrate changes in climate for a particular geographic location. A possible problem with the state records arises as a result of their measurements being too coarse to display any underlying local changes. For example, mountain regions may exhibit different patterns than lower valley areas. The individual stations can be examined for trends or they may be classified and considered according to region, elevation or proximity to factors such as ocean influence. This research paper specifically looked at the trends over time at individual sites. The station site and the equation of the best-fit line over the time period are given in the Table 2. Interannual trends are shown in Graph 2. The complete data set is found in Appendix 2.

Table 2:

Station, State abbrev.	**Years of Record**	**Best-Fit Equation**	**Average Annual Change**
Pinkham, Notch, NH	1949-1999	y = .027x + 69.37	0.027
Hanover, NH	1949-1997	y = -.007x + 34.73	-0.007
Mount Washington, NH	1949-1999	y = -.004x + 15.42	-0.004
First Connecticut, NH	1949-1999	y = -.022x + 56.46	-0.022
Mount Mansfield, VT	1955-1999	y = .032x - 52.59	0.032
West Burke, VT	1949-1998	y = .009x + 31.26	0.009

Graph 2:



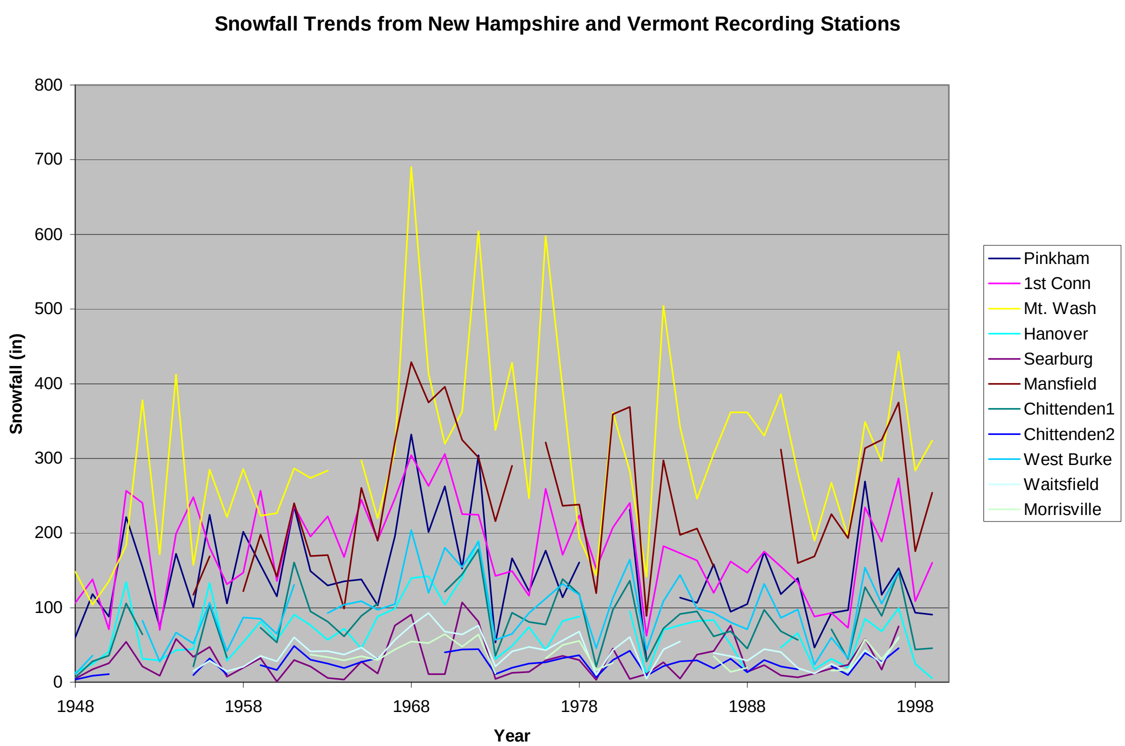
Three sites including Hanover, Mount Washington and First Connecticut all demonstrated cooling over the recorded period of time. Three other stations, Pinkham Notch, Mount Mansfield and West Burke all recorded warming for the same period of data. The changes for each of these sites were of a lower magnitude than any of the changes at the state level and in fact, three of them showed a change of less than 1 one-hundredth of a degree year. Mount Mansfield demonstrated the most significant change. The 0.032º F increase each year means that if the trend were to continue, the mountain could see a 1º F increase every 31.25 years. Mount Washington's 0.004º F decrease over the 50 years would translate into 1º F of cooling in 250 years. Examination of relationships between geographic location and elevation do not show any apparent reasons for the differences in temperature changes. The most eastern station, Pinkham Notch and the most western station, Mount Mansfield, both demonstrated increasing temperatures. Mount Washington, the highest station elevation and Hanover, the lowest station elevation both recorded cooling over their associated periods of observation. Another interesting consideration involves the idea that temperatures at some of the higher elevation stations may be some of the least representative and therefore most extreme in the region.

In addition to temperature patterns, another facet of winter skiing conditions considers snowfall variability. Although the differences in the water content of each snow event makes comparisons between stations and years less certain, the amount of precipitation that falls as snow is critical to the success of a ski season. The quality of the snow falling is especially important to individual skier and to the ski industry, although each may value different “types” of snow. Cold, fluffy snow may make for good conditions on the day of the event, but it is the denser, wet snow that provides for an improved base. The snowfall data from 12 sites throughout the two state region displays a much finer analysis of trends than any statewide data. Annual winter month totals for each site are listed in Appendix 3. Graph 3 demonstrates these annual trends while the information is summarised in Table 3 in the form of a list of the recording location names, the dates of record, the equations of the best-fit line and the average annual change.

Table 3:

Station, State Abbrev.	Years of Record	Best-fit Equation	Average Annual Change
Pinkham Notch, NH	1949-1999	y = -2.46x + 5169.69	-2.46
First Connecticut, NH	1949-1999	y = -1.57x + 3423.86	-1.57
Mount Washington, NH	1949-1999	y = 1.97x - 3450.77	1.97
Hanover, NH	1949-1999	y = -0.93x + 2013.51	-0.93
Durham, NH	1896-1995	y = -0.04x + 139.64	-0.04
Searburg, VT	1949-1998	y = -0.94x + 2084.36	-0.94
Mount Mansfield, VT	1955-1999	y = 2.35x - 4252.68	2.35
Chittenden, VT	1949-1999	y = 0.20x - 206.07	0.2
West Burke, VT	1949-1998	y = 0.49x - 755.51	0.49
Chittenden II, VT	1949-1997	y = 0.02x + 7.11	0.02
Waitsfield, VT	1956-1997	y = -0.10x + 281.74	-0.1
Morrisville, VT	1963-1997	y = -0.43x + 912.90	-0.43

Graph 3:



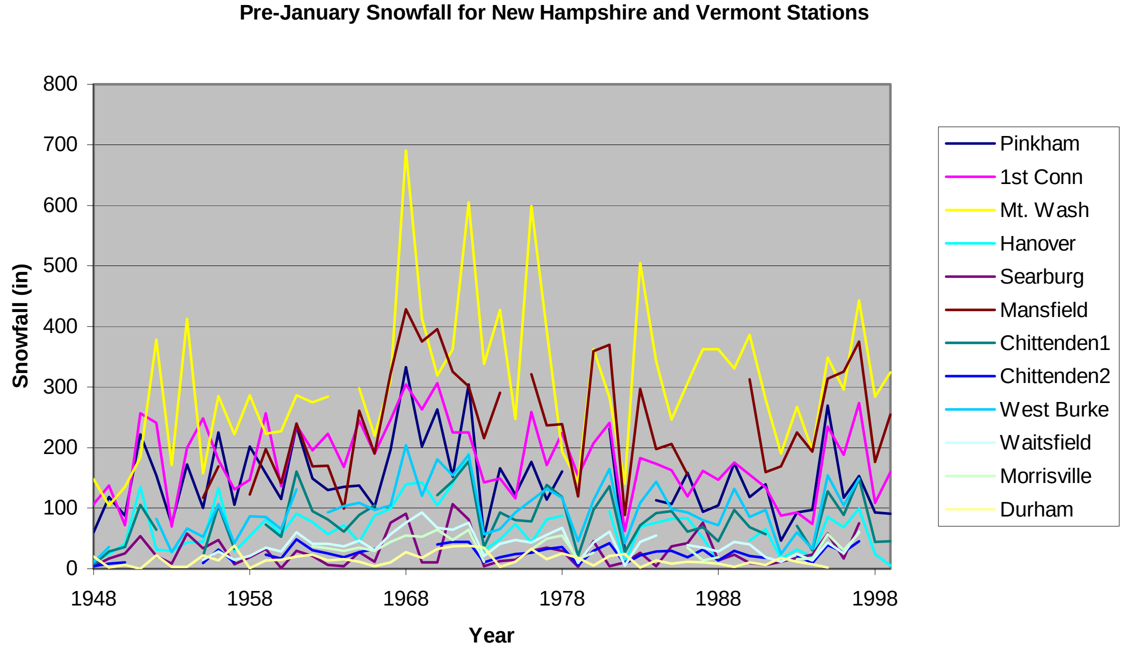
Within this data there is a high degree of inter-annual variability for the recorded period of observation. The highest r-squared value and consequent correlation is a value of .1208 at the Pinkham Notch station. Some r-square values are as low at .0004 at the Chittenden II site. Low values, such as this, indicate that there is a weak correlation between the two variables, snowfall and time. Understanding this, three of the seven stations in Vermont and four of the five sites in New Hampshire showed a trend of decreasing snowfall. Of these changes, there are few consistent regional or characteristic trends related to the increased or decreased snowfall. Pinkham Notch and First Connecticut Lake, two sites in Northern New Hampshire demonstrated the greatest average decreases of 2.46 and 1.57 inches per year respectively, over the 51 years of their records. Mount Mansfield and Mount Washington, the highest elevation stations in each state showed the largest increases in snowfall over the associated observations. Mount Washington is averaging an additional 1.97 inches per winter season while Mount Mansfield finds 2.35 more inches each year. Given the high degree of variability and weak correlation, predictions for futures changes are not well supported by the historical data.

