

**Behavioural Adaptation of Skiers and Snowboarders in the
US Northeast to Climate Variability and Change**

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis.

This is a true copy of the thesis, including any required final revisions, as accepted
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Abstract

Climate change has been referred to as the 'greatest challenge to the sustainability of the global tourism industry in the 21st century' (UNWTO-UNEP-WMO, 2008). As a result, climate change is one of the most widely discussed environmental and sustainable development topics today. The winter tourism industry has been repeatedly identified as being vulnerable to climate change. The implications for winter tourism include a lack of snow in winter sport destinations, increased snowmaking and operational costs, shorter winter sports season, decreased visitation, and the potential for a loss of ski area operations.

The intent of this study was to understand the adaptive behaviours of skiers/snowboarders taken in response to climate conditions. More specifically the objectives of this research were: to examine how skiers/snowboarders have responded to changing snow conditions in the past as well as how they may react in the future, to understand the role of substitution (time, place, activity) within specific behavioural responses to both past and future snow conditions, and to examine the extent to which activity commitment and place loyalty influence climate-induced behavioural change.

Skier/snowboarder surveys were distributed at seven resorts in the New England states of Vermont and New Hampshire during the winter months of February and March 2010. A total of 572 surveys was collected and analyzed. The research findings revealed that skiers and snowboarders in New England are very loyal to their preferred winter resorts and are extremely loyal to the New England region. Only a small percentage of respondents said that they would travel outside New England to find better snow conditions. The level of a skier's/snowboarder's involvement in the sport, as well as their level of destination loyalty were also found to be important determinants of substitution behaviors.

As climate change causes more significant changes to the mountain landscape and snow conditions, understanding how different tourist segments react to climate change and related environmental change is important for various

tourism stakeholders: ski resort managers, nearby communities and also states that are dependent on this winter tourism revenue.

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Chapter 1: Introduction

One of the most widely discussed environmental and sustainable development topics today is climate change. The most recent major report published by the Intergovernmental Panel on Climate Change (IPCC) 'Climate Change 2007' concluded that 'the warming of the climate system is unequivocal, and is now evident due to increases in average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea levels' (IPCC, 2007, p.30).

The IPCC (2007) estimated that the global mean temperature increased by 0.74°C during the past 100 years. However, in only the last 50 years, this warming trend has occurred at twice this rate (IPCC, 2007). Eleven of the last twelve years (1995-2006) rank among the warmest years in the instrumental record of global surface temperature since 1850 (IPCC, 2007). Average global temperatures under a range of GHG emissions scenarios are projected to increase. Based on the SRES emission scenarios the best estimate is that global average temperatures will increase 1.8 to 4.0°C by the end of the 21st century (IPCC, 2007). Yet, even an increase of a few degrees could have detrimental environmental and economic impacts (IPCC, 2007).

The effects of climate change are projected to have consequences for almost all natural systems, countries and industries. The IPCC identified several natural systems and regions that are likely to be especially affected by climate change. These include: tundra, boreal forest, mountains, Mediterranean types, mangroves, salt marshes, coral reefs, and the sea-ice biome (IPCC, 2007). The most vulnerable industries are those that are climate sensitive (IPCC, 2007). Tourism consists of a wide variety of activities and assets that are dependent on climate and climate-sensitive natural resources. Both the availability and quality of tourism assets can be affected by the presence or absence of specific conditions associated with weather and climate (Wall, 1998). As a result, climate change has been referred to as the

'greatest challenge to the sustainability of the global tourism industry in the 21st century' (UNWTO-UNEP-WMO, 2008, p.180).

Climate change is not simply a problem that will threaten the success of sustainable tourism in the future, as it is already influencing tourism businesses and travel patterns (UNWTO-UNEP-WMO, 2008). Weather conditions influence not only whether people will participate in certain tourism and recreation activities but also the quality of their experiences (Wall, 1998). These implications have led to a rapidly increasing literature on the interactions of climate change and tourism. According to Scott *et al.* (2006), the literature doubled between 1995-1999 and 2000-2004. The economic value of the tourism industry on a global level has initiated the commitment of certain governmental agencies, industry leaders and academic researchers to understand not only the impacts that climatic changes will have on the tourism industry, but also how tourists will respond to these changes.

According to the UNWTO-UNEP-WMO (2008) mountain regions are important destinations for tourism. Mountain areas are second only to coasts and islands as popular tourism destinations, generating 15-20% of annual global tourism or US\$70-90 billion per year (UNEP-CI-WMO, 2007, p.11). Snow cover and pristine mountain landscapes are the principal attractions for tourism in these regions (UNWTO-UNEP-WMO, 2008). One of the main elements of mountain-based tourism is snow dependent recreation activities. The ski industry's direct revenues approached \$9 billion annually in 2003: \$3 billion in the US, \$680 million in Canada, \$94 million in Australia, \$3 billion in Western Europe, and \$1.4 billion in Japan (Scott & McBoyle, 2007). However, winter and mountain tourism, which rely heavily on natural resources, have been repeatedly identified as being potentially vulnerable to climatic changes (Scott, 2005). The implications for winter tourism include a lack of snow in winter sport destinations, increased snowmaking and operational costs, shorter winter sports season, reduced aesthetics, decreased visitation, increased avalanche risk, and the potential for a loss of ski area operations (UNWTO-UNEP-WMO, 2008).

The majority of academic research on climate change and mountain tourism has focused on the supply side of the ski industry and how climate will impact the

ski resorts (Scott & McBoyle, 2007). To date, there have only been a few studies that have examined how the impact of climate variability and change could influence tourist behaviors (Koenig 1998, Behringer *et al.* 2000, Hamilton *et al.* 2007, Unbehaun *et al.* 2008, Shih *et al.* 2009, & Dawson *et al.* 2009). A greater understanding of the adaptive behaviour of skiers/snowboarders to climatic changes has been deemed essential to assessing the vulnerability of winter tourism (Scott & McBoyle, 2007 Scott *et al.*, 2008, and Unbehaun *et al.*, 2008). Therefore, the focus of this research is to fill this gap and add to the recent studies that have attempted to understand how climate variability and change might influence tourist (skier/snowboarder) behaviours.

1.1 Research Goal and Objectives

The goal of this research is to understand the adaptive behaviours of skiers/snowboarders in response to climate conditions. More specifically the objectives of this research are:

- 1) To examine how skiers/snowboarders have responded to changing snow conditions in the past as well as how they may react in the future.
- 2) To understand the role of substitution (time, place, activity) as specific behavioural responses to both past and future snow conditions.
- 3) To examine the extent to which activity commitment and place loyalty influence climate-induced behavioural change.

1.2 Study Area

New England was chosen as a study area because of the importance both economically and culturally of the ski industry in this area (Figure 1.1). When the ski industry first came to the United States it became established in and around the northeastern ports of Boston and New York (Leich, 2009). Due largely to its proximity to Boston, New Hampshire rose as the epicentre of American skiing from the 1930s into the 1950s (Leich, 2009). Today, there are approximately 103 ski resorts in the US Northeast ski region, which consists of seven states: Connecticut, Maine, Massachusetts, New Hampshire, New York, Vermont and Rhode Island,

according to the National Ski Areas Association (NSAA). Mountain ranges make up significant parts of New Hampshire, Vermont, and Maine's inland regions. Mount Washington, located in the White Mountains of New Hampshire, is the region's highest peak, standing at an elevation of 6284 feet or 1915 meters.



Figure 1.1 Map of the New England Region

The states of Vermont and New Hampshire benefit the most from ski tourism in New England. Together, the two states receive approximately 6 million ski visits annually. In New Hampshire, snow is the state's main tourism draw and skiing has been named the official state sport (Hamilton *et al.*, 2003). An economic impact study conducted during the record 2007/08 winter showed a total of \$940 million dollars spent by guests visiting New Hampshire ski areas. Of that total, only 12% was spent directly at ski areas with the remaining 88% spent on ski visit-related expenses such as lodging, restaurants, gas, tolls, retail, and other (Ski NH, 2010). Vermont's motto, "The Green Mountain State," describes an uneven range in the western half of the state, with Mount Mansfield at its highest elevation of 4,393 feet or 1339 meters. For the 2007-08 season Vermont had 4.3 million skier visits.

Direct spending topped \$750 million with \$700 million in indirect spending for a total economic activity, due to skiing, of about \$1.5 billion (Vermont Business Magazine, 2009).

These states rely heavily on ski tourists and the economic value of the ski tourism industry. Therefore, there is a need to understand what the impact of climate change will be on the ski industry within New England on both the part of academics as well as the ski industry and the communities that are highly dependent on it for jobs and tourism spending. There have been a number of academic articles that have specifically examined the effects of climate change on the winter tourism industry in New England. These include: Badke (1991), Hamilton *et al.* (2003 & 2007), Scott *et al.* (2006 & 2008), and Dawson *et al.* (2009). As a result of these studies, New England has been identified as being vulnerable to climate change, especially the southern states within the region. The ski industry has already begun to see first-hand the impacts of climate change and how it is affecting the length of the ski season, the increased energy costs of snowmaking, and the fluctuating visitor numbers. As a result, the ski industry's interest in and its commitment to environmental issues has increased in recent years.

The NSAA created the 'Sustainable Slopes Charter' in 1999 and 2000 in an attempt to define a uniform response to the issues of energy efficiency, water use, and waste production. Within New England, the charter has been endorsed by ten resorts in New Hampshire and eight in Vermont. The NSAA has also developed an awards program honoring ski resorts for their efforts to make the slopes more environmentally friendly. Their golden award for overall environmental excellence has been given twice to ski resorts in New England: Jiminy Peak (MA) in 2008 and Stowe (VT) in 2000. Their silver award for excellence in water conservation has been awarded to three resorts in New England: Smugglers' Notch (VT) in 2003, Stratton (VT) in 1998 and Killington (VT) in 1994. A number of ski resorts in New England are also offsetting 100% of their green house gas (GHG) emissions in order to reduce their impact on the environment. These include: Shawnee Peak (ME), Sugarloaf (ME), Sunday River (ME), Mount Sunapee (NH), Killington (VT), Middlebury Ski Bowl (VT), Okemo (VT) and Stratton (VT).

The implications of climate change on the supply side of the ski industry have been examined to a large extent. For example, a lack of snow in winter sport destinations, increased snow making costs, shorter winter sports season, and decreased aesthetics of mountain landscapes. However, what is far less understood is how climate variability may affect the demand side of the ski industry. According to Dawson *et al.* (2009) during the 2000-01 and 2004-05 average ski seasons, US Northeast ski areas drew more than 13.5 million skier visits. Visitation however, during the climate change analogue seasons of 1998-99 and 2001-02 drew 10.8% and 11.6% fewer visits respectively (Dawson *et al.*, 2009). This would ultimately impact ski resorts and nearby cities in New England economically and therefore, it is important to determine how skiers and snowboarders may adapt their behaviour as a result of climate change and variability.

1.3 Outline of the Thesis

This thesis consists of six chapters. The introductory chapter outlines the purpose of the research, the goals and objectives, and the study area in which the research takes place. The second chapter reviews the main bodies of literature that have focused on climate change and its impact on the tourism industry (particularly the winter tourism industry), and tourism/recreation behaviour. The third chapter discusses the specific research methods that were used for this study. The fourth chapter summarizes the key findings that emerged as a result of the analysis of the collected data. The fifth chapter discusses the findings of this study in comparison to the findings of previous research. The concluding chapter reviews the significant findings and main conclusions of this study, and discusses opportunities for future research.

Chapter 2: Literature Review

This research project incorporates three distinct concepts: sustainable tourism, climate change, and tourism/recreation behaviors. Climate change is a topic that threatens the future sustainability of various tourism destinations, industries, and businesses. Therefore, there is a need to understand how tourists/recreationalists may react to climate change, so that appropriate planning, policies, and strategies can be implemented to reduce the level of vulnerability and ensure the future sustainability of these tourism products. This chapter outlines the current knowledge on the topics of sustainable tourism, climate change, climate change and its impact on the tourism industry (particularly the winter tourism industry), and tourist/recreation behaviour research.

2.1 Climate Change

Climate change is the most important and widespread form of global change affecting mountain regions. The threat of global climate change to mountain regions was recognized in the second assessment of the IPCC (IPCC, 1995). Some of the impacts of climate change that are affecting mountain regions include: glacial retreat, melting permafrost, elevation of treeline, changes in species composition, non native species introductions, and increased rates of geomorphic processes (IPCC, 2007). Substantial decreases in snow and ice have also resulted due to the warming of our climate. According to the IPCC (2007), mountain glaciers and snow cover on average have declined in both hemispheres. Northern hemisphere snow cover observed by satellite over the 1966 to 2005 period decreased in every month except November and December (IPCC, 2007).

According to the IPCC (2007) mountain snow can be sensitive to small changes in temperature, particularly in temperate climatic zones where the transition from rain to snow is generally closely associated with the altitude of the freezing level. Declines in mountain snowpack in western North America and in the Swiss Alps are largest at lower, warmer elevations. Mountain snow water equivalent

has declined since 1950 at 75% of the stations monitored in western North America. Mountain snow depth has also declined in the Alps and in southeastern Australia (IPCC, 2007). Ultimately the decreasing levels of snow and the increased melting conditions of glaciers will place mountain and winter sports destinations at risk as a result of the projected implications of climate change.

Precipitation patterns have also shifted substantially in recent decades, both in terms of their amount as well as their intensity. Some areas have received a greater level of precipitation while others experienced a decline that has resulted in larger areas being impacted by water scarcity (IPCC, 2007). The IPCC (2007) stated that precipitation has increased significantly in the eastern parts of North and South America, northern Europe, and northern and central Asia. The predicted precipitation patterns might also be unevenly distributed over the year, causing further concern. For example, larger levels of precipitation might fall during the winter as rain rather than snow, causing the snow to melt faster resulting in greater run off (IPCC, 2007).

There is evidence that even with the current climate change policies and sustainable development practices, global greenhouse gas emissions will continue to grow (IPCC, 2007) Therefore, there is a need for more extensive adaptation policies in order to reduce the world's vulnerability to climate change. The United Nations World Tourism Organization (UNWTO), United Nations Environment Program (UNEP), and World Meteorological Organization (WMO) identified climate change as the 'greatest challenge to the sustainability of the global tourism industry in the 21st century' (UNWTO-UNEP-WMO, 2008, p.180).

2.2 Climate Change and Tourism

Tourism has been implemented on a global scale as a vehicle for economic development. When the industry first emerged, the focus was on the economic value that tourism could provide, such as foreign exchange earnings, employment creation, economic diversification, and growth among a variety of other factors (Sharpley & Telfer, 2004). It was not until the late 1960s and 1970s that the environmental impacts of tourism began to be realized, yet the focus was largely

local in scale, including beach erosion and over-crowding (Gössling & Hall, 2006). In 1987, the Brundtland Report was published and, since then, the term sustainable development has been commonly used in the tourism industry (Gössling & Hall, 2006). Sustainable tourism was introduced as an alternative type of tourism that would address and minimize the environmental and social impacts of tourism. A variety of other tourism development terms are also associated with sustainable tourism. These include: green tourism, low impact tourism, alternative tourism, soft tourism, responsible tourism, nature tourism, and ecotourism (Sharpley & Telfer, 2004). The implementation of these types of tourism in the late 1980s and 1990s led to a more positive view of the tourism industry and how it could provide countries with the economic benefits of tourism while also preserving their natural environment (Sharpley & Telfer, 2004).

The concept of sustainable tourism became popular in the 1990's. However, it originated from the wider concept of sustainable development (Swarbrooke, 1999). By 1991 discussions of launching a Journal of Sustainable Tourism had begun, and its first volume was published in 1993 (Lane, 2009). Sustainable tourism may be defined as 'tourism, which is economically viable but does not destroy the resources on which the future of tourism will depend, notably the physical environment and the social fabric of the host community' (Swarbrooke, 1999, p.36). This implies the objective of achieving a balance between environment, economy and community issues (Kastenholz, 2004). In many regions of the world, tourism has had damaging impacts on the natural environment. However, at the same time tourism can be beneficial to the natural environment by providing a motivation for environmental conservation (Swarbrooke, 1999). Economically, tourism is a major industry and foreign currency earner. However, these economic benefits do not always benefit the host country or community, and vary based on who is employed in tourism, wage rates, and the degree of leakage from the local community (Swarbrooke, 1999). The social dimension of tourism has been given less attention in the sustainable tourism debate. It incorporates equity, equal opportunities, ethics and equal partners (Swarbrooke, 1999).

Currently, the concept of sustainable tourism has moved up in the public agenda. The fundamental reason for this is the recognition that climate change is happening and that its consequences could be seriously damaging (Lane, 2009). Those changes could affect very strongly upon tourism and its growth. For the first time since 1950 tourism's growth rates are being threatened, and for some regions the very existence of the tourism industry will be threatened (Lane, 2009). Climate change is one of the issues facing sustainable tourism and therefore, tourism research began to examine this topic. The first scientific paper on the potential implications of climate change for tourism (the impacts of warming temperatures on the ski industry) was published in 1986 (Wall *et al.*, 1986). However, according to Scott & Becken (2010) very little progress to advance the understanding of the implications of climate change for tourism was made over the next decade. Climate change and tourism scholarship saw substantial growth towards the end of the 1990s, with the number of publications increasing threefold between 1990–1994 and 1995–1999 (Scott *et al.*, 2005). Then the volume of publications on climate change and tourism once again doubled between 1995–1999 and 2000–2004 (Scott *et al.*, 2005), with contributions from North America, Europe and New Zealand.

Tourism and climate change have been described as a two-way relationship. On the one hand, tourism has an obligation to minimize its adverse impact on the environment, by reducing its greenhouse gas emissions. On the other hand, the changes to the world's climate will have both direct and indirect influences on many tourism destinations (WTO, 2003). Researchers have focused on topics that include: a changing climate and the effects that it has on the attractiveness of a destination (Maddison 2001, Lise & Tol 2002, Hamilton *et al.* 2005, Bigano *et al.* 2006), a changing climate in the countries of origin and its effect on outbound and domestic tourism (Scott *et al.* 2004, Gössling & Hall 2006b, Amelung *et al.* 2007), tourism's contribution to global climate change and ways of offsetting or mitigating these (Gössling *et al.* 2007, UNWTO-UNEP-WMO 2008, Peeters & Dubois 2010, Mayor & Tol 2010), and increasing travel costs due to mitigation efforts and its effect on travel patterns (Gössling, Peeters & Scott 2008).

Tourism is sometimes dependent on climatic and natural resources. Beaches and coastlines, mountains, forests, lakes, oceans, and the scenery provided by these elements are crucial to the attractiveness of destinations worldwide (Gössling & Hall, 2006). The quality of these natural resources directly impacts the quality of the tourism product, particularly so for coastal and ski tourism. Climatic changes threaten these very foundations of the tourism industry in some locations. As a result of climate change, the environmental features that are the attractions for many tourists may be compromised (Gössling & Hall, 2006). Although much research is still needed on this topic, one thing that is evident is that the tourism industry must address the effects of climate change. These issues are not just important for the tourism industry but for the communities that are dependent on it.

2.2.1 Implications of Climate Change on Tourism Flows and Seasonality

The implications of global climate change for tourism flows and seasonality are an area of research which has been examined by Hamilton, *et al.* (2003 & 2005), Hamilton and Lau (2005), Bigano *et al.* (2006), and Gössling & Hall (2006b). Climate considerations can play a major role when choosing specific holiday destinations. Climate can be both a push and pull factor, and climate change may lead to changes in seasonality at various destinations. Therefore, it is predicted that climate change will affect travel behaviour. According to Gössling and Hall (2006b), there are two types of publications on this topic. One assesses the consequences of climate change for the tourism industries in relation to demand and the other focuses on tourists and their response to climate change.

Weather and climate affect tourists and the desirability of tourist destinations in different ways. Weather affects the tourist experience and holiday satisfaction, as well as key aspects of tourism operations, including infrastructure, activity programming and operating costs (Scott, *et al.* 2007). Hamilton *et al.* (2003), found that the majority of tourists stated 'climate' was an important factor when making travel decisions. The article also indicated that, overall, tourists viewed rain and storms as the most important factors influencing travel decisions,

with large percentages of the tourists ranking these as a huge or major influence (Hamilton *et al.*, 2003). Some destinations may suffer in terms of attractiveness due to climate change (for example, a loss of snow at ski resorts). However, for other destinations climate could also lengthen the season for many outdoor recreational activities including camping, golf and visits to national parks (Scott & Jones, 2007 and Scott *et al.*, 2007a).

‘Anticipated impacts include a gradual shift in preferred destinations to higher latitudes and to higher elevations in mountainous areas. Tourists from temperate nations that currently dominate international travel (e.g., Northern Europe) are expected to spend more holidays in their home country or nearby, adapting their travel patterns to take advantage of new climatic opportunities closer to home’ (UNWTO-UNEP-WMO, 2008, p.104). ‘This shift in travel patterns would have three important implications: proportionally more demand for temperate nations, proportionally less demand for warmer nations which are now highly frequented by tourists from temperate regions, and a net reduction on the total number of international tourists. In warmer countries, the reverse would occur, as these nations would attract less tourists from temperate regions and would have increased outbound travel’ (UNWTO-UNEP-WMO, 2008, p.104). Scott *et al.* (2004) found that there would be a shift in the 2080s where the boundary between the summer peak and bimodal zones shift further north to the Canadian border. The winter peak boundary also shifts north to northern Texas and coastal areas of Georgia and South Carolina. This would allow certain destinations such as these to capitalize on their warmer climates.

It is thought that for many travelers, weather conditions at the destination are central to overall trip satisfaction, although further research to understand the influence of weather on consumer travel satisfaction is required. Seasonal climate fluctuations at tourism destinations and at high latitude source regions are considered a key driver of the seasonality of global tourism demand (Gössling & Hall, 2006b). There will be winners and losers in terms of various tourism regions and sectors that emerge as a result of future climatic changes and as a result of both the industry and tourists ability to adapt. Therefore, the crucial question will be, “To

what extent can destinations capitalize on the climatic improvements in order to attract tourists during the off seasons to lessen the impact on the environment during the peak season?" (Amelung *et al.*, 2007)

2.2.2 Implications of Climate Change on Destination Choice

Climate is an important factor of international tourism, and tourism researchers have recently examined the importance of climate in destination choice. According to Hamilton and Lau (2005) there are economic modeling studies that involve estimating the demand for destinations using, among other things, climate variables (Maddison 2001, Lise & Tol 2002, Hamilton *et al.* 2005, Bigano *et al.* 2006). Related to these studies are global models of tourism flows that include temperature as a determinant of the flows of tourists between countries (Hamilton *et al.*, 2005). There are also studies that use tourism climate indices to predict the effect of a changed climate on tourism demand (Braun *et al.* 1999, Scott & McBoyle 2001 & 2004, Amelung & Viner 2006)

Hamilton and Lau (2005) reviewed 25 destination studies, and found that climate was included as an attribute in 12 studies. Studies that have examined destination image and include climate/weather as an attribute find that it is one of the most important components affecting the image of a destination. However, there are differences in the preferences shown by different types of tourists from different places. Scott *et al.* (2007c) examined tourist perceptions of optimal climatic conditions for tourism and the relative importance of four climatic parameters (air temperature, precipitation, sunshine, wind) in three major tourism environments (beach-coastal, urban, mountains). Preferred temperatures for each of the three environments varied among respondents and among the three tourism environments. For a beach holiday, a majority (58 %) preferred a range of between 25-28°C, while an additional 25 % of respondents preferred temperatures of 30°C or warmer. In an urban destination, 82 % preferred a cooler daily maximum temperature of between 19-26 °C. The preference for mountain destinations was even cooler, with 84 % identifying a daily maximum temperature of 15-26 °C as ideal and 44 % indicating a narrower range of between 19-22 °C (Scott *et al.*,

2007c).

