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Ski Resorts and Climate Change: The Environmental and Business Conflicts of the Relationship

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Ski Resorts and Climate Change: The Environmental and Business Conflicts of the Relationship

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by

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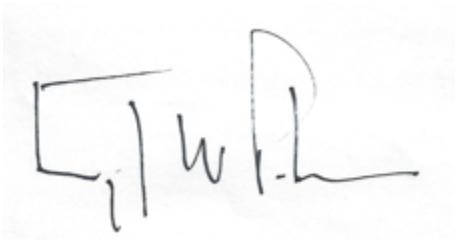
___  _____

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SKI RESORTS AND CLIMATE CHANGE: THE ENVIRENMENTAL AND BUSINESS CONFLICTS OF THE RELATIONSHIP

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Ski Resorts and Climate Change: The Environmental and Business Conflicts of the Relationship by Jordan Comerio explores the effect that the changing climate has on the ski industry. The project looks at the sport of skiing and the impact on personal, communal, and economic levels and an analysis of how the changing of the sport's season will be affecting each and will provide specific data and accounts.

After the relationship between the sport and changing climate is established, the critical question is how to combat the issue. Suggestions will be given in ways that help continue the sport of skiing and add longevity whereas other ideas focus on business incentives for ski companies to drive revenue in other areas. Regardless, the goal of this project is to raise awareness of the drastic negative impacts on the ski industry and how to combat the issue as individuals and businesses in sustainable ways.

I. Introduction

Skiing. It's a sport that gives and takes. It gives memories, peace, adventure, community, exercise, and plenty more. Yet it takes risk, money, and devotion.

During my sophomore year at Regis University, I found myself finally committing to the sport of skiing. I acquired Salomon skis and new boots, bought the Epic pass, and made friends who I could go with. I did everything to get me set up for I now lived in a state that offers incredible skiing, Colorado. I was excited but also terrified. Where I grew up, St. Louis, there were not many adrenaline pumping outdoor sports to enjoy. The idea of flying down a snow-covered mountain on skinny plexiglass planks was enticing yet created anxiety.

The second ski day of the season, I found myself unable to stand after a hard fall. I was unsure what had happened or whether I was truly injured. Long story short, I found myself in an immense feeling of pain coming out of surgery from the incident two days later. The fall ended up causing a spiral fracture to my tibia in my right leg. For the healing process, they had to insert a metal rod and few screws into the bone to restructure it and allow healing to begin.

I've been enjoying other outdoor pursuits up to that point such as backpacking, rock-climbing, white-water rafting, and long-distance hikes. I developed the understanding through those sports that the mountains are always in control, their purpose does not concern you. With this understanding and speaking with others with similar experiences, the only thing to do is to move on, recover and don't let the challenges deter you from a motivation you once had.

The healing process was quite a challenging yet one that I will always cherish. I could not walk for three months, leading me to have to rely on others and feel unable to complete common everyday tasks. To put this experience in perspective, I'm somebody who values independence. To ask somebody for help in tasks that should not be challenging, such as carrying my dishes,

made me feel weak. Regardless, this experience was humbling and grounding. It forced me to realize what I value in life such as the simple aspect of ability and mobility but more so the connection I have with others.

Regarding my connection to skiing, I found myself defeated from the sport. I gave it my one shot and here I am, unable to do the things I love as well as simple daily tasks. At times I felt quite a grudge to the sport. Yet at the same time I could not stop watching skiing videos and tutorials as I lay bedridden for the first few weeks. Through this grudge I developed a devotion to overcome and pick it right back up once I had a working leg despite the setback it gave me. And I did.

The following winter, I did go back out there to ski again. To say it was challenging would be an understatement. I initially found excuses not to go but ultimately decided I was undervaluing myself and went. After a couple of days, I finally felt like a "skier", which to a Midwest kid simply meant I could go down the intermediates with ease. I felt a sense of comfort while skiing that season, forgetting the fact that I shattered my leg a year before. As I was skiing down Paradise Bowl in Crested Butte, I finally understood that "bug" that people get for the sport, where they drop just about anything to spend the whole season near a ski hill. It's quite a feeling and the only way to explain it is I ask you to think of what activity you find yourself making sacrifices due to the joy it brings you. The smile on your face when you're participating in said activity.

So why am I telling you this? How does this relate to skiing and climate change? Where's the connection to the finances of the sport and companies that gift us the opportunity of pursuing the sport? Where does my experience come into play?

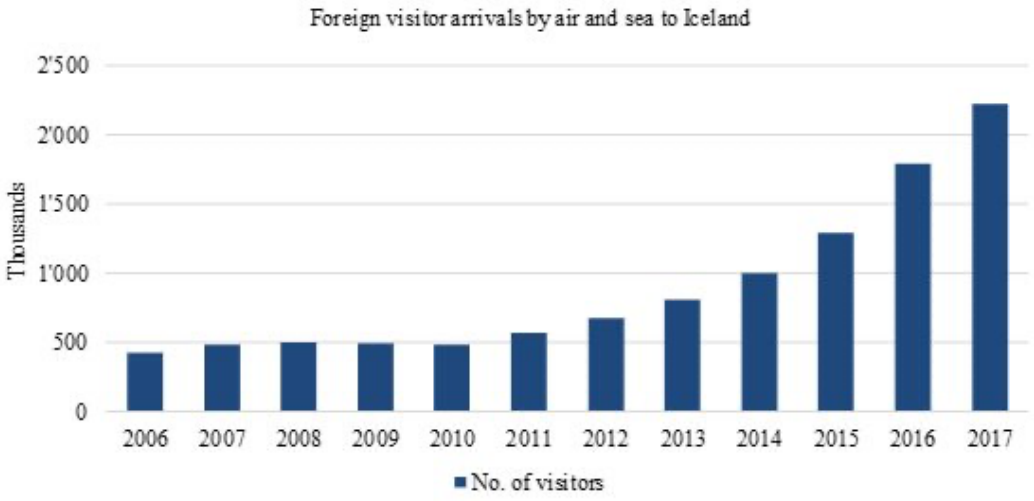
I offer this insight into my experience in the hope of creating outreach to those who have not developed their own connection with the sport. It's more than the upper middle-class family vacation with kids who need naps and parents excited for elevated drinking or the east coast ski bum raving about the run they just shredded. It's a sport worth caring about for it creates appreciation to those who either seek it or simply find themselves upon it. It provided an insightful and testing experience that bettered my view of people, the human condition, challenges, and my own ability to overcome as it has for many others. It's a sport that has touched past and present generations, but the clock of climate change is ticking for the chance of future generations. First, let's look at how tourism can drastically affect the environment and economy on a national level.

II. Benefits of Tourism and Recreation

Before diving into how the changing climate is affecting the ski industry and tourism, let's look at how tourism can help our climate. Tourism is what propels certain regions and countries forward. It's the driver of revenues and is what keeps certain communities and industries afloat. National parks and protected lands would not exist without the revenue of visitors to those designated areas. Countries such as the Maldives even impose a green tax on tourists, produces up to 40 million USD a year, which is then allocated to marine conservation or local communities to help with the country's economy (De Sousa, 2020). Costa Rica is a country that almost entirely runs on renewable energy due to the money that tourism brings into the country (De Sousa, 2020). There are plenty of other examples on how tourism can benefit the environment, but one example sticks out.

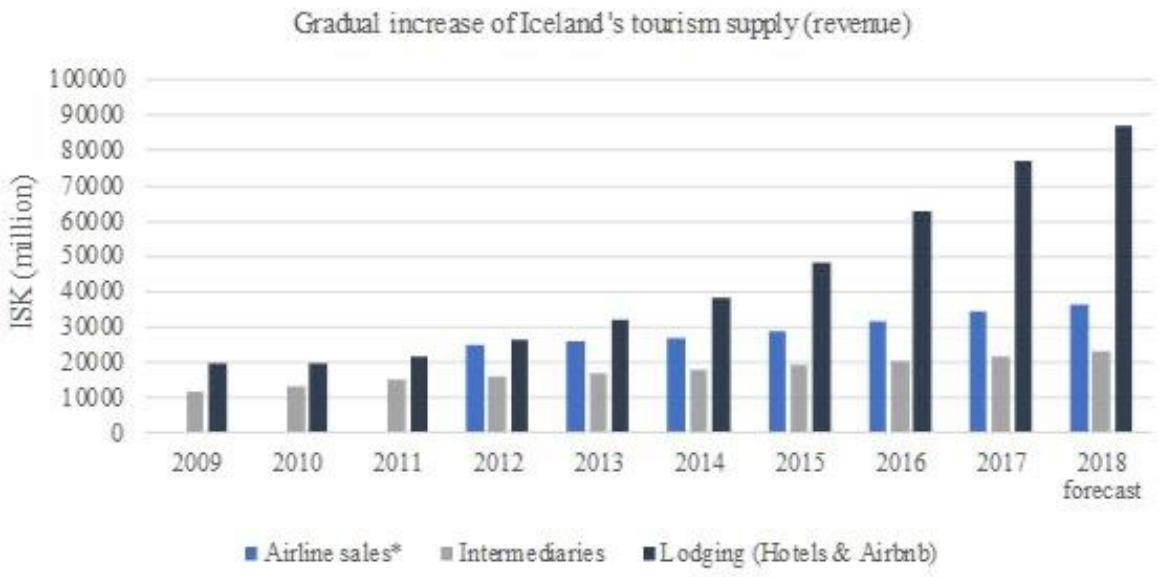
In 2008, like many countries, Iceland found themselves in economic disaster after the financial crisis. Their economy used to rely heavily on fishing yet with territory disputes in the 1900s, this economy was on a decline. The next answer was utilizing the massive amounts of rivers and waterfalls the country provides for hydroelectricity and aluminum production, which for a nation that is known for untouched wilderness, many environmentalists were up in arms for this. To put into perspective how one dam affects the environment here, when the government built the first dam in 2008, it affected 5% of their highlands area or the equivalent size of Los Angeles (McDonald, 2019). Many locals were not pleased with this new idea of how to propel their economy because of the effect it had on their backyards. A volcanic eruption happened on the island in 2010, which grounded the largest number of planes since WWII (McDonald, 2019). The event allowed many people to discover the tiny island's beautiful nature after this natural marketing campaign. This timing also was during the explosion of cheap flights and digital

marketing, which allowed the tourism industry for the country to boom. Within a few years, the tourism industry overtook both the fishing and aluminum industries (McDonald, 2019). Figure 1 below represents the increasing of foreign travelers to the country after the eruption.