Total snowfall amounts for the winter months may be a good determinant of the skiing conditions throughout the year, but with this determination, an inch of snow in February is equally important as an inch in December. Considering that there are fewer days of probable prior snow in December and a large proportion of the all-important winter vacation takes place at the end of this month, it can be argued that snow falling in December is much more valuable than snow in February. Snow that comes early in the season also helps to set the scene for the snow base while gaining the attention of new and old skiers. In order to capture this aspect of ski resort interest, each of the stations that measured total snowfall were then examined to obtain snow totals from November 1st through December 31st, or "pre-January snow." The following table considers the station name and state, the dates of record, the equation of the best-fit line and annual changes. The background data is found in Appendix 4 and is represented in Graph 4.

Table 4:

Station, State Abbrev.	**Years of Record**	**Best-fit Equation**	**Average Annual Change**
Pinkham Notch, NH	1949-1999	y = -0.58x + 1292.74	-0.58
First Connecticut, NH	1949-1999	y = -0.65x + 1469.97	-0.65
Mount Washington, NH	1949-1999	y = 1.87x – 3379.68	1.87
Hanover, NH	1949-1999	y = -0.29x + 365.62	-0.29
Durham, NH	1896-1995	y = 0.03x - 42.1	0.03
Searburg, VT	1949-1998	y = 0.07x – 119.32	0.07
Mount Mansfield, VT	1955-1999	y = 1.24x – 2219.32	1.24
Chittenden, VT	1949-1999	y = 0.31x – 535.25	0.31
West Burke, VT	1949-1998	y = 0.67x – 1221.43	0.67
Chittenden II, VT	1949-1997	y = 0.19x – 357.20	0.19
Waitsfield, VT	1956-1997	y = -0.15x + 346.24	-0.15
Morrisville, VT	1963-1997	y = -0.27x + 587.99	-0.27

Graph 4:



Similar to the data found in Table 3 that determined winter season snowfall totals, there is a great deal of variability and the data is not well correlated along a time line. A great deal of inter-annual variability makes long-term and future predictions based on this historical data, ill advised. Although many of the trends demonstrated in winter snow were also found in the pre-January totals, there were two differences. The records from Durham and Searburg describe increasing snow totals before January while their seasonal snowfall amounts showed a decrease in the total amount of snow. The patterns in Table 4 illustrate that there were seven stations that saw a historical increase in the amount of snow in November and December. Based on the observed records, an average of 1.87 more inches fall annually at the Mount Washington station. This is the largest average change. Since five of seven stations in Vermont had recorded snowfall increases, a higher percentage of the increases are taking place in the more western of the two states.

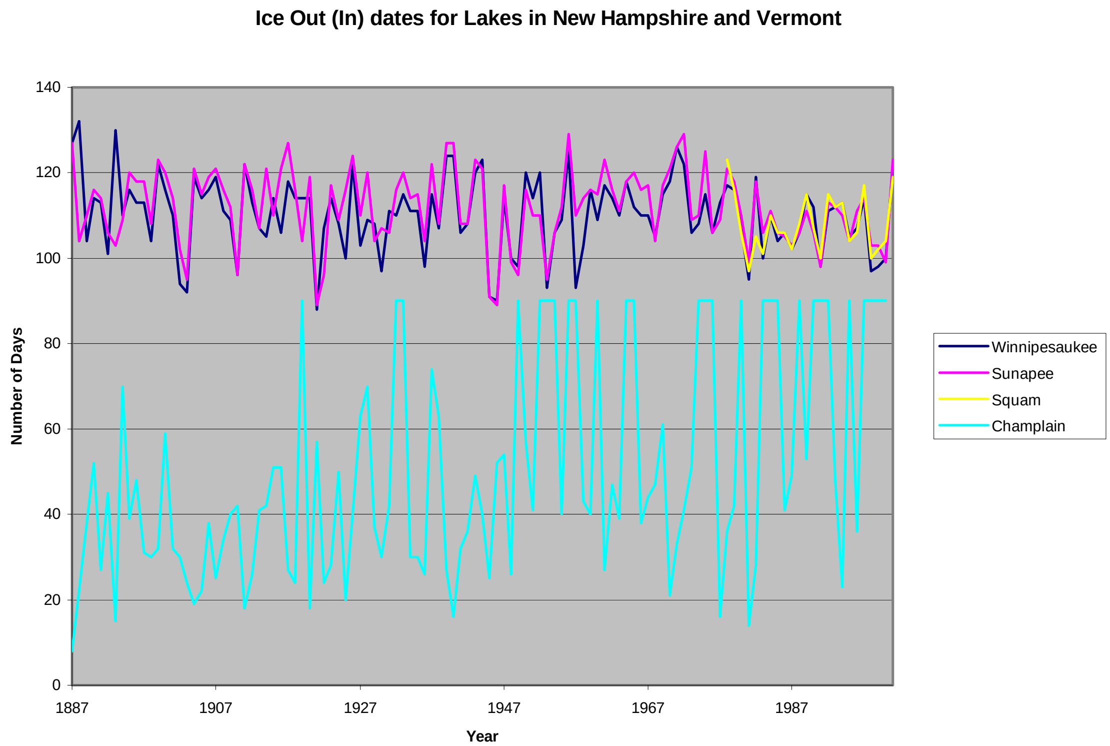
Maritime influences may be affecting this early winter disparity. Interestingly, this effect does not appear in the earlier winter records and in fact it appears to have the opposite effect at that time. The cooling of sea surface temperatures may impact the differences because the warmer water left from the summer may increase the likelihood of rain in early season storm events. This effect would decrease over the course of the winter.

Another climatic indicator used in the analysis of change and variability in New England utilised the date that ice either prevented on-water travel or melted enough to permit passage. The data sets for three of the lakes comprise some of the longest documented climate data for the region. Although changes in the individual collecting the data and the bias of those people may have altered the information, an excellent read on a long history of climate may be interpreted. The four recording lakes, the length of record and the equation representing the trend over time are entered into Table 5. Entire data sets are located in Appendix 6 and shown graphically in Graph 5.