The following studies have focused on how tourists perceive climate change impacts in various destinations and how this influences their choice of traveling to, or returning to, these destinations. In a study by Gössling *et al.* (2005) of tourists surveyed in Zanzibar, tourists were asked to rate the climate's importance in their decision to travel to Zanzibar, more than half rated climate as important. Braun *et al.* (1999) investigated how possible climate change effects may influence the choice of a vacation destination. They provided information to participants that described potential impacts of climate change on the coastal areas and marine life on the German coasts of the North and Baltic Seas, in order to determine if this would change their perceptions of the destination. Braun *et al.* (1999) found that when presented with scenarios, respondents were less likely to intend to spend their main vacation at these destinations. In coastal locations, the impact of climate change was also projected to adversely affect tourist preferences for these destinations. In Bonaire and Barbados, more than 75% of tourists were unwilling to return if the preferred environmental feature at the destination (coral bleaching or reduced beach area) occurred as a result of climate change (Uyarra *et al.*, 2005). In a similar case study of Mauritius, Gössling *et al.* (2007) found that the state of coral reefs was largely irrelevant to dive tourists and snorkelers, as long as a certain threshold level was not exceeded. This threshold level was defined by visibility, abundance and variety of species, the occurrence of algae or physically damaged corals, and was not exceeded in the case study, despite the fact that considerable damage had already occurred. However, experienced divers can be assumed to be more critical about climate change related damage of coral reefs than holiday divers (Gössling *et al.*, 2007). These articles found that climate is an important factor for tourists when choosing a holiday destination and climate change impacts might affect their destination preferences and lead to a shift in destination choice.

2.3 Tourist/Recreation Behaviour

The study of tourist/recreation behaviour has become a significant contributor to the overall analysis of tourism. Understanding the decision-making

and behavioural adaptation of tourists is important for improving the sustainability of various tourism/recreation industries.

2.3.1 Motivation

From the outset, motivation has been an important topic of leisure and tourism research (Crompton, 1979). Crompton (1979) observed that 'it is possible to describe tourist behaviour and to classify tourists but it is more difficult to answer the question 'why' - the key factor underlying all tourist behavior' (p. 50). There are numerous factors that can influence tourist motivation. These include: cost (both of the tourism product as well as the cost of transport to get there), amount of leisure time/length of trip, personal, social and situational factors, etc. In order to classify these motivations the concept of 'push and pull' factors have been applied to explain these tourist motivations. Push factors are those that influence our desire to travel and the reasons for leaving home. Pull factors are the attributes at a destination that attract the individual after the decision to travel has been made. Weather and climate are two main pull factors that affect the length and quality of tourism seasons. However, future climatic changes may threaten the environmental resources that draw tourists to a particular destination and the quality of tourism experiences.

2.3.2 Substitutability

It is important for managers to have an understanding of potential substitutability in order to predict and mitigate the impacts of these behavioural changes. The concept of recreation substitution was first introduced in 1974 by authors Hendee and Burdge. The articles that followed on this particular topic challenged these authors' approach to the issue of substitutability, and then researchers began to shift their focus to how substitutes for recreation should be identified (Brunson & Shelby, 1993). An important goal of substitutability research is to understand how people react to constraints on their recreation behaviours. Vaske, *et al.* (1990) stated that there are two types of approaches. The first is the construction of activity types: typologies of substitutable activities derived from this

approach are based on similarities in participation rates or preference patterns reported by respondents. The second type is the direct questions method where respondents are asked to specify their substitutes for a particular activity, or whether they would not engage in substitution behaviours.

Iso-Ahola (1986) defined substitution as a psychological choice process that occurs when “ the originally intended activity is no longer possible and therefore must be replaced by another behaviour if leisure involvement is to be initiated or continued” (p.369) However, the substitute activity should be perceived as being as similar to the original activity as possible. Christensen and Yoesting (1977) discussed the substitutability concept and how activities with common characteristics may be substitutable with only a small loss in the level of satisfaction. Similarly, Manfredo and Anderson (1987) stated that, substitutability is seen as a matter of degrees not absolutes: perfect substitutes (those resulting in no loss of satisfaction), and poor substitutes (those resulting in a high loss of satisfaction), and varying degrees of quality between them. As stated by Iso-Ahola (1986) people are better able to cope with the outcomes of occurrences that they see as unavoidable (bad weather), and ultimately a better level of coping translates into a greater willingness to substitute. When the need for substitution arises unexpectedly an individual’s willingness to substitute is lower than when the substitution is expected (Iso-Ahola, 1986). Also, the more a person has invested in the original activity in terms of money, time, and effort, the less willing they are to replace this participation by another activity or experience (Iso-Ahola, 1986).

The three main streams of substitution behaviours include: activity substitution (in which a new activity is pursued), spatial substitution (participating in a different location than originally intended), and temporal substitution (participating at a different time or at a different frequency than originally intended) (Hall & Bo, 2000; Gilbert & Hudson, 2000). These concepts regarding recreation substitution behaviours are particularly relevant when examining the influence of climate change on recreational demand change within the ski tourism sector since all three possibilities could occur.

‘Specialization’, which refers to a continuum and progression of participation

from the generalist to the 'specialist', is thought to play a significant role in substitution patterns (Bryan, 1977; Scott & Schafer, 2001). A specialist is someone who would limit their interests to a particular activity, while an unspecialized individual would exhibit more general recreation interests among a variety of activities. Individuals who are more specialized within a particular activity are generally more committed to regular participation, but often require increasingly particular settings in order to participate at desirable levels (Bryan, 1977; Scott & Schafer, 2001). Specialists tend to exhibit the most complex motivations and participation behaviours, as they have more information to draw upon when making decisions (Williams et al., 1997). Specialization levels can be measured by past experience and skill level, including the amount and type of events individuals have participated in (Scott & Shafer, 2001). An individual's specialization level could be useful in understanding climate-induced behaviour patterns, for highly-specialized individuals may be expected to have different substitution strategies than novices.

2.3.3 Destination Loyalty

'Loyalty' is seen as a common measurement for investigating commitment to specific service providers and/or brands (Dimanche & Havitz, 1994; Kyle et al., 2007). Prichard & Howard's (1993) Psychological Commitment Instrument (PCI) provides a rigorous measure of tourists' commitment to service providers (Dimanche & Havitz, 1994) through measurement of several antecedent processes thought to collectively evaluate loyalty. The scale measures both consumer purchase behaviour as well as attitude towards a service. The multiple items measured within the scale include, *resistance to change*, *position involvement*, *volitional choice*, and *informational complexity*. An individuals' *resistance to change* is considered central to the development of loyalty and is at the core of the scale. Similar to identity affirmation (MIS), *position involvement* is evident when an individual's values or self-images are identified within a particular service provider. The link between a preference and one's personal values and self-images is thought to strengthen resistance to change. *Volitional choice* is the ability to make decisions freely and in

the absence of constraints. Loyalty, is also thought to be related to *informational complexity*, or how knowledgeable an individual is about a particular service provider. Vaske (1980) found that as commitment increases individuals are more likely to change resources (eg. travel out of state if an activity is not available in their state) than they are to change the activity (Buchanan, 1985, p.411). However, according to Buchanan (1985) the degree of commitment should be negatively related to the willingness to shift participation between and among activities. Loyalty to activity and loyalty to place both have implications for the willingness of skiers/snowboarders to substitute when faced with climate change and variability.

2.3.4 Activity Involvement

It has been suggested that differences in an individual's level of experience or personal involvement in a particular activity can have a strong influence on participation behaviour (Havitz & Dimanche, 1990). The Modified Involvement Scale [MIS] developed by Kyle et al., (2007) employs multiple dimensions that have been validated through previous research. The multiple dimensions included in the scale are; *attraction, centrality, social bonding, identity affirmation, and identity expression*; which collectively measure overall involvement. *Attraction* measures the importance of an activity to an individual including the amount of pleasure they derive through participation. *Centrality* refers to 'centrality to lifestyle', measuring the extent to which individual lifestyle choices and personal investments (financial and social) are made to support continued association with an activity (McIntyre, 1989). The concept of commitment has been related to substitution research by Baumgartner and Heberlein (1980) who conclude that individuals who are more committed to a particular activity perceive the activity to have fewer substitutes. Three approaches have been used to measure commitment 1) amount of past experience (number of years participated, number of days); 2) centrality of participation to lifestyle (psychological importance, resistance to change); and 3) degree of investment in activity (equipment owned, money invested, organizational membership) (Buchanan, 1985). Obviously degree of commitment on the part of skiers/snowboarders will have implications for their willingness to substitute in the

face of climate change.

2.4 Climate Change and Winter Sports Tourism

After coasts and islands, mountains are the most important destinations for global tourism, constituting an estimated 15-20% of the global tourism industry (Price *et al.*, 1997 & UNEP-CI-WMO, 2007). Snow cover and pristine mountain landscapes are the principal attractions for tourism in these regions and are also the features that are most vulnerable to climate change (UNWTO-UNEP-WMO, 2008). The international community first recognized the importance of mountain regions in the global environment-development agenda at the 1992 United Nations Conference on Environment and Development (Scott, 2005). Then, in 1995, the IPCC also recognized the vulnerability of mountain destinations due to climate change when it dedicated a whole chapter to the impact of climate change in mountain regions (Scott, 2005). The United Nations General Assembly proclaimed 2002 as the International Year of Mountains, in order to promote the conservation and sustainable development of mountain regions. Finally, the World Tourism Organization highlighted the vulnerability of tourism in mountain regions during the first conference on climate change and tourism in 2003 (Scott, 2005).

As a result of these various assessments, the sustainability of winter tourism and the ski industry in particular, has been repeatedly identified as highly vulnerable to global climate change (Wall 1992, IPCC 2001, WTO 2003, Scott, 2005, UNWTO-UNEP-WMO 2008). The implications of climate change that will directly impact the winter tourism industry include: a lack of snow in winter sport destinations, increased snow making costs, shorter winter sports season, and decreased aesthetics of mountain landscapes (Scott, 2005). Known vulnerabilities exist in Australia, Austria, Spain, Canada, France, Germany, Italy, Switzerland, and the United States (Scott, 2005). However, the extent of these vulnerabilities will vary in magnitude and over different time periods. Besides the negative impacts, climate change can also bring opportunities in mountain areas. While the winter tourism season may shorten, summer seasons may be lengthened, providing opportunities for other types of outdoor activities and tourism businesses that supply them (Scott,

2005). Also, if some of the ski resorts are forced to close, the other resorts within that region may gain new market share (Scott *et al.*, 2008).

The global ski industry has received a large amount of attention from researchers and ski associations on the topic of climate change and its implications for this lucrative industry. The research findings called attention to the fact that, in the future, there will be an increase in the number of winters with marginal snow conditions for skiing as a result of climate change. This climate variability from one season to the next impacts the length of the ski season and, ultimately, economically affects the ski/snowboard tourism industry. The following sections will highlight the research that has focused on how climate change is predicted to impact the supply and demand side of the ski industry, the adaptation methods of the ski industry, and the behavioural adaptation of skiers and snowboarders.

2.4.1 Implications of Climate Change for Skiing Supply

Climate variability affects each ski region differently but the changes in climate that directly affect the global ski industry are fluctuations in snow cover and temperature (Scott, 2005). Increases in temperature have already had severe consequences for ski tourism and are predicted to have an even greater importance in the future (Gössling & Hall, 2006). Therefore, research has focused on measuring the impact of climate change on the reliability of snow conditions at various ski destinations around the world. The authors that have explored this area include: McBoyle *et al.* (1986), Galloway (1988), Lipski and McBoyle (1991), Badke (1991), Carmichael (1996), Koenig and Abegg (1997), Breiling and Charamaza (1999), Harrison *et al.* (1999), Elsasser and Burki (2002), Hamilton *et al.* (2003), Hennessy *et al.* (2003), Scott *et al.* (2003, 2005, 2006, & 2008), Bicknell and McManus (2006), Abegg *et al.* (2007), Kundzewicz *et al.* (2007), Moen and Fredman (2007), Scott and McBoyle (2007), Lazar and Williams (2008), Shih *et al.* (2009), Hoffmann *et al.* (2009) and Uhlmann *et al.* (2009).

Initial research on climate change and ski tourism, projected negative scenarios for the future of the ski industry. However, this research did not account for snow making abilities when predicting the future viability of the industry due to

snow conditions. Therefore, some of the current research studies on the topic of climate change and ski tourism have begun to account for the new snowmaking technologies when analyzing the impact of climate change on mountain destinations. When taking into account snowmaking technologies, the industry becomes less vulnerable than earlier predicted to future climatic changes. The following sections divide the global ski industry into various regions and highlight the main research findings in each area.

Eastern North America

Ski areas in eastern North America have been identified as being vulnerable to climate change. Initial studies predicted this level of vulnerability to be quite dramatic, however, once snowmaking abilities were accounted for in research studies, the level of vulnerability in this region has been reduced. The researchers that have focused on how climate change will impact the ski industry in this area include: McBoyle *et al.* (1986), Lamothe and Périard Consultants (1988), Badke (1991), Lipski and McBoyle (2001), Hamilton *et al.* (2003) and Scott *et al.* (2003,2006,2007,2008).

In southern Ontario, Scott *et al.* (2003) found that the importance of snowmaking and the value of investments in snowmaking systems would only increase under climate change. They found that under climate change when implementing the current snow-making technologies, the average ski season in southern Ontario was reduced by 0-16% in the 2020s, 7-32% in the 2050s and 11-50% in the 2080s (Scott *et al.*, 2003). This is significantly lower than previously projected for this area. Scott *et al.* (2006) re-assessed the vulnerability of several ski areas in eastern North America, again taking into account the use of snowmaking technologies. They examined six ski resorts in Ontario, Quebec, Michigan, and Vermont. Using different temperature scenarios for the 2020s, 2050s, and 2080s they predicted ski season length, the probability of being open during the holidays, and projected changes in snowmaking. They found that in the 2020s, even under the high impact climate change scenario, there would only be minor risks to the six ski resorts being analyzed (Scott *et al.*, 2006). In the 2050s though the reduction in the

ski season and the decreased probability of being open during the holidays are not insignificant (Scott *et al.*, 2006). Figure 2.1 highlights how incorporating snow-making technologies into climate change models greatly reduces measures of the vulnerability of eastern North America to climate change as predicted by previous research.

Study Area	Baseline average (days)	Climate change scenario	% Change from 1970s baseline		% Change in earlier studies (~2050s)
			2020s	2050s	
Brighton, Michigan	114				-59 to -100 ¹
		Low Impact	-5	-12	
		High Impact	-28	-65	
Orillia, Ontario	149				-40 to -100 ²
		Low Impact	-3	-8	
		High Impact	-19	-46	
Québec City, Québec	160				-42 to -70 ³
		Low Impact	-1	-5	
		High Impact	-13	-34	
Rutland, Vermont	119				-56 to -92 ⁴
		Low Impact	-5	-14	
		High Impact	-25	-60	
Ste Agathe-des-Monts, Québec	163				-48 to -87 ³
		Low Impact	0	-4	
		High Impact	-13	-32	
Thunder Bay, Ontario	163				-30 to -40 ²
		Low Impact	-2	-4	
		High Impact	-17	-36	

¹ Lipski and McBoyle (1991)

² Harrison *et al.* (1986)

³ Lamothe and Périard Consultants (1988)

⁴ Badke (1991)

Figure 2.1 Modeled ski season length for eastern North America incorporating snow-making technologies (Scott *et al.*, 2006 p.388)

Another study done by Scott *et al.* (2006) in Quebec found that as a result of projected climate change, in both high and low emissions scenarios, there will be a larger need for snowmaking. The greatest reductions in snow depth occur under the warmest 2050s scenario. This is when the loss of the ski season due to insufficient snow varies from 13-15% (Scott *et al.*, 2006). Although this seems like a considerable loss for ski resort revenues, these lost days occur at the start and end

of the season and not during the peak periods of Christmas and school holidays (Scott *et al.*, 2006).

The US Northeast and its vulnerability as a ski destination to climate change have also been examined by Hamilton *et al.* (2003), Scott *et al.* (2008), and Dawson *et al.* (2009). Hamilton *et al.* (2003), looked at the history of the New Hampshire ski industry and how due to reduced snowfall averages in the 1970s and 80s, a large number of small ski resorts in southern New Hampshire which did not have the economic means to invest in snowmaking technologies were forced to close. This ultimately led to a shift of the ski industry further north in New Hampshire as illustrated in Figure 2.2.

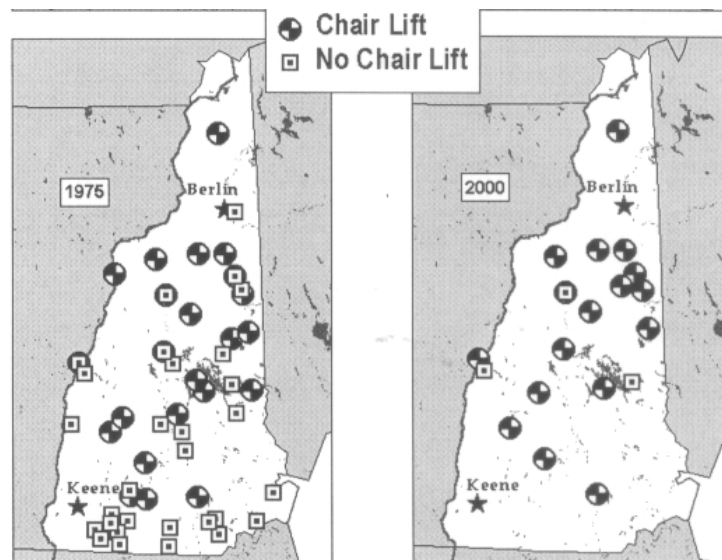


Figure 2.2 Geographical distribution of New Hampshire downhill ski areas known to be operating in 1975 and 2000 (Hamilton *et al.*, 2003 p.66)

As of 2002, there were only 17 chairlift areas remaining in operation. The strongest ski resorts were those with massive investments in snow-making and grooming, supported by real estate developments and year-round diversification programs (Hamilton *et al.*, 2003, p.65). Today, all of New Hampshire's large ski areas rely on snow-making as a means of extending their ski season and, on average, the snow guns can cover more than 90% of their terrain (Ski New Hampshire, 2002).

Scott *et al.* (2008) examined the vulnerability of alpine skiing in the US Northeast in both high and low emissions scenarios for the 21st century. They found that the ski season in the US Northeast ski region has varied as a result of climatic changes between 101 and 146 days between 1990-1991 and 2004-2005 (Scott *et al.*, 2008). In the Northeast, 15-20% of skier visits occur in the holiday period between December 22 and January 2. As a result, a ski area is identified as being vulnerable if their ski season falls below 100 days and if they could not be open during the entire Christmas holiday as a result of a warmer climate (Scott *et al.*, 2008). The study found that the adaptive capacity offered by snowmaking technologies drastically reduces the risk of the US Northeast ski industry. 'Through to 2040-2069, only seven out of the 14 study areas examined (Connecticut, western New York, southeastern New York, western Pennsylvania, southeastern Maine, eastern Pennsylvania, and eastern Massachusetts) were projected to have average ski seasons that were shorter than 100 days and have a lower than 75% probability of being open for the entire Christmas-New Year's holiday period, and thus be considered at risk economically' (Scott *et al.*, 2008, p.593). Although projected climate change would contribute to the loss of ski areas in some parts of the US Northeast, other areas such as southern Vermont, northeastern New Hampshire, northeastern New York and Western Maine, would be in a position to gain market share and possibly be able to offset the increased economic costs of snowmaking and a shorter season (Scott *et al.*, 2008).

Western North America

The implications of climate change for this mountain area have not yet been fully examined. There is one study conducted by Lazar and Williams (2008). They examined how future climate change scenarios would impact the timing and occurrence of wet avalanches in Aspen. Using the low, mid and high range scenarios outlined by the IPCC, they found that by 2030, wet avalanches are likely to occur

between 2 and 19 days earlier than previous avalanches (Lazar & Williams, 2008). In the future, wet avalanches will occur during the operational ski season, and therefore, ski area managers may be forced to close certain areas of their terrain, which could have economic impacts for ski areas that rely heavily on spring ski revenue (Lazar & Williams, 2008). More research is essential to understand the vulnerability of this area to climatic changes.

Europe

Some of the earliest studies on the impacts of climate change and the vulnerability of ski areas focused on the European Alps. Although these studies did not include snowmaking capabilities when assessing the levels of vulnerability, it is still an area that a large number of academics have studied. These include: Konig and Abegg (1997), Breiling and Charamaza (1998), Elsasser and Burki (2002), Moen and Fredman (2007), and Uhlmann *et al.* (2009).

Koenig and Abegg (1997) looked at winter tourism in the Swiss Alps. They found that those resorts with a lower elevation were the most vulnerable and this resulted in an advantage for resorts at higher altitudes. Under the current climate conditions, they found that 85% of all Swiss ski areas were snow reliable. However, with a two-degree rise in temperature, the number of snow reliable resorts would drop to 65%. Breiling and Charamaza (1999) assessed climate sensitivity and its implications for Austrian winter tourism. Using a two-degree warming, they examined each region and found that ski regions above 2000m in altitude are less vulnerable to global warming. However, in regions with low altitudes, the snow depth cover will be reduced by approximately 25% (Breiling & Charamaza, 1999). Elsasser and Burki (2002) also examined how climate change may threaten tourism in the Alps. They found that the snow shortage at the end of the 1980's left a clear mark on the ski tourism industry. The earnings of cable-way companies decreased by 20% compared to the 'normal' winter of 1986/1987 (Elsasser & Burki, 2002). Those that were particularly affected were smaller companies at lower and medium altitudes. A number of companies in regions above 1700 m achieved good and even first-rate results due to the lack of snow at lower and medium altitudes (Elsasser &

Burki, 2002). These early studies on the impact of climate change on ski tourism predict significant decreases in snow levels and resorts below a certain altitude within the Alps are projected to be extremely vulnerable.