(Fig. 1 Documents the amount of foreign visitor arrivals to Iceland by the thousands from the time frame 2006 to 2017, noticing an increase. [Troxler, 2017])

The importance of this is that 93% of visitors cited Iceland's wild and pristine nature to be the reason for their visit and allowed the government and environmentalists to then focus on protecting the nature of the country to keep their highest economic exporter alive (McDonald, 2019). For Iceland specifically, tourism had a 23 to 1 economic benefit to cost ratio, entailing that each krona (Iceland's currency) spent, 23 return in economic impacts (McDonald, 2019). Other important notes on how tourism benefits the Icelandic economy is that due to the boom, 5,500 jobs were founded nationwide as well as 98% of the money coming into the country was from foreigners (McDonald, 2019). Figure 2 below represents the increase in Iceland's revenue that they saw through tourism in three different categories: airline sales, intermediaries, and lodging.



(Fig. 2 Represents the increase of Iceland's revenue through tourism in millions of ISK by airline sales, intermediaries, and lodging from 2009 to 2017, with year 2018 being forecasted. [Troxler, 2017])

Now, why mention some small island in the middle of the north Pacific Ocean in a paper about skiing? It can be argued by that with these facts above, Iceland's pristine environment was saved by the booming tourism and the economic profit it brought with it. This country was planning on damming and completely changing areas of this island due to the economic strain they were in but by a stroke of luck, that volcano brought a different way the country would rely on in terms of economic gain. That way is people wanting to see their wild land. The country has most certainly seen negative effects from the mass tourism such as overcrowding, real estate prices rising, visitors not respecting their land, and more. The tradeoff is the government's focus is now to find ways to protect certain areas of their natural land instead of dam it and use it for factories that would negatively impact the environment more so compared to the effects of tourists. This idea of tourism bringing in money which then causes governments and companies to focus on preserving the draw, nature, can be seen in many other areas. A study of the American West from the 1970s to the 2010s found that rural counties with more protected lands

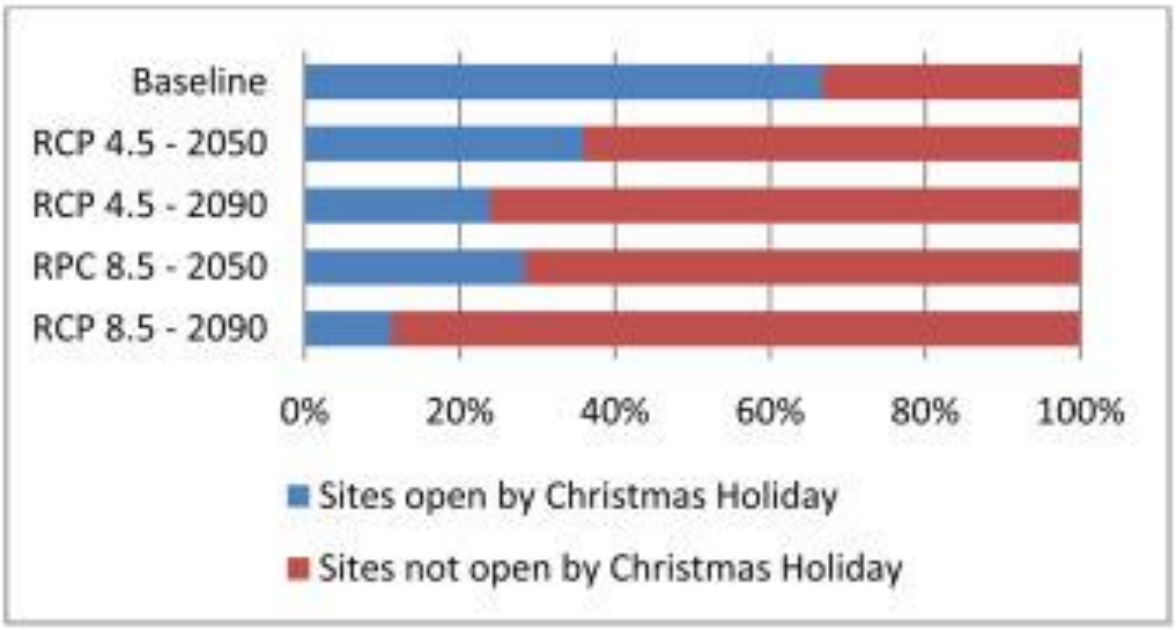
saw in increase in population growth, employment, and personal income (McDonald, 2017). These findings affect ski areas as well, which rely on the land to generate revenue. But as Iceland was in an economical predicament, the ski industry is in an environmental predicament.

III. The Climate's Effect

For downhill skiing to take place, there needs to be one of two, natural snow or man-made snow. At most resorts, we see both, but one may be used more than the other. Man-made snow is usually very icy and slushy and seen in areas that do not see feet of snow each winter. Natural snow will be softer to ski on with a more powder feeling than man-made snow. Now, each resort based on geographical locations will have a different type of governing snow and depending on the year will also see different conditions. Regardless, both forms are seeing effects from the changing climate. To note, there is backcountry skiing and heli-skiing where more advanced athletes will go that will not be groomed by a resort or have any man-made snow. This form of skiing will not be focused much on this project but is still being affected and something to pay attention to over time.

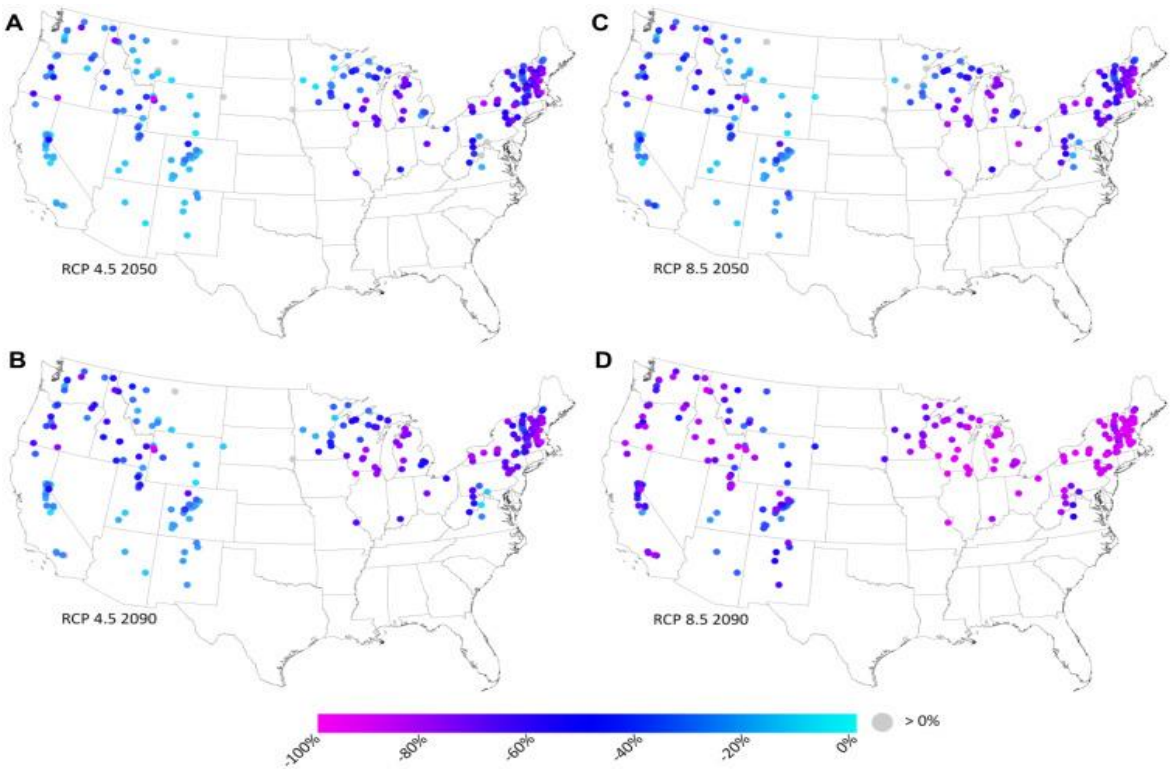
A given skiing area needs roughly 400 to 500 hours of the right conditions to occur before the area can use their snowmakers effectively. This is to ensure that the environment that the snow will be covering is cold enough to increase efficiency of the snow makers and not simply melt. These conditions are described as holding a temperature of 28 degrees Fahrenheit or less (Wobus, 2017). Now if you have any idea of what is going on in our climate today, you'll know that this time frame is getting shortened. Figure 3 below represents how ski areas will see a decline in the ability to begin snowmaking before the holiday season, which is a critical time for ski companies to operate due to families taking holiday vacations. On the figure you will see RCP 4.5 and RCP 8.5. RCP stands for Representative Concentration Pathways which in simple terms entails ways to predict future changes in our climate depending on concentration of greenhouse gas in our atmosphere up until 2100. The difference between 4.5 and 8.5 is how dramatic the change may be, 8.5 being more extreme whereas 4.5 is more intermediate.

Therefore, the charts below will contain both, since we can't perfectly predict how the climate will change in the next century.



(Fig. 3 Percentage of modeled areas able to reach the necessary hours of snowmaking before December 15, the start of the holiday season, [Wobus, 2017])

Similar results can also be seen in the length of the downhill ski season. Figure 4 below looks at projected shortened seasons by percentage in many different resorts around the US.



(Fig. 4 Percentage of change for downhill skiing season length by region based on a combination of UEB model and snowmaking results. A) Results for RCP4.5 in 2050. B) Results for RCP4.5 in 2090. C) Results for RCP8.5 in 2050. D) Results for RCP8.5 in 2090. [Wobus, 2017])

By looking at the findings above, one can't deny that the ski industry will be heavily affected within the next century from the changing climate, certain areas more than others. Figure 4 shows that places in lower elevations will see more of an effect than higher elevations.