Table 5:

Lake, State Abbrev.	Dates of Record	Best-Fit Equation	Average Annual Change
Winnipesaukee	1887-2001	y = -0.04x + 181.59	-0.04
Sunapee	1887-2001	y = -0.03x+ 171.91	-0.03
Squam	1978-2001	y = -0.02x + 153.06	-0.02
Champlain	1815-2001	y = 0.21x - 358.91	0.21

Graph 5:



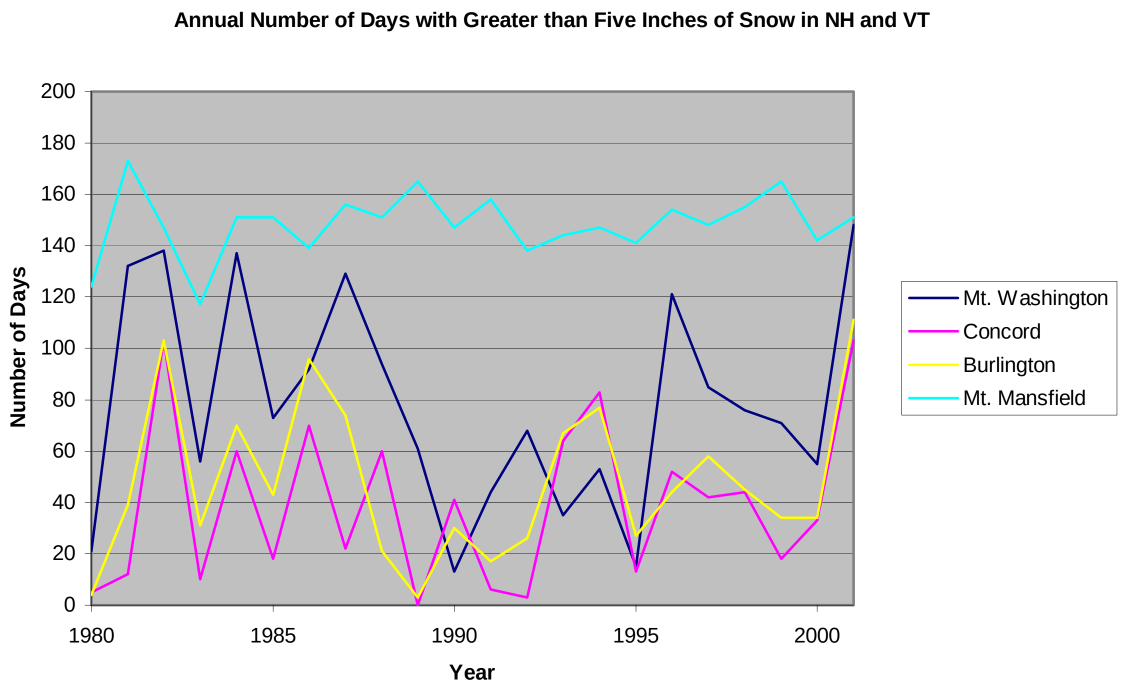
Although the longest data set, from Lake Champlain has the highest r-squared value of .2056 when compared to the passage of time, each of the other historical records has a value of less than 0.02. Each of these indicates weak to poor correlation between the day of ice out and the year, meaning that any trends of increasing or decreasing season length are not well founded. Still, each of these records at least demonstrates the same pattern: ice covers the lakes for fewer days each year. At first examination, Lake Champlain has an annual change of +0.21, which should mean that the ice season is getting longer. The record for this lake though refers to the day that the lake first freezes over and becomes impassable to specific boat traffic. In an historical context, this means that there is one less day of ice every 4.76 years if the historical average continues at the determined rate of change. This rate of change is much lower for each of the three New Hampshire lakes. Lake Winnipesaukee has one more day free of ice every 25 years. This same incremental change takes 33.33 days on Lake Sunapee and 50 years on Squam Lake given the changes suggested by the past records. Since ice cover requires sufficiently cold temperatures during the winter and adequate snow depth for proper insulation in the spring, it serves as an excellent determinant of winter severity. Considering the length of records, these sources unveil a consistent means of measurement that exceeds other forms for this part of the world.

Temperature and snowfall amounts throughout the winter season are also considered in another climate characteristic that analyses the number of days with a certain depth of snow on the ground. “Season length,” for the purposes of this paper, considers all of the days between November 1st through April 15th. Although there are areas that do not use these dates to define the limits of their operation, they serve as a means to compare winter snowfall while understanding that it is the snow on the ground that is most important to the ski area. A significant snow event may yield many inches of snow, but depending on blowing, settling and the water content of the snow, this may result in a different amount of “skiable” snow on the ground after the precipitation is complete. Snow pack totals were not gleaned from ski areas despite the fact that they may record these on a daily basis. In addition to not keeping the records for an extended period of time, ski resorts benefit from higher snow totals and are therefore less likely to report as rigorously. Since these reports are not using their information for scientific scrutiny, the methodology for recording and measuring is suspect and probably not consistent on an annual basis. Groups reporting to the University of Vermont and NOAA made measurements that were used for the purpose of this paper. The procedure of collecting this type of data often includes taking a reading of the snow depth at one point, such as the “stake” on Mount Mansfield. Therefore, the totals only give the reading for a single point on the mountain and not a mountain average. This technique is affected by changes in the wind direction of each storm event as it will influence the reading by either piling more snow or taking it away from the measuring area. Regardless, if the method of determination is done consistently over the years, it will at the least represent a consistent, geographically stable timeline even if there are biases (positive or negative) in the location of sampling position. Table 6 shows the station names and state, the years of record, the equation of the best-fit line and the average annual change. Graph 6 displays the individual records for each year at each site. These values are found in Appendix 6.

Table 6:

Station, State Abbrev.	Dates of Record	Best-Fit Equation	Average Annual Change
Mount Washington, NH	1980-2001	y = -0.71x + 1484.10	-0.71
Concord, NH	1980-2001	y = 0.88x - 1725.4	0.88
Burlington, VT	1980-2001	y = 0.41x - 772.57	0.41
Mount Mansfield, VT	1980-2001	y = 0.39x - 636.15	0.39

Graph 6:



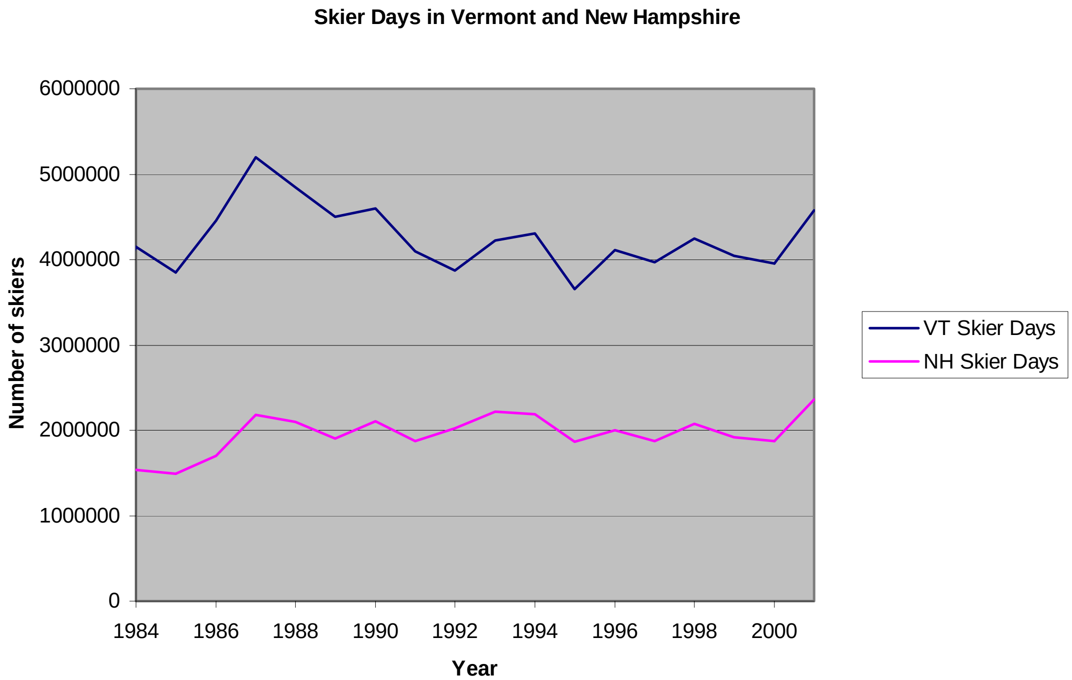
The considerable variability and again, lack of a strong correlation, makes determining conclusions difficult and imprudent. With all r-square values less than 0.04, there is little agreement of the data with the best-fit line. Although Concord demonstrated the greatest rate of annual change over the 22-year period, three of the four sites recorded increases in the number of days with greater than five inches of snow pack. Mount Washington, at the highest elevation noted a loss of 0.71 days annually. The short amount of time considered by data does not serve to provide concepts of long-term trends. The main purpose of this data set is to analyse the recent winters so that a determination can be made regarding the ranking of the three most severe and three most moderate winters. The classification of “greater than five inches” represented each season at all four of the data gathering stations in that this was a reasonable snow pack to expect to have on the ground for a good portion of the winter. Once five-inch totals were reached, the snow usually stayed until the end of the season with the exception of particularly bad thaws. In order to get these days when significant thawing had taken place it was important to count the number of days within a predefined range rather than simply obtain a start and stop date. The designation of five inches was sufficient to recognise these thaw events in the middle of the season. As further means of checking the viability of the five-inch requirement, this total number of days was compared to the total when an amount of 10 inches was chosen. Although different in magnitude, the results followed similar patterns over the course of the season and between years.

