Sustainability in the New England Ski Industry

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Sustainability in the New England Ski Industry
HONORS THESIS
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Environmental and Resource Economics, Sustainability

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Purpose

The goal of this study is to explore the extent to which sustainable investments are worthwhile for the New England ski industry. Research has shown that the New England ski industry will be greatly impacted by the effects of climate change within the near future. Anthropogenic climate change over the next several decades will cause frequent low snow winters, increases in night time winter temperatures, and overall shorter winters. Detailed economic analysis has shown that low snow and warm winters result in roughly $54 million in lost revenue for the New Hampshire ski industry in the past (Burakowski, Magnusson, 2012). However, little research has been done on what ski mountains themselves can do to adapt to and mitigate these impacts. Due to the magnitude of this research question and relatively short time frame for data collection and analysis, this paper represents the beginning of this research. My goal is to identify key sustainability initiatives that have proven successful at New England ski resorts, as well as identify what consumers value when it comes to sustainable investments. This first question is addressed by completing a case study on Jiminy Peak, a net-zero carbon emissions ski mountain in Massachusetts that operates using onsite wind and solar power. The second question is addressed by conducting an online survey with members of the UNH Ski and Board Club. It is my hope that this study will provide New England ski mountains with decision relevant analysis that informs investments and practices so they can prosper in the future.
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Introduction

Skiing is a sport integrated into the identity of New England. Despite the allure of West coast ski culture, New England ranks the highest in skier turnout (Dawson, Scott, 2013). Characterized by family run hills, challenging, often icy conditions, and wonderful views, New England skiing makes its mark in the United States. However, it is at risk of vanishing from the maps. New England is warming faster than any other area of the country, particularly its winters (Kelsey, Cinquino, 2021), and ski areas are no stranger to its impacts. Ski areas are reliant on natural snow and cold temperatures to produce and retain manufactured snow in order to operate. Without these cold temperatures, ski areas cannot open their slopes. Although manufactured snow allows for coverage when natural snow is lacking, the snow guns are reliant on cold temperatures. Therefore, ski areas must turn to other adaptation and mitigation efforts in order to do their part in reducing greenhouse gas emissions and slowing climate change.

Literature Review

Climate Change Impacts on New England Winters

The evidence of anthropological climate change impacts have become significantly apparent in New England winters. There is ample data on recorded and projected impacts climate change has and will have on wintertime in New England.

Recorded Impacts

The Northeast of the United States is warming at a more rapid pace than the national average, and the winter season experiences the fastest rate of warming in the Northeast (Kelsey, Cinquino, 2021). According to Stampone et al. (2022), the number of days with minimum temperatures below freezing has decreased by 9 days since 1970 in Berlin, n New Hampshire. This study also found that from 1971 to 2020 the average annual winter minimum temperatures across New Hampshire have increased by 3.3°C. This warming is not singular to Northern New Hampshire however. In a study conducted using temperature data from 73 climate stations across New England and New York and linear regression methods found a 1.1°C increase during the
twentieth century (Trombulak, 2004). Northeastern winters are warming at a rate of 0.127°C per decade, and this rate is only increasing (Kelsey, Cinquino, 2021).

The most visible changes caused by the climatic warming are seen as declines in snowfall, snow depth, and snow extent, as well as decreased seasonal lake ice cover and earlier melting of snow and ice (Hamilton et al., 2018). Since 1970, Northern New Hampshire has seen a decline of 1.5 snow-covered days (at least 1 inch of snow) per decade (Stampone et al., 2022). Winter precipitation is transitioning to a higher rain proportion, which leads to increased flooding and dangerous ice events. Additionally, ice layers forming within snowpacks caused by warm weather days and increased rain leads to increased risk of slab avalanches (Kelsey, Cinquino, 2021). These increased rain and thaw events have also caused significant flooding events downstream from the mountains, impacting New England residents (Kelsey, Cinquino, 2021). Aside from impacts on snow, warming winter weather and climatic changes also have negative impacts on the New England flora such as impacts on the dormant season of plants, damage to fine roots of trees due to soil frost, and shortening of sugar season due to impacts on maple sap production (Kelsey, Cinquino, 2021).