The idea of decreasing snow reliability has also been seen in other studies. By looking at figure 4 above, it's noticeable how if a ski resort is at a higher elevation, such as Colorado, they will be less impacted by the rising temps that lower elevated locations such as the coasts, especially the US Northeast. This is what a study in Switzerland noted. They operated on the idea that there must be 30 cm of snow for 100 days of the season to be considered a commercially viable ski resort (Jianming, 2013). Through this study they found that only ski resorts above 1,200 m (3937 ft.) elevation match the rule in the current day climate, which totals

to 85% of Swiss ski resorts (Jiamning, 2013). They then looked at if temperatures rose by 2 degrees Celsius, which most studies believe will happen by mid-century, then ski resorts must be above 1,500 m (4921 ft.) to match the rule (Jiamning, 2013). This implication would then drop the amount of Swiss ski resorts to having snow reliability to 63%. As time goes on and temperatures rise within the next few decades, the study then proposed the amount of ski resorts with snow reliability would end up around 44% (Jiamning, 2013). The idea of a country's ski resorts with reliable snow conditions being cut in half within this century is worrisome. This would see tremendous loss of jobs and profits for the economy. The idea of lower elevated ski resorts facing more of an impact from climate change has already been seen current day.

Another finding representing how lower elevated ski resorts are being impacted is a study in Scotland, which is not famous for skiing nowadays but once was. For reference, Scotland only has two resorts above 1,200 m elevation whereas the rest are below the "rule" the study above provided for reliable ski conditions. Scotland used to see 650,000 skiers a season in the 80s and 90s but now it's dropped to more around 150,000, largely due to the decrease of sufficient snow fall to sustain their slopes (Leake, 2019). Evidence of this decrease appears in these two findings:

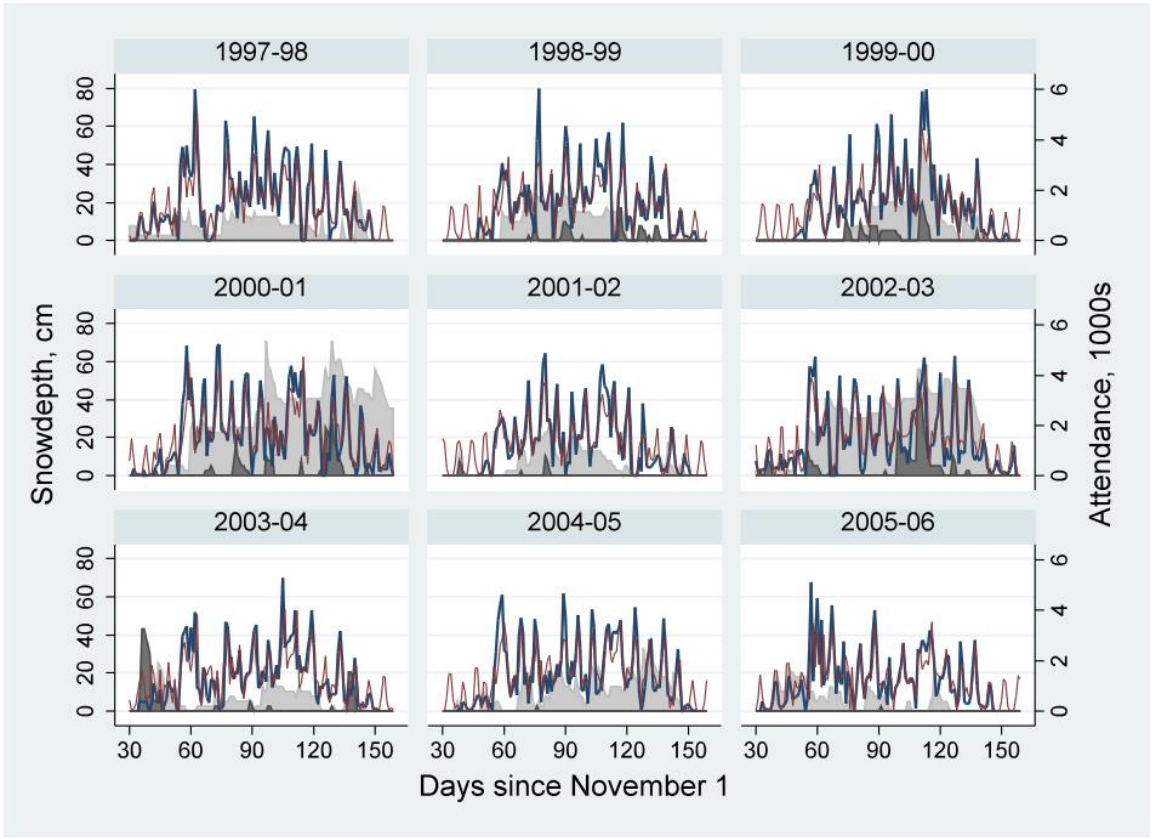
- By 2060, average winter temperatures will warm to 35-37 °F and even up to 41°F by 2100.
- Within one year the amount of ski days drastically dropped from 60 days to 15 days during the 2016-17 season.

From these two findings alone, Scotland is expecting their ski industry to be dead within the next 40 years and will need to find alternative ways to keep their companies alive financially. This will become a struggle for even more skiing companies across the globe including powerhouses such as Vail Resorts, Alterra, Aspen Skiing Company and more. One such study

even found that although a ski resort may have a great season certain people may not plan a trip if their backyard lacks snow. This finding is known as the “backyard effect”.

IV. The Backyard Effect

An interesting study came out of the University of New Hampshire in 2007, which looked at how snowfall in a city impacts the visitors of ski resorts. They focused on how snowfall and temperatures in Boston, Lakeport, and Bethlehem effect the visitors to two of the oldest resorts in the US, Canon Mountain and Gunstock Mountain Resort, both located in New Hampshire. Their findings are interesting and important when looking at the effects of climate change on skiing. They found a direct correlation in terms of snow in cities and number of visitors to the ski resorts. Figure 5 represents these findings.



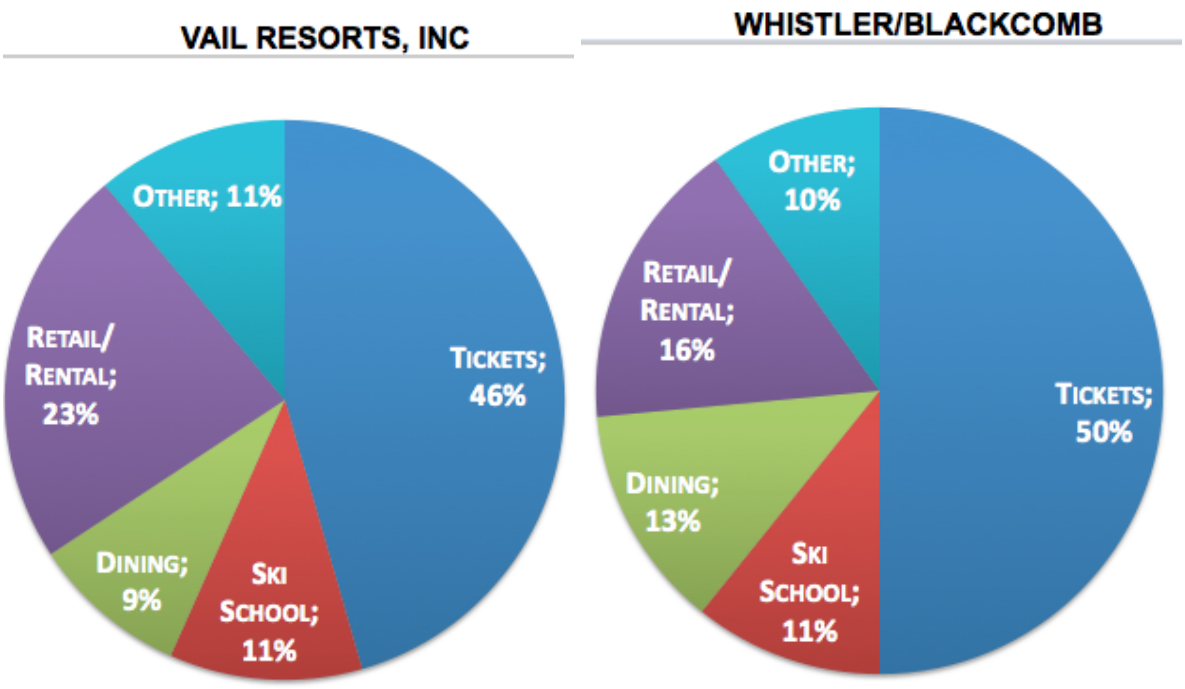
(Fig. 5. Representation of the predicted and actual attendance for Gunstock ski resorts in correlation with the snow depth in both Boston and Lakeport throughout nine seasons. [Hamilton, 2007])

By looking at the charts above (fig. 5), it's clear to see a correlation between snowfall in certain cities and attendance to nearby ski resorts. In certain seasons such as 2000-01 and 2005-06, it is clear that with higher snowfall in those living areas, the attendance rose as well. In other seasons such as 2003-04 and 2005-06, the reverse correlation is seen in terms of lower snowfall in living areas equaled lower visits. This idea of a correlation between how much snow one has in their backyard and whether they go skiing at a nearby resort, even if that snowfall does not touch the ski resort, is called the "backyard effect".

The finding of the "backyard effect" is important for as cities see less snowfall visitation will decrease, regardless of how much snow falls at ski resorts. If a city such as Kansas City sees less snowfall over a winter, then residents may be less inclined to plan a skiing trip in say Colorado, whether the resorts saw massive amounts of snowfall. People are inclined to follow the "mood" of the season. When leaves fall, they watch a scary movie; when they walk outside and immediately sweat, they plan a trip to the beach; when flowers begin to bloom, they plan their first hike of the season; and when it snows, they plan a ski trip. As more and more areas in the world see less snowfall and less of a "wintery" winter, this will also affect certain people's probability to plan a ski trip. As certain areas will be seeing less snowfall in the coming years, particularly lower elevated areas, the "backyard effect" will likely result in decreased visitation at ski resorts which then results in less economic value added by the industry. Understanding how ski resorts make their money further represent the economic implications of less visitation.