Examination of ski resort performance is a difficult task. First, there are few indicators of the industry that are kept for a significant number of years. Furthermore, a number of ski areas are not willing to release this information. Tracking information such as tax records are made difficult to obtain because many of the areas are privately owned and the information is not open to the public. For the few resorts that are owned by shareholders and traded, the change to this form of ownership is recent. The American Skiing Company, based in Bethel, Maine provides an example of this trend as they went public in November of 1997. New Hampshire’s lack of a sales tax also complicates any recording or comparing mechanism between the states. Indicators such as water use that might be equated with snowmaking hours have only recently been regulated through environmental reporting. The category of “skier visits” is a designation chosen because these records are kept by independent sources and they contain enough historical data to get a good idea of resort performance in the 1980’s and 1990’s. The number of skier visits is a measure of consumer demand, based on numerous decision-making processes that consider direct and indirect factors. As mentioned in Chapter 2, these decisions are related to the snow conditions, upcoming weather, the ability to travel, accessibility and other resort and mountain characteristics. The condition of the snow is a variable factor in this primarily unchanging set of attributes. Any annual alterations in those conditions would influence the end of season totals for the number of skiers. Table 7 displays the skier numbers for the individual states of New Hampshire and Vermont, including the equation of the best-fit line and average annual changes. Graph 7 demonstrates these values in another format.

Table 7:

Year	**Vermont**	**New Hampshire**
1984	4150000	1535000
1985	3850000	1491000
1986	4460000	1699000
1987	5200000	2177000
1988	4850000	2094000
1989	4500000	1901000
1990	4600000	2108000
1991	4100000	1873000
1992	3871299	2026000
1993	4225819	2220000
1994	4308633	2188000
1995	3652751	1865000
1996	4109109	2002000
1997	3971920	1876000
1998	4250569	2074000
1999	4042461	1917000
2000	3957457	1874000
2001	4579719	2358000
Best-Fit Equation	y = -22032.46x + 48159660.42	y = 20749.23x - 3938294.93
Average Annual Change	-22032.26	20749.23

Graph 7:



The annual season totals between the two states do not have a strong correlation. This means that the number of skiers in each state respond in a different manner to the impetus provided by changing climatic conditions. The r-squared value between New Hampshire and Vermont's skier visits is .2401, which demonstrates a fair correlation. Although total numbers are significantly higher in Vermont, the visitor numbers in that state have been averaging 22,032 fewer skiers on an annual basis since 1984. The trend in New Hampshire demonstrates a different trend as this state has seen an increase of just over 20,000 skiers each year. The divergence of these trends may happen for a number of different reasons. Although the same number of resorts were considered from year to year, these season totals and annual changes do not pick up on alterations within each resort. Ski areas may have expanded their capacity and increased its attractiveness with capital improvements. If this occurred more regularly in one state, the visitor numbers would be affected disproportionately. In addition, advertising spending schemes that are not uniform over the period of time and may have impacted one state more than the other. Due to the proximity and connectivity of roads, Vermont likely receives more New York visitors than New Hampshire. Because snow amounts within metropolitan areas impact skier decisions, different snow amounts in Boston and New York may affect skier decisions unevenly resulting in differences in consequential turnout. Regardless of the reason for the different trends that are seen in the two adjacent states, this section of the study (similar to the examination of season length) considers only a short period of record. Both of these examinations are based on a short record period. Predictions that consider this minimal amount of data are not recommended. Data sets such as these may find that the overall trend is heavily influenced by the choice of start and end dates that may have been particularly high or low. This data set was considered primarily to allow for a ranking of the past 18 years of skier turnout.

In order to obtain a measure of ski industry performance under different climatic conditions, each of the above climatic variables needed to be blended to get a final ranking of the severity of each winter. An equal weighting of six climate characteristics, not including precipitation (due to the non-specific nature of this signal) contributed to the final ranking. The cumulative severity ranking included the individual ranking for state temperature, station temperatures, station winter season snowfall, station pre-January snowfall, ice records and season length. Table 8 ascribes an ordering for the years 1984-2001. “1” denotes the snowiest, coldest or longest within the aforementioned time period. A ranking of the sum of the Vermont and New Hampshire skier totals is also included for comparison. Skier visit numbers are ranked according to the turnout magnitude, with a "1" for the year with the most visitors and an "18" for the year with the lowest total.

Table 8:

Year	Cumulative Winter Severity Ranking	Skier Visits Ranking (NH&VT)
1984	9	16
1985	13	18
1986	4	9
1987	6	1
1988	12	3
1989	11	7
1990	7	4
1991	18	11
1992	16	13
1993	8	6
1994	3	5
1995	17	17
1996	2	10
1997	10	14
1998	15	8
1999	13	12
2000	5	15
2001	1	1

Since 1984, the most severe winters (snowiest, coldest and longest) occurred in 2001, 1996 and 1994. The three most moderate winters, in terms of climate, were in 1991, 1995 and 1992. The ranking system considers each climatic variable with equal importance. Although there may be certain ones that should have made up a more significant proportion of the final ranking, it was thought that any attempts to do so without perfect knowledge may have led to greater bias than the system used. A source of error may develop from the fact that some of the more recent years, specifically 2000 and 2001 only had climate information from three of the six factors. This inequity may have led to a bias that resulted from having a larger percentage of the ranking determined by only a few conditions. The reason for this was due to climate data sets that only went up through 1999. Judging the 2001 season from first and second hand reports from ski industry members at Ski NH, Loon Mountain and skivermont.com and the consistent marks it received in the three categories, it certainly deserved the "1" designation. The ranking for the 2000-year is less certain and its final ranking is suspect. The ranking system suffered slightly from missing information within certain data sets. This means that the average for one year was calculated by dividing the total by 11 stations while another was divided by the full set of 12. If the missing data set were one of the higher or one of the lower totals, the magnitude of the final average would be influenced. A more complete set of data and/or the consideration of only entire historical records would improve this shortcoming but would exclude a tremendous amount of collected station information. The method of ranking each climatic variable was created for the purposes of this paper and has not been tested on other data. Proper testing using other historical information would improve accuracy and confidence.

Table 9 includes a list of the years that were the coldest, snowiest and longest compared with the years that were the warmest, least snowy and shortest. Rankings for each climate variable on an annual basis can be found in Appendix 7.

Table 9:

Climatic Condition	Coldest, Snowiest or Longest Year	Warmest, Least Snowy or Shortest Year
Station WinterTemperature	1994	1998
State Winter Temperature	1994	1999
Station Winter Snowfall	1996	1989
Station pre-Jan Snowfall	1997	1994
Lake Ice	2001	1991
Season Length	2001	1995

In an effort to link the climate variables with ski area performance, the skier numbers totals for New Hampshire and Vermont for the three best years are compared with visitor totals from the three worst winter snow seasons in Table 10. Statistical analysis demonstrated any difference between the two sets of skier information.

Table 10:

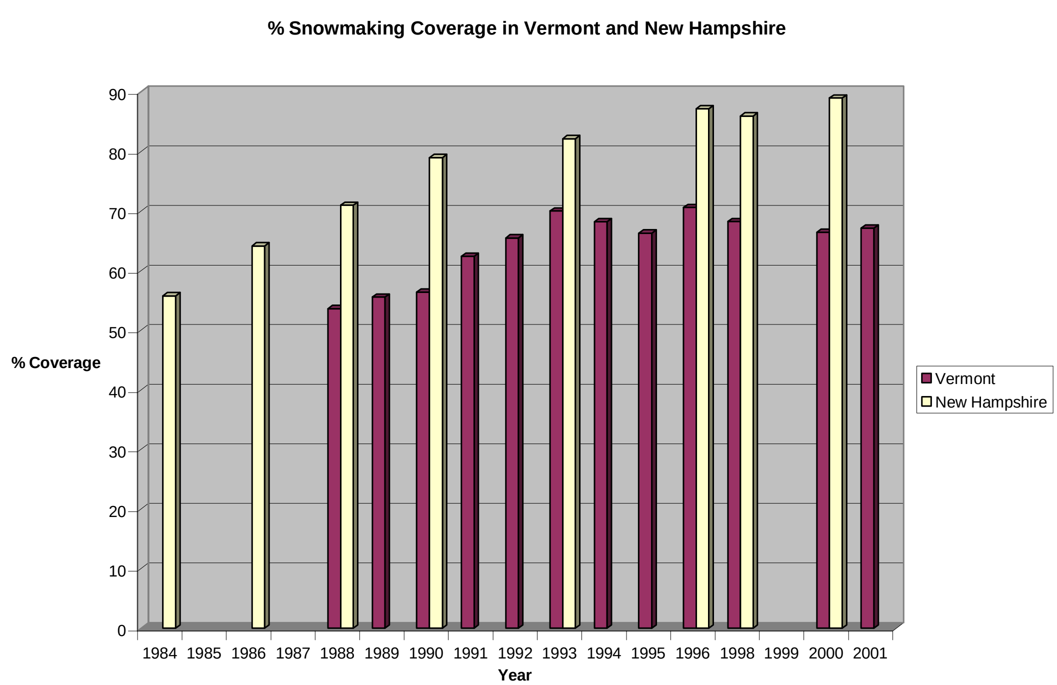
Three Best Snow Years	Skier Visits for those years	Three Worst Snow Years	Skier Visits for those years
2001	6937719	1991	5973000
1996	6111109	1995	5517751
1994	6496633	1992	5897299

