2014

Potential Investment in High-Efficiency Snowmaking at Sugarloaf

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Cover Page Footnote

1. Introduction:

Maine's economy maintains dependence on ecosystem services beyond the provisioning services of forestry and agriculture. Recreational services provide hiking, water activities in the lakes and oceans, and in the wintertime, skiing on the mountains becomes vital to Maine recreation and tourism. These ski areas bring people beyond cities like Portland and Augusta to more rural regions of the states, bringing business and development to smaller communities. Although prices in the ski industry have risen extensively (from $1.00 in the 1950s to $83.00 today for an adult full-day ticket at Sugarloaf) the ski season still brings in revenue through tourism and avid skiers who wish to take advantage of the recreation available with the winter snow.

The New England ski season has become dependent on snowmaking in order to maintain a season from the middle of November to the beginning of May. Ski areas can no longer depend on the natural snowfall and accumulation to reach sufficient depths in order to open before Thanksgiving. This year 2013, Sugarloaf experienced their earliest opening on November 16 since 2007, the mountain credits this success to their recent investment in high-efficiency snow equipment. In 2012 Sugarloaf received a $300,000 Efficiency Maine grant and invested $1 million in high-efficiency tower snow guns from Snow Economics/HKD Snowmakers. "The HKD SV10 Impulse guns are able to make the same amount of snow using up to 90 percent less compressed air (depending on temperature)," and the compressed air production represents the largest portion of electricity consumption while snowmaking (sugarloaf.com). Reducing electricity consumption also leads to increased monetary gains due to a lower cost. Economically, this remains important as ski areas are forced to invest in recreation that makes their business fruitful in all months of the year: golf courses, water parks, lakefront properties. Although Sugarloaf received an Efficiency Maine Grant of $300,000, which aided the cost of the snowmaking equipment in their previous $1 million investment, it may be necessary for the mountain to continue looking towards investing more of these high-energy snowguns to decrease future costs.

Another concern for the ski industry is the potential effect of global climate change. There is a large difference between abnormal weather patterns and gradual temperature increases. Snow cannot be made in temperatures greater than 28 F, and this is with the newest equipment, older equipment requires even lower temperatures that are often not reached on the East coast until the end of December or January. The region of Tahoe, California, where

multiple ski areas reside has recently experience a huge loss due to lack of natural snow. In the past, this area could subsist on consistent snowfall in order to have a ski season longer in length than resorts in the east, which also meant that these mountains never invested in snowmaking equipment. Their loss in the past couple years would have been remediated if they had previously invested in snowmaking equipment in order to at least open a portion of the mountain and enable skiers to purchase tickets or season passes. Maine's coastal location could lead to a potential increase in temperature as the Gulf Stream warms the Atlantic waters.

Over the past three decades, Maine has not experienced a dramatic increase in temperature like other areas of the Earth; however, the region has become subject to more extreme temperatures and weather patterns. This would include consistent below freezing temperatures, warm Januaries, lack of snow, and punishing Nor'easters that bury the area in snow. The threat remains in the potential decrease in ski season length, which leads to a decrease in revenue. Sugarloaf maintains a reputation on being the largest mountain in the east, with 1230 skiable acres of terrain, and the ability to be one of the first mountains in the East to open its lifts. This reputation has gained reliable customers and season pass holders who are important to the ski industry.

2. Literature Review

Extensive research has been conducted about climate change and its impact on the seasons and the associated temperatures; however, few have yet to consider the affects on the ski industry and the potential end of the business. A study conducted by Daniel Scott, Geoff McBoyle, and Brian Mills examined different climate scenarios on a ski area in Southern Ontario, serving one of the largest skiing markets. The authors looked at 17 years of snowfall and snowmaking data, comparing ski conditions across the years: whether the ski area was in operation, snow depth, snow conditions, number of ski runs open, and snowmaking activities for the winters of 1981/82-1999-2000.

Using this data and six climate change scenarios obtained from the Canadian Climate Impact Scenarios (CCIS) Project, they were able to simulate daily temperature and precipitation data predictions according to each of the scenarios. The data was produced for three time series: 2010—2039, 2040-2069, and 2070-2099. The authors of "Climate Change and the skiing industry in southern Ontario (Canada): exploring the importance of snowmaking as a technical adaption" used their simulations to determine the number of skiable days available after the six scenarios of climate change. A skiable day is where

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many smaller mountains make the most of their revenue, larger mountains are able to invest in real estate, golf courses, and other activities to generate recreational revenue year-round.