Moen and Fredman, (2007) attempted to predict the impact of climate change on downhill skiing in Sweden. They also predicted the number of ski days that may potentially be lost and how this might impact revenues. They used two different climate scenarios (a low and high emission), and they found that 64 skiable days were lost under the cooler scenario and under the warmer scenario 96 days would be lost (Moen & Fredman, 2007). However, these lost ski days will occur at the start and end of the ski season and will not disrupt the holiday periods, which are the most important economically (Moen & Fredman 2007) (Figure 2.3).

Period	Current ski season ¹ (days)	RH-B2		RE-A2	
		Reduced ski season (days)	Reduced expenditures (Mill SEK ²)	Reduced ski season (days)	Reduced expenditures (Mill SEK ²)
Nov(24) – Dec	38	–32 (–85%)	–294.6	–38 (–100%)	–346.6
Jan – Mar	90	0 (0%)	0.0	–24 (–27%)	–722.5
Apr – May(4)	34	–32 (–95%)	–651.9	–34 (–100%)	–686.2
TOTAL	162	–64 (–40%)	–946.5	–96 (–59%)	–1755.3

(1) November 24 to May 4; 2) 1 EUR ≈ 9 SEK

Figure 2.3 Reduction in skiable days and total expenditures under both low and high emissions climate scenarios (Moen & Fredman, 2007 p.428)

According to Moen and Fredman (2007), it is likely that the alpine skiing industry in Sweden will have to either develop new or existing ski resorts further north in Sweden, develop alternative tourist activities that are less dependent on snow conditions, or employ the use of snowmaking technologies.

Uhlmann *et al.* (2009) analyzed the sensitivity of snow patterns in Swiss ski resorts to shifts in temperature, precipitation and humidity under future climate change conditions. Through the use of the Surface Energy Balance model, the potential future snow depth and duration as a result of climate change were established (Uhlmann *et al.*, 2009). They found that snow cover was reduced in each of the regions and some could suffer from a total loss of snow cover (especially during a particularly warm winter) (Uhlmann *et al.*, 2009). The most threatened

resorts are those situated in the western part of the country and in the Eastern Prealps, where snow depth is already less than other areas. They also found that snow becomes scarce on the lower runs of all the 20 ski resorts that were assessed (Uhlmann *et al.*, 2009).

Australia

The Australian ski industry consists of 10 ski resorts and is concentrated in the Australian Alps near New South Wales and Victoria. There have been a number of models developed to predict snow cover in Australia as a result of climate change. These include: Galloway (1988), Haylock *et al.* (1994), Whetton *et al.* (1996 and 1998) and Hennessy *et al.* (2003). The study by Whetton *et al.* (1996) showed that, under a best-case climate scenario, snow cover would decline by 18% before the year 2030 and by 39% before 2070. The worst-case climate scenario changes were much more drastic. The area was predicted to have more than 30 days cover reduced by 66% before 2030 and 96% before 2070. However, snowmaking technologies have been viewed by the Australian ski industry as a means of overcoming these drastic reductions in snow cover. Similar to the work of Scott *et al.* (2003 and 2005), Hennessy *et al.* (2003) examined the potential impact of two climate change scenarios at six ski area locations incorporating the use of snowmaking systems. They concluded that with the investment in snowmaking systems, the six ski areas would be able to cope with the impact of projected climate change until at least 2020 (Hennessy *et al.*, 2003).

2.4.2 Climate Change Adaptation in the Ski Industry

Climate change adaptation has been gaining importance in the last decade in the international literature as a crucial response to reduce the risks and take advantage of any opportunities associated with climate change. Various ski regions around the world have been identified as being vulnerable to climate change due to their dependence on snow reliability and as a result many of these areas have already begun to develop and implement adaptive measures in order to reduce their

level of vulnerability. According to Scott (2008) discussions of climate change adaptation in the tourism sector are the most advanced for the ski industry.

There are many types of potential climate change adaptations that could be undertaken by the ski industry. These can be classified as technical (snowmaking, slope development, cloud seeding, and artificial ski slopes), managerial (marketing and revenue diversification, accurate snow condition reports, low season closures, and ski conglomerates), and government and industry policy (public education campaigns, ski industry climate change policy, government energy policies, and government subsidies) (Scott & McBoyle, 2007). There are also a large group of stakeholders that can influence the adaptation options available to the ski industry. These include: individual ski areas, ski industry associations, government (all levels), the financial sector, tourists, skiers, and snowboarders. Figure 2.4 illustrates the climate adaptation options on both the supply and demand sides of the ski industry. This study contributed to the understanding of how skiers/snowboarders might alter the timing of skiing/snowboarding during the season, the skiing/snowboarding location (local, regional, international), and the substitution of skiing/snowboarding with another recreational activity.

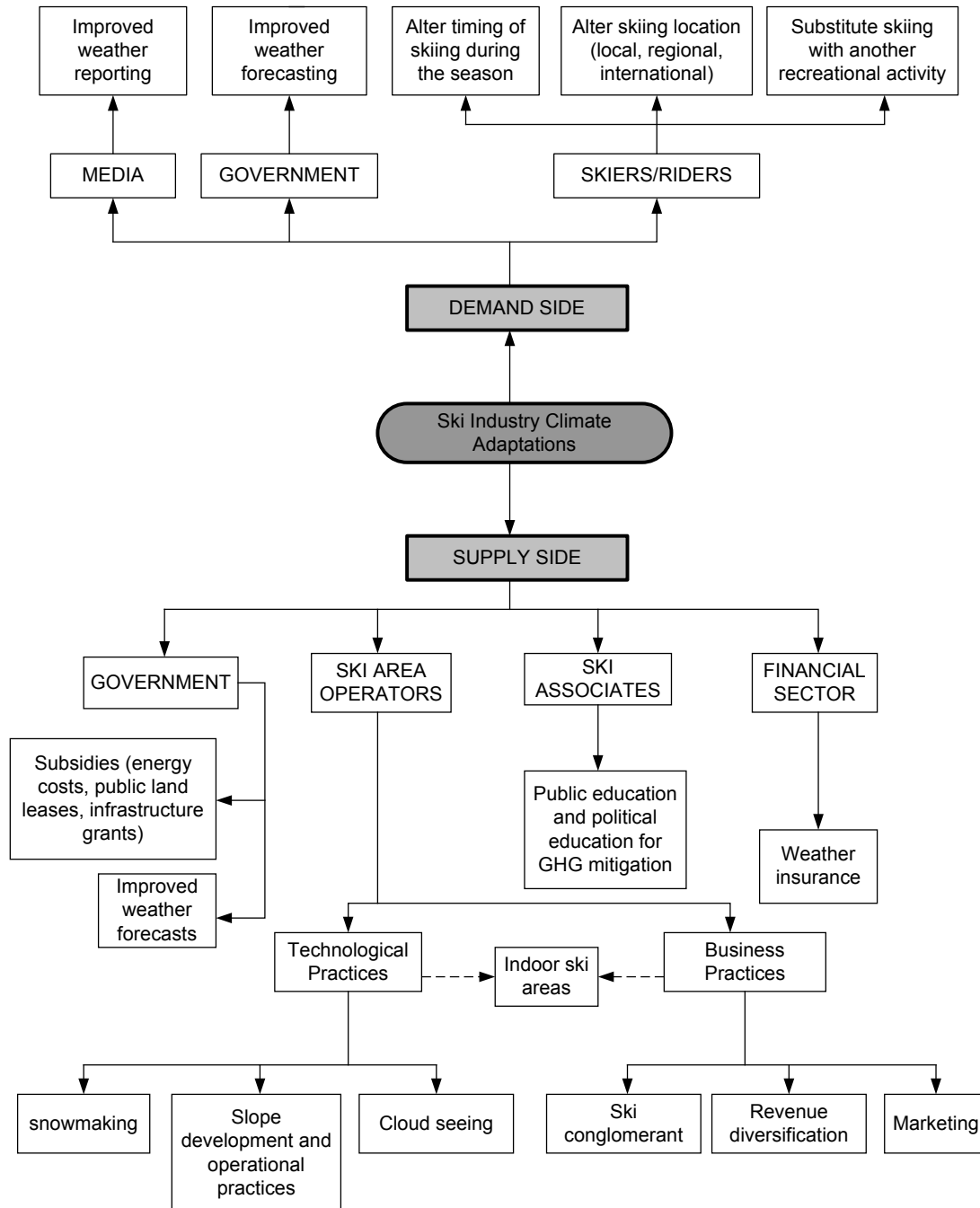


Figure 2.4 Ski Industry Adaptations (Scott & McBoyle, 2007 p.1415)

Snow-making is the most widely used adaptation strategy in the global ski industry. According to Scott and McBoyle (2007), the technology was first implemented in 1952 at the Grossinger Resort at Fahnestock, New York and, over the last 30 years, it has become an integral component in the ski industry in some regions (for example:

eastern North America, Australia, and Japan). Figure 2.5 illustrates the increased use of snow-making systems among ski areas in the US. Snow-making has proven to be essential in extending the average ski season for ski areas in eastern North America. Scott *et al.* (2006), found that snowmaking extended the average ski season in this area between 55 and 120 days during the baseline period of 1961-1990.

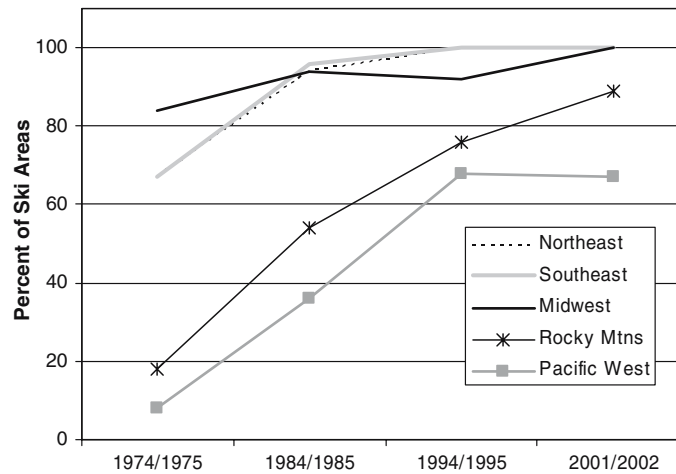


Figure 2.5 US ski areas with snowmaking systems (Scott & McBoyle, 2007 p.1416)

Due to the increased levels of snowmaking under future climate scenarios the question of the sustainability of this type of adaptation method has been raised. As stated in Scott and McBoyle (2007), communities and environmental organizations have expressed concern over the environmental impact of the large water withdrawals associated with snowmaking. Not only will the availability of water resources prove to be a constraint for the implementation of snowmaking, but the energy costs due to making snow in higher average temperatures may be too costly for some ski operators (Scott & McBoyle, 2007).

Slope development is another adaptation method that several ski operators have resorted to in order to minimize their vulnerability to climatic changes. Slope development adaptations consist of: slope contouring, landscaping, and the protection of glaciers. According to Scott and McBoyle (2007), the development of north-facing slopes that retain snowpack longer is one strategy that is currently being implemented by the Mont Tremblant ski area in Quebec. Another is the

expansion of ski areas into higher elevations. According to Konig and Abegg (1997), Elsasser and Burki (2002) and Breiling and Charamaza (1999), this strategy is the principal adaptation method being considered by ski operators in the European Alps. These areas at a higher elevation provide the possibility of a longer ski season and the snow levels are more reliable. However, these higher elevation ski areas may cause severe environmental degradation, as the high elevation mountain environments are particularly sensitive to disturbance.

Cloud seeding is a weather modification technology that has been used to produce additional precipitation. Although it has been largely used for agricultural purposes, some ski areas in North America and Australia have also used this technology as a means of generating additional snowfall (Scott & McBoyle, 2007). Another technological adaptation is the use of indoor ski slopes. The first known indoor ski slope, the 'Casablanca Dome', opened in Belgium in 1986. As of 2005 there were more than 50 indoor ski domes in operation globally. The value of indoor ski slopes is the potential to encourage an interest in skiing near urban markets that do not have the climate conditions to offer actual ski resorts (Scott & McBoyle, 2007).

Managerial adaptation measures are the types of adaptations that can be made among individual ski areas to their business practices. Ski resort conglomerates have emerged in the ski industry over the past decade. Examples within North America include: Intrawest, American Skiing Company, Boyne Resorts and Booth Creek Resorts. This business model allows for greater access to capital and reduces the vulnerability of individual ski areas to the effects of climate change. The probability of various regions in North America having poor snow conditions simultaneously is highly unlikely. Therefore, average economic performances in some regions can buffer losses in others (Scott & McBoyle, 2007).

Revenue diversification has been an integral component in the adaptive capacity of ski areas. Many ski resorts have made substantial investments to provide alternative activities for non-skiing visitors. These include: snowmobiling, skating, indoor pools, health and wellness spas, fitness centers, squash and tennis, games rooms, restaurants and retail stores (Scott & McBoyle, 2007). According to the NSAA

prior to 1975, almost 80% of ski resort revenues in the US came from lift ticket sales. During the 2001-2002 ski season, lift ticket sales only accounted for just below 50% because of a substantial increase in revenues associated with lessons, food and beverage, and accommodations (Scott & McBoyle, 2007). Many ski resorts have even gone as far as becoming four-season resorts and investing in real estate construction and management as a source of revenue (Scott & McBoyle, 2007).

There are various adaptation strategies available to the ski industry in order to decrease their vulnerability, and Hoffmann *et al.* (2009) found that a company's awareness of climate change and the possible effects it may have on the ski industry have a positive impact on the implementation of adaptation strategies. A few articles have focused on how stakeholders within the ski industry view the topic of climate change and how they plan to adapt to the future impacts. Behringer *et al.* (2000) spoke with tourism managers in order to understand their position on the issue of climate change. They found that tourism managers perceive climate change as a problem for the ski industry; however they give low priority to this problem. They also feel that media reports, and to some extent scientific reports, are too dramatic with their climate predictions and this ultimately leads to a bad image associated with ski tourism (Behringer *et al.*, 2000). Managers agree that snow reliability is becoming more important and does play a role in influencing the destination choice of skiers. They also view future adaptation strategies (such as extending into higher regions) as important in maintaining the sustainability of the ski tourism industry (Behringer *et al.*, 2000).

Bicknell and McManus (2006) conducted semi-structured interviews with ski resort representatives, local council, and state agency representatives. There were six important issues that emerged from these discussions: 1) they accepted climate change; however they played down the industry's vulnerability to it, 2) they perceived all-season tourism as important for the future viability of the industry as a way to remove dependence on winter tourism and snow, 3) they felt snowmaking has given resorts confidence in their ability to overcome certain climate change impacts, 4) they felt the availability of scientific research on the topic is very important, 5) their feelings on advocacy were mixed: some were for promoting their

resorts' environmental initiatives in response to climate change, others were against it because it makes them appear vulnerable to climate change and may deter investors, and 6) the majority of the resorts in this study had environmental policies in place (Bicknell & McManus, 2006).

Kundzewicz *et al.* (2007) also held a workshop in Switzerland in 2003 where one of the issues discussed was skiing in Alpine destinations. Participants consisted of: stakeholders (managers and employees within the sector, public administrators, planners, non-government organizations, and environmentalists), media and researchers. When discussing artificial snowmaking, participants agreed that producing artificial snow is beneficial for Alpine ski resorts because, without it, certain Alpine ski areas would be vulnerable, although, they all agreed that this may only reduce rather than eliminate the adverse effects of warming on winter tourism (Kundzewicz *et al.*, 2007). Stakeholders also felt that skiing is a mass tourist activity and alternative winter offers not related to snow can only partly compensate for the ski season loss. Ski tourists in these workshops accepted artificial snow as long as the snow quality is adequate and they stated that snow reliability is a key factor when choosing their holiday resort (Kundzewicz *et al.*, 2007). Although, in theory, this type of adaptation method appears to decrease the vulnerability of Alpine skiing destinations, stakeholders were also aware that, in the future, problems relating to artificial snow may be critical and volumes of water use will be very high (Kundzewicz *et al.*, 2007). Then the focus groups discussed the various management strategies that the ski industry is currently using as adaptation methods. Adaptive strategies that were discussed include: adaptation of infrastructure, new spatial planning, introduction of flexible dates of school holidays, retraining of winter tour employees, extension towards higher locations, snowmaking, and shaping an attractive alternative offer (Kundzewicz *et al.*, 2007).

Wolfsegger *et al.* (2008) found snow-making, sharing snow-making costs with the accommodation industry and expanding to higher elevations were the top three most preferred climate change adaptation strategies by Austrian ski area managers. They also found that government subsidies for snowmaking were highly supported by Austrian ski area managers, while government support for economic losses

following poor winters was only moderately supported (Wolfsegger *et al.*, 2008).

2.4.3 Implications of Climate Change for Skiing Demand

Most research on climate change and skiing has focused on the effects of climate change and how it may impact the ski season. However, how climate change will impact skiing demand is also crucial to understanding the full impact of climate change on the ski tourism industry. Gilbert and Hudson (2000) examined the demand constraints facing both skiers and non-skiers. These constraints were organized into three different categories: structural, interpersonal, and intrapersonal. Their study confirmed the results of previous researchers (Carmichael, 1992 and Richards, 1995) that snow conditions are a key variable when making destination choices. For skiers, the concern of a lack of snow and overcrowding were the two main constraints affecting their level of participation. They also revealed that they were constrained by time, family and economic factors (Gilbert & Hudson, 2000). Skiers and snowboarders are perceived to be very adaptable to climate variability as they can easily alter their destination, timing of their ski trip, or even substitute skiing with another recreational activity. The following section outlines the research that has focused on understanding how skiers and snowboarders may adapt to altered snow conditions as a result of climatic changes.

Eastern North America

Three studies have examined the behavioural response of winter sports tourists as a result of changes in snow conditions in eastern North America. Hamilton *et al.* (2007) conducted a study that focused on the impact of weather on skier demand. They tested the applicability of the “backyard hypothesis” which predicts that urban snow conditions significantly affect skier activity. Using the attendance records of two ski areas in New Hampshire and weather data they measured the applicability of the ‘backyard hypothesis’. They found that the presence of snow in urban market areas could be as important to ski businesses as snow cover in the mountains (Hamilton *et al.*, 2007). They also wondered if skiers

adapt to poor weather by waiting until conditions improve, or by skiing more frequently once conditions became acceptable. They found no pattern of skiers adapting to a poor start of the season by increasing their attendance later on (Hamilton *et al.*, 2007).

The second study looked at the impact of weather on downhill ski lift ticket sales. The explanatory factors that affect ski participation as identified by this study include: weather, prices, economic conditions, leisure time, etc (Shih *et al.*, 2009). Shih *et al.* (2009) looked at actual changes in demand for winter sports activities based on observed weather conditions and skier behaviour in Michigan. They found that snow depth as a local weather variable had a positive impact on sales. They observed a 7-9% increase in daily lift ticket sales with each additional inch of snow. Opposite to the results of Hamilton *et al.* (2007) in New Hampshire, they found that weather conditions in visitors' home areas did not have an effect on upstate ski areas in Michigan (Shih *et al.*, 2009). They found the greatest influence on daily lift tickets to be time of the week and holidays. During the peak ski season (Dec., Jan., Feb.) 50% of the average daily lift ticket sales occurred on Saturday and Sunday, and during the off peak season (Nov., Mar., Apr.) this increased to 56%.

The third study examined the past and future substitution behaviours of skiers in the US Northeast to marginal snow conditions. In this study, a climate change analogue approach was used to understand the potential response of the ski tourism marketplace to future climate change. The winter of 2001–2002 was the record warm winter throughout much of the region and closely related to the normal temperatures expected in mid-century under a mid-range warming scenario (approximately +4.5° C). As shown in Figure 2.6, it was found that 79% of respondents indicated that during past seasons with marginal snow conditions, they had stopped for an entire season and 79% stated they had skied more often as a result of shortened season lengths (Dawson *et al.*, 2009). This study also found that just over 50% of respondents indicated they stopped skiing for part of the season, 30% skied less often during a season, and 70% purchased less skiing related equipment and apparel. Just under 60% skied elsewhere within the US Northeast and 67% skied elsewhere outside of the region (Dawson *et al.*, 2009). Notably, skier

visits declined the least at larger ski areas, suggesting that skiers may have adapted by selecting ski areas that generally have greater snow-making capacities and diversified tourism products.

Type of Substitution	Past	Future	Difference
Stop for full season	78.7	79.6	+1
Stop for part season	53.3	47.8	-5.5
Ski less often	38	33.6	-4.4
Ski at higher intensity b/c of shorter season	79.1	76.8	-2.3
Ski elsewhere in Northeast	59.6	38.7	-20.9
Ski elsewhere outside Northeast	66.7	38.8	-27.9
Do something else	51.9	45.6	-6.3
Act the same	53.7	55.1	+1.4
Purchase less equipment/apparel	69.4	56.1	-13.3

Note: multiple response questions precludes responses from adding up to 100

Figure 2.6 Past and Future Substitution Behaviours (Dawson, 2009 p.72)

Western North America

One of the first studies that examined skier behaviours in western North America was conducted by Morey (1984). The author surveyed 163 post-secondary Colorado student skiers and found that costs, ability, and characteristics are all important determinants of the allocation of ski days (Morey, 1984). Beginner and intermediate skiers prefer resorts that have a number of hills less than their stated ability level and those that are advanced and frequent skiers prefer resorts with hills that challenge their ability. Therefore, demand for a ski resort will increase if the acreage that a person can ski at increases. Similar to Englin and Moeltner (2004), Morey (1984) also found that demand for most ski sites are cost elastic and that there is a large potential for substitution among the sites.

Englin and Moeltner (2004) examined the value of snowfall to skiers and boarders. This study used information about ski trips taken by college students in the winter of 1997/1998 at 13 different ski resorts in the Lake Tahoe region. The authors of this study felt that the skier/snowboarder experience would be impacted by weather and the snow conditions on that particular day. What they found was that, while skiers and riders do react to snow conditions (preferring lower temperatures and more snow), the characteristic that most impacted trip demand

was the cost of a lift ticket (Englin & Moeltner, 2004). As far as the importance they place on snowfall, skiers in this study placed a higher value on addition to the snow pack than boarders did. They also found that beyond 3 or 4 feet of added powder, little is gained by additional accumulations (Englin & Moeltner, 2004).

Europe

Several mountainous regions in Europe will face glacier retreat, and reduced snow cover and winter tourism. As a result several researchers have examined how these environmental impacts may alter winter tourists' behaviour. Alexandris *et al.* (2006) examined the relationship between place attachment and the concept of loyalty. They explored the degree to which service quality influences the development of place attachment in a ski resort. Data were collected through the use of a questionnaire at a ski resort in Southern Greece. They determined that both the dimensions of place identity and place dependence were applicable in the context of ski resorts and predicted a significant amount of variation in skiers' loyalty (Alexandris *et al.*, 2006).