The three best snow years coincide had an average total number of visits of 6,515,153.67 per year. The average ranking (based on the final assignments) for these same years is 5.33. The average annual number of visits for the most moderate winters is 5,796,016.67. This coincides to an average ranking of 13.67. A paired, two tail, t test was performed on the two groups of skier visitor data in order to determine if there was a difference in the means between the two groups. From this information it is possible to tell if there is a statistical difference between the years that were ranked as severe and the years that were ranked as poor in regards to snow and skiing conditions. The P value obtained through the t test is 0.02794. A confidence interval of 0.05 is generally accepted in most scientific studies. As a consequence, the differences in the two sets of skier numbers are statistically significant. As this relates to skiing, New Hampshire and Vermont's ski industry will record statistically different visitor numbers in years that receive less snowfall, are warmer and are shorter. Thus, the null hypothesis, there is no difference in different climatic conditions is not true and implications do in fact exist for the ski industry if alterations resulting from climate include less severe winters.

Interestingly, all of the poor snow years and all of the good snow years occurred in the 1990's, which appears to contradict the idea that the 1990's were the warmest decade on record. It is important to remember that 12 of the 18 years measured came after 1990 so there was a high probability of this outcome and the severe winters in the late 1960's and early 1970's were not included. This close proximity points to the fact that the past 12 years have been tremendously variable. One of the predicted impacts of climate change is this increased variance. Due to the narrow window that is examined it is impossible to determine how this 18-year period compares to other years in the past. But, at least for the current set of conditions, it can be said that the ski industry in New England is forced to operate in conditions that are unreliable and challenging for providing consistent snow conditions to skiers.

Changes in snowmaking coverage represent an important way of measuring the changes that have taken place within the ski industry as a result of strong climate variability. Since the mid-late 1980's, many areas have resorted to the use of capital expenditures to improve snowmaking with the hope of smoothing out the snow seasons. The amount of terrain covered by this equipment and technology at each resort is usually designated by a percentage of the total terrain that has snowmaking means in place. Records are kept at the same state agencies that keep the skier visitor numbers. Graph 8 displays a record of the changes that have taken place in each state over period of time from the mid-1980's to present. Since the agencies are not related, the records do not have the same start dates and some of the New Hampshire data points are missing. All of the specific data points are included in Appendix 8.

Graph 8:



The trends present for each state demonstrate the increasing capital requirements that are necessary to ensure successful years by having the type of sufficient, continuous snow conditions that attracts skiers. New Hampshire has seen an increase of 33.2% coverage since 1984 while Vermont has seen an increase of 13.5% since 1988. Tremendous costs are associated with the functioning of the equipment, in addition to the initial one-time cost of purchasing the equipment and installing it. Operation of these systems also requires significant input of valuable resources including water, electricity and/or diesel as well as the employee hours needed to set up, move, take down and maintain the equipment. Not only are these tremendous expenses providing an initial barrier to entry, they also often result in precarious loans that demand returns regardless of the past winter's weather. A better method of tracking snowmaking use would involve the use of recorded use or expenditures of electricity or water. Unfortunately, this sort of record is difficult to obtain for a period of time greater than five years since companies tend to only keep old records for that long. Environmental regulation regarding the recording of water use is only a recent consideration as well.

7. ***Discussion and Recommendations***

Although the climate research performed for this paper is not conclusive in its determination of the changes in New Hampshire and Vermont, there are certainly indications of patterns of warming, shorter seasons and less snow. The analysis of skier visits in these years demonstrates that there is a statistically significant impact on the ski industry during times with inferior snow conditions. The industry records an average of over 700,000 fewer visits in years that have warmer conditions. The vast number of variables that define climate makes any examination of this issue complicated particularly when local trends are expanded to include larger regions of a country or section of the world. The New England region's changeable baseline also serves to demonstrate the complications that result from attempting to pick up any climate change patterns that are evident above natural variability. Despite the lack of certainty surrounding climate change patterns, the research in this paper concludes that any shift in the baseline will impact the ski industry and may have similar impacts on other weather dependant economic sectors. This new information may encourage interest groups and governing agencies to reconsider their stance and actions revolving around greenhouse gas production.

Records from individual stations did not demonstrate any clear trends. In the analysis of temperature, 50% of the stations recorded increases while the other half demonstrated decreases (See Table 2). This same complicated signal was seen in the snowfall data (Tables 3 and 4). Although winter season totals observed a decrease in amounts at seven out of twelve stations, the same proportion saw increases in pre-January snow levels.

The state averaged winter temperatures illustrated excellent agreement with a warming pattern as both states showed higher temperatures over a 42-year period (Table 1). The ice out records also supported the idea of a warming trend with all four lakes displaying decreased time of ice cover (Table 5). Snow pack data pointed towards the opposite pattern because there were more days with a specific snow depth at three of the four sites (Tables 6). With this relatively inconclusive information it is difficult to make specific predictions about the future climate in New England. The lack of agreement does little more than to cement the idea that there are great differences in climate over small differences especially with changes in altitude and distance from the ocean.

Independent of these conclusions, there is little doubt that the ski industry is affected by the climate and any warming in combination with less snowfall would adversely impact its performance. This is supported by the statistically significant difference (P=0.02794) between skier numbers in the three most severe winters compared with the same numbers in the three most moderate years. It is also difficult to argue against the idea that there is an increasing concentration of carbon dioxide in the atmosphere and human beings are the central source of this change. Because the connection between higher carbon dioxide levels and increasing temperatures is well documented, it is important to understand the potential implications of further carbon releasing activities. Individuals in the ski industry, and related parties, are just a few of the more vulnerable groups of people that are impacted by declining snow quality that may result from increased concentrations of greenhouse gases.

The potential impacts of climate change influence an incredibly diverse array of activities and affect many geographic locations and the people who inhabit those areas. The recreational pastime of alpine skiing in New Hampshire and Vermont, describes only a single activity in a confined region. As a topic, climate change and the associated possible negative economic consequences for the United States gains little attention. Much of the debate in the country revolves around the detrimental implications that economy would suffer from under strict carbon emission standards, higher fossil fuel prices and other conservation practices. It is imperative that the decisions surrounding those regulations also consider the sectors of the economy that are vulnerable if carbon reductions are *not* made. States with a heavy reliance on the tourism industry and specifically, winter recreation are particularly vulnerable to the shorter and warmer seasons that may result from climate change.

This point is even more significant considering the physical capital and monetary investments that have already been made under the assumption of a constant and continuing set of climatic conditions. Parallels may be drawn to regions of the mid-west where development and farming in flood plains have taken place with the presumption that the government would continue to maintain and protect the area with structures such as levees and dams. A number of states could argue that precautions should be taken to insure that built industry, jobs and tax revenue related to the ski industry should be protected in a similar manner. States that rely heavily on skiing recreation to generate visitors and income include Alaska, Washington, Oregon, California, Utah, Colorado, New Mexico, Montana, Wyoming, Idaho, Michigan, Pennsylvania, New York, New

Hampshire, Vermont, Maine and Massachusetts. The ski industry's importance to each state also involves the contribution of tax monies gained from tourist spending. As a political topic, discussion about the associated risk in these regions may generate similar goals for areas that have been traditionally separated according to geography and the ideals of local industry and resource management.