Projected Impacts

The projected warming in New England varies depending on greenhouse gas emissions scenarios: low emissions versus high emission. In the short term, current emissions ensure a temperature increase of about 1.1°C by 2040. However, in the long term under a low-emissions scenario, temperatures are projected to increase 2.2°C by 2099. A high emissions scenario would increase this warming to up to 5.0°C. During the twenty-first century, Northern New Hampshire is expected to lose 25% of nights with temperatures below freezing, and 50% of days with temperatures below freezing under a low emissions scenario. Under a high emission scenario, minimum winter temperatures are set to increase by 6.0°C by the end of the twenty-first century (Stampone et al., 2022).

Given this estimated warming, by the end of the twenty-first century, Northern New England is projected to lose 25-50% of its snow-covered days (Kelsey, Cinquino, 2021). Regardless of which emission scenario, the number of snow-covered days is projected to decrease during the twenty-first century. With focus on the Stampone et al. (2022) study, Berlin, NH had on average 165 snow cover days per winter. Due to the already baked in warming, this
number will decrease by 13 - 20% by mid-century days. Looking to the end of the century, under a low emission scenario, it will decrease by 20-34%.

The standard New England ski season aims for 100 days of operational time. Under a high emission scenario, New England ski areas are facing an average winter season with only 102 days of natural snow; given the variability in winter climate from year-to-year, this means there will be many more years with low snow winters compared to what we currently experience.. Ski areas typically do not open for operation until 30cm or roughly 1 ft of snow (natural or man made) has accumulated at the base (Rutty et al., 2017), although some areas spend considerable resources on making snow to open early. Therefore, in order to combat decreased snowfall and the threat of an increasingly shortened season, ski mountains must adapt and mitigate.

**Economic Impacts of Climate Change on the New England Ski Industry**

New England is home to over 150 ski areas (Rutty et al., 2017) and has the highest rate for skier visits in the United States, 13% above the United States average (Dawson, Scott, 2013), with individuals averaging 10 ski days per season(Rutty et al., 2017). The United States winter tourism industry is valued at $12.2 billion (Burakowski, Magnusson, 2012). The industry contributes $4.6 billion annually in the Northeast (Dawson, Scott, 2013), and New Hampshire and Vermont alone contribute $1.8 billion to their state economies annually (Rutty et al., 2017). However, this booming industry still faces economic impacts due to climate change. A 2012 study conducted by Elizabeth Burakowski and Matthew Magnusson analyzed the impacts of low snow winters on the winter tourism industry. The low-snowfall winters of 2001/2002 and 2006/2007 were studied and compared to the high snowfall winters of 2007/2008 and 2008/2009. The New England states results are displayed in Table 1 (Burakowski, Magnusson, 2012). These low snowfall years impacted the revenue of the ski resorts, totally to a regional loss of $190 million. However, the ski industry also directly and indirectly supports other businesses and industries in the region such as lodgings, restaurants, gas stations, local purchases of equipment, and employees spending earned money on a variety of products and services. This is grouped together and categorized as economic value added. Regionally, during low snow years, $143.9 million was lost in economic value added from the ski industry. This study shows the direct
impact of natural snow loss due to climate change on not only the direct ski industry but also the regional economy.

<table>
<thead>
<tr>
<th>State(s)</th>
<th>Difference in Skier Visits (%)</th>
<th>Difference in Ski Resort Revenue (millions)</th>
<th>Difference in Economic Value Added (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>-396,588 (-14%)</td>
<td>-$27.1</td>
<td>-$20.5</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>-793,088 (-17%)</td>
<td>-$54.3</td>
<td>-$41.1</td>
</tr>
<tr>
<td>Vermont</td>
<td>-889,264 (-9.5%)</td>
<td>-$60.8</td>
<td>-$46.0</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>-521,622 (-20%)</td>
<td>-$35.7</td>
<td>-$27.0</td>
</tr>
<tr>
<td>Connecticut and Rhode Island</td>
<td>-179,919 (-24%)</td>
<td>-$12.3</td>
<td>-$9.3</td>
</tr>
<tr>
<td>Regional Impact</td>
<td>-2,780,481</td>
<td>-$190.2</td>
<td>-$143.9</td>
</tr>
</tbody>
</table>

It is clear how reduced natural snow will impact the ski industry in New England. However, let’s take a deeper look into the impacts of reduced skier visitation on New England ski areas and the need for increased snowmaking.