The study found that an "approximate doubled-atmospheric CO_2 equivalent scenarios (2050s) reduced the average ski season with current snowmaking between 7% and 32%, and 1% and 21% with improved snowmaking capabilities. However, the paper is quick to point out that snowmaking costs represent a large share of operating expenses at ski areas. These costs include the current efficiency of the equipment in place, electricity, labor costs, and climactic conditions. However, skiers seem unlikely to adjust their recreational behavior, which provides reason to invest in high-efficiency equipment in order to maintain the ski season despite predicted climate changes scenarios. If ski areas are concerned about revenue, there is also an important investment in becoming a four-season resort. Climate change is vulnerable and variable, predictions have the ability to change; therefore, this study does not necessarily say that the impact on ski areas will be to this extent. The conductors of this study had an extensive amount of data gathered in order to perform these predicted, I will not have this specific data for Sugarloaf and will be basing my study off the temperature data for the area and the snowmaking capabilities if the mountain were to invest in new equipment.

In 2009 the University of Maine published "Maine's Climate Future: An Initial Assessment." The goal of the assessment was to "discern the direction and range of likely changes in temperature and precipitation, and the relative variation among climate zone in Maine." Even if the human population were to somehow limit greenhouse gas use, the Earth would still experience a temperature increase and climate change. Maine's position by the coast entails that it is increasingly likely to experience changes due to the warming of the ocean and the effect of the gulf stream.

Sugarloaf would be considered in the Northern portion of Maine. This study indicated that during the most recent decades this region experience a temperature increase of +0.39 F from 1975-2007. This increase is concerning for ski areas as it greatly diminishes the days predicted for snowfall, but also the days that you can make snow, as the temperature needs to be under 28 F.
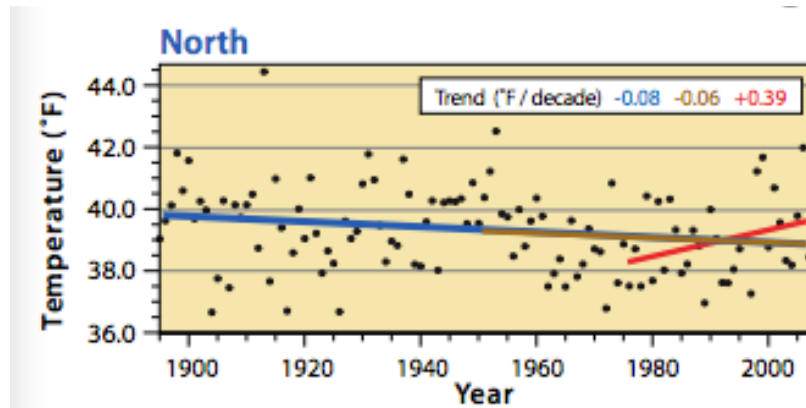
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Figure 1: Annual average temperature for each climate division, 1895-2007. Linear trends since 1895 (brown), 1975 (red), and 1950 (green), computed based on area-averaged monthly data for the three climate divisions, show the increasing rate of warming in the last three decades (University of Maine).

I will use these predictions to determine whether investment in high-efficiency snowmaking equipment will be necessary for sugarloaf to continue to open their ski season in mid-November. The University of Maine also predicted 100-year temperature changes where during the winter, the temperature is expected to increase a mean of 7.9 F.
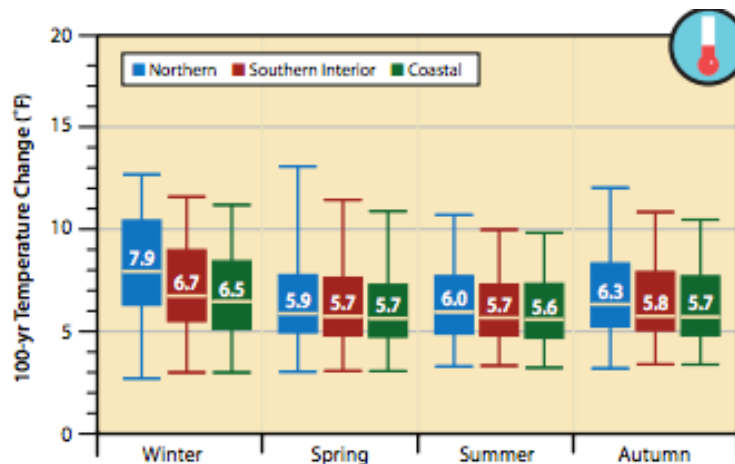

Figure 2: Multi-model prediction of 21st century winter, spring, summer, and autumn temperature changes in each Maine climate division from model runs forced with scenario A1B, which projects concentrations of CO2 for each year of the 21st century.