Behringer *et al.* (2000) examined the perceptions of tourists on the topic of climate change and the manner in which they might adapt their behaviours. They surveyed 1000 skiers and snowboarders in Switzerland and found that 83% of respondents believed that climate change would threaten ski tourism and almost half believed that this would occur between the year 2000 and 2030 (Behringer *et al.*, 2000). When respondents were asked about the substitutability of ski destinations, 49% said they would ski in a more reliable location if they knew the next 5 winters would be snow deficient, 32% would ski less often and 4% would give up skiing altogether (Behringer *et al.*, 2000). Unbehaun *et al.* (2008) examined how climate change impacts may affect winter sports tourists, in terms of their activity levels as well as destination choice. When provided with scenarios of consecutive winters with snow deficiency, 68% of winter tourists would give up their destination loyalty in favor of a more snow-secure one (Unbehaun *et al.*, 2008). According to those surveyed, the attractiveness of snow secure destinations is influenced by price and travel time to get there. In order to make the shift to a more

snow reliable resort, the majority of respondents accept a 10% increase in the trip cost, but anything above that is unacceptable (Unbehaun *et al.*, 2008). They also found that the main motives of winter sports tourists include: physical activity, spending time with family and friends, and the winter experience.

Australia

One study has been conducted that has examined skier behaviours as a result of climatic changes in Australia. Koenig (1998) presented skiers with environmental scenarios and found that only 25% of the people surveyed indicated that they would continue to ski with the same frequency in Australia if winters became snow deficient. Thirty-one percent said they would ski less often but still remain in Australia, while 38% of the tourists surveyed said that they would substitute destinations and ski in New Zealand and Canada instead. Quite a large percentage are reporting that they would not ski in Australia, however the feasibility of traveling to another country to ski (cost and time) may prevent this large of a number from actually being able to ski outside of Australia.

Asia

In Japan, according to Fukushima *et al.* (2002), the ski industry has been involved in a 'weeding out' process which has been attributed both to the decrease in the younger population as well as the deterioration of natural snow quality. Therefore, it is important to determine how visitor numbers may decrease even further as a result of future climatic changes. Fukushima *et al.* (2002) investigated the influence of global warming on the leisure industry, particularly on the ski industry in Japan. Using a model for predicting snow depth, the relationship between climate conditions and the number of skiers was analyzed. They examined skier numbers in response to temperature increases. They found that at two of the six ski areas (both in southern locations) examined, visits were expected to fall more than 50% with a two-degree increase in temperature that would ultimately affect the level of snow depth. On the other hand, there was an insignificant drop in

numbers in northern ski areas even with an increase in up to three-degrees in temperature (Fukushima *et al.*, 2002).

2.5 Conclusion

Climate change is having and will have an impact on the global ski industry. It will affect certain countries and communities differently. However, all will have to address the issue in order to preserve the sustainability of ski tourism. There are a variety of adaptation measures (technical, managerial and government/industry policy) that the ski industry has access to and has begun to implement in order to reduce their vulnerability to climatic changes. Snow-making has allowed various regions and ski resorts to be less susceptible to climate change. However, the sustainability of this adaptation method may not be feasible in the future due to the availability of water and the financial cost. A lack of snow is thought to have a detrimental effect on skier demand. However, too much snow also negatively affects the industry because it can disrupt transportation systems and it can increase the risk of avalanches. Evidence in different studies also suggests that the potential impacts of climate change may alter the demand and adaptability of skiers. These changes may include choosing alternative destinations, different timing of vacations and even replacing skiing with another activity. Understanding how skiers may change their behaviours as a result of decreased environmental conditions at ski resorts is essential in predicting the future vulnerability of this industry.

Chapter 3: Research Methods

This chapter outlines the research method used to assess the behavioural adaptations of skiers and snowboarders in the US Northeast. It also provides an overview of the study area, the data collection process, the ethical considerations, and the research challenges and limitations involved in this study.

3.1 Data Collection

Questionnaire surveys were used to collect data from skiers and snowboarders on how they have responded to changing snow conditions in the past as well as how they may react in the future. Questionnaire surveys are appropriate when: trying to capture primary data from stakeholders, trying to get a broad look at people's opinions, perceptions, and behavioural changes, confirming the validity or reliability of existing data and when sufficient human and financial resources are available (Creswell, 2009). The disadvantages of questionnaire surveys include the data collection time and costs, findings are only as reliable as the survey instrument, they are unable to capture the latent demand market and they are unable to account for the differences between stated and revealed behaviour.

3.1.1 Study Area

The study area for this research consisted of seven ski resorts in the New England states of Vermont and New Hampshire. These were: Cranmore Mountain Resort (NH), Wildcat Mountain Ski Resort (NH), Loon Mountain (NH), Suicide Six (VT), Mad River Glen (VT), Jay Peak (VT) and Smugglers' Notch (VT). Table 3.1 summarizes the main ski resort characteristics. These resorts were chosen because they vary in size, location, travel time from Boston, and ownership properties in order to allow for a comparison among responses. Also, these resorts allowed for a survey to be distributed in the base lodge.

Table 3.1 Ski Resort Characteristics

	Cranmore	Wildcat	Loon	Suicide Six	Mad River Glen	Jay Peak	Smugglers Notch
Skiable Acres	200+	225	312	100	115	385+	1000
Summit Elevation	2000ft	4062ft	3050ft	1200ft	3637ft	3986ft	3640ft
Trails	54	50	55	23	47	76	78
Lifts	5	4	9	2	4	8	6
% of skiable terrain with snow-making capabilities	100%	90%	100%	50%	15%	80%	62%
Snow Conditions Guaranteed	No	Yes	Yes	No	No	Yes	Yes
Proximity to Boston	3hrs	3hrs	2hrs	2 ¾ hrs	3 ½ hrs	4hrs	4hrs

*** For more detailed information on each of the resorts - refer to Appendix B**

Cranmore, Loon, Jay Peak and Smugglers' Notch all have 'slope side' accommodations and are owned by ski conglomerates or affiliated with other travel companies, and, therefore, can be classified as large ski resorts. Wildcat, Mad River Glen, and Suicide Six are small to medium-sized independent ski resorts. These resorts do have special circumstances that allow for comparisons between the results. Wildcat is 100% located on National Forest Land and, therefore, cannot expand any further with regards to skiable terrain or on-site lodging, Mad River Glen is a resort that, in order to remain independent, has become a cooperative and currently is owned outright by skiers who have purchased shares. The travel times to these resorts from major cities in New England are also different. Some (Loon, Wildcat, Cranmore, and Suicide Six) are easily a day trip from a large urban market such as Boston, while others (Mad River Glen, Jay Peak, and Smugglers Notch) require a weekend trip or even a ski holiday (consisting of 3 or more days). Having a variety of resort sizes, locations and ownership properties allowed for a broader range of responses. Three resorts (all located in New Hampshire) have between 90-100% snowmaking capabilities (Cranmore, Wildcat, and Loon), Suicide Six, Jay Peak, and Smugglers Notch have between 50-75% of their trails equipped with

snowmaking capabilities, and only one resort had as low as 15% snowmaking capabilities (Mad River Glen). Wildcat, Loon, Jay Peak and Smugglers Notch also offer a free lift ticket (to be used at a later date) if skiers or snowboarders are unsatisfied with the ski conditions at the resort on that particular day.

3.1.2 Survey Design

Studies in the past that attempted to understand the intended future behaviours of winter sports tourists when faced with climate change impacts had known limitations and, therefore, special effort was made to improve on these areas. The survey scenarios in this study were more detailed than in previous skier behaviour surveys. This is the climate scenario question used by Koenig (1998) in the Australian skier survey:

‘Assuming that the next five winters had very little natural snow: please circle one option as to where you would ski/snowboard’. The options were ‘Australia same frequency’, ‘Australia less often’, ‘Overseas’ or ‘Give up’. (p.140)

Behringer *et al.* (2000) also asked skiers and snowboarders at Swiss ski resorts where and how often they would ski, if they knew that the next five winters would be snow deficient. Unbehaun *et al.* (2008) incorporated the aspect of future behaviour during possible climate change effects into their model of destination choice:

- Step 1: Choice between the two hypothetical profiles of ski destinations to learn about the preferences concerning the ski related performance of winter sport destinations.
- Step 2: Choice between the chosen alternative in step 1 and an equivalent destination with guaranteed perfect snow conditions.
- Step 3: If the snow-safe option was chosen in step 2, then the destination chosen in step 1 was offered one more time against the snow safe option but this time with additional resort amenities offered free of charge (p. 39)

The climate scenario questions in this survey went into much greater detail describing the length of the ski season, the opening date, the probability of being open over holiday periods and the average level of snowfall. Then respondents were asked if another winter like this happened next year, how they would change how

often, and where they would ski/snowboard. This is an example of one of the climate scenarios presented in this study:

‘Average snowfall at ski resorts in New England is 40% lower than normal, with little snowfall until after Christmas, except at high elevations. The ski season in the region starts 3 weeks late and is only 118 days long (an average winter is 132 days). A number of resorts have only some of their runs and chairlifts open over Christmas-New Year and Spring Break holidays’ (Appendix A – Question 19)

The inclusion of actual past winter scenarios (the 2001-2002 winter season) that also resemble future climate projections for the 2050s in the study area allowed the results of this survey to be related to past real events and help skiers better relate to the scenarios posed to them. The first climate scenario presented to respondents was based on the climate change analogue conditions from 2001-2002 (which was the warmest winter on record) and the 2050s mid range projections, as well as the NSAA data that were analyzed in Dawson *et al.* (2009). The second scenario respondents were presented with was partially based on the 2050s high emissions model (worst case scenario), and the season length was based on results from Scott *et al.* (2008). The survey used the framework of two similar studies conducted by Scott *et al.* (2007) who examined behaviour patterns of tourists visiting a Rocky Mountain National Park as a result of environmental changes and Dawson *et al.* (2009) who examined skier behaviour within New England as a result of climatic changes. The questions regarding both the importance of skiing or snowboarding to them, as well as how they feel about the ski resort that they go to most often were identical to those used by Dawson *et al.* (2009). Then the survey was expanded by using recent climate change and ski tourism literature to address other areas of interest that had not yet been explored in the study area.

The survey instrument consisted of three main areas. The first section focused on skier/snowboarder travel motivations and participation patterns. Questions in this section explored where, when and with whom people ski or snowboard, their opinion on acceptable travel times, main factors influencing their choice in ski resorts, and the importance of weather and ideal snow conditions. The second section addressed issues that may affect ski and snowboard participation patterns.

These include the importance of snow at their place of residence and how economic, weather and personal factors affect their participation levels. Then respondents were presented with two ski season scenarios using the projected climate changes for the 2050s (similar to the 2001-2002 ski season) and 2050s worst-case scenario and then asked whether they would participate in substitution behaviours as a result of these environmental changes. The third section is focused on respondent characteristics (gender, age and place of residence). The final version of the survey instrument can be found in Appendix A.

3.1.3 Pre-Testing

Prior to the distribution of the survey, pre-testing of the survey instrument was conducted on approximately ten of the researcher's friends and family to determine if the survey instrument would capture meaningful information and be easily understood by respondents. This pre-testing confirmed that the climate change scenarios were understood and allowed the researcher to gain a sense of the time required to complete the survey. The survey instrument received ethics approval through the Office of Research Ethics at the University of Waterloo in January 2010 and by ski resort managers also in January 2010.

3.1.4 Survey Implementation

The surveys were distributed at seven ski resorts in the New England states of New Hampshire and Vermont during the winter months of February and March 2010. The researcher approached everyone in the base lodge but only distributed the surveys to those who were an adult (18 years and older), had participated in skiing or snowboarding activities during the specific day and were willing to complete the survey. Respondents were informed that the survey would take approximately 10-15 minutes and that their participation was voluntary and a covering letter described the intent of the study. Their confidentiality was ensured since the survey was anonymous and their responses were being summarized with those of hundreds of other skiers and snowboarders. A total of 625 skiers and snowboarders were approached at various ski resorts in New England and 572

surveys were returned that were useable which resulted in a 92% response rate (Table 3).

Table 3.2 Survey Respondents Location

Resort	# of Surveys Collected
Cranmore	71
Wildcat	66
Loon	151
Suicide Six	53
Mad River Glen	64
Smugglers Notch	39
Jay Peak	128

3.2 Data Analyses

Following the fieldwork phase of the research the survey responses were input into SPSS (Version 17.0) for analysis. Frequencies were used to reveal the demographic, trip characteristics, factors influencing destination choice, weather preferences, factors affecting the participation levels, and substitution behaviours of skiers and snowboarders in the New England area. Then, through the use of chi squared tests, different groups within the sample were compared regarding their substitution behaviours. Factors that were examined include: activity involvement levels and place loyalty levels.

The existing literature on the topic of tourism and recreation behaviour has suggested that differences in an individual's level of experience or personal involvement in a particular activity can have a strong influence on participation behaviour (Havitz & Dimanche, 1990, Kyle et al., 2007, Baumgartner & Heberlein, 1980, Buchanan, 1985). 'Loyalty' is also seen as a common approach to investigating commitment to specific service providers and/or brands (Dimanche & Havitz, 1994; Kyle et al., 2007, Prichard & Howard, 1993, Buchanan, 1985). Therefore, the level of

activity involvement and the level of destination loyalty were used to analyze the substitution behaviours of skiers/snowboarders.

Individuals can become committed to particular activities through a series of three basic developmental stages. According to Iwasaki and Havitz (1998) first a high level of physical involvement is developed followed by the establishment of a psychological commitment and, finally, this leads to the maintenance of strong attitudes towards resistance to changing preferences. In order to measure the extent to which activity involvement and place loyalty play a role in influencing climate induced behavioural change, two previously validated behavioural psychology scales were used in the survey. Kyle et al.'s (2007) Modified Involvement Scale (MIS) was used to examine activity involvement and Prichard et al.'s (1999) Psychological Commitment Instrument was used to measure ski resort loyalty. Dawson (2009) reduced these behavioural psychology scales from 15 and 12 items to 10 and 8 respectively, due to the fact that they were too long to maintain respondents attention and threatened the response rate. Therefore, these condensed behavioural psychology scales were also used in this study.

In order to evaluate how respondents' climate induced behavioural change may differ based on their different levels of involvement in the activity of skiing or snowboarding three distinct groups were created (high, medium and low activity involvement). Those in the 'high level involvement' group scored a total of 40 or higher out of a possible 50 on Kyle et al.'s (2007) Modified Involvement Scale. Those in the 'medium level involvement' group scored a total of 30-39. Those in the 'low level involvement' group scored a total of 29 or lower on Kyle et al.'s Modified Involvement Scale (with the lowest possible score being 10). It is expected that those with a higher level of involvement, based on the importance of the activity in their lives, will be less likely to participate in temporal and activity substitution behaviours. The level of participation frequency in the activity of skiing/snowboarding was thought to be a key factor in predicting the importance of an activity to participants and, therefore, skiers/snowboarders were divided into three distinct groups, each with 33% (low, medium and high participation frequency). Those in the 'low level of participation' group ski/snowboard less than

10 days during the winter season. Those in the 'medium level of participation' group are those who ski/snowboard between 10 and 20 days during the winter season. Those in the 'high level of participation' group ski/snowboard more than 20 days during the winter season. It is anticipated that those with a higher level of participation will be less likely to participate in temporal and activity substitution behaviours.

In order to evaluate how respondents climate induced behavioural change may differ based on different levels of destination loyalty to their preferred ski resorts in New England three distinct groups (each with 33% of respondents) were created (high, medium and low destination loyalty). Those in the 'high level of destination loyalty' group scored a combined total of 32 or higher out of a possible 40 on Prichard et al.'s (1999) Psychological Commitment Instrument. Those in the 'medium level of destination loyalty' group scored a total of 24-31. Those in the 'low level of destination loyalty' group scored a total of 23 or less (the lowest possible score was an 8) on Prichard et al.'s (1999) Psychological Commitment Instrument. It is expected that skiers/snowboarders with a high level of loyalty to their preferred ski resort will be less likely to engage in spatial substitution behaviours. Those skiers/snowboarders that own a property at or near their preferred winter resort in New England could be classified as the 'most committed' group of skiers/snowboarders to their preferred resort in New England. Therefore, property owners versus non-property owners were also compared to determine any differences in their climate-induced behavioural changes. It is more likely that property owners will be much less likely to engage in spatial substitution behaviours.

3.3 Research Challenges and Limitations

This study has several limitations. The very subject of the survey may have been enough to affect the responses of respondents. Even the very mention of the 'climate change' issue in the US receives negative reactions from some people and with certain skiers and resort owners in New England. This perception could have

had an impact on the responses of some people. The survey was designed to avoid the mention of climate change and any related biased responses to the extent possible, by focusing on scenarios of 'climate variability' and ideal climate conditions.

The selection of survey sites is also a limitation. For this study Massachusetts, particularly Boston, was chosen as the market to be examined for New England ski resorts. Therefore, the only resorts that were contacted were those in New Hampshire, Vermont, and Massachusetts. Due to the need to receive resort approval, seven resorts out of 20 that were initially contacted chose to participate in the study. Some winter resort owners/managers have a negative attitude to the topic of climate change. Therefore, there were several resorts that did not give their approval to distribute a survey that was focused on the topic of climate variability and how skiers/snowboarders may respond to winters with marginal snow conditions. These managers did not agree with the scenarios presented, or the lines of questioning, and, ultimately, did not want their customers being reminded of, or informed about the concept of climatic variability and the future vulnerability of ski resorts due to warmer winters. During the resort approval process, it was evident that small-scale resorts, as a whole, were much more receptive to the distribution of the survey, and more interested in the results as well.

Initially, three resorts in Massachusetts were chosen. However, in the end they were not included in the study. One resort that initially agreed to participate chose not to in the end, another due to size and the age of skier participants (mostly under 18 years of age) was not surveyed, and the last resort happened to be closed the weekend that the surveyor was supposed to visit due to poor snow conditions.

Another limitation is the amount of time respondents had available to complete the survey. Most skiers and snowboarders approached were either in the base lodge for a mini break or for lunch. Therefore, the time required to complete the survey was kept to less than 15 minutes so that it was not too long. Ideally the survey could have been much longer to incorporate more lines of questioning and even open-ended questions. However, this was not feasible without negatively affecting response rates.

The weather on certain survey days was less than optimal for skiing/snowboarding. At one of the survey locations, for the first day, there were optimal ski conditions present. However, on the second day of surveying it was raining. At another location on the day that I distributed surveys, the conditions were very icy. A lot of respondents discussed the fact that they had received a free lift ticket due to the poor weather conditions. This poor weather may also have impacted some of the responses given on those particular days when asked about ideal weather conditions.

The responses from all resorts will be combined and treated as one sample. Also, the responses of skiers and snowboarders will be combined and treated as one sample.

This chapter has outlined the research methods used in this research study. The following chapter will present the findings of the skier/snowboarder survey.

4.0 Results

This chapter presents the results of the skier/snowboarder survey. The first section will discuss the demographics of skiers and snowboarders that participated in the study. The second section will outline the trip characteristics of the respondents to this survey. The third section will describe the factors influencing destination choice. The fourth section will examine the importance of weather preferences and ideal weather conditions while skiing or snowboarding. The final section will explore how climate change has impacted skier and snowboarder behaviours in the past, as well as how it might impact their behaviours in the future, in relation to participation levels.

4.1 Skier/Snowboarder Demographics

The gender of the respondents was split fairly evenly for skiers with 52% being female and 48% being male. On the other hand, with snowboarders, males accounted for 73% of respondents and 27% were female. The average age of skiers was 42 years old, and the average age of snowboarders was 28. Skiers accounted for 81% of the respondents, snowboarders accounted for 12% of the respondents and 7% considered themselves as both skiers and snowboarders. The majority of respondents considered themselves as either intermediate (49%) or expert (44%) level skiers, while 7% considered themselves beginners. When skiers were asked about their years of experience in the sport, 53% of respondents had less than 20 years of experience and 47% had greater than 20 years of experience. When snowboarders were asked about their years of experience in the sport 94% had less than 20 years of experience and only 6% had greater than 20 years of experience. Due to the large percentage of experienced skiers and snowboarders, 86% of the respondents owned their own equipment, while only 7% rented and 7% owned some equipment and rented some. The majority of respondents (63%) did not own or rent a property at or near their ski area. There is still, however, a significant

percentage (37%) of respondents who own a property (22%), own a timeshare (3%), or rent a property (12%) at or near their preferred ski area.

4.2 Trip Characteristics

The following section describes various trip characteristics for skiers and snowboarders within this study. Skiers ski on average 18 days per year and snowboarders ride on average 17 days per year. Half (52%) of skiers and 59% of snowboarders have purchased a season's pass in the past at a resort in New England, with 37% having purchased a season pass for more than 5 years and 63% for less than 5 years. On the other hand 48% have never bought a season's pass. The average number of days that respondents who have never bought a season's pass ski/snowboard during a season is 10 days. However, for those respondents who have a season's pass or have bought one in the past, the average number of days they ski/snowboard increases to 25 days per season. Skiers stated that when it comes to who they ski with, the largest percentage (63%) of people ski with friends or with a partner (61%). There is still a significant portion of individuals who ski with their parents (12%) and siblings (13%) as well. Only a small percentage of people ski with new acquaintances (6%) and a few respondents stated that they also ski with their coaches, team, other students, co-workers, and by themselves. Snowboarders on the other hand, stated that when it comes to who they snowboard with, the largest percentage (85%) of people ski with friends or with a partner (42%). There is still a significant portion of individuals who ski with their parents (16%) and siblings (22%). Skiers and snowboarders are different in terms of demographics and trip characteristics. However, their responses on factors influencing destination choice, weather preferences, factors affecting their participation levels and substitution behaviours (which are the focus of the thesis) were very similar, if not identical, and therefore, from this point on, the survey data was kept as one sample when analyzing skier/snowboarder responses.

Another area that was examined was where respondents ski (strictly in New England or do they travel elsewhere) as well as what days they typically ski on (weekends, weekdays, or public holidays). It was found that the majority of

skiers/snowboarders do not ski on weekdays and, if they do, it is less than 10 days per season. Just over one third (35%) of skiers and snowboarders do not ski weekdays at all during the winter months and 47% ski between a total of one to nine weekdays within a ski/snowboard season, and only 5% of people ski 20 or more weekdays (Table 4.1).

Table 4.1 Weekday Skiers/Snowboarders

Number of Weekdays	% of Respondents
0	35%
1-9	47%
10-19	13%
20-29	3%
30-39	1%
40+	1%

Weekends are when the majority of respondents report skiing/snowboarding. Only 7% of skiers do not ski on weekends at all. A total of 77% of respondents reported skiing/snowboarding anywhere between one and 19 days on the weekend throughout the year (Table 4.2).