**Skier Visitations**

In New England, 15-20% of all skier visits occur during the Christmas-New Years holiday season (Dawson, Scott, 2013). Although later season holidays such as February breaks also provide important visitations, this early season period from December 22nd to January 2nd is critical to New England ski areas. *_et al… springer study* conducted an analysis where the potential impact of the loss of this important time period was lost. This was quantified as a less than 75% chance of being open for the entire Christmas-New Year’s holiday. The study found
that under both low and high emissions scenarios, nearly all New England areas (except Western Maine) would be at economic risk of closure. The National Ski Areas Association found that during the low-snow winter of 2011/2012, 50% of all ski areas opened late. As low-snow winters become a more consistent issue, that critical early-season holiday time period is at risk of being lost (Burakowski, Magnusson, 2012).

Skier visitations are directly dependent on ski conditions and the length of the season. Ski condition impact will be further analyzed in the next section. In a study conducted by Rutty et al in 2017, it was found that ski season lengths were 3.4% to 10.9% shorter during seasons with limited natural snow (40% less snow compared to climatically normal seasons). This totaled to an average season reduction of almost 2 weeks. This study also found that during these climatically impacted seasons, skier turnout declined by 10.8% to 11.6%. This in turn resulted in 19% to 32% lower operating profits. It was found that the revenue per skier decreased by roughly $5 during these seasons as well. This reduction in skier visitation indirectly impacts the local economy and tourism industry as well, however this study did not detail those impacts.

**Snowmaking: The Most Popular Adaptation Method**

Snowmaking has become a necessity to ski areas, and has been found to be the most preferable climate adaptation strategy for alpine skiing (Dawson, Scott, 2013). The National Ski Areas Association found that by the winter of 2009/2010, 88% of all National Ski Areas Association resorts were using snowmaking (Burakowski, Magnusson, 2012). Snowmaking, however, is not a cheap endeavor. According to the National Ski Areas Association, snowmaking contributes to approximately 5-6% of operating costs in Northeastern ski resorts. Additionally, Burakowski et al. found that snowmaking consumes up to 50% of a ski resort's energy costs, totalling roughly $500,000 a season. However, the need for snowmaking will increase, therefore increasing operational costs. Under a low emissions scenario, New England ski areas will need to increase snowmaking by 25% to 50%, while under a high emission scenario that need is projected to increase to 50% to 90% (Dawson, Scott, 2013). The need for increased snowmaking during low snow winters is already critical for New England ski areas. In the winter of 1998-99, snowmaking hours were increased by 75.8% due to the 40% reduction of natural snow. During that same winter, the power utilized for snowmaking increased by 36.7% (Rutty et al., 2017).
Although snowmaking may appear to be a viable option for ski mountains to remain operable though low snow winters, there are flaws associated with the process. The minimum temperature required to produce snow is -5°C or 23°F (Dawson, Scott, 2013). Therefore, as New England experiences warming winters (and especially warming nighttime temperatures) with few below freezing days, the ability to produce snow will also decrease. However, snowmaking does significantly improve the viability of the ski industry in the twenty-first century. A study conducted in Ontario, Canada found that with current snow making capabilities, between 7% and 32% of the average ski season would be lost due to climate change, and improved technologies could improve that range to 1% and 21%. Although there is still season loss, these percentages have improved from the estimated 40% to 100% loss there would be without snowmaking (Scott et al., 2003).

**Methods**

The goal of this thesis is to analyze the benefits of sustainable impact investing by New England ski areas. In order to gain a better understanding of the current status of sustainability in the New England ski industry, three approaches were taken. These were desk research, informational interviews, and consumer surveys.

*Desk Research*

Desk research was performed to build a foundational understanding of current climate impacts on winters in New England and how these will affect the ski industry. Additionally, this method was used to investigate the sustainable impact investments available to ski areas, as well as perform a case study on ski areas which have already implemented these tools. Scientific, peer reviewed journals and reports, information from ski area websites, and industry records were the primary source material for the desk research. Peer reviewed journals and reports were used to gather data on climate change impacts, economic impacts endured by the ski industry, and information related to sustainable investments such as costs, energy usage, and skier turnout. Ski area websites were utilized to form an understanding on the current standing of sustainability in the industry, as well as gather information for the case study. Finally, industry records such as ticket and pass costs were used to evaluate the impacts taken by consumers related to years in
which sustainable investing took place. These combined sources provided the information used in the literature review and case study.