V. Understanding How Ski Resorts Make Money

To view ski resorts in an economic view, it'd be smart to understand how they make their money in the first place, right? At the end of the day ski resorts are tourist attractions, not much different than say Disneyland, Six Flags, or tropical resorts. They rely on visitors whether that be locally, domestically, or internationally. To put numbers on how many people visit ski resorts, 55 million were counted in the 2019 season for US resorts (Xavier, 2020). Now to put this number into perspective, France is noted to be the most visited country in the world for overall tourism and in 2018, they totaled just over 89 million visitors (Elliot, 2020). The idea that US skiing visits alone are comparable to the count of the most visited country represents the significance of the industry. Ski resorts own very important and expensive land but that is what not drives revenue for the companies, it is the tourists as seen by the graphs below (Figure 6).



(Fig. 6 Breaks up the revenues for Vail Resorts, Inc and Whistler/Blackcomb respectively by percentage. The breakdown is split in 5 categories for each: tickets, ski school, dining, retail/rental, and other. [Thompson, 2012])

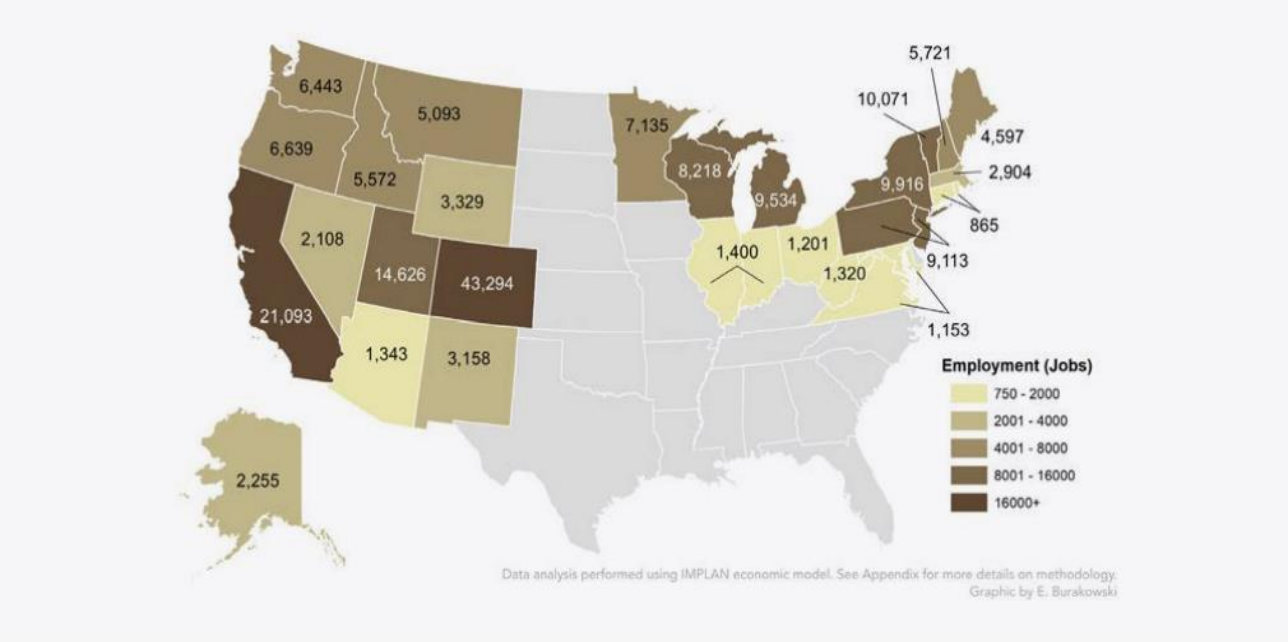
Numbers aside, each of these percentages are made up of visitor driven aspects, and tickets are what must be sold to make up roughly half of a ski company's profits each year. Tourism and visitors are what will keep the ski industry's financial position stable. Without visitors there will be a crisis of what these companies will do. This is where the changing in snow patterns comes into play and whether demand has a direct link with the snow's conditions of the major ski resorts. But why should a typical citizen or even the government care for this issue? By analyzing just how much revenue and jobs that the industry creates, it's hard to deny the importance that the industry has on a given country's financial status but more importantly thousands of citizens means of living.

VI. Economic Importance of the Skiing Industry

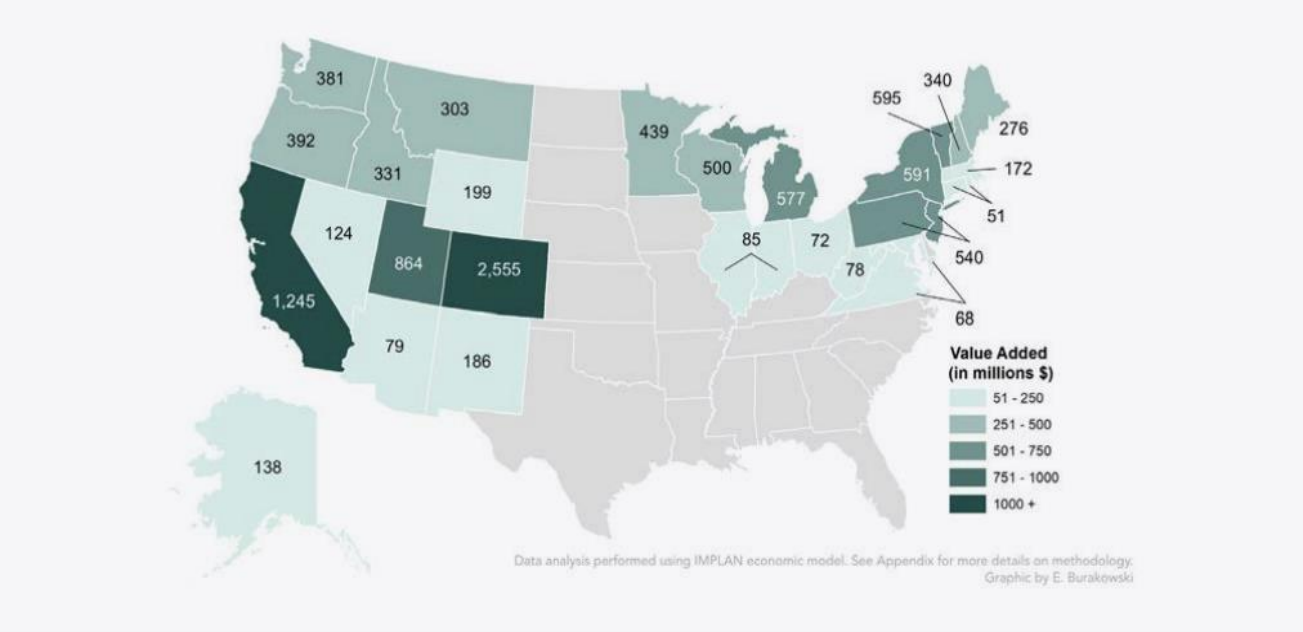
"Snow is currency" (Hagenstad, 2018). In certain mountain towns and areas of the world, this statement is becoming more and more backable with studies looking at how important the tourism industry is to certain economies, especially the ski industry. Quick findings of what the skiing industry provides for certain economies are below.

- The ski industry generated $12.2 billion in revenue for the US economy in 2012 (Hagenstad, 2018).
- In Colorado alone, the ski industry produces $4.8 billion and provides roughly 46,000 jobs that rely on the industry as studied by Colorado Ski Country and Vail Resorts (Wallner, 2015).
- A study by the Quebec Ski Areas Association found that the skiing industry brings in $800 million for the economy and produces 12,000 jobs in relation to the industry.
- In terms of how the industry affects the US government, studies found that the results were $1.4 billion in state and local taxes and $1.7 billion in federal taxes (Burakowski, 2012).

Figures 7 and 8 give a look at employment and value-added totals by state in the US in the year 2016, respectively.



(Fig. 7. A map of the US representing jobs that rely on Winter Tourism separated by state. [Hagenstad, 2018])



(Fig. 8. A map of the US representing how different states employment adds to their given state's economy in millions $. [Hagenstad, 2018])

Figure 9 below gives a depiction of the top 10 industries affected by winter tourism and ranked by employment as well as how it affects the national economy. Resort operations is

noticeably the highest in all three categories: employment, labor income, and value added. Operations itself provided 73,000 jobs which makes up 36% of total winter tourism employment and with it an added $2.6 billion in revenue (Hagenstad, 2018). This represents the importance of how skiing itself is what brings in these positives to our economy as the main draw of winter resorts. Although ski resorts provide more than just the operations to allow visitors to ski down their slopes, those attractions are not what brings in millions of visitors and supplies tens of thousands of jobs.