The National Ski Areas Association provides a unique organisation that accesses resorts in each state and serves as a clearinghouse for management guidelines and ski area responsibility. The NSAA has demonstrated a desire to manage the industry "in a way that demonstrates commitment to environmental protection and stewardship" while "improving performance in all aspects of operation to allow for their continued enjoyment for future generations" (www.nsaa.org, 2001). Though much of their work is laudable in the domain of minimizing environmental impacts through traditional pathways of reducing, reusing and recycling, a broadening of scope is necessary to include a proactive climate change response. As an interest group the ski industry and the NSAA should be involved in decisions regarding energy policy, fossil fuel use and further extraction. National policies surrounding these issues are critical to the amount of carbon produced by the United States that in turn ultimately related to the climate, weather and temperature patterns in the country. The NSAA and individual resorts nationwide have a vested interest in current and future production of this byproduct.

Individual citizens also have significant reason to become involved in the idea of climate change as it relates to the ski industry. People often have little practical understanding of what changes in climate will actually mean to their daily lives. Science research commonly refers to such potential impacts as the melting polar ice, sea level rise and greater incidence of extreme events. Since these ideas are not specific to an activity or a life style, they are easy to ignore from a personal point of view. Alterations in ski season length, quality of snow and ultimately the cost of skiing are ideas that people in many areas of the country may understand and relate to. Their connections to the industry and its success may stem from different origins. Investments in real estate and equipment may become less valuable to individuals if there are fewer opportunities to participate in winter recreation. Residents may realise job loses and lower income from a reduction in the number of ski resorts or the length of season. Others may also lose the ability to participate in much needed outdoor activities if the outlet of skiing was lost. Each of these interested parties has a tremendous amount at stake with any changes that take place within the skiing sector. A unified response from the individual skier, the NSAA and the concerned state governments is a consideration that stands to build a foundation that would insure future sustainability for the economies of the states while saving the heritage of skiing. Recognition of this point may also serve to shift the focus away from looking at only the negative impacts of complying with greenhouse gas reductions instead of the detrimental results of ignoring the situation. An understanding of the impacts of climate change on the ski areas in New England demonstrates that the United States, like many other parts of the world, is also at risk.

In addition to the political form of affecting a change in order to ensure a more stable climate, there are other actions that the resorts and individuals involved in skiing may seek to perform in order to minimise risk and decrease their vulnerability. Diversification of activities is recommended to reduce the resort's reliance on solely winter related usage. A number of areas around the country have already begun to move in this direction. The addition of facilities to attract businesses and companies for seminars and weekend retreats and the creation of services to deal with activities such as summer weddings would improve the "four season functionality" of the ski resort. Resorts may also be interested in promoting existing local summer and fall scenic sites to gain visitors during those times of year. Creation of golf courses, water sports recreation areas and hiking and biking trails may further serve to increase demand for the area's facilities. This movement towards increase functionality is critical to the sustainability of the ski industry.

Snowmaking has become a tremendous benefit to the ski industry. It has allowed for more consistent trail conditions even outside of normal snow constraints. Unfortunately, there are also a number of significant environmental costs to the operation of this technology including electricity and water use. Lower water levels have been associated with changes and declines in fish and macro invertebrate populations due to the decreased river and stream flows that result from snowmaking withdrawls. Understanding the necessity of this technology for the continued sustainability of the industry, future snowmaking processes must improve on water and energy conservation. A balance must consider both the environmental implications and the economic benefits.

Although the concept of ski company conglomerates may have been initiated for purposes of greater purchasing power, name recognition and other reasons revolving around marketing and economies of scale, this strategy may actually best serve to buffer against changes in climate. Through the purchasing of geographically dissimilar ski areas, the parent company has consequently insulated itself against a bad winter in a single region of the country or world. This tactic has provided a greater chance that at least one resort under management will be located in an area that has good snow conditions. The trend towards larger ski companies has a potential globalisation effect because local mountains may lose their unique colour and attitude. This must be considered to allow for region specific traditions to continue in the face of a homogenised ski world.

All of these larger industry goals provide a means of minimising the risks associated with shorter, warmer ski seasons. Individual resorts should also attempt strategies that continue to intensify the use of the days that they are open. Development of advertising tactics that promote less expensive and less hassle for ski families may generate the development of a greater number of young winter enthusiasts which will in turn help to ensure the sport's future. Resorts should also look to involve a more diverse array of social, economic and ethnic backgrounds in the sport that has a traditionally Caucasian history. There is a significant, untapped resource of potential ski clients in other racial groups. Improved information and accessibility of up-to-date conditions and pictures provided over the internet would also help to convey the actual ski conditions so that people can see and believe what is happening even if it is not snowing where they are located. Ski resorts do not want a lack of snow in metropolitan areas to influence skier decisions especially when the conditions in the mountains are good. Tactics to decrease lift, ticket and food lines are also important. Since people are spending a premium for a day of skiing, it becomes less appealing if much of the day is spent just waiting to ski.

The best means of coping and adjusting to climate change may be to consider each of these alternatives and adjust flexibly to the suit the individual ski resort. Restrictions of land ownership, expansion possibilities or proximity to the target market may necessitate that some of these strategies are employed while others are not. The idea of resort specific changes will take into consideration the characteristics and traditions that are unique to each site, while ultimately reducing resort vulnerability. It is critical to understand the implications of the potential voice that the ski and tourism industry could have at the national level. The lack of cohesive response may mean further destabilisation while proper and appropriate action could work to ensure a more stable future climate.

Appendix 1: State Average Winter Temperature Data

Year	NH Temp	VT Temp
1960	24.5	22.4
1961	17.8	15.9
1962	19.3	18.2
1963	18.3	16.2
1964	19	17.1
1965	19.6	18.2
1966	22.1	20.4
1967	21.2	19.8
1968	17.9	15.9
1969	20.7	19
1970	18.3	15
1971	17.1	15.7
1972	20.5	19.3
1973	21.4	20.1
1974	22.6	20.8
1975	23.2	23
1976	19.7	18.1
1977	16.2	15.7
1978	17.5	15.7
1979	18.2	16.3
1980	21.7	20.6
1981	19.1	17.1
1982	17.9	16.4
1983	24.9	22.9
1984	22.2	20.3
1985	21.9	20.3
1986	20	17.6
1987	21	18.3
1988	21.9	20.5
1989	21.4	19.4
1990	19.4	17.7
1991	24.4	22.3
1992	21.8	19.5
1993	20	18
1994	17.3	14
1995	24.5	22.7
1996	20.3	18
1997	24.7	23
1998	25.8	23.9
1999	25	23
2000	22.7	20.6
2001	19.8	19

Appendix 2: Station Average Winter Temperature Data

Year	Pinkham Notch	Hanover	Mt. Washington	First Connecticut	Mt. Mansfield	West Burke
1949	22.91	26.23667	11.37	17.32333333		
1950	20.66666667	22.92333	9.24	16.1		17.2033333
1951	22.26333333	24.75	11.59	16.83		18.3966667
1952	19.89	23.06333	8.52	14.65333333		16.46
1953	21.48666667	25.43	9.74	18.45		19.4466667
1954	21.7	24.60333	10.81333333	16.53666667		18.2466667
1955	18.14666667	21.78	8.803333333	12.52666667		15.7466667
1956	17.64333333	21.17667	7.055333333	12.09666667	12.19666667	14.55
1957	17.90666667	21.64	6.416666667	12.18666667	11.52333333	13.6966667
1958	19.70333333	22.67667	9.593666667	14.37333333	13.08333333	15.48
1959	13.80333333	16.37333	1.953	4.373333333		5.71333333
1960	21.17333333	25.02	9.623333333	14.83	14.96333333	18.95
1961	16.57333333	17.79333	3.863333333	5.69		10.4133333
1962	16.41333333	20.26667	6.293333333	9.876666667	10.66666667	11.5566667
1963	16.17	18.01333	3.523333333	9.64	8.17	12.0733333
1964	16.05333333	18.55333	3.638666667	11.02		10.9333333
1965	15.60666667	19.62333	5.923333333		10.08333333	11.37
1966	18.32333333	22.32	7.676666667	13.6	12.69	14.54
1967	17.35666667	21.35667	6.91	13.72	12.11666667	13.2433333
1968	14.03333333	17.37	4.206666667		9.53	10.31
1969	17.32333333	20.57	7.84		12.06666667	14.5066667
1970	14.73333333	17.42	3.973333333		8.134	10.4033333
1971	13.54333333	17.82333	4.196666667	8.336666667	8.983333333	10.4733333
1972	16.97666667	21.13	5.496666667	10.85666667	11.31	12.99
1973	17.99666667	21.91667	7.323333333	12.26666667	12.67	14.2666667
1974	18.38666667	22.84667	8.683333333	12.75333333	13.59333333	15.4733333
1975	19.15666667	23.35333	8.416666667	14.50333333	15.53	17.6066667
1976	16.28666667	20.6	6.626666667	11.16666667		12.7366667
1977	12.88666667	17.32333	0.658	7.42	6.303333333	10.11
1978	14.49333333	17.96	2.856666667	8.883333333	8.083333333	11.1666667
1979	14.94666667	18.37667	4.533333333	9.196666667	8.976666667	11.35
1980	18.94		5.71	12.76	11.5	15.7433333
1981	15.45	22.66	5.466666667	9.777666667	10.64666667	11.9466667
1982	13.68666667	19.68	4.67	9.856	9.206666667	11.3563333
1983	21.24333333	25.34667	11.75666667	16.08666667	15.56	18.7233333
1984		23.55	9.403333333	14.81666667	13.74	16.04
1985	17.46666667	22.46333	6.4	13.84	13	15.8833333
1986	17.21333333	19.41	4.87	11.35666667	10.23666667	12.1433333
1987	17.00333333	21.67	6.573333333	10.87	11.43	13.73
1988	19.04666667	23.39667	7.11	13.53	13.23	15.0633333
1989	16.61666667	22.44333	5.51	10.14666667	11.54	12.1066667
1990	16.45	19.96333	5.303333333	9.593333333	9.830666667	11.75
1991	20.48666667	24.50333	9.25	14.55333333	13.78666667	16.93
1992	17.81	22.05333	7.403333333	11.55333333	11.27333333	12.7833333
1993	16.27333333	20.88	6.794666667	11.40666667	10.05	13.2466667