*Informational Interviews*

In order to enhance the understanding of climate change impacts on the New England ski industry, two informational interviews were conducted. These interviews aimed to collect information from both the scientific and industry perspectives of the research topic. These interviews contained purely informational based questions, and no opinion based or informal answers were recorded. Due to the nature of these interviews, no Institutional Review Board approval was needed. Interviews were conducted with Dr. Elizabeth Burakowski, and Ben Wilcox. Dr. Burakowski is a climate scientist at the University of New Hampshire who has published multiple papers and reports investigating the impacts of climate change on the winter recreation industry. Ben Wilcox is the general manager of Cranmore Mountain Resort, located in North Conway, New Hampshire. These interviews helped to identify key topics to investigate, as well as build the consumer survey.

*Consumer Survey*

The consumer survey collected data with the aim to identify consumer opinions of sustainability within the New England ski industry. The survey was created using Qualtrics and was distributed via email and social media. The target audience of this survey was members of the University of New Hampshire Ski and Board Club. The objective was to gain information on what the “next generation” of skiers' opinions were relating to sustainable investments, climate change, and costs related to sustainability. The survey was anonymous, however respondents were given the opportunity to complete an additional Qualtrics survey to be entered in a drawing for a $25 gift card to a local ski shop. These recorded emails were deleted upon the winner being chosen. Due to the use of human subjects, this survey required Institutional Review Board approval, which was given under the IRB-FY2022-319. The survey gathered 78 responses. The questions within the survey can be found in appendix A.

Utilizing these methods, this paper aims to clarify the impacts of climate change on the New England ski industry, as well as identify the investments that will aid in the adaptation to these
changes as well as a reduction in greenhouse gas emissions. The following sections review successful sustainable ski area operations, as well as consumers' perspectives regarding the future of the New England ski industry.

**Case Study: Jiminy Peak Mountain Resort**

Jiminy Peak Mountain Resort, located in Hancock, Massachusetts, has been in operation since 1948. Initially opening with a T bar and three rope tows, the mountain is now home to a high speed six person lift, two quad lifts, three triple lifts, and one double lift. The mountain has a vertical drop of 1,150 feet, making it the second tallest mountain in Massachusetts, just 40 feet shorter than Berkshires East. Jiminy Peak has become one of the most popular ski areas in Southern New England. Throughout its over 70 years of operation, Jiminy Peak has strived to become a more resilient and sustainable mountain.

**Snowmaking**

Jiminy Peak is no stranger to the struggles of low-snow winters. After a short 30 day season in the winter of 1953-54, Jiminy Peak management decided to invest in a snowmaking system. This installation changed operations for Jiminy as they were now able to open before Christmas. Since then, Jiminy has made investments in their snowmaking and snow retention. There was even a brief trial of the “Sno Coat”, which was a 40x1,000 ft long tarp made of plastic placed on top of the snow to prevent washout during rain events. It wasn’t until 1997 the Jiminy Peak began investing in snowmaking technology with the intention of energy conservation. From 1997 to 2015, Jiminy installed various snow making technologies focused on efficiency and saving energy. In 2002, they even began capturing the heat from the snowmaking compressors to heat 34,000 square feet of space inside their Village Center buildings. In 2016, they replaced the entire snowmaking system with 450 Sledgehammer technology snow guns. Sledgehammer snow
guns use less compressed air than the previous technology, while producing 100% more snow. This transition has created an annual energy savings of 41.7%.