Industry	Winter Tourism Employment (thousands)	Labor Income (millions)	Value Added (millions)
Resort operations	73.0	$ 1,707.2	$ 2,603.7
Full-service restaurants	29.0	$ 706.9	$ 778.8
Accommodations	15.2	$ 579.9	$ 1,135.8
Real estate	5.1	$ 132.6	$ 804.7
Food and beverage stores	3.9	$ 126.3	$ 185.9
General merchandise stores	3.2	$ 90.5	$ 151.4
Gasoline stores	2.5	$ 93.9	$ 107.8
Wholesale trade	2.1	$ 191.1	$ 361.8
Employment services	2.1	$ 86.3	$ 124.4
Fast-food restaurants	2.0	$ 40.9	$ 99.0

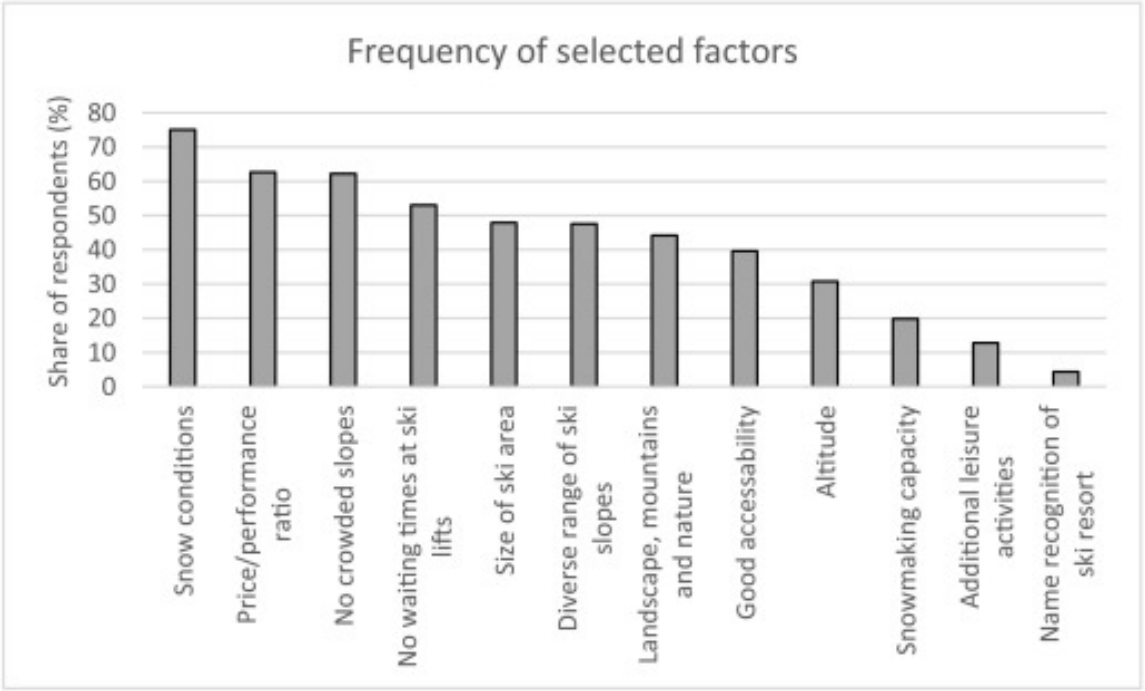
(Fig. 9. Ranks different industries impacted by Winter Tourism by employment and how it affects the national economy. [Hagenstad, 2018])

It’s important to also note that these profits and employment numbers are for the resorts alone. The awareness of the amount of indirect jobs ski resorts produce such as retail stores selling skiing gear off the mountain, factories and shops that manufacture and repair skiing equipment, as well as companies that manufacture the many appliances and machines needed for ski resorts are also important. The same study above included such factors and found that the

general recreational snow sports industry brings in 695,000 jobs and $72.7 billion when it comes to any trip-related expenditures (Hagenstad, 2018). The ski industry is important in an economical sense and by looking at these numbers, it's hard not to worry about the thousands of affected people who rely on the industry as the seasons are cut short as time goes on. But the idea of less snow isn't important without establishment of a correlation between demand and snow conditions.

VIII. Connection Between Snow Conditions and Demand on the Ski Industry

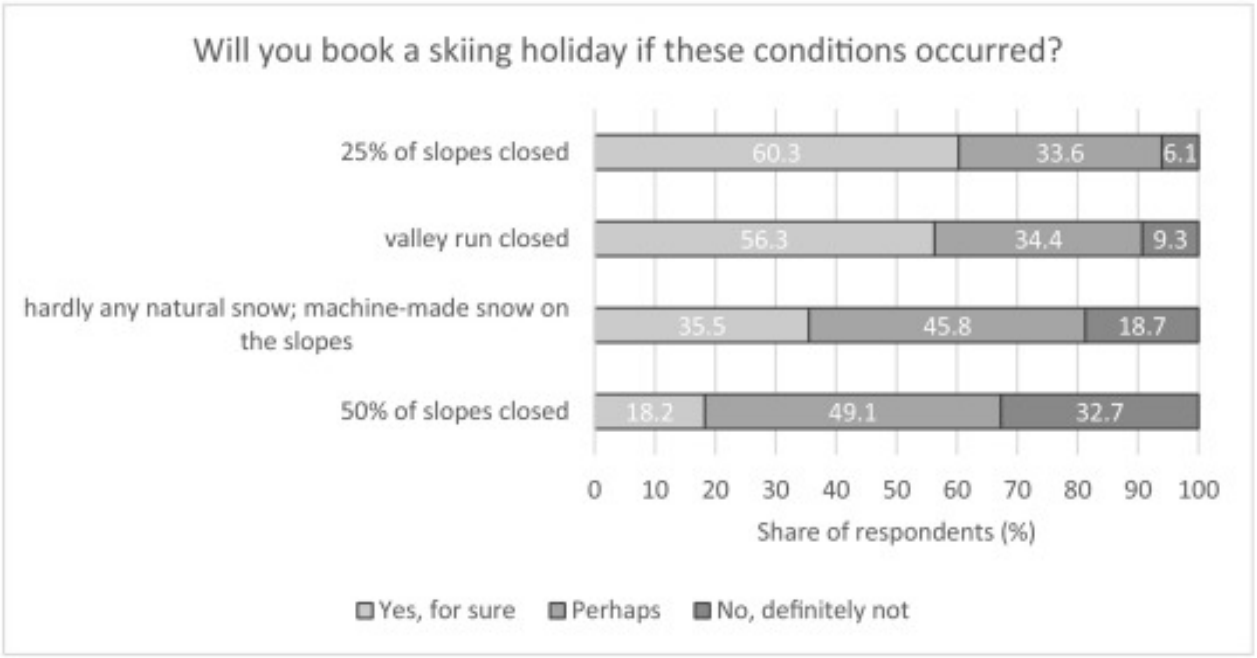
If you or anyone you know join in on the sport of skiing, you'll know the importance of good snow conditions for a positive experience. If you ski in poor snow condition, icy or slushy, it's more difficult to navigate the terrain as well as people will then be at higher risk of injury. If one is skiing on natural snow that is softer and smoother, then one will have better control with less risk of injury. If you're unfamiliar with skiing, which would you prefer? The latter I'd imagine. If a resort is failing to produce this due to the variability of the season or their location, they will see less visitors and therefore less economic gain. This can be seen across multiple studies. One such study focused on the factors that play in a visitor's demand or desire to ski in Austrian resorts. Figure 10 below represents why a person decides to ski at a certain resort.



(Fig. 10. A study recording why certain respondents decide to visit a particular resort. [Steiger, 2020])

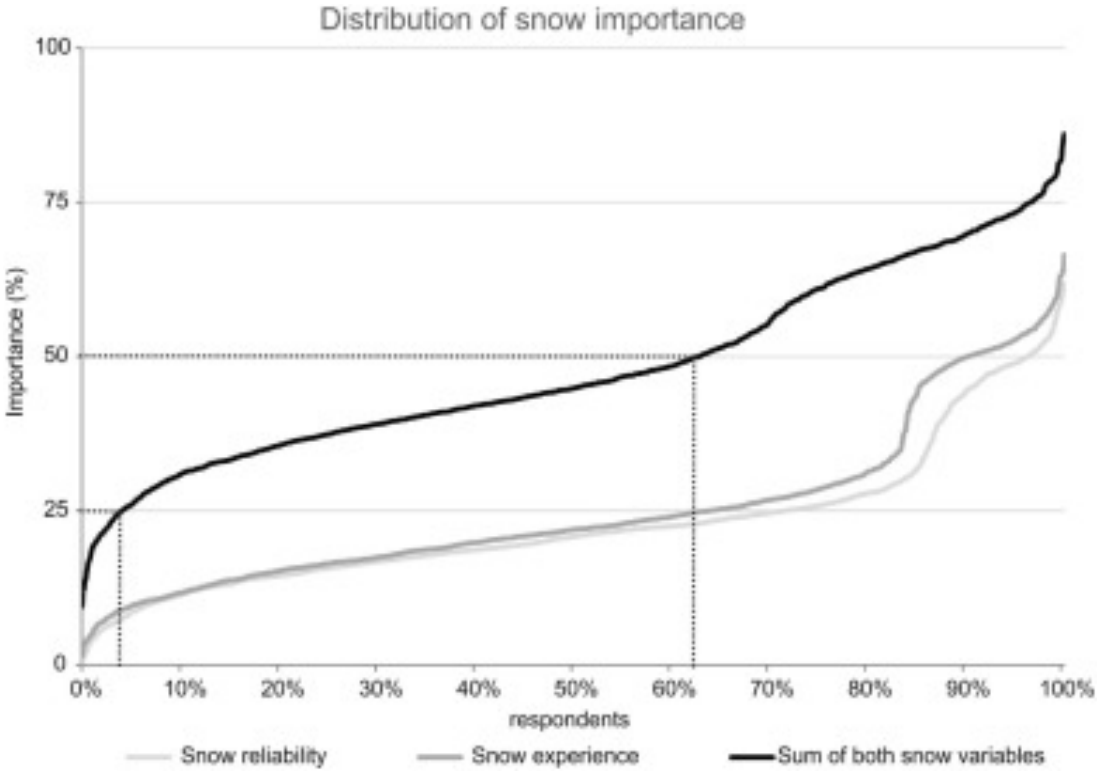
By looking at figure 10, snow conditions are listed as the top draw for respondents to choose a given ski area, followed by price/performance ratio and low crowds. Roughly 75% of respondents listed snow conditions as an important selected factor yet it is notable to mention

how a quarter of respondents did not list it as a factor in their decision. Regardless, ¾ is a significant percentage to note. Figures 11 and 12 also represent the importance of snow conditions regarding demand for skiers and whether they would plan a trip depending on snow conditions.



(Fig. 11. Ask respondents on their decision to plan a trip during the holiday season depending on different snow scenarios. [Steiger, 2020])

By looking at the scenario in figure 11, the idea of 50% of slope closure and primarily man-made snow had the greatest number of respondents indicating they would “definitely not” choose to plan a trip and in both roughly 50% said they “perhaps” would. As conditions continue to worsen, it’s important to note changes in these scenarios.



(Fig. 12. Represents the distribution of snow importance from respondents. [Steiger, 2020])

By looking at the shape of figure 12, one can gather that less and more snow sensitive respondents are apparent in this study. For 4% of the sample, snow variability holds 25% or less importance whereas for 37% of the sample, snow variability holds at least 50% importance in decision making to ski (Steiger, 2020).