Table 4.2 Weekend Skiers/Snowboarders

Number of Weekends	% of Respondents
0	7%
1-9	52%
10-19	25%
20-29	11%
30-39	4%
40+	1%

The majority of respondents do not ski on public holidays (65%), while 32% reported skiing on anywhere from one to five public holidays and 3% reported skiing 6 or more public holidays. Respondents were also asked to determine the number of days that they ski during the year where they ski more than 3 days in a row (allowing for the classification of a ski holiday versus a day trip).

Skiers and snowboarders were asked to identify the number of days that they ski in particular global ski areas (for example: New England, Midwest, Rocky Mountain states, Canada, Europe). Since the survey was distributed in the New England region, this was where the majority of respondents reported skiing (Table 4.3).

Table 4.3 Number of Days Respondents Ski in New England

# of Days in New England	% of Respondents
0	34%
1-9	36%
10-19	28%
20-29	14%
30-39	9%
40-49	6%
50 +	3%

Only 1% of respondents stated that they skied at least once in the Midwest, 15% in the Rocky Mountain States, 2% in California and Washington, 3% in the South Eastern US, 8% in Canada and 3% in Europe.

Skiers and snowboarders in New England typically travel by car or truck (95%). This is probably due to the fact that the majority of ski resorts in this region are within a six-hour drive. A small percentage of respondents travel either by bus (2%), or by train (1%) or by airplane (1%). Respondents were also asked their opinion on acceptable travel times for a day trip, a weekend trip, and a ski holiday (which consists of 3 or more days). For a day trip it was found that they majority of skiers/snowboarders find between either 3 or 4 hours (mean is 2.53, mode is 2) to be an acceptable travel distance. For a weekend trip the acceptable travel time rises to between 3 and 6 hours (mean is 4.09, mode is 4) For a ski trip the acceptable travel time is the greatest with 52% feeling that 6 hours or more is an acceptable travel time (mean is 5.04, mode is 6) (Table 4.4).

Table 4.4 Acceptable Travel Times for Ski Trips

Hours	Acceptable travel times for a day trip	Acceptable travel times for a weekend	Acceptable travel times for a ski holiday
1	13%	2%	1%
2	43%	6%	3%
3	32%	27%	11%
4	6%	30%	18%
5	2%	17%	13%
6 or more	4%	18%	55%

(n=541)

4.3 Skier/Snowboarder Motivations

Respondents were asked to rate on a five point scale numerous questions regarding both the importance of skiing/ snowboarding to them, as well as how they feel about the ski resort that they go to most often. Tables 4.5 and 4.6 outline the various statements and whether respondents agreed or disagreed with these statements. These questions were used to group respondents based on the level of involvement skiing/snowboarding has in their lives, as well as the level of destination loyalty to their preferred resort. These two questions were also used in Dawson *et al.* (2009) and were based on standard scales that have been developed and validated through previous research including: Dimanche & Havitz (2004), Kyle *et al.* (2007) and Prichard & Howard (1993).

Those in the 'high level involvement' group scored a total of 35 or higher out of a possible 50 on Kyle et al.'s (2007) Modified Involvement Scale (MIS). A score of 35 or higher indicated that they stated either 'agree' or 'strongly agree' to all the statements on the MIS. Those in the 'low level involvement' group scored a total of 34 or lower on Kyle et al.'s Modified Involvement Scale. This range of scores indicated that they stated either 'unsure' 'disagree' or 'strongly disagree' on all the statements on the MIS. Those in the 'high level of destination loyalty' group scored a total of 19 or higher out of a possible 30 on Prichard et al.'s (1999) Psychological Commitment Instrument (PCI). A score of 19 or higher indicated that they stated either 'agree' or 'strongly agree' to the statements on the PCI. Those in the 'low level of destination loyalty' group scored a total of 18 or less on Prichard et al.'s (1999)

Psychological Commitment Instrument. This range of scores indicated that they stated either 'unsure' 'disagree' or 'strongly disagree' on the statements on the PCI.

Table 4.5 The Importance of Skiing/Snowboarding

	Strongly Agree	Agree	Un- sure	Dis- agree	Strongly Disagree	Mean (1-5)	SD
Skiing/snow-boarding is one of the most enjoyable things I do	47%	42%	7%	3%	0%	4.33	0.8
Skiing/snow-boarding is very important to me	41%	39%	13%	7%	0%	4.14	0.9
I find a lot of my life is organized around skiing/snow-boarding	17%	29%	18%	29%	6%	3.22	1.2
Skiing/snowboardi ng has a central role in my life	18%	28%	19%	26%	9%	3.21	1.3
I enjoy discussing skiing/snow-boarding with my friends	25%	49%	14%	11%	1%	3.86	0.9
Most of my friends are skiers/snowboarders	12%	34%	22%	27%	5%	3.22	1.1
When I participate in skiing/snowboarding, I can really be myself	26%	41%	19%	11%	3%	3.75	1.1
I identify with the people and image associated with skiing/snowboarding	16%	34%	26%	18%	6%	3.37	1.1
Participating in skiing/snow-boarding says a lot about who I am	12%	31%	27%	24%	6%	3.20	1.1
When I ski/snowboard, others see me the way I want them to see me	8%	26%	35%	23%	8%	3.05	1.1

(n = 566, mean = 35, median = 36, mode = 36)

Table 4.6 Feelings About Preferred Ski Resort

	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree	Mean (1-5)	SD
My preference to ski/snowboard at my usual resort would not willingly change	19%	31%	24%	21%	4%	3.40	1.1
To change my usual resort would require major rethinking	18%	22%	20%	33%	6%	3.12	1.2
I ski/snowboard at my usual resort because the image comes closest to reflecting my lifestyle	10%	22%	24%	34%	11%	2.86	1.1
When I ski/snowboard at my usual resort it reflects the kind of person I am	9%	22%	25%	33%	12%	2.83	1.2
My decision to ski /snowboard at my usual resort was freely chosen from several alternatives	20%	45%	17%	14%	4%	3.64	1.1
I did not control the decision on whether to ski/snowboard at my usual resort	4%	13%	14%	42%	27%	2.26	1.1
I don't know that much about my usual ski resort	2%	9%	13%	44%	31%	2.07	1.0
I am knowledgeable about my usual resort	35%	43%	13%	8%	2%	4.02	0.9

(n=562, mean = 28, median = 28, mode = 24)

4.4 Factors Influencing Destination Choice

Respondents were presented with questions, based on previous literature, especially Dawson (2009), Unbehaun et al. (2008) and Gilbert & Hudson (2000), regarding factors that could influence their choice of resorts and then asked to rank whether they had a strong, minor, or no influence at all on their decision-making process when choosing a ski resort. The main factors that were found to have a strong influence when choosing a ski resort are: the quality of snow conditions (mean 2.73), the absence of crowded slopes (mean 2.67), close proximity to their place of residence (mean 2.52) and the price of lift tickets / passes (mean 2.45) (Table 4.7). Those that have little influence when choosing a ski resort are: an attractive nightlife (mean 1.53), the presence of non-related snow activities (mean 1.57) and the presence of beginner runs (mean 1.58) (Table 4.7). Respondents were also provided a space to include any other factors that are influential to them when choosing a ski resort. Those that were stated include: parking, quality of instruction/ski clubs/races, cleanliness, terrain parks/bumps/variety in terrain/glades, cheap accommodations, atmosphere, lifts/lift lines, and no snowboarders.

Table 4.7 The Importance of Destination Choice Factors

	Strong Influence	Minor Influence	No Influence	Mean (1-3)	SD
Quality of snow conditions	74%	25%	2%	2.73	0.7
Absence of crowded slopes	63%	34%	3%	2.62	0.7
Close proximity to my place of residence	61%	30%	9%	2.52	0.5
Price of lift tickets/passes	54%	37%	9%	2.45	0.8
Snowmaking capacity	42%	43%	15%	2.27	0.7
Good service	39%	46%	15%	2.25	0.8
Good facilities (e.g. accommodation, chalet, etc)	43%	38%	19%	2.24	0.7
Friends and family usually ski/snowboard there	42%	39%	19%	2.24	0.8
Presence of expert runs	32%	41%	28%	2.05	0.7
Absence of crowded chalet / services	29%	43%	28%	2.00	0.7
Presence of beginner runs	12%	33%	55%	1.58	0.7
Presence of non-snow related activities (e.g. pool, spa, restaurant)	10%	36%	54%	1.57	0.6
Attractive nightlife	10%	33%	57%	1.53	0.8

(n=555)

4.5 Weather Preferences

Respondents were asked the importance of various weather aspects as well as ideal conditions while skiing or snowboarding. They ranked their importance along a five point scale with five being extremely important, three being neutral and one being not important. It was found that the absence of rain was the most influential weather factor out of the 6 presented in this study with a mean of 4.44 (Table 4.8). Not having rain was extremely important to 66% of respondents. The second most important weather factor was having good visibility while skiing/snowboarding. A total of 61% of all respondents surveyed found that good visibility while skiing or snowboarding was either important or extremely important. The absence of strong winds was the next most important weather aspect. On average respondents found this to be very important with a mean of 3.66. A total of 60% of respondents felt that the absence of strong winds was either an

extremely important or an important weather factor when skiing or snowboarding. The fourth weather condition was the presence of sunshine when skiing or snowboarding and the greatest percentage of respondents 40% remained neutral on this issue. The fifth aspect of weather assessed was whether or not there were comfortable air temperatures while skiing/snowboarding. When skiing and snowboarding 33% of respondents found that a comfortable temperature outside while at the ski resort was important. With a mean of 3.20, falling snow was the least important weather factor affecting skiers and snowboarders. The largest percentage of respondents (48%) remained neutral on the aspect of falling snow being an ideal condition while skiing/snowboarding (Table 4.8).

Table 4.8 The Importance of Weather Aspects while Skiing/Snowboarding

	Extremely Important		Neutral		Not Important	Mean (1-5)
1) No rain	66%	19%	10%	2%	3%	4.44
2) Good Visibility	21%	40%	31%	5%	4%	3.68
3) No strong winds	23%	37%	31%	4%	6%	3.66
4) Sunshine	19%	30%	40%	4%	7%	3.51
5) Comfortable air temperature	16%	33%	35%	8%	9%	3.38
6) Falling snow	13%	23%	48%	7%	10%	3.20

(n=567)

Respondents were then asked to identify their ideal weather conditions for skiing/snowboarding. The first question was about which temperature(s) are ideal and the answers varied. With 60% of respondents incorporating it into their ideal temperature range, 30°F (-1°C) is the ideal temperature for skiing and snowboarding. As far as ideal wind conditions, 95% of respondents ideal wind conditions include either no wind at all or simply a light breeze while skiing and snowboarding: 55% do not want any wind and 40% are okay with a light breeze (1-5 miles/hour). With respect to ideal sky conditions 50% prefer 0% of cloud coverage, 39% would prefer 25% cloud coverage, and 9% prefer 50% cloud coverage.

4.6 Factors Affecting Participation Levels

Respondents were asked to rank the importance of a range of factors affecting participation levels on a five-point scale with five being the greatest importance and one having no affect at all. The factors examined include: economic, personal, and weather conditions. The most important factors in affecting the number of days that respondents ski/snowboard each winter are the snow conditions at their usual ski areas, good weather for skiing, ability to take holidays, the number of times family and friends want to go, and the price of a lift ticket/season pass (Table 4.9). Those with the least amount of influence affecting the number of days respondents ski/snowboard include: the cost of airplane tickets (mean 2.13), the amount of snow at their place of residence (mean 2.20) and gas prices (mean 2.37) (Table 4.9).

Table 4.9 The Importance of Factors Affecting Participation Levels

	Greatest Importance	Very Important	Somewhat Important	Not Very Important	No Affect at All	Mean (1-5)
Snow conditions at my usual ski areas	22%	39%	31%	5%	3%	3.73
Good weather for skiing	16%	39%	32%	7%	5%	3.56
Ability to take holidays	17%	30%	29%	13%	11%	3.28
Number of times family and friends want to go	14%	34%	29%	12%	11%	3.28
Price of lift ticket / season pass	14%	30%	36%	13%	8%	3.27
Depth of snow base at my usual ski areas	7%	30%	42%	15%	6%	3.16
Good road conditions to ski resort	6%	22%	34%	24%	14%	2.81
State of the economy	5%	14%	40%	24%	17%	2.65
Gas prices	3%	10%	31%	35%	22%	2.37
Amount of snow at my place of residence	4%	9%	21%	31%	34%	2.20
Cost of airplane tickets	5%	13%	17%	17%	47%	2.13

4.6.1 The 'Backyard Snow Effect'

When respondents were asked “When there is snow at your place of residence do you go skiing/snowboarding more often than when there is no snow in your backyard/neighbourhood?” 44% said yes, while 56% said no. Therefore, skiers and snowboarders in this study were split regarding the bearing that the ‘backyard snow effect’ has on their level of ski activity. This was the one question where the responses were significantly different depending on whether the respondent was a skier or a snowboarder. Snowboarders stated that they were more impacted by the ‘backyard snow effect’ (54%), compared to skiers (42%).

4.6.2 Climate Scenarios

The following section highlights the two climate scenarios that respondents were presented with in order to determine how climate might impact their skier/snowboarder participation patterns. Skiers and snowboarders surveyed were presented with a scenario that resembles the record warm winter of 2001/02 and was also a mid range 2050s analogue that resembles climate change projections for an average winter in this region.

Scenario A: Average snowfall at ski resorts in New England is 40% lower than normal, with little snowfall until after Christmas, except at high elevations. The ski season in the region starts 3 weeks late and is only 118 days long (an average winter is 132 days). A number of resorts have only some of their runs and chairlifts open over Christmas-New Year and Spring Break holidays.

Then they were asked if another winter such as that were to occur the following year, how they would change their skiing/snowboarding behaviour. In terms of how often they would go skiing/snowboarding: 87% would ski/snowboard their usual frequency, just a fewer total number of days, 11% would ski/snowboard more often than normal to make up for a shorter season, and 1% would stop skiing/snowboarding for the entire winter.

In relation to where they would go skiing/snowboarding: 60% said that they

would wait until their usual ski/snowboard locations in New England were open. 23% said that they would travel further to find better snow conditions within New England. 9% said that they would take a ski holiday outside of New England and not ski in New England, and 3% said that they would do something else instead of skiing.

The second climate scenario that respondents were presented with resembles the worst-case scenario for the 2050s high emissions model as outlined by the IPCC.

Scenario B: Average snowfall at ski resorts in New England is 65% lower than normal, with little snowfall until after Christmas, except at the highest elevations. The ski season in the region starts 4 weeks late and is only 99 days long (an average winter is 132 days). Many resorts in the region are closed over Christmas – New Year and Spring Break holidays. Only ski/snowboard areas in Vermont, Northern New Hampshire, and Northern Maine have good snow conditions.

When asked how often they would go skiing/snowboarding: 84% would ski/snowboard their usual frequency, just a fewer total number of days, 11% would ski/snowboard more often than normal to make up for a shorter season, 4% would stop skiing/snowboarding for the entire winter, and 1% said they would stop skiing/snowboarding altogether if a winter like the one described occurred.

In terms of where they would go skiing/snowboarding: 53% said that they would wait until their usual ski/snowboard locations in New England were open. 30% said that they would travel further to find better snow conditions within New England. 11% said that they would take a ski holiday outside of New England and not ski in New England, and 6% said that they would do something else instead of skiing.

The substitution responses were then compared to determine if there were any similarities or differences between skiers/snowboarders based on the survey location, and respondents' place of residence. The seven survey locations were in different states, and they varied based on their skiable terrain, number of trails, snowmaking capabilities and ownership properties. However, the responses to the

substitution questions in both the 2050s mid-range and worst-case scenario are all very similar, regardless of the resort location (Table 4.10 and Table 4.11).

Table 4.10 Substitution behaviours based on survey locations

	Cranmore	Wildcat	Loon	Suicide Six	Mad River Glen	Jay Peak
2050s mid-range scenario						
Usual frequency just a fewer total # of days	85%	86%	91%	88%	87%	87%
More often than normal to make up for shorter season	13%	12%	8%	10%	13%	13%
Stop for the entire winter	2%	2%	1%	2%	0%	1%
Stop altogether	0%	0%	0%	0%	0%	0%

2050s worst-case scenario						
Usual frequency just a fewer total # of days	69%	66%	69%	70%	67%	52%
More often than normal to make up for shorter season	22%	20%	21%	18%	25%	32%
Stop for the entire winter	6%	11%	8%	10%	8%	10%
Stop altogether	3%	3%	3%	2%	0%	6%

When presented with the 2050s mid-range and worst-case scenarios, temporal and activity substitution behaviours are similar among all resorts. Loon Mountain has the highest percentage of skiers/snowboarders that would ski their usual frequency, just a fewer total number of days (91%). However, this means that they also have the lowest percentage of respondents (8%) that would ski/snowboard

more often than normal to make up for a shorter season (Table 4.10). During the 2050s worst-case scenario, again substitution behaviours are similar among all resorts, except for Jay Peak. Half (52%) of respondents stated skiing/snowboarding their usual frequency just a few number of days, while 32% would ski/snowboard more often than normal to make up for a shorter season (Table 4.10). Another interesting result is that skiers at Mad River Glen are the only respondents in both climate scenarios where not one person reported that they would stop skiing altogether (Table 4.10).

Table 4.11 Substitution behaviours based on survey locations

	Cranmore	Wildcat	Loon	Suicide Six	Mad River Glen	Jay Peak
2050s mid-range scenario						
Wait until usual ski resort in New England opened	83%	86%	84%	84%	92%	83%
Travel further to find better snow in New England	10%	11%	9%	12%	8%	14%
Take a ski holiday outside New England and not ski in New England	7%	3%	6%	4%	0%	2%
Do something else instead of skiing	0%	0%	1%	0%	0%	1%

2050s worst-case scenario						
Wait until usual ski resort in New England opened	61%	53%	58%	53%	60%	40%
Travel further to find better snow in New England	29%	36%	23%	29%	27%	40%
Take a ski holiday outside New England and not ski in New England	3%	5%	13%	16%	13%	12%
Do something else instead of skiing	7%	6%	6%	2%	0%	7%

When presented with the 2050s mid-range and worst-case scenarios, spatial and activity substitution behaviours are similar among most resorts surveyed. There were, however, a few differences that should be noted. In the 2050s mid-range scenario skiers at Mad River Glen were much more likely to wait until their preferred ski resort opened (92%) and none of the skiers would either travel outside New England and not ski in New England, or do something else instead of skiing (Table 4.11). During the 2050s worst-case scenario, only 40% of skiers/snowboarders at Jay Peak would wait until their usual ski resort opened, while 40% would travel further in New England to find better snow conditions (Table 4.11).

The majority of respondents were from the states of Massachusetts (42%), New Hampshire (8%) and Vermont (17%). The substitution responses, in relation to where they would ski/snowboard during snow deficient winters, as well as, their level of participation frequency were compared based on the respondents' place of residence. Those who lived in New Hampshire and Vermont were classified as local visitors (since this was where the resorts surveyed were located). Those who lived in the other states that make up New England (Massachusetts, Maine, Rhode Island and Connecticut) were considered regional visitors. Any other states or provinces were considered extra-regional visitors. During the 2050s mid-range scenario local and extra-regional visitors are very similar regarding their temporal and activity substitution behaviours and therefore the chi square result was not significant. While the majority of local and extra-regional visitors (85% and 83%) reported that they would ski/snowboard their usual frequency but just a fewer total number of days, 14% and 15% would ski more often than normal to make up for a shorter season. Regional visitors (90%) reported that they would ski/snowboard their usual frequency, and only (9%) would ski more often than normal to make up for a shorter season. When presented with the 2050s worst-case scenario local visitors were more likely (73%) to ski/snowboard their usual frequency but just a fewer total number of days. On the other hand, regional and extra-regional visitors were more likely (23% and 27%) to ski/snowboard more often than normal to make up for a shorter season. Extra-regional visitors are however much more likely to stop

skiing for the entire winter (14%) as well as stop skiing altogether (8%). (Table 4.12)

Table 4.12 Substitution behaviours based on respondents place of residence

Climate Projections		Local (NH & VT)	Regional (NE)	Extra-Regional
n = 545				
2050s (mid-range)	Usual frequency just a fewer total # of days	85%	90%	83%
($\chi^2 = 6.15$, $p < 0.4$, $df = 6$)	More often than normal to make up for shorter season	14%	9%	15%
	Stop for the entire winter	2%	1%	2%
n = 540				
2050s (worst-case)	Usual frequency just a fewer total # of days	73%	63%	55%
($\chi^2 = 19.22$, $p < .004$, $df = 6$)	More often than normal to make up for shorter season	17%	27%	23%
	Stop for the entire winter	9%	7%	14%
	Stop altogether	2%	3%	8%

***To avoid empty cells in a contingency table for chi square testing the variable stop skiing altogether was excluded from the 2050's mid-range scenario analysis.**

There are a few key overall findings, with regard to substitution behaviours, that are worth noting. The first is that very few respondents will give up skiing, and few will go outside of New England to ski. The second is that there is little variance among substitution responses for the mid-range scenario but are more marked for the worst-case scenario.

Table 4.13 Substitution behaviours based on respondents' place of residence

Climate Projections		Local (NH & VT)	Regional (NE)	Extra-Regional
n = 546				
2050s (mid-range)	Wait until usual ski resort in New England opened	87%	86%	79%
($\chi^2 = 9.92$, $p < .128$, $df = 6$)	Travel further to find better snow in New England	13%	9%	13%
	Take a ski holiday outside New England and not ski in New England	1%	4%	8%
n = 538				
2050s (worst-case)	Wait until usual ski resort in New England opened	68%	50%	45%
($\chi^2 = 23.11$, $p < .001$, $df = 6$)	Travel further to find better snow in New England	25%	32%	29%
	Take a ski holiday outside New England and not ski in New England	6%	12%	16%
	Do something else instead of skiing	1%	6%	10%

***To avoid empty cells in a contingency table for chi square testing the variable do something else instead of skiing was excluded from the 2050's mid-range scenario analysis.**

Only in the 2050s worst-case scenario are local visitors much more likely to wait until their preferred ski resort opens (68% compared to 50% and 45%). Local visitors are also much less likely to take a ski holiday outside (6% compared to 12% and 16% in the 2050s worst-case scenario) (Table 4.13). While the 2050s mid-range scenario responses were not statistically significant they are still worth noting. Extra-regional visitors were 7-8% less likely than local and regional visitors to wait until their usual ski resorts opened. Extra-regional visitors were also more likely to take a ski holiday outside New England and not ski in New England (8% compared to 4% of regional and 1% of local visitors).