Renewable Energy

Jiminy Peak is home to Zephyr, the 1.5 megawatt wind turbine. This turbine was constructed in 2006 and sits on Jiminy Peak’s summit. The turbine on average provides 33% of Jiminy’s annual electrical demands and can provide up to 50% during the winter months. The initial installation cost of the turbine was $4 million, however a $582,000 grant from the Massachusetts Technology Collaborative paid in part for the design and purchase. Jiminy also receives tax rebates and Renewable Energy Credits from the state. Through these credits, rebates and the saving on energy provided by the turbine, the project was completely paid back in 2015. Each year, the turbine produces 4,600,000 kWh of electricity. This production not only saves the need for 113,022 gallons of diesel generated power, but also offsets 7,100,000 pounds of CO₂, the leading cause of climate change. Additionally, Jiminy Peak’s ability to produce its own energy safeguards the mountain from falling victim to increasing energy prices. Jiminy Peak now consumes no external energy. Zephyr is not the mountains’ only involvement in renewable energy however. Jiminy Peak is also involved in the Nexamp Peak Community Solar Project. This is a 2.3 megawatt solar facility on 12 acres of Jiminy Peak property. The solar facility is owned by Nexamp, who sells energy credits to partners to offset energy expenses. Jiminy Peak as a partner buys energy credits and then offers these credits to local homes and small businesses. Jiminy Peak is also home to a cogeneration plant, installed in 2012. The cogeneration plant uses propane gas to power a motor, which then produces heat, which is then cooled by circulating water. This now hot water is then
used to heat the central core of the building. The cogeneration unit produces electricity as a by-product of this action, totalling 400,000 kWh annually.

*Other Sustainable Investments*

Jiminy Peak has found other ways to operate sustainably aside from energy production and snow making. A key initiative the mountain has taken is converting to LED lighting. In 2015 - 2017, the base lodge, resort inn, resort restaurant, night skiing slopes and night lifts were all converted to LED lighting. This saves the resort about 171,551 kWh of energy. Jiminy Peak has also reduced water usage by installing waterless urinals, saving approximately 40,000 gallons of water per urinal annually. Additionally, Jiminy Peak installed an ozone water treatment system for the laundry center on site. The goal of the ozone water treatment is to send cleaner water to the wastewater treatment plant. Another tool to reduce water use was changing lodging housekeeping standards. Housekeeping will only change sheets and towels upon request for guests staying more than one night. This saves roughly 25,000 gallons of water per year. Additionally, housekeeping only uses green, biodegradable solvents and cleaners.

Jiminy Peak’s record of sustainable investments is extensive. From erosion protection by better land management practices to reducing energy used to pump water by creating a summit reservoir, this Massachusetts mountain has done it all. Jiminy Peak has been awarded for their work in sustainability including the Climate Change Impact Award in 2019 and the National Silver Eagle award in 1994 for fish and wildlife habitat protection (Jiminy Peak, 2022)

*Results of Survey*

An anonymous survey was conducted with members of the University of New Hampshire Ski and Board Club to collect consumer opinions on sustainable investments, climate change, and ski pass costs. This survey received 78 responses after distribution via email and social media (Instagram). The survey was broken into three sections: respondent variables, perspectives and opinions on ski industry investments, and general perspective on climate change. These three sections combined provide a well rounded review of consumer opinions from a group of active skiers and snowboarders.
Respondent Variables

This portion of the survey was intended to create a grouping of respondents. The questions within this section are listed in Appendix A. For this section we will focus on the following question “Are you a New Hampshire resident? [if yes] Would you accept an increase in taxes, up to $100, as a result of improved renewable energy policy in the state?” Of the respondents, 50.7% (36 respondents) reported that they are residents of New Hampshire. Upon selecting yes, respondents were directed to answer the corresponding tax related question. For this question, they were provided with three options, yes, maybe, and no. The majority of 52.8% responded “maybe”, while 44.4% responded “yes”, and only 2.8% responded with a definitive “no”.

Perspectives and Opinions on Ski Industry Investments

This section was the foundation of the survey. The main goal was to understand what consumers considered when purchasing a ski pass, which investments they considered the most worthwhile, what communication tools they felt were most effective, and their opinions on potential pass price increases. Due to the significance of this portion of the survey, the data will be presented for each question. When asked if the impacts from climate change have caused impacts to their skiing experience, 98.3% of respondents responded “yes”. However, only 38.3% of respondents claim to consider sustainability when purchasing their ski passes. That being said, the majority of respondents (86.7%) agreed that they would pay up to 10% more for a ski pass if the mountain implemented a wide array of sustainability practices.