1994	12.99333333	17.25	3.673333333	7.156666667	7.347666667	8.66
1995	20.06666667	24.53333	10.33233333	15.71666667	13.95	17.6
1996	15.03333333	21.43333	5.886666667	10.25	9.673333333	12.9033333
1997	20.14333333	25.96667	9.636666667	15.89333333	14.32	18.75
1998	23.46666667		14.73666667	16.95666667	17.3	19.7433333
1999	21.84666667		10.65	16.57666667	15.37	

Appendix 3: Station Winter Season Snowfall

Year	Pinkham	1st Conn	Wash	Hanover	Searburg	Mans	Chitt1	W. Burke	Chit2	Waits	Morris	Durham
1949	254.5	280.2	221.8	127.1	147		85.1	145.4	25			63.8
1950	335.5	332.9	214	158	259.3		126.8	189.5	37			25.4
1951	280.1	262.8	184.5	174.1	180		81.4					37
1952	506	351.1	320.7	269.4	348.7		187.7		52			26.8
1953	340.2	378.9	511.7	125.7	266.2		148.5					90.3
1954	375.9	375.7	340.8	180.3	253.3			243.4	52.5			29.8
1955	285.5	417	518	108.9	210.9	223.7	154.1	215.9	45.6			31.7
1956	257.3	344.2	232.5	123.4	198.1	229.9	118.6	113.2	35.4	29.8		45.8
1957	320.6	306.4	302.6	190.6	240.9	235.2	141	174.8	43.5			106.7
1958	540.6	409.8	708	331.2	279.4	616	196.7	190.4	59.3	84		70.4
1959	313.3	362	385	155.2	200.4	239.3	146.4	219	43.1	62		53
1960	353	441	623	207.5	287.7	351.7	247.4	171.5	74	79.3		43.1
1961	251.9	262.5	203.2	136.3	242.9	239.8	148.6		45	56		61.9
1962	378.3	309.3	356.9	247.5	351.2	262.1	212.2	231	62.5	77.5		80.3
1963	392	392	337.9	217	396	336.3	268.4		80.5	91	99	65.4
1964	278	294.1	390.6	182.2	368.5		165.9	197.3	50	67	56.8	58.2
1965	233.9	285.6	324	156.1	224.4	277.5	149.4	199.3	45	79.5	72.2	65.4
1966	371.7	360.7	456.9	210.4	201.9	286	242.3	162.6	72.8		65.1	32.3
1967	275.3	348.1	332.7	210.8		448	247.7	226.8	73.5	86	77	63.9
1968	295.1	314.5	286.4	151.8	170.4	440		180.1		76.5	67	85.8
1969	780	509	892	255.8	238.2	539		347		125	98.4	58
1970	247.5	371.1	720.4	167	270.9	435.6	233.9	189.1		106	64.5	77.1
1971	411.4	540	560	242.2	355.5	538	277	351.2	83	121	119.5	62
1972	324	346	593	158.6	259.1	446	192.6	229.7	58	90	72.5	93.5
1973	295.6	384.9	648	209.1	282.4	448	238	254.6	62.3	102	79.4	100.9
1974	197.1	244.3	506	113	163.1	377	127.8	148.3	38.5	69.5	44.5	53
1975	222.1	337.8	691	151.4	300	433	180.9	203	53.8	91		29.4
1976	328	356.4	618	160.9	228		218.8	260.6	66.4	118		44.9
1977	324.9	399.7	792	144	219.3	455.9	227.3	254.2	65.8	88.6	67.6	82
1978	383	351.9	582.4	282.5	303.4	404.8	340.7	253.1	103	112	88.4	77.5
1979	359.1	419.6	396.3	186.1	284.7	514.1	261.2	250.1	79.8	113	97.6	90.4
1980		196.9	175.1		91.2	262.9	85.4	86.2	25.6	26	29.4	58.6
1981	159.4	231.8	284.4		178.9	317.1	208.1	146.2	53.6	57.5		24
1982	388.4	398	473	183.3	281.6	448	223.6	337.3	67.9	106		38
1983	192.1	185.7	186.9	118.5	167.6	283.9	116.8	121.4	34.8	53		84
1984		259.3	599	122.2	210.1	424	123.4	191.4	37.6	54		47.1
1985	211.4	266.7	559	158.1	177.6	354.2	170.8	227.7	51.8	88		68.5
1986	209.8	316.2	584	185.3	179.2	394.9	214	248.9	63.9		56	35.7
1987	265.4	253.8	563	175.7	269.6	343.4	179.1	210.7	54.1	98	39	28.1
1988	262.3	282.2	546	172.6	258.8		186	231.9	54.1	61.1	49.6	58
1989	180.8	282.1	335.3	61	96.6	315.1	100.6	212.3	29.9	46.5		45.7
1990	304.4	316.1	423	222	185.3		198.2	255.6	59.1	82		13.5
1991	199.8	261.3	491	121.7	131		121.1	142.1	36.8	68		42
1992	252.2	264.6	382.7	100.7	152.8		108.5	223.3	32.8	93.5		27
1993	224.2	264	342.9	163.3	291.3	470.4		201.2		65		25
1994	236.1	286.7	368.4	209.5	325.3	431	233.3	233.9	71	75.6	76.7	71.2
1995	257.1	236.4	389.9	105.7	181.3	405.1	124.7	146.3	36.6	61	73.3	45.5
1996	436	380.5	583	176.9	312.9	496.8	233.5	249.6	61.6	83	85.2	19.5
1997	283.4	363	521	166.5	240.9	457	149.3	223.1	45.2	76.1	60.9	
1998	202.1	341.9	360.6	117.9	214.7	430	157.2	217.5				
1999	218.5	246.2	343	103.2		335.8	139.8					