4.6.3 Influence of Climate on Use of Recreational Properties

Respondents were also asked whether or not they owned or rented a property near their preferred ski resort. The 37% of respondents who answered “Yes” were asked questions regarding the level of use of these recreational properties and how it may change as a result of the length of the ski season due to climatic conditions. It was found that 63% of skiers/snowboarders in New England do not own or rent a property at or near their ski area, 22% own a property, 3% own a timeshare and 12% rent a property. The number of days that they use these recreational properties on average, is 79 days with the median being 99 days, and on average, 73 days are within the ski/snowboard season.

If the average ski season length was reduced by 33% over a normal winter (similar to the climate analogue season of 2001/02): 5% would use the property more often, 57% would use the property about the same amount as they do now, 30% would use the property a little less often, 7% a lot less often and 1% would simply sell the property (Table 4.14). If the average ski season length was reduced by 50% over a normal winter (more severe than the 2050s worst case scenario for the regional average, however this level of reduction did occur for some areas in the Scott et al. 2008 models): 3% would use the property more often, 45% would use the property about the same amount as they do now, 30% would use the property a little less often, 17% a lot less often and 5% would simply sell the property (Table 4.12). If the ski area that their property was nearby happened to close as a result of poor climate conditions (an extreme case, however, ski resort closures will occur for some areas in the Scott et al 2008 models): 5% would use the property more often, 28% would use the property about the same amount as they do now, 12% would use the property a little less often, 33% a lot less often and 21% would simply sell the property (Table 4.14).

Table 4.14 Influence of Climate on Property Use

	33% reduction in average ski season length	50% reduction in average ski season length	If the nearby ski area closed
Would use the property more often	5%	3%	5%
Would use the property about the same	57%	45%	28%
Would use the property a little less often	30%	30%	12%
Would use the property a lot less often	7%	17%	33%
Would sell the property	1%	5%	21%

(n=210)

4.6.4 Activity Involvement and its Impact on Participation

In order to further understand the future substitution behaviours of skiers and snowboarders their responses were analyzed in relation to various components of the survey that examined activity involvement. Using chi square testing, 'high involvement participants' 'medium involvement participants' and 'low involvement participants' were compared based on their responses to the two climate scenarios, and whether they would ski/snowboard their usual frequency, more often to make up for a shorter season, stop for an entire winter, or stop altogether. The 'high level of involvement' group is those who place skiing/snowboarding as an important activity in their lives. This was determined based on their mean score being greater than or equal to 40 on the Modified Involvement Scale (MIS). Respondents in this group selected either 'agree' or 'strongly agree' on each of the statements in the MIS question and 31% of respondents fall into this category. These respondents are those who have progressed through the stages of commitment and therefore thought to be highly involved in the activity of skiing/snowboarding. The 'medium level of involvement' group had a combined score of 30-39 on the Modified Involvement Scale. Respondents in this group selected either 'unsure' or a combination of 'agree'/'disagree' on each statement in the MIS question and 47% of respondents fall into this category. The 'low level of involvement' group does not

demonstrate this type of ‘committed involvement’. Respondents in this group do not consider skiing/snowboarding as an important activity in their lives.

Skiers/snowboarders in their group have a total mean score of less than or equal to 29 on the Modified Involvement Scale. Respondents in this group selected either ‘disagree’ or ‘strongly disagree’ on all statements in the MIS question and 22% of respondents fall into this category. However, their participation in the activity at all suggests that they do have some level of involvement when compared to someone who has never skied/snowboarded and does not intend to.

Table 4.15 Comparing Levels of Involvement and Substitution Behaviours

Climate Projections		Low Level of Involvement	Medium Level of Involvement	High Level of Involvement
n = 532				
2050s (mid-range)	Usual frequency just a fewer total # of days	93%	88%	83%
($\chi^2 = 10.90$, $p < .091$, $df = 6$)	More often than normal to make up for shorter season	5%	11%	16%
	Stop for the entire winter	1%	1%	1%
n = 532				
2050s (worst-case)	Usual frequency just a fewer total # of days	56%	69%	59%
($\chi^2 = 14.30$, $p < .03$, $df = 6$)	More often than normal to make up for shorter season	25%	21%	28%
	Stop for the entire winter	11%	7%	11%
	Stop altogether	8%	3%	2%

***To avoid empty cells in a contingency table for chi square testing the variable stop skiing altogether was excluded from the 2050’s mid-range scenario analysis.**

While the chi square result for the 2050s mid-range scenario is not statistically significant, there may be a trend. Those who are thought to be 'highly committed' to the activity of skiing/snowboarding are more likely (16% compared to 5%) during the 2050s mid-range scenario to ski more often than normal to make up for a shorter winter season (Table 4.15). Whereas, those who do not demonstrate a level of 'committed involvement' are more likely (93% compared to 83%) during the 2050s mid-range scenario to ski their usual level of frequency, just a fewer total number of days (Table 4.15). Chi square test results reveal a statistical difference between respondents in the low, medium and high level of involvement groups in the 2050s worst-case scenario. The percentages are much closer and therefore, even though chi square testing determined a statistical significance, it may not be substantively important. There is a substantial difference in whether respondents would stop skiing for an entire winter. Here, those in the 'low level of involvement' group are more likely (8% compared to 3% and 2%) to not ski/snowboard if conditions in the second climate scenario occurred (Table 4.15).

The second variable examined was respondents' level of involvement based on the number of days they ski/snowboard in a season. Three distinct groups were created based on participation frequency (low, medium and high). The 'low participation' group ski/snowboard on average less than 10 days per winter season (33% of respondents fell into this category). The 'medium participation' group ski/snowboard on average between 10 and 20 days (33% of respondents fell into this category) and the 'high participation' group ski/snowboard on average greater than 20 days each winter season (33% of respondents fell into this category).

Table 4.16 Comparing Participation Frequency and Substitution Behaviours

Climate Projections		Low Level of Participation	Medium Level of Participation	High Level of Participation
n = 550				
2050s (mid-range)	Wait until usual ski resort in New England opened	82%	85%	87%
($\chi^2 = 20.55$, $p < .002$, $df = 6$)	Travel further to find better snow in New England	8%	12%	12%
	Take a ski holiday outside New England and not ski in New England	10%	3%	1%
n = 542				
2050s (worst-case)	Wait until usual ski resort in New England opened	55%	50%	55%
($\chi^2 = 28.38$, $p < .001$, $df = 6$)	Travel further to find better snow in New England	26%	32%	33%
	Take a ski holiday outside New England and not ski in New England	7%	14%	12%
	Do something else instead of skiing	13%	4%	1%

***To avoid empty cells in a contingency table for chi square testing the variable do something else instead of skiing was excluded from the 2050's mid-range scenario analysis.**

During the 2050s mid-range scenario 82% – 87% of respondents regardless of their participation level would wait until their usual ski resort in New England opened. However, these percentages drop significantly during the 2050s worst-case

scenario, where only 50% - 55% would wait until their usual ski resort in New England opened (Table 4.16). The major differences in behavioural responses occur between those considered 'low level participants' and 'high level participants'. During the 2050s mid-range scenario, 10% of 'low level participants' stated that they would take a ski holiday outside New England and not ski in New England, compared to 3% of 'medium level participants' and 1% of 'high level participants' (Table 4.16). Also during the 2050s worst-case scenario, 13% of 'low level participants' stated that they would do something else instead of skiing/snowboarding (Table 4.16).

4.6.5 Destination Loyalty and its Impact on Resort Substitution

Using chi square testing, 'high loyalty participants' 'medium loyalty participants' and 'low loyalty participants' were compared to the two climate scenarios (2050s mid-range and 2050s worst-case), and whether they would wait until their usual ski resort in New England opened, travel further to find better snow in New England, take a ski holiday outside New England and not ski in New England, or do something else instead of skiing. Based on the responses to Question 12 (the Psychological Commitment Instrument), those with a mean score of greater than or equal to 32 (32% of respondents) are thought to have a 'high level of destination loyalty' towards their preferred winter resort, whereas those with a mean score of less than or equal to 23 (18% of respondents) are thought to have a 'low level of destination loyalty'. Those with a mean score of 24 – 31 (50% of respondents) are thought to have a 'medium level of destination loyalty'.

Table 4.17 Comparing Resort Loyalty and Substitution Behaviours

Climate Projections		Low Level of Loyalty	Medium Level of Loyalty	High Level of Loyalty
n = 534				
2050s (mid-range)	Wait until usual ski resort in New England opened	81%	87%	87%
($x^2 = 15.56$, $p < .001$, $df = 3$)	Travel further to find better snow in New England	7%	9%	12%
	Take a ski holiday outside New England and not ski in New England	11%	4%	2%
n = 530				
2050s (worst-case)	Wait until usual ski resort in New England opened	45%	49%	65%
($x^2 = 10.79$, $p < .01$, $df = 3$)	Travel further to find better snow in New England	32%	33%	26%
	Take a ski holiday outside New England and not ski in New England	13%	12%	10%
	Do something else instead of skiing	10%	5%	0%

***To avoid empty cells in a contingency table for chi square testing the variable do something instead of skiing was excluded from the 2050's mid-range scenario analysis.**

Chi square tests revealed significant differences among these three loyalty level groups. Those respondents that were knowledgeable about their preferred resort, chose it freely from all other alternatives, and those who felt that their preference would not willingly change, were less likely to engage in resort substitution behaviours in both the 2050s mid-range and worst-case climate scenarios. Eighty-seven percent and 65% of 'high level loyalty' respondents compared to 81% and 45% of 'low loyalty respondents' would wait until their usual resort in New England opens during the 2050's mid-range and 2050s worst case scenarios respectively

(Table 4.17).

The second variable examined was the influence of owning a property on resort substitution behaviours. A chi square test was run to determine if there were any differences in the future behavioural adaptation of skiers/snowboarders if they own a property (25% of respondents) versus if they do not (75% of respondents).

Table 4.18 examines these differences:

Table 4.18 Comparing Property Owners and Substitution Behaviours

Climate Projections		Own Property	Do Not Own Property
n = 449			
2050s (mid-range)	Wait until usual ski resort in New England opened	73%	59%
($x^2 = 8.15, p < .05, df = 3$)	Travel further to find better snow in New England	18%	26%
	Take a ski holiday outside New England and not ski in New England	8%	10%
	Do something else instead of skiing	1%	5%
n = 450			
2050s (worst-case)	Wait until usual ski resort in New England opened	59%	51%
($x^2 = 2.75, p < .5, df = 3$)	Travel further to find better snow in New England	27%	32%
	Take a ski holiday outside New England and not ski in New England	11%	11%
	Do something else instead of skiing	3%	6%

Chi square tests reveal small but significant differences in relation to ‘resort loyalty levels’ in both climate scenarios. Those who own a property in the area are more likely to wait until their usual ski resorts open (73% compared to 59% in the 2050s

mid-range scenario and 59% compared to 51% in the 2050s worst-case scenario) (Table 4.18). Property owners are also less likely to travel further in New England to find better snow conditions (18% compared to 26% in the 2050s mid-range scenario and 27% compared to 32% in the 2050s worst-case scenario) (Table 4.18).

4.6.6 Summary

This chapter investigated skier/snowboarder demographics, trip characteristics, factors influencing destination choice, weather preferences, and factors affecting participation levels (specifically future climate scenarios). Then visitor segments based on loyalty and participation levels were created and later compared to the climate change scenarios that were presented. The purpose of this was to examine if certain visitor segments would respond differently to the future impacts of climate change. Using the climate scenarios for the 2050's mid-range and 2050's worst-case winter ski season scenarios respondents were able to assess their participation levels in response to these decreased snow conditions and ski seasons. The changes identified in the scenario depicting the climate predictions for the worst-case 2050s had the largest percentage of respondents participating in activity, spatial, and temporal substitution behaviours.

5.0 Discussion

This research study has sought to examine the behavioural adaptations of skiers/snowboarders as a result of climate variability and change. The following section interprets the main findings of the study and relates these to the relevant academic literature discussed in earlier chapters.

5.1 Willingness to Travel

Willingness to travel among skiers and snowboarders provides an insight into the practicality of skiing at a more snow-secure destination within New England if marginal snow conditions exist at their preferred resort. This study evaluated the acceptable travel time for winter holidays of different lengths. It was found that for a day trip the majority (72%) of skiers/snowboarders find between either 3 or 4 hours to be an acceptable travel distance. For a weekend trip the acceptable travel time rises to between 3 and 6 hours (71%) and for a ski trip the acceptable travel time is the greatest with most (55%) feeling that 6 hours or more is an acceptable travel time (Table 4.4). The resorts that were surveyed in this study have different travel times from main market areas. Some (Loon, Wildcat, Cranmore, and Suicide Six) are easily a day trip from a large urban market such as Boston, while others (Mad River Glen, Jay Peak, and Smugglers Notch) are more of a weekend trip or even a ski holiday (consisting of 3 or more days).

Having an understanding of the distances skiers and snowboarders are willing to travel will allow resort managers to gain a better sense of how far they might travel if the ski resorts within close proximity to their place of residence were either snow deficient or not available. According to the results of this study, one of the main factors affecting destination choice is close proximity to place of residence. As well, two important factors that influence participation levels include cost and the amount of leisure time available. In order to find a more snow-secure destination within New England all these factors would all come into play. In the future a snow reliable resort may no longer be close to their place of residence. This

would ultimately increase the cost of the trip and the travel time to a resort and might impact the level of participation in the sport.

5.2 Destination Choice Factors

In this study, the main factors that were found to have a strong influence when choosing a ski resort are: the quality of snow conditions, the absence of crowded slopes, close proximity to their place of residence and the price of lift tickets / passes. Those that have little influence when choosing a ski resort are: an attractive nightlife, the presence of non-related snow activities and the presence of beginner runs (Table 4.7). Other studies have also tried to understand the influence of destination choice factors among skiers/snowboarders. Unbehaun *et al.* (2008) examined important destination choice determinants for skiers in Austria. They found that the most important factors when choosing a winter ski resort include: sureness of snow, winter experience, size of skiable area, and waiting time at lift. They also concluded that shopping facilities, après ski, and snow independent activities were the least important factors when choosing a ski resort (Unbehaun *et al.* 2008). Dawson *et al.* (2009) surveyed skiers/snowboarders in the US Northeast and found that the most important structural factors (what the resort has control over: skiable terrain, number of runs, amenities, etc) influencing respondents decision making to participate in the activity of skiing included presence of beginner runs, presence of nightlife, presence of non-snow-related activities (e.g. pool, snow tubing) and the presence of expert runs. Factors that were seen as least important in terms of influencing destination choice include: absence of crowded slopes, quality of snow conditions, quality of service, and quality of snowmaking capacity. Other than in Dawson *et al.* (2009), snow conditions have been found to be a very important choice determinant for skiers and snowboarders. Gilbert and Hudson (2000) found that snow conditions are a key variable when making destination choices. For skiers in this study, their concern about a lack of snow was one of the main constraints for skier participation. Shih *et al.* (2009) also determined that weather variables such as temperature and snow depth have a statistically

significant impact on downhill ski lift ticket sales. Finally, Englin and Moeltner (2004) showed that both trip demand and surplus values are strongly affected by snow conditions.

Snow conditions were found to be the most important choice determinant for skiers and snowboarders in this study and many others (Unbehaun *et al.*, 2008, Shih *et al.*, 2009, Englin & Moeltner, 2004, Gilbert & Hudson, 2000). Therefore, the unreliability of the quality of snow conditions in the future will be an important obstacle for ski resort owners to overcome. Currently snowmaking technologies have allowed ski resorts to overcome this issue to a large extent. However, in the future, other factors (such as cost, and water availability) may influence the sustainability of this solution.

Cost was also an important choice determinant. In this study it was ranked third. Therefore, the challenge for ski resorts will be how to not increase the cost of a lift ticket/season's pass with the increased future operational costs that are inevitable due to increased snowmaking among other things. Ski resort managers will need to find another way to offset their costs because an increase in the cost of lift tickets as outlined by the respondents of this survey may result in a decline in visitor numbers. Unbehaun *et al.* (2008) explored the price sensitivity of skiers. The majority of respondents accept an increase in costs of up to 10% in order to shift to a more secure snow destination. They found an increase in costs of 20% to be the threshold value, where more than 50% would no longer choose the snow secure region.

One of the proposed adaptation strategies to counteract the future impacts of climate change on winter snow conditions is to offer activities that can be a substitute for skiing/snowboarding activities. Over the past three decades, ski areas in North America have been diversifying their business operations to include alternative snow activities (i.e. snow-tubing, Nordic skiing, snowmobiling, skating, dog sledding) and non-snow activities (i.e. pools, health spas, fitness centres, squash and tennis courts, restaurants, bars and retail opportunities) (Scott & McBoyle, 2007). However, based on this study, as well as, Unbehaun *et al.* (2008) these non-related snow activities do not play an important role in influencing destination

choice of current skiers/snowboarders. However, they might attract a different clientele that has not been approached in this study. It is imperative for ski resorts to understand the importance of various choice determinants. There is also a need to understand which factors are not important when choosing a ski destination.

5.3 Ideal Weather Aspects

When asked the importance of various weather aspects while skiing/snowboarding, it was found that the absence of rain was the most influential weather factor out of the six presented in this study. The second most important weather factor while skiing/snowboarding was good visibility, followed by no strong winds and sunshine. The least two important weather factors for respondents in this study were comfortable air temperature and falling snow (Table 4.8). Unbehaun *et al.* (2008) also examined ideal weather and temperature aspects while skiing/snowboarding. This study also found that the most important aspect was the absence of rain, as this prevents winter sport activity for that day and also affects the snow conditions for several days after. The absence of strong winds, and comfortable air temperatures were also perceived as being important.

The presence of high winds and uncomfortable air temperatures may no longer be perceived as extremely important due to the technical innovations in winter apparel that are now available to skiers and snowboarders. The use of balaclavas and outerwear that uses technologies such as air vent systems, ClimaPro fabrics and Gore-Tex, ski apparel today combats harsh, cold, windy and snowy conditions. Therefore the ability to still enjoy a day of skiing even with these conditions may be one of the reasons why they are not perceived as important as factors such as rain. The only time that the absence of strong winds becomes extremely important for skiers and snowboarders is when these high winds cause the resort to close certain ski lifts due to safety reasons. As some respondents mentioned, weather and temperature were not as important to them as the snow conditions.

Due to the unreliability of weather and snow conditions on a day-to-day basis, especially in certain regions within New England, winter resorts need to

provide their visitors with a level of confidence in the ski conditions at their resorts. This is why Scott and McBoyle (2007) observed an increase in the number of resorts with snowmaking abilities and the constant addition of snow guns to cover an even larger percentage of their ski terrains. As a means of encouraging visitors to plan trips in advance and to follow through even if the weather might not cooperate, a majority of the resorts surveyed offer a free lift ticket if the visitor is not satisfied with the snow conditions prior to noon that day. Therefore, skiers do not feel that they have to continue skiing in marginal ski conditions to get their money's worth. The day that the conditions were icy, respondents also discussed how they were not going to ski for the afternoon due to the conditions but that they were not worried as they had a season's pass and could come again when conditions improve. If skiers and snowboarders begin to anticipate marginal ski conditions due to climate change, they may buy season's passes so that they do not have to worry about getting their money's worth out of a single day lift ticket. They can choose more freely when they want to ski and will not feel obligated to ski/snowboard on days where the snow conditions are not acceptable. On the other hand, if more days are marginal it is harder to get a season's pass worth, therefore skiers/snowboarders in the future may opt for single day passes, especially if they come with a conditions guarantee for a replacement day.

There is a very delicate balance among weather conditions, specifically snow depth and air temperatures in relation to skier and snowboarder behaviour. If there is not enough snow, skiers and snowboarders may not participate in the activity or travel further to find better snow conditions. However, too much snow can be a problem as it disrupts transport systems and ultimately may prevent skiers from reaching winter resort areas. As far as air temperatures are concerned (while respondents reported this as not important), if it is too cold it may not be comfortable for those skiing/snowboarding with children). Temperatures above freezing affect the snow conditions and may prevent the ability to make snow efficiently.

5.4 The 'Backyard Snow Effect'

The concept of the backyard snow effect has provided contradictory results in previous climate change and winter tourism research. Some studies, such as Hamilton *et al.* (2007), found that the 'backyard snow effect' was relevant at the two resorts that they studied in the Northeast, finding that a 1 cm increase in the previous days snow depth in a close city to the ski resorts predicted an increase in attendance by 11 skiers/snowboarders. Even a 1 cm increase in a city as far away as Boston increased predicted attendance by 18 skiers, even though the weather conditions in Boston may have no bearing on the conditions at the ski resorts in New Hampshire. Shih *et al.* (2009), who studied Michigan ski resorts, found that contrary to the opinion of many ski industry members and other research studies, weather conditions in South Michigan do not have a discernible effect on upstate ski activity. This study found that there was a difference in the applicability of the 'backyard snow effect' among skiers versus snowboarders. In this study 54% of snowboarders stated that that when it snows at their place of residence they go snowboarding more often than when there is no snow in their backyard. Skiers, on the other hand responded quite differently, with 58% stating that when there is snow at their place of residence they do not go skiing more often than when there is no snow in their backyard. These results are not what might be expected. Since snowboarders typically snowboard in terrain parks at the resorts (where the snow is always man-made) it would seem to be more likely that they would not be influenced by the 'backyard snow effect'. A reason for this anomaly may be due to the fact that demographically snowboarders are typically younger than skiers and therefore may be more influenced by 'snow in their backyard' when deciding when to go snowboarding.

Today most ski resorts post the weather and snow conditions on their website in order to attract visitors from parts of New England that may not have a similar level of snow. Some even put a live web feed on their website so that skiers and snowboarders can see for themselves exactly what the conditions are like on a particular day. With all these technological means of communicating to skiers the

snow conditions at resorts, this may be why a large portion of skiers and snowboarders go skiing/snowboarding regardless of whether there is snow in their backyard.

The ski resorts that participated in this study have implemented numerous options to counteract the concept of the 'backyard snow effect' and get skiers and snowboarders to visit their resorts even when there is no or little snow at their place of residence. Out of the seven resorts only one resort did not post a daily snow report on their website. Two of the resorts had live web cameras and several posted a photo of the day. The majority of these resorts also use social media sites as a means of communicating snow conditions. There are websites such as snowreport.com and applications for new smart phones that communicate snow forecasts that are delivered daily by phone. In the future this will be an extremely useful tool to counteract the concept of the 'backyard snow effect' with the younger generations of skiers and snowboarders. Whether they think about skiing most when there is snow at their home or whether they live close to their preferred ski resort where the snow at home would be equivalent to that on the mountain, in this study it is an influential concept for nearly half of the respondents.