Overall, by looking at this Austrian study, the greatest implications they gathered are that snow conditions are the most important factor for destination choice. Now what effects did they have on people shutting down the option of skiing? Demand reduces by 12% given low snow reliability but a good experience and it declines by 64% if their visit is overall bad including snow conditions (Steiger, 2020). If looking at only the beginning and end of the season being affected, December and April respectively, then demand would decrease by 18% (Steiger, 2020). It's important to note that with the shoulder months seeing less snow, this will greatly affect the number of visitors throughout the season. December is holiday season when many adults will

have time off and then be able to use that time off work to visit ski resorts. In March and April, since these are spring break times for kids, if the snow continues to decline in these months and cities continue to warm, people will instead choose to do warm weather trips due to the backyard effect. With these numbers and ideas, we see the importance of good snow conditions to keep demand up and with that, profits, which the next section looks into just how important the correlation is between demand and snow conditions.

VIII. The Economic Effects of Snow Conditions

Having explored the effects of bad snow on demand and the ski industry's importance in the larger economy we can there will be severe economic effects for the economy as a whole. Now how can we analyze these effects with numbers that support this correlation? One such report conducted by the NRDC and POW looked at these effects with IMPLAN. IMPLAN is "a regional input-output economic analysis, which calculates employment, wages and benefits, and overall value added to the economy" (Burakowski, 2012). Using this method, they were able to gather data on projected effects of a good snow year vs. a bad snow year with the lens of value added and employment. These findings can be seen with figures 13 and 14 below.

		With Replacement Consumer Spending		Without Replacement Consumer Spending	
	2010 Employment	Employment Difference (# of jobs)	Percent Change	Employment Difference (# of jobs)	Percent Change
Direct	125,300	-16,455	-13%	-16,455	-13%
Indirect	31,400	-3,775	-12%	-3,775	-12%
Induced	55,200	7,265	13%	-6,600	-12%
Total	**211,900**	**-12,965**	**-6%**	**-26,830**	**-13%**

(Fig. 13. above looks at IMPLAN projects of national employment different through good and bad snow years. [Burakowski, 2012])

Figure 13 represents the number of jobs that are lost with poor snow conditions, which in a year where replacement consumer spending is present (meaning the money not gone into the industry still is spent in the national economy) totals 12,965. Without replacement consumer spending, the total increases to 26,830 positions that are not around anymore. This simply puts into perspective the importance of a positive snow year on thousands of lives that look to the industry to make a living.

		With Replacement Consumer Spending		Without Replacement Consumer Spending	
	2010 Value Added ($billions)	Difference in Value Added ($ millions)	Percent Change	Difference in Value Added ($ millions)	Percent Change
Direct Effect	$4.9	$(797.2)	-16%	$(797.2)	-16%
Indirect Effect	$2.9	$(446.9)	-15%	$(446.9)	-15%
Induced Effect	$4.4	$434.3	10%	$(689.6)	-16%
Total Effect	**$12.2**	**$(809.8)**	**-7%**	**$1933.7**	**-16%**

(Fig. 14. Looks at IMPLAN projections of national economic value-added difference through good and bad snow years. [Burakowski, 2012]).

The reason for a loss of jobs is the money that supports those jobs, and figure 14 represents such. With replacement consumer spending, the industry's prominence in the economy drops roughly 7 percent and without that replacement consumer spending, 16%. Putting numbers into play its $809.8 million and over $1.9 billion respectively. Something to keep in mind, this also will affect taxes and how much local governments receive out of these totals, which can affect a multitude of industries and people. One thing to note is that certain areas of the US will see these effects more than others. Figure 15 analyzes each state using the same method as in figures 13 and 14.

State	Difference in Skier Visits (%)[29]	Avg. Revenue per Skier Visit[5] (09/10–10/11)	Difference in Ski Resort Revenue (millions)	Difference in Total Employment[30]	Difference in Economic Value Added ($ millions)
Maine	-396,588 (-14%)	$68.42	-$27.1	-329	-$20.5
New Hampshire	-793,088 (-17%)	$68.42	-$54.3	-658	-$41.1
Vermont	-889,264 (-9.5%)	$68.42	-$60.8	-737	-$46.0
Massachusetts	-521,622 (-20%)	$68.42	-$35.7	-433	-$27.0
Connecticut & Rhode Island	-179,919 (-24%)	$68.42	-$12.3	-149	-$9.3
New York	-760,968 (-10%)	$68.42	-$52.1	-632	-$39.5
Pennsylvania	-828,260 (-12%)	$81.65	-$67.6	-820	-$51.2
Virginia & Maryland	-219,306 (-19%)	$81.65	-$17.9	-217	-$13.6
West Virginia	-89,893 (-6.2%)	$81.65	-$7.34	-89	-$5.6
North Carolina	-43,855 (-3.7%)	$81.65	-$3.5	-42	-$2.7
North Dakota & South Dakota	+37,999 (+3.6%)	$64.58	$2.45	30	+$1.9
Minnesota	-138,769 (-4.3%)	$64.58	-$9.00	-109	-$6.8
Wisconsin	-1,583,140 (-36%)	$64.58	-$102	-1237	-$77.3
Michigan	+100,755 (+1.4%)	$64.58	$6.51	79	+$4.9
Illinois	-17,658 (-4.8%)	$64.58	-$1.14	-14	-$0.9
Indiana	-86,856 (-13%)	$64.58	-$5.61	-68	-$4.2
Ohio	+53,196 (+4.3%)	$64.58	$3.44	42	+$2.6
Montana	-195,267 (-4.0%)	$82.59	-$16.1	-188	-$11.7
Wyoming	-133,134 (-9.0%)	$82.59	-$11.0	-133	-$8.3
Colorado	-1,864,477 (-7.7%)	$82.59	-$154	-1867	-$116.6
New Mexico	-577,550 (-30%)	$82.59	-$47.7	-578	-$36.1
Idaho	-523,105 (-17%)	$82.59	-$43.2	-524	-$32.7
Utah	-1,053,548 (-14%)	$82.59	-$87	-1055	-$65.9
Nevada	-166,763 (-19%)	$74.96	-$12.5	-152	-$9.5
Arizona	-247,557 (-29%)	$74.96	-$18.6	-226	-$14.1
California	-1,324,967 (-4.7%)	$74.96	-$99.3	-1204	-$75.2
Oregon	-1,021,186 (-31%)	$49.29	-$50.3	-610	-$38.1
Washington	-1,607,497 (-28%)	$49.29	-$79.2	-960	-$60.0
Alaska	-142,172 (-20%)	$49.29	-$7.00	-85	-$5.3
Total	**-15,214,459**	**--**	**-$1,069.3**	**12,965**	**-$809.8**

(Fig. 15. Represents each US state's change in ski resort revenue and employment between a good and bad snow year. [Burakowski])

Figure 15 represents that certain states will see a much more dramatic change in skier visits depending on a bad snow year such as Wisconsin (-36%), Oregon (-31%), and New

Mexico (-30%). In the same context, other states that may not see as much of a percentage loss, still see massive numbers in losses. Colorado represents this as the most visited state in regard to skiing. Although the state sees a relatively low -7.7 percentage change, the state makes up for the largest amount of economic value added and employment loss, -$116.6 million and -1867 jobs. These numbers indicate how certain states will need more attention based on percentage losses and overall large numbers that represent the importance they have in the total contribution of the industry's economic value. As time goes on and the temperatures warm, these numbers will only get worse, requiring the industry to find new means to generate revenue.

IX. What the Industry Can Do

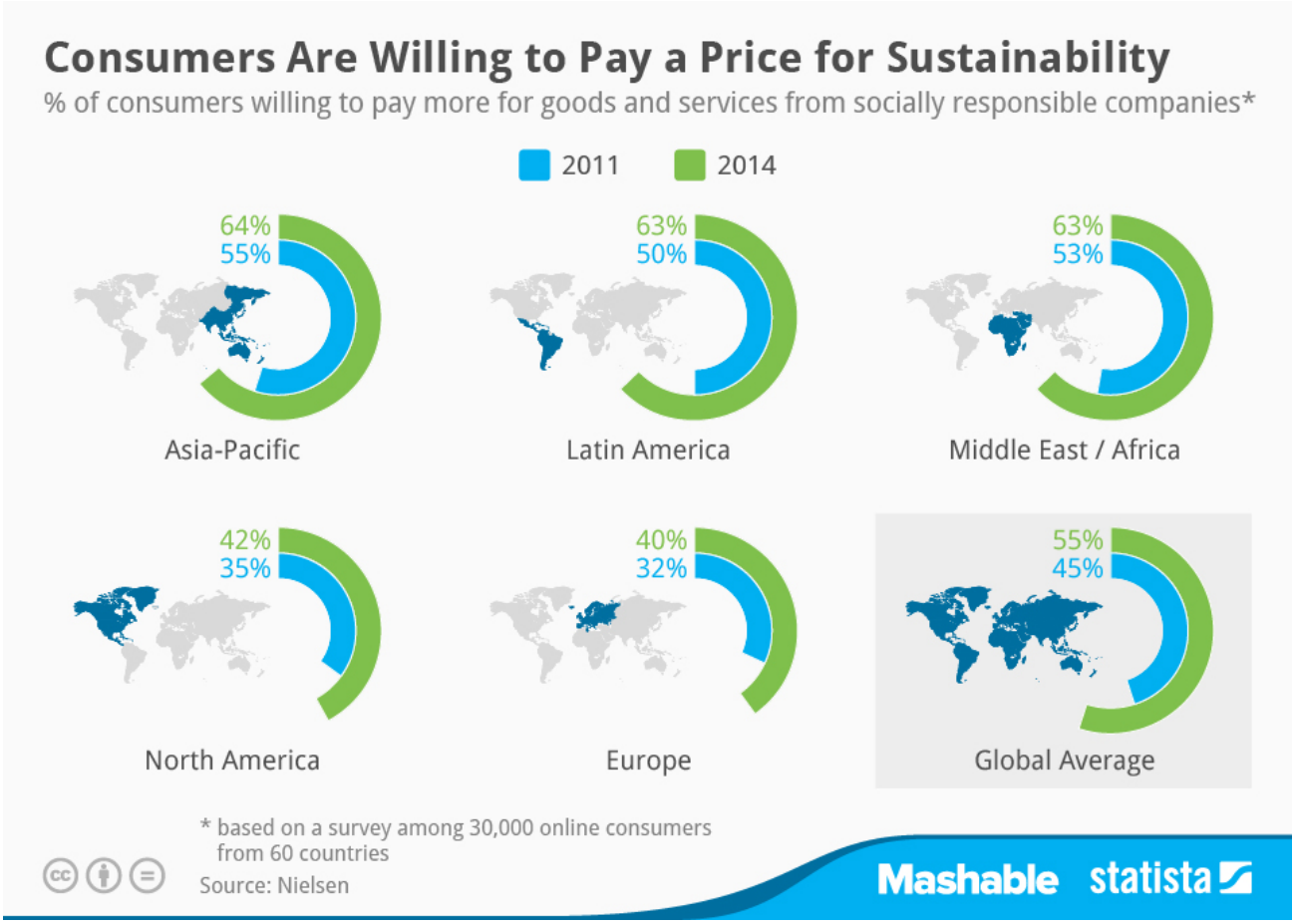
How can the industry deal with the impending future of snow conditions worsening beyond control within the next century? Many successful initiatives have already been put into place and have a different goal in place. The actions put into place accomplish one of three things: preserving the industry through combating the climate, driving revenue in the winter with differing business strategies, or driving revenue in other seasons or different activities for tourists. In this section we will go over both and look at how the skiing industry can maintain a positive impact onto our economies and the environment.