In this portion of the survey, respondents were also asked to rank sustainable ski mountain investments based on their importance to them. Table 2 displays the ranking of those investments. The survey found fair hiring practices, livable wages, renewable energy production and use, and lift technology to be the highest ranking investments among respondents. Additionally, respondents were asked to rank communication tools which ski mountains can use to inform their customers on their sustainable practices. Table 3 displays the ranking of those communication tools. The survey found resources on websites and media stories to be the highest ranking communication tools among respondents.
Table 2: Ranking of sustainable ski mountain investments based on percentage of respondents choosing very to extremely important

<table>
<thead>
<tr>
<th>Sustainable investment</th>
<th>% respondents ranking very-extremely important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair hiring practices</td>
<td>85.0%</td>
</tr>
<tr>
<td>Livable wages</td>
<td>80.0%</td>
</tr>
<tr>
<td>Renewable energy production and use</td>
<td>68.3%</td>
</tr>
<tr>
<td>Lift technology</td>
<td>63.3%</td>
</tr>
<tr>
<td>Facility improvements (low flow toilets, LED bulbs, etc)</td>
<td>63.3%</td>
</tr>
<tr>
<td>Energy efficient snowmaking technology</td>
<td>50.0%</td>
</tr>
<tr>
<td>Signage (non-idle areas, recycling, etc)</td>
<td>48.3%</td>
</tr>
<tr>
<td>Hybrid/electric grooming vehicles</td>
<td>38.3%</td>
</tr>
<tr>
<td>Electric vehicle charging stations</td>
<td>26.7%</td>
</tr>
</tbody>
</table>

Table 3: Ranking of ski mountain communication tools based on percentage of respondents choosing very to extremely important

<table>
<thead>
<tr>
<th>Sustainable investment</th>
<th>% respondents ranking very-extremely important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources on website</td>
<td>48.3%</td>
</tr>
<tr>
<td>Media stories</td>
<td>48.3%</td>
</tr>
<tr>
<td>Deals for customers based on sustainable practices (ex: discounts for electric car users)</td>
<td>45.0%</td>
</tr>
<tr>
<td>Hosting events (charity events, carpool days, etc)</td>
<td>41.7%</td>
</tr>
<tr>
<td>Advertisements</td>
<td>35.0%</td>
</tr>
</tbody>
</table>

General Perspective on Climate Change

The survey closed with three questions pertaining to the respondent's personal experiences with climate change. The respondent was asked how concerned they are about
climate change, how personally affected they are by it, and how often they experience climate anxiety. The purpose of this section was to understand how the next generation of consumers views a critical driver of the ski industry: climate. The following charts display the distribution of the respondents' answers. No respondents were not at all concerned or not at all affected by climate change. However, a small portion of respondents reported never experiencing climate anxiety.

**Graph 1: Survey responses to "How concerned are you about climate change?"**
- Extremely concerned (56.67%)
- Very concerned (20.67%)
- Somewhat concerned (15.00%)
- Not very concerned (1.67%)

**Graph 2: Survey responses to "How personally affected are you by climate change?"**
- Extremely affected (15.00%)
- Very affected (26.67%)
- Somewhat affected (48.33%)
- Not very affected (10.00%)

**Graph 3: Survey responses to "How often do you experience climate anxiety?"**
- Every day (8.33%)
- Most of the time (31.67%)
- Sometimes (33.33%)
- Rarely (21.67%)
- Never (5.00%)

**Discussion**

The New England ski industry is already dealing with the direct impacts caused by climate change. Furthermore, over the next several decades, New England ski mountains will be experiencing shorter ski seasons, decreased natural snowfall, increased need for energy to produce snow, and other issues associated with our changing climate. Climate change will not only directly impact the businesses which operate ski mountains, but also the consumers that frequent the mountains. Therefore, it was pertinent to understand the consumer perspective on the changing ski industry and what role they would be willing to play in helping the industry adapt to the impacts of climate change.
The survey revealed that of the New Hampshire resident respondents, only 2.8% would not be willing to pay up to $100 more in taxes for improved renewable energy policy. Although the research focuses on New England as a whole, New Hampshire stands out as it lags behind in the installation of renewable energy projects. Table 4 below shows the distribution of renewable energy usage among the New England states, particularly solar, wind, and hydro-power. The leaders in each category are highlighted in green. In the United States, Vermont is the fourth largest user of hydropower. For solar, Massachusetts is the fourth largest user, Vermont the fifth, and Rhode Island the sixth. Maine is the tenth largest user of wind. New Hampshire falls short in all three of these categories, only surpassing Connecticut in two areas (Choose Energy, 2022). The survey data reveals that the majority of respondents would be, to some capacity, willing to increase individual tax expenditure to encourage and fund state wide renewable energy policy and implementation.