5.5 Substitution Behaviours

A number of studies have tried to evaluate how skiers and snowboarders may change their behaviours as a result of insufficient snow conditions in the future due to climatic changes. However, the climate scenarios that respondents were presented with in these previous studies were vague and did not provide specific details (ski season length, percent of snowfall reductions, and descriptions of ski conditions), in comparison to a normal winter for that particular region. The study by Unbehaun *et al.* (2008) found that 60% of tourists would give up their destination loyalty in favour of a more snow secure destination, if there were several consecutive winters with snow deficiency and 25% of the tourists would no longer ski if this occurred. Koenig (1998) presented skiers with environmental scenarios and found that only 25% of the people surveyed indicated that they would continue to ski with the same frequency if winters became snow deficient and 38%

of the tourists surveyed said that they would substitute destinations. Behringer et al. (2000) surveyed skiers and snowboarders in Switzerland and found that 49% said they would ski in a more reliable location if they knew the next five winters would be snow deficient, and 4% would give up skiing altogether. Dawson *et al.* (2009) examined the past and future substitution behaviours of skiers in the US Northeast to marginal snow conditions. This was the first study to use detailed climate scenarios based on both future climate predictions by the IPCC as well as statistics from previous snow-deficient winters in the study region to evaluate future skier behaviour. In this study, 79% of respondents indicated that, during past seasons with marginal snow conditions (similar to 2001-02 and the beginning of 2006-07), they had stopped for an entire season and 79% stated they had skied more often as a result of shortened season lengths (Dawson *et al.*, 2009). This study also found that just over 50% of respondents indicated they stopped skiing for part of the season, 30% skied less often during a season, and 70% purchased less skiing-related equipment and apparel. Just under 60% skied elsewhere within the US Northeast and 67% skied elsewhere outside of the region (Dawson *et al.*, 2009).

In relation to the three main types of substitution behaviours, it was found that the most common 'temporal' substitution response of skiers/snowboarders when confronted with marginal conditions was to ski their usual frequency (just a fewer total number of days). When presented with the 2050s mid-range scenario, 87% of skiers/snowboarders stated this type of 'temporal' substitution behaviour and 60% during the 2050s worst-case scenario. If respondents were to engage in 'spatial' substitution the most common response was to travel further in New England to find better snow conditions. In this study 11% in the 2050s mid-range scenario and 30% in the 2050s worst-case scenario would travel further in New England to find better snow conditions. The majority of respondents would wait until their usual ski resort opened (84% in the 2050s mid-range scenario and 53% in the 2050s worst-case scenario) and only a small percentage of respondents would travel outside New England to find better snow conditions (4% in the 2050s mid-range scenario and 11% in the 2050s worst-case scenario). Very few respondents stated that they would take part in 'activity' substitution. Even in the

more severe 2050s worst case scenario, only a few respondents 6% would give up skiing/snowboarding for an entire winter or the activity altogether, due to the less than optimal winter snow conditions described (Table 5.1).

Table 5.1 Substitution behaviours (temporal, spatial, activity)

2050s Mid-Range Scenario	2050s Worst-Case Scenario
Time	Time
<ul style="list-style-type: none"> •87% would ski/snowboard their usual frequency •11% would ski/snowboard more often than normal 	<ul style="list-style-type: none"> •60% would ski/snowboard their usual frequency •23% would ski/snowboard more often than normal
Place	Place
<ul style="list-style-type: none"> •84% would wait until their usual ski/snowboard locations in New England were open •11% would travel further to find better snow conditions •4% would take a ski holiday outside of New England 	<ul style="list-style-type: none"> •53% would wait until their usual ski/snowboard locations in New England were open •30% would travel further to find better snow conditions within New England. •11% would take a ski holiday outside of New England
Activity	Activity
<ul style="list-style-type: none"> •3% said that they would do something else instead of skiing 	<ul style="list-style-type: none"> •6% said that they would do something else instead of skiing

These responses however, may be a result of other contributing factors. For example, one respondent discussed the fact that even though traveling outside New England would be the best solution for skiers/snowboarders in order to adapt to future marginal snow conditions, due to economic, personal, and time constraints, the option to travel outside of New England to find preferred snow conditions was not practical. The second scenario (reflecting the 2050s worst-case projections) was the level in which a substantial number of ski tourists' alter their destination choice and, therefore, the point where it will become problematic for the New England ski industry is several decades away. Similarly to the study conducted by Dawson *et al.* (2009) this study also found that the main type of substitution behaviours that skiers/snowboarders engage in is 'temporal' substitution. Also, there is very little difference in the substitution behaviours between participants at large versus small-scale resorts, or at different locations in the New England region in both this study

and the study done by Dawson *et al.* (2009). Opposite to the study by Unbehaun *et al.* (2008) where 60% of tourists would give up their destination loyalty in favour of a more snow secure destination, only 11% in the mid-range scenario and 30% in the worst-case scenario would travel further to find better snow conditions.

According to the modeling results of Scott *et al.* (2008) in 2040-2069, only seven of the 14 study areas examined in New England (Connecticut, western New York, southeastern New York, western Pennsylvania, southeastern Maine, eastern Pennsylvania, and eastern Massachusetts) were projected to be at risk economically. Other areas such as southern Vermont, northeastern New Hampshire, northeastern New York and Western Maine could remain 'viable' even with climatic changes. Nonetheless it should still be a concern for current ski area managers. It will be important for ski area managers to understand the variety of substitution behaviours expected from different types of skiers and snowboarders in order to develop and implement appropriate adaptation strategies to reduce their level of vulnerability to future climatic changes.

Many ski resorts are joining conglomerates and diversifying their tourism product to offset potential losses due to poor winters. Three of the resorts where surveys were distributed are owned by a larger ski or real estate conglomerates, allowing them to decrease their level of economic vulnerability when marginal snow conditions exist. These resorts will have access to capital from these corporations in order to make it through winters that are economically not as profitable as normal due to increased operational costs and decreased snow levels. These climatic impacts will most likely be a problem for small independent resorts where the operational costs may be greater than the economic gains. One of the independent resorts that was a survey location has attempted to decrease their level of vulnerability to climate in the future by making the decision to become a cooperative ski resort. In order to provide a consistent level of revenue for the resort, they sold shares to skiers themselves and this ski resort is now owned outright by its skiers. This is also a means of increasing ski resort loyalty among its guests, because they are part owners and therefore will be less likely to substitute their preferred ski resort for another in New England.

5.5.1 Activity Involvement

Consistent with what was expected based on the current literature, respondents who have a high level of activity involvement in skiing/snowboarding (place an importance on the activity and participate more frequently) have a higher participation level and are willing to continue skiing their usual frequency or even increase it if the seasons become shorter. They are also less likely to stop skiing.

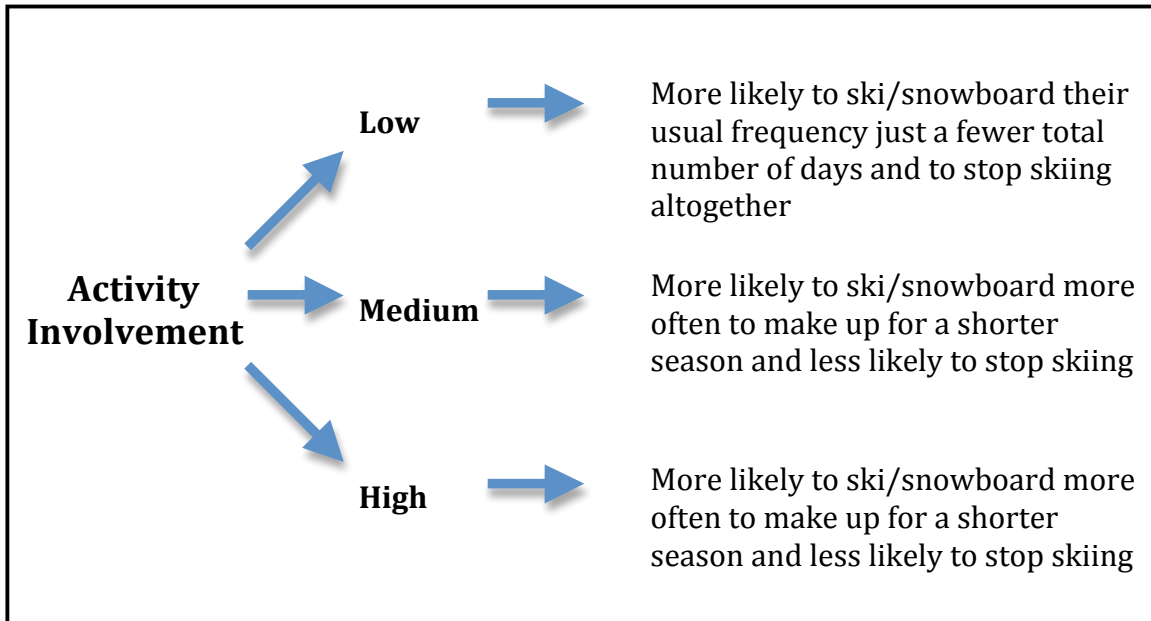


Figure 5.1 Impact of activity involvement on substitution behaviours

Understanding how individuals with different levels of involvement in winter sports will behave due to future climatic changes will be imperative for ski industry stakeholders (Figure 5.1). Those with a higher level of involvement have a greater knowledge of the sport and, therefore, may be more aware and susceptible to the negative influences that climate change may have on snow conditions. If skiing conditions are unavailable or if marginal snow conditions exist, those who are highly involved in the activity will be forced to make more decisions about their participation than those individuals who are only occasional skiers. Low-involvement skiers participate in skiing for different reasons. They have a low level of expectations and, therefore, they may be less influenced by marginal snow conditions as a result of climate change.

5.5.2 Destination Loyalty

In summary, respondents who had a high sense of resort loyalty and own a property in the area appear to be more willing to wait until their usual resorts in New England open during winters with late opening dates and less than optimal snow conditions and are less likely to travel further to find ski resorts with better snow conditions both in New England and outside New England (Figure 5.2). In both the 2050s mid-range and worst-case climate scenarios: 87% and 65% of 'high level loyalty' respondents compared to 81% and 45% of 'low loyalty respondents' would wait until their usual resort in New England opens during the 2050's mid-range and 2050s worst case scenarios respectively (Table 4.17).

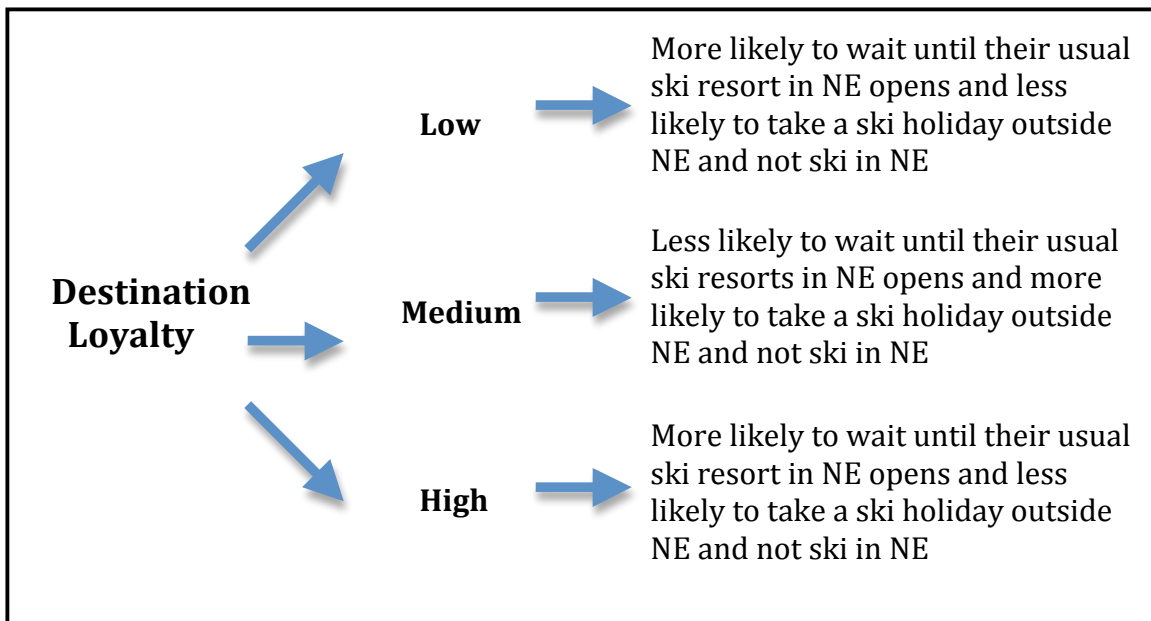


Figure 5.2 Impact of destination loyalty on substitution behaviours

These findings are consistent with what was expected based on the current literature on the topic. According to Alexandris et al. (2006) the concept of place attachment is a useful one in understanding aspects of an individual's leisure and tourism behaviours. They found that both place identity and place dependence in the context of a skiing resort predicted a significant amount of variance in skiers' loyalty to a ski resort (Alexandris et al., 2006). Place attachment is an important construct for ski managers and marketers to employ in their effort to build

customer loyalty. It is evident that under future climatic conditions, the extent to which individuals are loyal to a particular resort will play a significant role in the sustainability of numerous ski resorts in the New England region. Increasing the loyalty level that skiers and snowboarders have towards their resort will be essential in decreasing the number of their visitors who might participate in substitution behaviours in the future. Ski area operators will experience increased operational costs associated with snowmaking in order to provide essential snow conditions. Therefore, they will need to maintain the number of visitors currently skiing at their resorts through developing a sense of destination loyalty among them.

Another variable that indicates a high level of resort loyalty is ownership of a property at or near the respondents preferred ski resort. Those who own a property in the area are much more likely to wait until their usual ski resorts open up (73% compared to 59% in the 2050s mid-range scenario and 59% compared to 51% in the 2050s worst-case scenario) (Table 4.18). Property owners are also less likely to travel further in New England to find better snow conditions (18% compared to 26% in the 2050s mid-range scenario and 27% compared to 32% in the 2050s worst-case scenario) (Table 4.18).

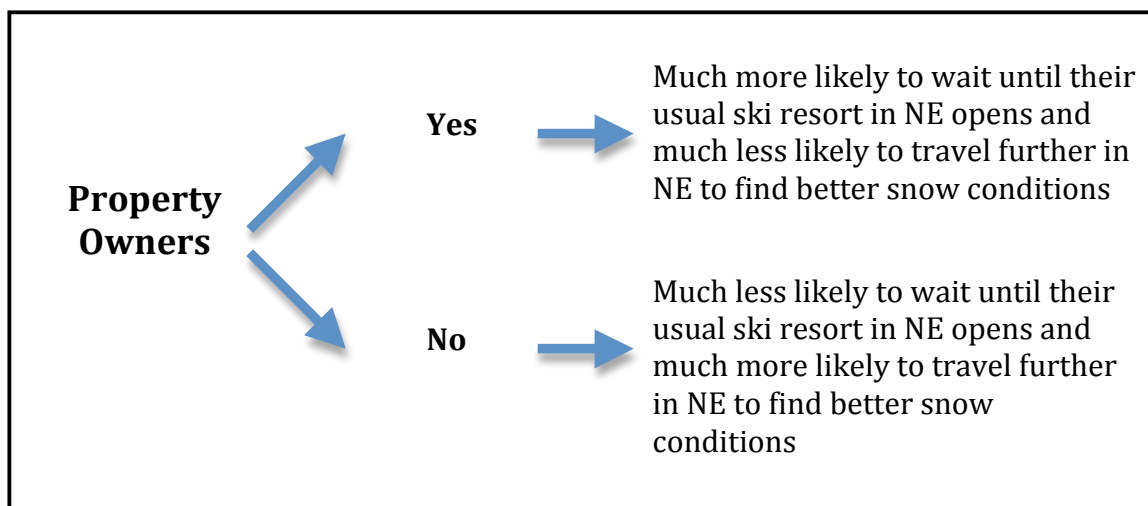


Figure 5.3 Impact of property ownership on substitution behaviours

6.0 Conclusion

There have been numerous studies over the years that have examined the topic of winter tourism and climate change. It is one of the most well developed bodies of literature that has focused on the relationship between climate change and tourism. The majority of studies have evaluated and predicted the impact that future climate change will have on the global service providers of this industry (supply-side). However, recently there has been a focus on how future marginal snow conditions as a result of climate change might impact winter tourist demand. Furthermore, in the UNWTO-UNEP-WMO (2008) report it is stated that understanding tourists' responses to climate change is a key knowledge gap. This study focused on adding to this body of literature that has attempted to understand the future behavioural response of skiers and snowboarders when confronted with the presence of marginal snow conditions. The key findings relate to how skiers/snowboarders have responded to changing snow conditions in the past as well as how they may react in the future, the role of substitution within specific behavioural responses to both past and future snow conditions and the extent to which commitment and loyalty influence climate induced behavioural change.

6.1 Main Findings

Snow conditions were found to be the most important choice determinant for skiers and snowboarders in this study, which is consistent with the literature (Unbehaun *et al.*, 2008, Shih *et al.*, 2009, Englin & Moeltner, 2004, Gilbert & Hudson, 2000). Therefore, the unreliability of the quality of snow conditions in the future will be an important obstacle for ski resort owners to overcome. Currently snowmaking technologies have allowed ski resorts to overcome this issue to a large extent. However, in the future other factors (costs and water availability) may influence the sustainability of this climatic adaptation. The ideal weather factors for skiers and snowboarders were examined in order to determine what factors, if any, are extremely important while participating in the sport. Their level of importance might help in determining, if these weather conditions are present or absent, the

number of skiers on a given day. It was found that the absence of rain was the most influential weather factor for skiers and snowboarders (similar to Unbehaun *et al.*, 2008). However, in a warmer world, a larger proportion of precipitation may be expected to fall as rain.

A number of studies have tried to evaluate how skiers and snowboarders may change their behaviours as a result of insufficient snow conditions in the future due to climatic changes. In relation to the three main types of substitution behaviours, it was found that the most common one for skiers and snowboarders in this study when faced with marginal snow conditions was 'temporal' substitution. This type of substitution behaviour is beneficial for winter resorts in New England. Even though the timing or frequency of their involvement in the activity of skiing/snowboarding may change, they are still choosing to ski/snowboard at their usual winter resorts in New England. The 'spatial' and 'activity' substitution behaviours will have an impact on the profitability of winter resorts in New England. Skiers/snowboarders choosing another resort within New England or even taking a ski holiday outside New England will have negative impacts on the profitability of New England ski resorts.

The level of a skier's/snowboarder's involvement in the sport is an important determinant of the types of substitution behaviors they will engage in. The number of days in which a skier/snowboarder participates in their sport during the winter season and the importance that the activity has in their lives have a significant impact on future substitution behaviours due to climate change. The level of a skier's/snowboarder's destination loyalty is another important component in predicting the types of substitution behaviours they will engage in. Respondents with a high level of destination loyalty, and those who own a property at or near their preferred resort are much less likely to participate in 'spatial' substitution as a result of future marginal snow conditions, particularly in the 2050s worst-case scenario..

As climate change causes more significant changes to the mountain landscape and snow conditions, understanding how different tourist segments react to climate change and related environmental change is important for various

tourism stakeholders: ski resort managers, nearby communities and also states that are dependent on this winter tourism revenue. The results presented could help in the recognition of the potential changes in visitor numbers at various ski resorts and for the ski tourism marketplace in the region as a whole. There may be more reliance on local visitors as there will be fewer long-haul visits taking place. There also may be a greater reliance upon those less motivated by sport-specific reasons, as they may not be as influenced by marginal snow conditions. There will be a need to develop a sense of destination loyalty among winter tourists. Also, the opportunity to market all-season and summer activities will increase in the future as a means of compensating for some of the losses in revenue during the winter months.

The results of this research have practical implications for the planning and policy of the ski/snowboard industry. Among the top destination choice determinants were proximity to place of residence and costs. In the future, as a result of climate change, some communities in New England may lose their ski resorts. Ultimately there will be a need to invest in ski resorts that are close to urban markets and vulnerable to future climate change (for example Boston). Due to the fact that the states of Vermont and New Hampshire benefit the most from ski/snowboard tourism, their governments might be wise to financially support a few ski resorts that are in close proximity to Boston. This financial support would ultimately be an investment for the future success of ski resorts and winter tourism in their own states. By ensuring the sustainability of these beginner hills they will be encouraging skiers/snowboarders to become more involved in the sport, and ultimately more willing to travel into their states for ski holidays.

The communities surrounding the ski resorts in New England may also be able to use the results of this study in order to increase the money that is spent by skiers/snowboarders. Many of the communities in Vermont and New Hampshire are reliant on ski/snowboard tourists. Investing in real estate development (to increase the number of second homes available to skiers/snowboarders) would be one approach to increasing the level of loyalty ski tourists have towards their resort. Another tactic to increase the number of ski destination tourists would be to partner

with ski organizations in the southern states of New England to purchase housing in the area. Communities should continue to work with resorts and other tourism stakeholders to diversify their tourism product so that they are less dependent on ski tourism (while based on visitor numbers, there is no easy substitute for ski tourism).

Ski resorts could also benefit from several of the findings that this study has outlined. Having an understanding of how different groups of skiers and snowboarders will engage in future substitution behaviours (temporal, spatial, and activity), will allow ski resort managers to better plan for these potential future behavioural adjustments. Implementing strategies to increase ski/snowboard tourists' level of loyalty to the resort so that they are less likely to participate in negative substitution behaviours will be essential for the future sustainability of the industry. One of the strategies that appears to be working for Mad River Glen (a small, independent ski resort) is to become a cooperative where the skiers themselves own shares of the ski resort. This level of personal investment makes them much more likely to continue to ski at their preferred resort even if it is slow to open and the snow conditions are marginal.

6.2 Future Research

There is still much uncertainty about visitor responses to environmental change. Whether climate change scenarios will even be realized or whether they will be worse than predicted creates uncertainty concerning how tourists will respond. Therefore, there is still a need for future research on the topic of tourist behaviour with regards to climatic changes and their impact on the winter tourism industry. Even though the current body of literature is growing on understanding the potential skier/snowboarder response to climate change, research could still continue to use quantitative surveys to examine winter tourist behaviour in other global destinations. To complement these studies the incorporation of qualitative research approaches, such as focus groups or informal interviews, would enhance this area of research. These qualitative methods might also allow researchers to gain an additional level of understanding in terms of future behavioural adaptations

(gain an understanding as to why respondents would engage or not engage in 'temporal' 'spatial' and 'activity' substitution behaviours).

Future research should evaluate the incorporation of other seasonal activities, and new nature based tourism options that winter resorts have begun to incorporate (zip lines, mountain biking, backcountry skiing, and tubing). Understanding whether skiers/snowboarders would engage in off-season nature based activities might be important knowledge for winter resorts to have. This is an area economically that could really affect the feasibility of remaining in operation during winters where operational costs are high. It should be explored further.