Preserving the Industry Through Green Efforts

As established earlier in this paper, many ski resorts and companies are implementing green ways to do business and do their part in slowing down the inevitable warming of our climate. These many ways are costly and still relatively new. The Aspen Skiing Company's CEO, Pat O'Donnell said in an interview that although the endeavor of building one of the first certified "green" buildings in the US cost the company thousands more, they did so for they believed it was the right thing to do (Schendler, 2014). Certain businesses in Breckenridge cited practicing green efforts as simply the right thing to do regarding their motivation (Smith, 2013).

The idea of implementing green practices because it's the right thing to do will be seen in businesses that rely on the environment whether than the prospects of profit, even though there are some. Therefore, roughly every ski resort company will have their own initiatives stated on their mission or websites. This is also likely to support due to the other reason stated, help with marketing. As time goes on and both the effects and awareness of the changing climate increase, consumer demand has also risen for more sustainable practices. Figure 16 below represents how

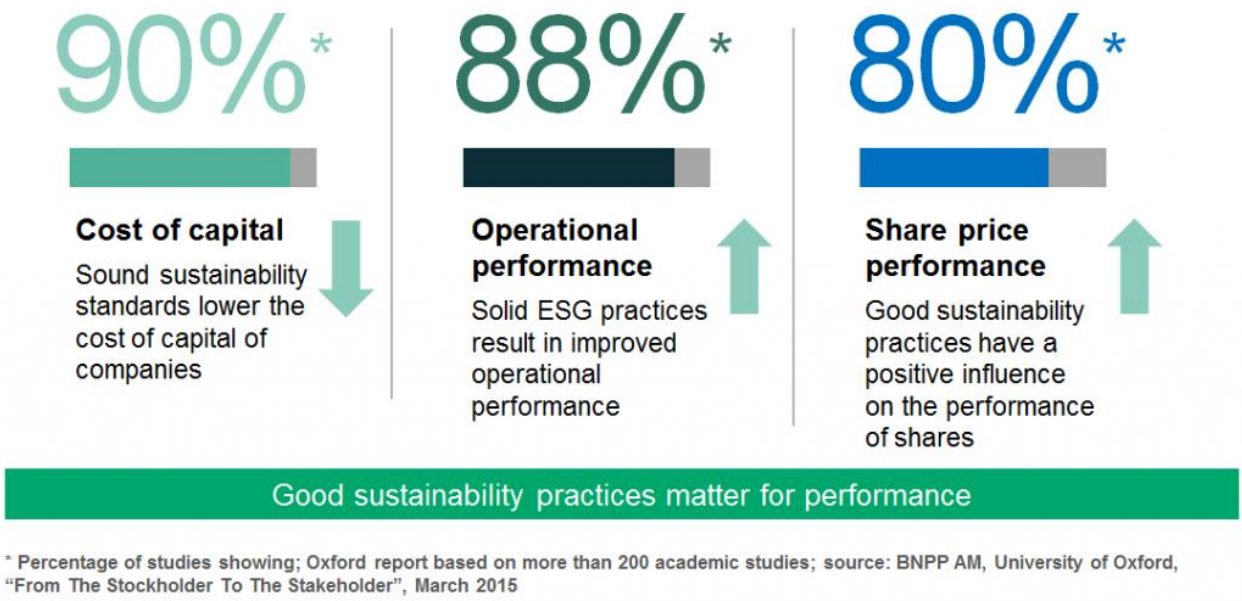
consumer trends on demand for sustainability has increased from 2011 to 2014 in different areas of the globe. By looking at the charts, it's clear to see that the consumer demand for sustainability increased. The global in consumer demand rose by 10% which is quite significant and will only continue to grow as time goes on.



(Fig. 16. Represents % of consumers willing to pay more for sustainable goods and practices. Separates these percentages through different areas of the globe and the globe collectively. [Richter, 2014])

Given growing consumer demand for sustainable practices, the result of higher performance is expected. Figure 17 looks at how companies with better governance practices (ESG) preform economically. The study conducted by Oxford University and Arabesque

Partners (Investment management firm) found there to be a direct correlation in sustainability and economic profitability.



(Fig. 17. Represents the effects of ESG on cost of capital, operational performance, and share price performance. [Fiestas, 2019])

Consumer demand is trending towards sustainable practices and there are economical profits to be gained by sustainable business practices, implementing these practices for ski companies seems like a win win. Sustainable practices for the skiing industry are also much more important due to the companies' clientele, skiers. There is the likelihood of a higher majority of their consumers demanding and willing to pay for sustainable practices given they are more likely to appreciate and care for the environment given their outdoor hobby.

Now what green practices should be implemented?

The answer to this question is more complicated because the results of different ski resorts' implementations have yet to be seen. The most common implementations focus on lessening

carbon emissions, which is cited to be the most detrimental human effect on warming our climate. How to do so? Many initiatives can be seen below:

- Arapahoe Basin ski resort in Colorado is pushing their visitors to carpool by offering $20 discount on of their lift pass as well as better parking at the resort. They are also committing to achieve a completely carbon neutral business by 2025, with strategies such as installing solar arrays (Davis-Flynn, 2019).
- Taos Ski Valley in New Mexico received a B Corporation certification which is held by only about 3,500 companies worldwide. They achieved such by re-using waste oil from their machines, and installing a food waste dehydrator which converts food waste into soil amendment, as well as being a member of the Rio Grande Water Fund which is restoring thousands of acres of forests (Benham, 2021)
- Aspen Snowmass in Colorado has partnered with other organizations to utilize a mine's production of waste methane which otherwise is a highly effective greenhouse gas for their own source of energy. This utilization results in a carbon reduction that equals three times the resort's operations methane output annually (Benham, 2021).
- Park City and Deer Valley in Utah in partnership are launching a solar farm nearby that they will use to source 100% of their electric energy in 2023 (Benham, 2021).
- Big Sky resorts in Montana has committed to achieve net zero emissions by 2030. They are achieving such by running their lifts on carbon free energy and ensuring all the resort's electricity is carbon free, which they've already met in March 2020 and January 2021 respectively (Benham, 2021).
- Jackson Hole Mountain Resort in Wyoming, since September 2019, has achieved sourcing 100% of their energy from a nearby wind turbine farm (Benham, 2021)

- Whistler Blackcomb in British Columbia donated land to help convert the area into a micro-hydroelectricity plant in 2010. On top of this, they are committed to achieve operating at a zero net footprint by 2030. They are progressing towards this by requiring 100% of the resort restaurants to be registered for a TRUE Zero Waste Certification which is committed to diverting waste into upcycling (Benham, 2021).
- Alta Ski Area in Utah launched their Alta Environment Center (AEC) in 2008 which has implemented the resort's efforts by land conservation efforts, reducing greenhouse emissions, environmental research, and more. Specific examples are since 1991, they have planted 40,000 tree seedlings to limit the effects of deforestation as well as since 2015 have offset 94 tons of carbon emissions by installing solar panels (Benham, 2021).
- Pejo 3000 in Italy practices two ways to achieve sustainability by banning all plastic products from its resort, yes you read that correctly, as well as using 100% renewable energy through hydroelectric plants (Young, 2021).

Now which should a given ski company new to green initiatives implement? Some of these practices ask the visitors to make certain sacrifices such as A-Basin asking people to carpool and Pejo 3000 not allowing plastics in the resort. People do not want to make sacrifices on vacation, at least many will not who are not aware of the purpose. Others who live sustainable lives personally may be inclined to but that won't total everyone. Other initiatives are purely on the resort and are unseen by visitors such as installing renewable sources of energy. That is what a newcomer to these practices should implement for it attacks the main cause of a resort's footprint, using non-renewable energy, and does not affect their consumers. Also, there are upfront costs for installation but afterwards, renewable energy can be relatively cheap. Average renewable energy cost at $20/MWh for wind and $37/MWh for solar and a fossil fuel source

such as coal cost $102/MWh (Inspire, 2020). There are issues with these new sources of energy such as solar can't produce energy at night and wind can't produce energy without wind, but this will only improve with time. As seen above, countless of resorts have already begun the change to renewable energy to reduce their carbon footprint and successfully. These efforts do not affect visitors' trips, financially better than fossil fuel sources, and greatly change a resorts environmental impact. This initiative could be the most viable idea thus far.