<table>
<thead>
<tr>
<th>State</th>
<th>Hydro</th>
<th>Solar</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Hampshire</td>
<td>7.2%</td>
<td>&lt;1%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Maine</td>
<td>24.6%</td>
<td>3.9%</td>
<td>27.7%</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>4.4%</td>
<td>19.1%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Vermont</td>
<td>45.7%</td>
<td>12.2%</td>
<td>21.3%</td>
</tr>
<tr>
<td>Connecticut</td>
<td>&lt;1%</td>
<td>2.6%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>&lt;1%</td>
<td>11.0%</td>
<td>4.1%</td>
</tr>
</tbody>
</table>

The survey gathered information on consumer opinions directly relating to the New England ski industry. It was found that only 38.3% of respondents actually consider ski mountain sustainability when purchasing a season pass. However, almost all (98.3%) of respondents attest that climate change has had a direct impact on their skiing experience. This shows that despite the experienced repercussions of climate change on the winter sport, most consumers do not consider mountain operations when deciding where to ski for the season. The respondents were then asked which sustainable practices were most important to them in relation
to the ski industry. The number one sustainable practice ranked by consumers was fair hiring practices, followed closely by livable wages. Although these two sustainable practices do not pertain to the environmental impact of climate change, the survey responses show the overarching importance of these practices. Ranked at the third most important sustainable practices was renewable energy production and use, remaining consistent with the previous tax related results. Although snow making is the most popular sustainable investment among ski areas, it was ranked six out of nine by consumers. This ranking of renewable energy far above snow making displays consumer knowledge of the importance of renewable energy sources and suggests the knowledge of the connection between snow making and energy usage. Respondents were further asked how best the ski areas could inform consumers about sustainable investments being made. Both resources on websites and media stories were ranked highest. With advertisements ranked last, this shows the rising importance of online and social media presence for businesses in all industries.

Additionally, respondents were asked if they would be willing to pay up to 10% more for a ski pass if the ski area implemented sustainable investments. At 86.7%, the majority said they would. Alpine skiing is a sport for the affluent. In order to participate, skiers must rent or buy gear, which can cost anywhere between $100-$1000 depending on source and style. Then, participants must purchase either a day pass, prices now rising to around $100 per day, or purchase a seasons pass, which can cost anywhere between $250 - $1200 depending on locations and age range. Additional costs associated with skiing are gas and vehicle costs, lodging, food, and maintenance. This all totals to a very expensive sport. By surveying the assumed “lower income bracket” of these participants (also known as college students) the survey was able to best gather information on how price increases would impact consumers. The results show that even lower income bracket participants would be willing to pay 10% more for a pass, as it would only be a small fraction of the already high costs. Consumers are willing to pay high prices to participate in these winter recreation activities, therefore the price increases potentially caused by an increase in sustainable investments should not act as a barrier or limiting factor for ski areas to implement these changes.

Finally, respondents were asked about their personal experiences with climate change. The data showed that no respondents lived completely without experiences or concerns of climate change. However, some respondents reported never experiencing climate anxiety.
Climate anxiety is the psychological response to climate change and has been called the “chronic fear of environmental doom” (Clayton, 2020). Climate change has several linkages to mental health impacts such as PTSD from extreme weather events, increased aggression due to high temperatures, and cognitive impairment from air pollution. Climate anxiety in particular does not require any direct impacts from climate change as climate related PTSD or other impacts may. Climate anxiety can be experienced by anyone who is aware of climate change and its impacts. This term has only recently surfaced as more and more people are experiencing the symptoms of mental disruption from climate change. The majority of survey respondents have experienced climate anxiety at least once in their life, and 40% experience it most of the time or everyday. This data demonstrates the overarching impact of climate change aside from industry impacts, as well as the cultural awareness of climate change.