Appendix 4: Station Pre-January Snowfall

Year	Pinkham	1st Conn	Wash	Hanover	Searburg	Mans	Chitt1	Chit2	W.Burke	Waits	Morris	Durham
1948	60.3	106.2	148.2	13	4.7		6.5	4	10.7			19.7
1949	118.5	137.6	104.4	24.4	17.3		28	8.5	35.8			1.6
1950	88	71.3	135	41.2	25.3		35.8	11				6.5
1951	221.3	256.6	183.4	134.6	54		105.6					0.5
1952	154.2	240.5	378.2	31.3	21.3		63.9		82.7			22.4
1953	74.4	70.1	171.3	29.4	8.7				27.4			3.2
1954	171.7	199.3	412.3	43.1	58.3				66.6			2.8
1955	100.4	248	157.2	44.7	34	117.2	21	10	52.3	15.3		22.4
1956	224.7	179.8	284.9	132.7	47.3	168.9	104.1	32	106.2	28.8		13.8
1957	105.9	131.1	221.5	28.9	7.7		33.2	10.3	41.9	14.9		37.5
1958	202	147	285.7	53.9	19.3	122.2			86.7	20.8		1
1959	157.5	256.8	222.8	81.5	32.3	197.7	73.2	23	85	35		13.6
1960	115	135.7	226.5	56.8	1	141.7	53.2	16.5	65	28		14.4
1961	235.2	236.2	286.4	90.8	29.7	240	160.4	49	130.9	60		19.6
1962	149	195.4	273.9	76.7	21.2	169.3	94.9	30.3		41	37	23.2
1963	129.8	222.5	283.7	56.8	6	170.3	81.4	25	92.6	41.5	33.4	13.2
1964	134.8	167.5		71.7	3.7	98.8	61.3	19	103.9	37	29.2	15.7
1965	137.7	244.4	297.2	44.8	27.7	260.5	89	27	108.5	46.5	34.7	12.1
1966	102.9	190.4	219.9	88.1	11.7	189.7	105	32.5	97	31	30	4.7
1967	195.9	246.2	310	98.9	75.9	322			104.6	57	44	10.1
1968	332	304.3	690.3	139.2	90.7	429			204	76	54.6	27
1969	201.1	263	413.4	142.3	11	375			120	92.5	52.5	17.8
1970	262.3	305.7	319.2	104.3	10.9	396	121.3	40	180.3	68	64.5	32.5
1971	152.4	225	362.3	140.4	107	325	144.8	44	153.8	64	47.5	36.5
1972	304.3	224.8	604.3	190	81.3	301	177.7	44.6	188	76	64	37.9
1973	53.2	142.9	337.7	31	4.3	215.7	35.5	11	56.8	21	12	35
1974	166	149.3	427.9	48.6	12.7	290	93.3	19.5	65.1	41		3.4
1975	122	116.1	246.8	73.7	14.3		80.7	24.8	92.5	47		11.7
1976	176.3	259.1	597.9	43.3	29.5	320.9	77.7	26.7	112.5	43.1	31.9	33
1977	114.1	170.7	393.4	81.7	35.3	236.3	138.3	32.5	131.7	56	49.8	15.5
1978	160.3	223.3	193.1	88	30	238.3	118	36.4	117.3	68	55.3	24.9
1979		152.6	143.2		3.3	119.4	21	6.5	45.6	10	16.3	18
1980		207	361.6		45	359	96.9	29.7	112.9	43	26.2	5.5
1981	230.9	240.4	282.8	94.8	4.3	369	136.3	42.2	164.3	61		21
1982	30.1	62.2	140.8	10	11	88.7	27.7	8.5	42.6	5		24
1983		182.5	504.5	69.9	26.7	297	71.9	21.9	108.7	44		2.6
1984	113.3	173	342.3	76.5	4.7	197.5	91.6	28.2	144	55		13.5
1985	106.1	163	245.9	81.9	36.7	206.2	94.7	29.2	98.6			8.5
1986	158	119.7	305.7	83.3	41.7	155.1	61.4	18.7	93.3	39	34.6	11.6
1987	94.3	161.7	361.9	50.8	76		68.1	31.2	80.2	34.5	14	10.5
1988	104.9	146.8	362	12.9	14.1	244	44.9	13.8	71.3	28.5	19.5	8.7
1989	174.5	175.2	330.5		23		97.2	29.7	131.8	44.5		3
1990	118.3	155.3	386	46.6	9.3	312	68.4	21	86	40.5		10.5
1991	139.6	133.8	280.2	65.6	6.7	159.3	56.9	17.5	97.6	19		6
1992	46.4	87.6	189.9	17.3	11.7	168.8			24.1	12		18
1993	92.8	92.5	267.5	31.7	18.2	225.3	70.9	21.8	59.7	24.6	16	11.5
1994	96.6	73.4	194.8	19.6	23.3	193.1	30.9	9.5	32.3	14	16.5	7.5
1995	269.2	234.2	348.6	85	58.3	313.7	127.7	39.3	153.6	43	57.3	2.5
1996	117.3	188.3	295.9	68.6	16.7	325	88.7	27.1	105	25.6	30.9	
1997	153.1	273.6	443	99.4	75	375	148.8	45.5	148.7	61	58.8	
1998	93.1	108.4	283.9	24.3		175.8	44.1					
1999	90.7	159.8	323.6	5.2		254	45.4					

Appendix 5: Lake Ice Information

Year	Winnipesaukee	Sunapee	Squam	Champlain
1887	127	127		8
1888	132	104		22
1889	104	110		38
1890	114	116		52
1891	113	114		27
1892	101	106		45
1893	130	103		15
1894	110	109		70
1895	116	120		39
1896	113	118		48
1897	113	118		31
1898	104	108		30
1899	122	123		32
1900	116	120		59
1901	110	114		32
1902	94	102		30
1903	92	95		24
1904	119	121		19
1905	114	115		22
1906	116	119		38
1907	119	121		25
1908	111	116		34
1909	109	112		40
1910	96	96		42
1911	122	122		18
1912	113	116		26
1913	107	107		41
1914	105	121		42
1915	114	110		51
1916	106	121		51
1917	118	127		27
1918	114	116		24
1919	114	104		90
1920	114	119		18
1921	88	89		57
1922	107	96		24
1923	114	117		28
1924	108	109		50
1925	100	116		20
1926	122	124		40
1927	103	110		63
1928	109	120		70
1929	108	104		37
1930	97	107		30
1931	111	106		42

1932	110	116		90
1933	115	120		90
1934	111	114		30
1935	111	115		30
1936	98	104		26
1937	115	122		74
1938	107	108		63
1939	124	127		27
1940	124	127		16
1941	106	108		32
1942	108	108		36
1943	120	123		49
1944	123	121		40
1945	91	91		25
1946	90	89		52
1947	114	117		54
1948	100	99		26
1949	98	96		90
1950	120	116		57
1951	114	110		41
1952	120	110		90
1953	93	95		90
1954	106	106		90
1955	109	112		40
1956	125	129		90
1957	93	110		90
1958	103	114		43
1959	116	116		40
1960	109	115		90
1961	117	123		27
1962	114	116		47
1963	110	111		39
1964	118	118		90
1965	112	120		90
1966	110	116		38
1967	110	117		44
1968	105	104		47
1969	115	117		61
1970	118	121		21
1971	126	126		33
1972	122	129		41
1973	106	109		51
1974	108	110		90
1975	115	125		90
1976	106	106		90
1977	113	109		16
1978	117	121	123	36
1979	116	118	116	42

1980	107	110	106	90
1981	95	99	97	14
1982	119	118	105	28
1983	100	106	101	90
1984	110	111	110	90
1985	104	106	106	90
1986	106	105	106	41
1987	102	103	102	49
1988	106	106	108	90
1989	115	111	115	53
1990	112	106	107	90
1991	98	98	100	90
1992	111	113	115	90
1993	112	112	112	48
1994	113	110	113	23
1995	105	104	104	90
1996	107	111	106	36
1997	114	114	117	90
1998	97	103	100	90
1999	98	103	102	90
2000	100	99	104	90
2001	122	123	119	

Appendix 6: Snow Pack Length

Year Ending	Mt. Washington	Concord	Burlington	Mt. Mansfield
1980	21	5	4	124
1981	132	12	39	173
1982	138	103	103	147
1983	56	10	31	117
1984	137	60	70	151
1985	73	18	43	151
1986	92	70	96	139
1987	129	22	74	156
1988	94	60	21	151
1989	61	0	3	165
1990	13	41	30	147
1991	44	6	17	158
1992	68	3	26	138
1993	35	64	67	144
1994	53	83	77	147
1995	15	13	27	141
1996	121	52	44	154
1997	85	42	58	148
1998	76	44	45	155
1999	71	18	34	165
2000	55	33	34	142
2001	148	103	111	151

Appendix 7: Ranking of Climate Variables

Year	Station Temp	Station Snow	Ice Out	Pre Jan snow	State Temps	Season Length	Final Rank
1984	12	8	9	5	12	2	9
1985	10	11	13	8	9	12	13
1986	4	4	6	11	3	3	4
1987	8	5	7	12	7	4	6
1988	11	9	12	10	11	8	12
1989	6	16	3	9	8	16	11
1990	2	10	11	4	2	15	7
1991	13	15	18	13	14	17	18
1992	9	14	10	15	10	14	16
1993	7	7	3	14	4	10	8
1994	1	3	2	16	1	6	3
1995	14	13	14	3	15	18	17
1996	3	1	3	7	5	5	2
1997	15	2	8	1	16	7	10
1998	16	6	17	6	17	9	15
1999	5	12	15	2	18	11	13
2000			15		13	13	5
2001			1		6	1	1

Appendix 8: Snowmaking Data

Year	Vermont	New Hampshire
1984		55.8
1985		
1986		64.2
1987		
1988	53.65	71
1989	55.58	
1990	56.42	79
1991	62.43	
1992	65.51	
1993	70.05	82.2
1994	68.26	
1995	66.34	
1996	70.62	87.2
1998	68.27	86
1999		
2000	66.48	89
2001	67.15	

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