By looking at these countless examples of ski resorts around the world looking to become a sustainable business, it's hard to deny that the industry can help the issue of climate change even if they do have their disadvantages in the process. By offering these examples, one hopes that businesses and organizations can rally behind these efforts in other industries and see ways they can also do their part whilst being profitable. At the end of the day, any global enterprise will have unsustainable practices, that is the fact of how our world works, we rely on certain types of energy, construction, travel, etc. that impacts our environment in a negative way. Regardless, the ski industry's efforts are still relatively new, and the long-term results have yet to be seen but switching to renewable energy is a go to for these ski companies.

Preserving the Industry Through Business Strategies

The ideas that ski resort businesses are already implementing to keep profits up despite declining snow conditions is quite interesting and can be seen by looking at the leading ski companies. If you ask any person familiar with the industry who is a leading ski resort company, many will speak on Vail Resorts. Vail Resorts, INC owns 40 resorts and in partnership with 33 more across the world leading any other ski resort company. They do not lead by chance and by looking at their efforts and strategies, it's understandable why.

Throughout the past decade, Vail resorts have begun to diversify the resorts they own throughout the globe. Figures 18 and 19 below show that Vail owns or partners with resorts all over North America, Europe, Australia, and Japan. All these regions are the most popular destinations for the sport as well. In doing so, Vail Resorts can generate revenue in a higher volume throughout the winter as well as some revenue in the summer with resorts in the southern hemisphere. Another reason for acquiring many resorts is with the diversification of climates and elevations. The reason is although the Northeast may not have a good snow year, the Rocky Mountains or France may, allowing some of their resorts to still maximize profits.

(Fig. 18. Map of ski resorts that Vail Resorts, Inc own or are in partner within North America and Australia. [epicpass.com])

(Fig. 19. Map of international ski resorts owned or in partner with by Vail Resorts, Inc. [epicpass.com])

What Vail Resorts also does that helps combat the issue of worsening snow conditions is the idea of a season pass. Vail Resorts introduced the idea of a way for skiers to greatly save money on purchasing lift tickets for a single day back in 2008. They cut their season pass price from $1,849 to $579 and branded this pass as the Epic Pass (Barro, 2020). Nowadays, the pass has separate options with differing benefits depending on the option but the most expensive is totaled at $939 as of 2020. To put into perspective how much this saves money, a day pass for Vail Ski area costs roughly $220. With this, if someone skis only 4 times, they've already made up for what 4 single-day passes would cost. The most expensive pass also allows skiers to ski any one of their resorts, with certain limitations for certain resorts. Now why would Vail allow skiers to have a way to ski all their resorts with plenty of "free days" after those initial 4 visits? Aren't they losing a ton of potential profits? In a way yes, they lose money yet those who purchase these passes also are putting risk into the upcoming season's snow conditions. Also, if people do ski a high number of days that also means they will hopefully spend money on lodging, eating, etc. on the resort. Also, many ski resorts offer free lift tickets for children to both help keep the ability for families to afford a trip as well as have kids develop the hobby early and

continue it. As seen in figure 6, tickets are roughly half of how resorts make their money whereas the other half is the lodging, dining, ski lessons, and more.

There are other ways that ski areas can leverage in a business sense to attract customers to ski, yet Vail is leading the rest and mainly due to the ideas mentioned above. How can other ski companies do the same? Follow their lead which the main competitor Alterra Mountain Company has done by buying resorts this past decade as well and offering their own version of a season pass, the Ikon Pass. These business strategies have clearly helped, as is seen by the increase in growth of sales by both companies.

- Vail saw an increase of 23% in the 2017/18 season (Brown, 2018) and has announced a $320 million investment across 14 resorts to keep the customer experience high in the 2022/23 season (news.vailresorts.com, 2021).
- Alterra has seen a 21.40% revenue growth from the 2018/19 to 2019/20 seasons (Storer, 2021) and announced massive investment into the company, $223 million, for improvements last season (alterramtnco.co, 2020).

Although there is growth in the skiing industry, the bigger companies are the ones experiencing this. Smaller ski resorts and companies are finding themselves selling their resort to one of the big companies, shutting down, or finding their niche as any small company does in any given industry. Regardless, the business strategies implemented by the major players in the market are resulting in success, yet these implementations may not matter in the long run.

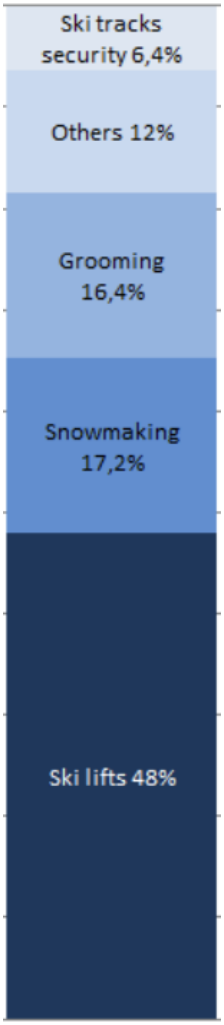
Artificial Snow

Artificial snow has helped lengthen seasons and keep certain resorts in business that simply do not see enough natural snow. As of 2015, roughly 90 percent of ski resorts use snow

machines in North America, representing the reliance of man-made snow (Lagasse, 2016). Utilizing man-made snow allows certain resorts to simply exist because they do not receive enough snow and other areas to create a much better snow base as well as extend their seasons. Deer Valley resort is an example of how crucial this practice is. In the 2017-18 Utah ski season, they saw some of the lowest snow totals in recorded history for the resorts (Reimers, 2021). Ski visits decreased 10% from the previous season yet the industry was still able to generate $1.32 billion in the state, the state's second most lucrative year (Reimers, 2021). Without snow making in place, this number would be significantly less, and the effects of poor snow conditions would have been much more noticeable. The practice is simply crucial for the industry yet at what price?

Snow making is costly. It uses up thousands of gallons of water and an incredible amount of electricity and tends to be the largest consumer of energy for ski resorts (Reimers, 2021). Now, many resorts are beginning to use 100% reclaimed wastewater for snowmaking, yet in certain areas there may be chemicals within the wastewater that could affect the environment negatively or be seen as sacrilegious to certain lands from native tribes (Lagasse, 2016). Another complication is that when a company uses a source such as a water for their machines, they may be disrupting the biodiversity with moving that low elevation water to then higher elevations (Hickman, 2008). Other implications show that certain resorts will use pure water from environmentally valued water sources to ensure no damage to the environment (Hickman, 2008). The results seem to be inconclusive with how the source of water affects the environment yet is something to note. On top of this, for certain areas that have less water resources, there are complications with getting contracts with the government for the resource as well as sharing it with the agriculture industry that also consumes massive amounts of water. Although crucial,

there is still gray area in terms of what the consumption of water will look like in the future for ski resorts.



The cost of snow making operations is high. Resorts will spend roughly $500,000 to $3.5 million on their snow cannons each season and will spend around $1000 to $2000 for covering each acre with 12 inches of snow (Guglielmino, 2017). To give an idea of how this relates to other operating expenses, figure 20 represents the percentage difference for each operating cost for a resort in Switzerland, where snow making is less reliant than other ski resorts (Cognard, 2020). As seen, snowmaking is the second highest operating expense for a given resort accounting for 17.2% of expenses. For other resorts, snow making can make up 50% of a resort's energy costs (Burakowski, 2012). The main issue is that this is a short-term solution. Freezing conditions must still be present for snow machines to work, as well as to ensure that the snow produced doesn't melt quickly after it is produced. As technological advances are made, these conditions will continue to dwindle with a warming climate and regardless, they will prove to be less and less efficient.

(Fig. 20. Representation of different operating costs and their given percentages for a ski resort in Switzerland. [Cognard, 2020])

Looking Elsewhere

Ski resort companies operate on land that any outdoor enthusiast will want to flock to given any season. People will come in the winter for other sports as well such as snowmobiling, cross-country skiing, and snowshoeing. In other seasons when the snow has melted, ski resorts

have begun to offer other sports and activities such as mountain biking, paddle boarding, water parks, ski lift services, ziplining, hiking trails, golf, rock climbing, and other attractions such as offering venues for weddings, festivals, and concerts (Hagenstad, 2018). Offering off season activities apart from skiing has grown and most resorts are doing it. Both the percentage of ski resorts operating in the summer and growth of summer visitation as of 2014 have increased, 84% and 37% respectively. (EPR Insights, 2015).

With an established growth in people now visiting in the summer, utilizing the summer season as a ski resort is crucial to keep revenues up and leverage their already built infrastructure. In the 2019-2020 season, summer visitation made up 11% of ski resorts' revenue nationally (Swift, 2021), which may not sound like much but for certain resorts and areas of the US, that extra revenue creates more jobs and better support the industry to grow and be a voice for sustainable business practices. Offering year-round attractions will continue to be important for the ski industry for it's a way for resorts to generate revenue not thought of in the past as well as it utilizes infrastructure that has already been built. There's no need for empty hotel rooms and quiet restaurants in the summer when they can offer plenty of mountain activities. This will also increase the ability for a resort to better supply their skiing operations with more efficient snow cannons and other equipment to keep their skiing season alive. This response may be the best long-term practice for the industry to keep survival high and not lose out due to a warming climate, and though it should be noted that summer will see effects as well, the winter is facing the brunt of them.

X. Conclusion

As someone who has had an impactful life experience due to skiing, it's difficult to process many of these findings. The decline of the sport will affect many, including myself who is a simple enjoyer of the sport. Whether we like it or not, the climate is warming at worrying speeds and winter sports are some of the earliest victims in that change, seeing more drastic effects before other industries. The only hope now is that other industries will see these effects and help combat them with the directly affected industries, helping voice these worries and have certain government policies put into place focusing on the protection of our natural environment. Until then, the ski industry will continue to keep revenues up and add longevity to the sport and if I could recommend the best method, it would be to fight climate change. Otherwise, there is a time limit before the industry can't rely on natural conditions, milking as much revenue until that time runs out.

Tens of thousands of people depend on this industry for their livelihood and even more due to the economic value added to our national economy. Without it, many people will have to look elsewhere and develop new skills for a different industry. The issue is real and will only grow in relevance. If any of this info has impacted you, then I'd recommend you do your own part in helping the cause. Whether that is looking onto your local government, advising the company you work for, further educating yourself or others, or practicing green habits in your daily life, something is better than nothing.

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