Overall, the survey data demonstrated that consumers are aware and impacted by climate change, particularly in their skiing experience, and they are willing to monetarily contribute to sustainable initiatives in order to preserve their sport.

**Conclusion**

This preliminary study highlights the importance of sustainable investments for the New England ski industry. It is evident from existing literature that climate change is and will continue to impact the industry significantly. Jiminy Peak acted as a case study location to show how existing ski areas are able to operate sustainably and successfully. The survey brought to light the willingness of consumers to participate in the new era of sustainable ski areas. However, there is more work to be done.

It is suggested that future studies include more in-depth research into the ski areas themselves. A survey of existing sustainable infrastructure and technologies at ski mountains would provide a benchmark of where the New England ski industry stands with sustainability, and where improvements should be made. Additionally, research into the cost impacts of these sustainable investments on ski areas would be worthwhile, especially comparing the various New England states based on their rebate and tax incentive programs relating to renewable energy. This data could then be translated into a more detailed consumer study to understand consumer perspectives on specific cost impacts.
Climate change poses serious threats to the New England ski industry and its impacts are already being seen. Ski areas must invest in the appropriate technology and infrastructure in order to remain sustainable and continue to operate in the future. The impacts of climate change are evident now and will only escalate in the future. Action needs to be taken by consumers, industry heads, and state legislatures in order to have a future of skiing in New England.
Works Cited


Scott, D., McBoyle, G., & Mills, B. (2003). Climate change and the skiing industry in southern


Images


Appendix

A: Questions for Consumer Survey
Sustainability in the New England Ski Industry: Future Consumer Questionnaire

Section 1: Identifying variables

● What college are you affiliated with at UNH?
  ○ COLSA
  ○ COLA
  ○ Paul College
  ○ CHHS
  ○ CEPS
  ○ Thompson School
  ○ Graduate Student

● Are you a New Hampshire Resident?
  ○ No
  ○ Yes
    ■ If you answered yes, would you accept an increase in taxes, up to $100, as a result of improved renewable energy policy in the state?
      ○ Yes
      ○ No
      ○ Maybe

● Did you exclusively purchase the New Hampshire College Pass this season (2021-2022)?
  ○ Yes
  ○ No
    ■ What other pass do you hold?
      ● -written response-

Section 2: Perspective and Opinions on Ski Resort Investments

● Do you believe you have seen impacts from climate change on your skiing experience?
  ○ Yes
  ○ No

● Do you consider sustainability when purchasing a ski pass?
  ○ Yes
  ○ No

● Please rate the following sustainable ski mountain investments by how important they are to you when purchasing a ski pass: not important, somewhat important, very important, extremely important
  ○ Energy efficient snowmaking technology
  ○ Hybrid/electric grooming vehicles
○ Signage (non-idle areas, recycling, etc)
○ Renewable energy production and use
○ Facility improvements (low flow toilets, LED bulbs, etc)
○ Electric vehicle charging stations
○ Livable wages
○ Fair hiring practices
○ Lift technology

● Please rate the following communication tools used by ski mountains for sustainable practices by how important they are to you when purchasing a ski pass: not important, somewhat important, very important, extremely important
  ○ Resources on website
  ○ Hosting events (charity events, carpool days, etc)
  ○ Deals for customers based on sustainable practices (ex: discounts for electric car users)
  ○ Advertisements
  ○ Media stories
  ○ Other

● Would you be willing to pay up to 10% more for a pass if the mountain implemented a wide array of sustainability practices?
  ○ Yes
  ○ No

Section 3: General Perspective on Climate Change

● How concerned are you about climate change?
  ○ Extremely concerned
  ○ Very concerned
  ○ Somewhat concerned
  ○ Not very concerned
  ○ Not Concerned

● How personally affected are you by climate change?
  ○ Extremely affected
  ○ Very affected
  ○ Somewhat affected
  ○ Not very affected
  ○ Not affected

● How often do you experience climate anxiety?
  ○ Every day
  ○ Most of the time
  ○ Sometimes
  ○ Rarely
Section 4: Drawing for Gift Card

- If you would like to be entered into a drawing for a $25 Putnam’s gift card, please follow the link below.
  - “Link to email survey”