Previous research evaluating the vulnerability of the US Northeast has predicted the possibility of a redistribution of winter resorts to Northeastern New Hampshire, Western Maine, and Southern Vermont. However, the redistribution of the winter tourism industry will also highly depend on where tourists are willing and also able to go. Due to the increased costs and times of travelling to a snow secure destination, 'spatial' substitution behaviours may not be applicable for all skiers and snowboarders. Comparing survey results with actual visitation patterns in order to confirm if answers to behavioural questions are consistent with what actually occurred would be an area of research that is worth exploring.

Researchers could also examine the future need for ski / snowboard opportunities closer to main markets in New England such as Boston and New York. The resorts within close proximity to these major urban markets have been identified by previous research as being extremely vulnerable to climatic changes in the future. Due to their small size, lack of lifts and lack of challenging runs, these resorts serve as instructional hills. As was first stated in Wall and McBoyle (1992), these instructional hills are necessary to attract new participants to the winter sports of skiing and snowboarding. They provide newcomers to the sport with a relatively low cost option (reduced travel costs due to close proximity, equipment rentals, and reasonable lift tickets) to try to learn to ski/snowboard. Once they feel comfortable they will then be more likely to travel further within New England to ski at resorts with a higher quality of snow and more challenging runs. Without these instructional ski areas within close proximity to major cities, resorts in

Vermont and New Hampshire may lose out on a substantial visitor market. In the future the implementation of artificial ski hills in major southern cities in New England may prove to be essential in maintaining this key visitor market. It will be important in the future to understand the applicability of these indoor ski hills, and how future skiers and snowboarders might use them as a starting point, or a place to teach their children prior to investing the time and money into a ski vacation in Northern New England. This study has added to the literature related to the behavioural responses of winter tourists to climatic changes. However, as previously stated, there are still many areas that future research could focus on in order to improve the understanding of this topic.

6.3 The Future of the Ski/Snowboard Industry

According to the NSAA (2011), there are a variety of factors that represent challenges for the ski/snowboard industry. These include: an aging population, alternative leisure options, increased obesity, increased lodging and travel costs, increased cost of snow sports, unfavourable exchange rates, decreased leisure time, decreased funds for leisure, economic instability, shorter vacation trends, loss of low cost 'feeder' resorts, and climate change. In 2009, Michael Berry, NSAA President noted that:

"Simply put, as Baby Boomers, a generation that helped build the industry into what it is today, continue to age, they will begin dropping out of the sport at an alarming rate. Without an industry-wide effort focused on attracting newer, younger participants and converting them into loyal skiers and riders, ski areas could face dramatic declines in visitation in the not-so-distant future (NSAA, 2011)."

The future of snow sports will be dictated by today's tech-savvy youth. Therefore, there is a need for winter resorts to use social media platforms, and promotional events that cater to this younger generation. Strategies for future real estate development will be a future issue that the industry must address. The real estate markets have been improving and resorts should be looking to the future and analyzing the potential for real estate development, as this is an area that brings

economic benefit to the communities as a whole and not just the resort itself. Also how will income dynamics and demographic shifts in a post-recession era impact this industry? These questions and issues will need to be addressed in order to ensure the future sustainability of the ski/snowboard industry.

6.4 Final Thoughts

Climate change has been referred to as the 'greatest challenge to the sustainability of the global tourism industry in the 21st century' (UNWTO-UNEP-WMO, 2008, p.180). Also called 'the greatest threat to skiing' by the Aspen Skiing CEO, climate change is not simply a problem that will threaten the success of sustainable tourism in the future, as it is already influencing tourism businesses and travel patterns.

Mountain regions are important destinations for global tourism. Snow cover and pristine mountain landscapes are the principal attractions for tourism in these regions. Winter tourism, particularly ski and snowboard tourism is an extremely lucrative global sector of the tourism industry. As climate change causes more significant changes to these mountain landscapes and snow conditions, understanding how different tourist segments react to climate change and related environmental change will be essential. There is a need for various tourism stakeholders: ski resort managers, nearby communities and also states that are dependent on this winter tourism revenue to have an understanding of how skiers and snowboarders may react to changing snow conditions in the future so that they can address as many factors that are within their control in order to retain their current visitor numbers. Given the economic importance of the ski industry in New England, particularly the states of Vermont and New Hampshire, it is hoped that this study will encourage adaptation by the industry and future research into the impact of climate change on the ski industry in New England specifically, but also other ski regions in North America, and even worldwide.

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Appendix A: Skier/Snowboarder Survey



New England Skier/Snowboarder Survey



Dear Skier/Snowboarder,

This letter is an invitation to consider participating in a study I am conducting as part of my Masters degree in Tourism Policy and Planning at the University of Waterloo. Over the past few years the issue of climate variability and the impact that changing snow patterns may have on the ski/snowboard industry has been widely discussed. To gain a better understanding of how snow conditions may affect ski/snowboard tourism across States in the U.S. Northeast it is important to understand how people have responded to changing snow conditions in the past and how they may react in the future.

Your participation in this study is entirely voluntary and would involve completing a short survey. The survey would take approximately 10-15 minutes of your time. In the survey you will be asked questions about your skiing/snowboarding experience and how you have adjusted your ski/snowboard patterns to changing snow conditions in the past and how you might respond if similar circumstances occurred in the future. You may decline to answer any of the questions. All the information you provide is completely confidential as your responses will be summarized with those of hundreds of other skiers/snowboarders.

This study received ethics clearance from the Office of Research Ethics at the University of Waterloo (519-888-4567 ext. 36005, ssykes@uwaterloo.ca) and there are no known or anticipated risks to you as a participant in this study. If you have any questions or would like additional information about the study to assist you in reaching a decision about participation, you may contact my supervisor, Dr. Daniel Scott at (519) 888-4567 ext. 35497 or dj2scott@uwaterloo.ca.

Sincerely,

Kate Vivian
University of Waterloo
kvivian@uwaterloo.ca



Section 1: Your Ski/Snowboard Motivations and Participation Patterns

1. Do you consider yourself a skier, a snowboarder or both?
(please check one box) Skier Snowboarder Both

2. Do you own or rent your ski/snowboard equipment? *(please check one box)*
 Own Rent Own some/rent some

3. How many years have you been skiing/snowboarding? _____ years

4. Who do you usually ski/snowboard with? *(please check all that apply)*

<input type="checkbox"/> Husband/Wife/Partner	<input type="checkbox"/> Children
<input type="checkbox"/> Parents	<input type="checkbox"/> Siblings
<input type="checkbox"/> Friends	<input type="checkbox"/> New Acquaintances (people you met that day)
<input type="checkbox"/> Other <i>(specify)</i> _____	

5. On which ski/snowboard runs do you feel completely comfortable? *(please check all that apply)*
 - Beginner *(green circle)*
 - Intermediate *(blue square, single black diamond)*
 - Expert *(double black diamond)*

6. Do you buy a ski/snowboard season pass? *(please check one box)*
 - Have never bought one
 - Yes – have season pass for this season or had in past seasons

If yes – How many winters have you had a season pass in the last 10 years? _____

7. How many days do you usually go skiing/snowboarding each winter? _____ days
 - 7a. How many of these ski/snowboard days each winter take place on:

Weekdays - ____ days	The total for these four categories should equal the number of days you entered in question 7
Weekends - ____ days	
Public Holidays (e.g., New Year) - ____ days	
Vacations (of greater than 3 days) - ____ days	

 - 7b. Where do you spend your specified number ski/snowboard days each winter:

New England - ____ days	The total for these seven categories should equal the number of days you entered in question 7
Midwest - ____ days	
Colorado/Utah/Other Rocky Mountain State - ____ days	
California/Washington/Other Pacific State - ____ days	
Western or Eastern Canada - ____ days	
Europe - ____ days	
Other <i>(please specify)</i> : _____ - ____ days	

8. How do you most often travel to ski/snowboard? (please check one box)
 car/truck bus (public or tour) train airplane Other: _____

9. How would you rate the following travel times for each of these three types of ski trip:
 (please check either acceptable or not acceptable for each hour 1 to 6+)

A Day Trip

Hours	Acceptable	Not Acceptable
1	<input type="checkbox"/>	<input type="checkbox"/>
2	<input type="checkbox"/>	<input type="checkbox"/>
3	<input type="checkbox"/>	<input type="checkbox"/>
4	<input type="checkbox"/>	<input type="checkbox"/>
5	<input type="checkbox"/>	<input type="checkbox"/>
6 or more	<input type="checkbox"/>	<input type="checkbox"/>

A Weekend

Hours	Acceptable	Not Acceptable
1	<input type="checkbox"/>	<input type="checkbox"/>
2	<input type="checkbox"/>	<input type="checkbox"/>
3	<input type="checkbox"/>	<input type="checkbox"/>
4	<input type="checkbox"/>	<input type="checkbox"/>
5	<input type="checkbox"/>	<input type="checkbox"/>
6 or more	<input type="checkbox"/>	<input type="checkbox"/>

**A Ski Holiday
(3 or more days)**

Hours	Acceptable	Not Acceptable
1	<input type="checkbox"/>	<input type="checkbox"/>
2	<input type="checkbox"/>	<input type="checkbox"/>
3	<input type="checkbox"/>	<input type="checkbox"/>
4	<input type="checkbox"/>	<input type="checkbox"/>
5	<input type="checkbox"/>	<input type="checkbox"/>
6 or more	<input type="checkbox"/>	<input type="checkbox"/>

j). What are the main factors that influence your choice of which resorts to ski/snowboard at?

Please rate <u>each</u> factor by circling 1, 2, or 3	Strong Influence	Minor Influence	No Influence
Close proximity to my place of residence	3	2	1
Price of lift tickets/passes	3	2	1
Quality of snow conditions	3	2	1
Presence of expert runs	3	2	1
Presence of beginner runs	3	2	1
Friends and family usually ski/snowboard there	3	2	1
Good service	3	2	1
Good facilities (e.g. accommodation, chalet, etc.)	3	2	1
Attractive nightlife	3	2	1
Presence of non-snow related activities (e.g. pool, restaurant, spa)	3	2	1
Snowmaking capacity (e.g. comprehensive snowmaking system)	3	2	1
Absence of crowded slopes	3	2	1
Absence of crowded chalet/services	3	2	1
Other (please specify) _____	3	2	1

Note: In questions 11 and 12 there are some questions that may seem similar. This is purposeful and designed solely for statistical purposes.

11. Please answer the following questions about the importance of skiing/snowboarding to you

Please circle your answer along this 5-point scale for each statement	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
Skiing/snowboarding is one of the most enjoyable things I do	5	4	3	2	1
Skiing/snowboarding is very important to me	5	4	3	2	1
I find a lot of my life is organized around skiing/snowboarding	5	4	3	2	1
Skiing/snowboarding has a central role in my life	5	4	3	2	1
I enjoy discussing skiing/snowboarding with my friends	5	4	3	2	1
Most of my friends are skiers/snowboarders	5	4	3	2	1
When I participate in skiing/snowboarding, I can really be myself	5	4	3	2	1
I identify with the people and image associated with skiing/snowboarding	5	4	3	2	1
Participating in skiing/snowboarding says a lot about who I am	5	4	3	2	1
When I ski/snowboard, others see me the way I want them to see me	5	4	3	2	1

12. Please answer the following questions about how you feel about the ski resort you go to most often

Please circle your answer along this 5-point scale for each statement	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
My preference to ski/snowboard at my usual resort would not willingly change	5	4	3	2	1
To change my usual resort would require major rethinking	5	4	3	2	1
I ski/snowboard at my usual resort because their image comes closest to reflecting my lifestyle	5	4	3	2	1
When I ski/snowboard at my usual resort it reflects the kind of person I am	5	4	3	2	1
My decision to ski/snowboard at my usual resort was freely chosen from several alternatives	5	4	3	2	1
I did not control the decision on whether to ski/snowboard at my usual resort	5	4	3	2	1
I don't know that much about my usual ski resort	5	4	3	2	1
I am knowledgeable about my usual resort	5	4	3	2	1

13. When you go skiing/snowboarding, how important are the following aspects of weather?

Please circle your answer along this 5-point scale for <u>each</u>	Extremely Important		Neutral		Not Important
No strong winds	5	4	3	2	1
No rain	5	4	3	2	1
Sunshine	5	4	3	2	1
Good Visibility	5	4	3	2	1
Falling Snow	5	4	3	2	1
Comfortable air temperature	5	4	3	2	1

14. Please circle the temperature(s) that you think are **ideal** for a day of skiing/snowboarding.

>15°F 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 34 35 36 37 38 39 40°F>

EXAMPLE: if you feel the ideal temperature is between 27 and 30°F, then you would circle these temperatures as illustrated below.
 >15°F 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 34 35 36 37 38 39 40°F>

15. What is the **ideal** wind condition for skiing/snowboarding? (*check one box*)

- No wind
- Light breeze (1-5 miles/hr)
- Moderate wind, when sand begins to be blown around (6-25 miles/hr)
- Strong wind (26-40 miles/hr)
- Very strong wind (41-60 miles/hr)

16. What is the **ideal** sky condition for skiing/snowboarding? (*check one box*)

- 0% cloud coverage
- 25% cloud coverage
- 50% cloud coverage
- 75% cloud coverage
- 100% cloud coverage

Section 2: What Affects Your Ski/Snowboard Participation Patterns

17. When there is snow at your place of residence, do you go skiing/snowboarding more often than when there is no snow in your backyard/neighbourhood?

(*please check one box*) Yes No

18. How important are the following factors in affecting the number of days you ski/snowboard each winter?

Please rate <u>each</u> factor by circling your answer along the 5-point scale	Greatest Importance	Very Important	Somewhat Important	Not Very Important	No Affect at All
Gas prices	5	4	3	2	1
Cost of airplane tickets	5	4	3	2	1
Price of lift ticket / season pass	5	4	3	2	1
State of the economy	5	4	3	2	1
Snow conditions at my usual ski areas (e.g., icy versus fresh powder snow)	5	4	3	2	1
Amount of snow at my place of residence	5	4	3	2	1
Good weather for skiing	5	4	3	2	1
Good road conditions to ski resort	5	4	3	2	1
Depth of snow base at my usual ski areas	5	4	3	2	1
Ability to take holidays (how busy at work)	5	4	3	2	1
Number of times family and friends want to go	5	4	3	2	1
Other (please specify):	5	4	3	2	1

19. Recently there have been some warm winters with less than usual snowfall in New England, that have caused a delay in the start of the ski season, shorter than usual ski seasons, and a greater number of days with poor/marginal snow conditions throughout the region.

Please read the following descriptions of recent winters (see *Winter A and B below*) and indicate how you would most likely respond to these conditions if they were to happen again.

Winter A: Average snowfall at ski resorts in New England is 40% lower than normal, with little snowfall until after Christmas, except at high elevations. The ski season in the region starts 3 weeks late and is only 118 days long (an average winter is 132 days). A number of resorts have only some of their runs and chairlifts open over Christmas-New Year and Spring Break holidays.

A1 - If another winter like this happened next year, how would you change how often you go skiing/snowboarding? (please check only one box)

- I would ski/snowboard my usual frequency, just a fewer total number of days
- I would ski/snowboard more often than normal to make up for a shorter season
- I would stop skiing/snowboarding for the entire winter
- I would stop skiing/snowboarding altogether

A2 - If another winter like this happened next year, how would you change where you go skiing/snowboarding? *(please check only one box)*

- I would wait until my usual ski/snowboard locations in New England were open
- I would travel further to find better snow conditions within New England
- I would take a ski holiday outside of New England and not ski in New England
- I would do something else instead of skiing/snowboarding
(e.g. another recreational activity or take a different type of holiday)

A3 - If another winter like this happened next year, do you think you would ski as many days as you normally do? *(please check yes or no)*

- Yes - I would ski as many days as I usually do *(as you identified in question 7)*
 - No
- If No** - would you ski a greater number of days - How many more? _____ (days)
 fewer days - How many less? _____ (days)

Winter B: Average snowfall at ski resorts in New England is 65% lower than normal, with little snowfall until after Christmas, except at the highest elevations. The ski season in the region starts 4 weeks late and is only 99 days long (an average winter is 132 days). Many resorts in the region are closed over Christmas-New Year and Spring Break holidays. Only ski/snowboard areas in Vermont, northern New Hampshire and northern Maine have good snow conditions.

B1 - If another winter like this happened next year, how would you change how often you go skiing/snowboarding? *(please check only one box)*

- I would ski/snowboard my usual frequency, just a fewer total number of days
- I would ski/snowboard more often than normal to make up for a shorter season
- I would stop skiing/snowboarding for the entire winter
- I would stop skiing/snowboarding altogether

B2 - If another winter like this happened next year, how would you change where you go skiing/snowboarding? *(please check only one box)*

- I would wait until my usual ski/snowboard locations in New England were open
- I would travel further to find better snow conditions within New England
- I would take a ski holiday outside of New England and not ski in New England
- I would do something else instead of skiing/snowboarding
(e.g. another recreational activity or take a different type of holiday)

B3 - If another winter like this happened next year, do you think you would ski as many days as you normally do? *(please check yes or no)*

- Yes - I would ski as many days as I usually do *(as you identified in question 7)*
 - No
- If No** - would you ski a greater number of days - How many more? _____ (days)
 fewer days - How many less? _____ (days)

20. Do you own or rent a recreational property at or near your ski area? (please check one box)

No **If No - go to section 3**

Own a property Own a timeshare Rent a property

21. How many days a year do you use this recreational property? ____ days

22. How many of those days are during the ski/snowboard season? ____ days

23. Please indicate how you think changes in the ski/snowboarding season might affect your use of this property.

If the average season length was reduced by 33% over a normal winter: (please check one box)

- would use the property more often (greater number of days per year)
- would use the property about the same, but fewer days in winter months
- would use the property a little less often (fewer number of days per year)
- would use the property a lot less often (far fewer number of days per year)
- would sell the property

If the average season length was reduced by 50% over a normal winter: (please check one box)

- would use the property more often (great number of days per year)
- would use the property about the same, but fewer days in winter months
- would use the property a little less often (fewer number of days per year)
- would use the property a lot less often (far fewer number of days per year)
- would sell the property

If the nearby ski area closed: (please check one box)

- would use the property more often (great number of days per year)
- would use the property about the same, but fewer days in winter months
- would use the property a little less often (fewer number of days per year)
- would use the property a lot less often (far fewer number of days per year)
- would sell the property

Section 3: About You

24. Are you: (please check one box) Female Male

25. What is your place of residence: State _____ City _____

26. How old are you? _____



~ Thank you very much for your time! ~



Appendix B: Ski Resort Characteristics

Cranmore Mountain Resort (North Conway, NH)

Skiable Acres: 200+

Elevation: Summit 2000ft

Trails: 54 Beginner – 24%
 Intermediate – 46%
 Expert – 29%

Lifts: 5

Snowmaking: 100%

On Mountain Lodging: Yes

Ownership: Jiminy Peak Mountain Resort / CNL Lifestyle Properties Inc

Snow Conditions Guaranteed: Unknown

Proximity to Major Cities: Boston – 3 hrs
 Burlington – 3 hrs
 Hartford – 4½ hrs
 Manchester – 2 hrs
 New York – 6¾ hrs
 Portland – 1¾ hrs
 Providence – 3¾ hrs

Wildcat Mountain Ski Resort (Pinkham Notch, NH)

Skiable Acres: 225 (100% located on National Forest Land)

Elevation: Base 2000ft Summit 4062ft

Trails: 50 Beginner – 25%
 Intermediate – 45%
 Expert – 30%

Lifts: 4

Snowmaking: 90%

On Mountain Lodging: No

Ownership: Independent

Snow Conditions Guaranteed: Yes

Proximity to Major Cities: Boston – 3 hrs
 Burlington – 3 hrs
 Hartford – 5 hrs
 Manchester – 2¾ hrs
 New York – 7 hrs
 Portland – 2 hrs
 Providence – 4 hrs

Loon Mountain (Lincoln, NH)

Skiable Acres: 312

Elevation: Base 950ft Summit 3050ft

Trails: 55 Beginner – 20%
 Intermediate – 53%
 Expert – 27%

Lifts: 9

Snowmaking: 100%

On Mountain Lodging: Yes

Ownership: Boyne Resorts

Snow Conditions Guaranteed: Yes

Proximity to Major Cities: Boston – 2 hrs
 Burlington – 2½ hrs
 Hartford – 4 hrs
 Manchester – 1½ hrs
 New York – 6 hrs
 Portland – 2½ hrs
 Providence – 3½ hrs

Suicide Six (South Pomfret, VT)

Skiable Acres: 100

Elevation: Base 550ft Summit 1200ft

Trails: 23 Beginner – 30%
 Intermediate – 40%
 Expert – 30%

Lifts: 2

Snowmaking: 50%

On Mountain Lodging: No (affiliated with Woodstock Inn 2 miles away)

Ownership: The Woodstock Inn and Resort

Snow Conditions Guaranteed: No

Proximity to Major Cities: Boston – 2¾ hrs
 Burlington – 1½ hrs
 Hartford – 2¾ hrs
 Manchester – 2 hrs
 New York – 5 hrs
 Portland – 3½ hrs
 Providence – 3½ hrs

Mad River Glen (Waitsfield, VT)

Skiable Acres: 115

Elevation: Base 1600ft Summit 3637ft

Trails: 47 Beginner – 30%
 Intermediate – 30%
 Expert – 40%

Lifts: 4 (still has a single chair)

Snowmaking: 15%

On Mountain Lodging: No

Ownership: Independent / Cooperative (owned outright by skiers)

Snow Conditions Guaranteed: No

Proximity to Major Cities: Boston – 3 hrs
 Burlington – 1 hr
 Hartford – 4 hrs
 Manchester – 3 hrs
 New York – 5¾ hrs
 Portland – 4½ hrs
 Providence – 4¾ hrs

Jay Peak (Jay, VT)

Skiable Acres: 385+

Elevation: Base 1815ft Summit 3986ft

Trails: 76 Beginner – 20%
 Intermediate – 40%
 Expert – 40%

Lifts: 8

Snowmaking: 80%

On Mountain Lodging: Yes

Ownership: Independent

Snow Conditions Guaranteed: Yes

Proximity to Major Cities: Boston – 4 hrs
 Burlington – 1½ hrs
 Hartford – 4½ hrs
 Manchester – 3 hrs
 New York – 6½ hrs
 Portland – 3¾ hrs
 Providence – 5 hrs

Smugglers' Notch (Smugglers' Notch, VT)

Skiable Acres: 1000

Elevation: Base 2610ft vertical

Trails: 78 Beginner – 19%
 Intermediate – 50%
 Expert – 31%

Lifts: 6

Snowmaking: 62%

On Mountain Lodging: Yes

Ownership: Smugglers' Notch Skiways Inc (affiliated with RCI)

Snow Conditions Guaranteed: Yes

Proximity to Major Cities: Boston – 4hrs
 Burlington – 45 mins
 Manchester – 3 hrs
 Hartford – 4 hrs
 New York – 6 hrs
 Portland – 4½ hrs
 Providence – 5 hrs