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Although these changes are concerning, predictions may not necessarily be perfect and there is always the possibility that Maine may not suffer from extensive climate change. These temperature predictions; however, will be valuable in determining the number of hours available to make snow in the future compared to the number of hours now.

3. Methods

Hourly temperature data for Bangor, Maine was retrieved from the National Oceanic and Atmospheric Administration in 2010. The hourly temperature data under 28 F determinates the total number of hours that snow can be made and the snow coverage. Temperatures from Bangor, Maine differ greatly from those at Sugarloaf; therefore, the data was transformed to hourly temperatures that better fit Rangeley, Maine. The difference in average daily temperature for every day of the month of November in Bangor, Maine was compared to the temperature in Rangeley, Maine. These mean of these differences (a 5.3 F decrease from Bangor to Rangeley) was subtracted from the Bangor hourly temperatures to determinate the hourly temperature in Rangeley, Maine. It is expected that temperature in Bangor to be higher due to its coastal location, where as Sugarloaf is higher in altitude and inland.

The hourly data for November 2010 was inputted into STATA, then temperatures using a +0.039 increase per year, hourly temperature data for 2060 was predicted. The assessment of the University of Maine showed a +0.39 increase from 1975-2007, which determined this set of data. Therefore, we could determine the number of hours in November under 28 F in 2010, and compare that to the number of hours under 28 F in November 2060, and look at how these hours decrease between the years.

This temperature data and predictions can be combined with the snowmaking potential of high-efficiency equipment. The HKD SV10 can produce snow in temperatures up to 28 F, and with these conditions it takes 11062.5 hours to open 50% of the terrain, if they were to achieve this goal by the end of November.

Sugarloaf currently maintains 300 of these efficient snowguns due to their $1 million Efficiency Maine Grant. Therefore, we can convert these numbers to determine the hours it currently takes Sugarloaf to cover 50% of their terrain.

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Table 1: 10 HKD SV10 Impulse Snowguns	
Guns	10
Ski Trail Acres	10.33
Percent of Terrain Covered	0.008
Hours to open % terrain covered by guns	177
Hours to open 100%	22125
Hours to open to Goal of 50%	11062.5

Table 2: 300 HKD SV10 Impulse Snowguns	
Guns	300
Ski Trail Acres	309.9
Percent of Terrain Covered	0.25
Hours to open % terrain covered by guns	177
Hours to open 100%	708
Hours to open to Goal of 50%	354

With the currently equipment we see that it takes Sugarloaf 354 hours to open 50% of the terrain. Unfortunately, from the current hourly temperature data we see that November only had 131 hours below 28 F. Without investing in any new equipment, the mountain could open 17.7% of the terrain by the end of November. This; however, has minimal appeal and may not generate recreational revenue.
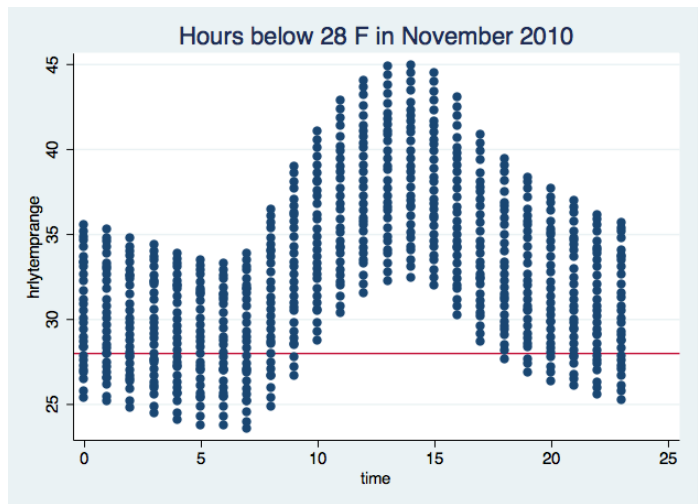

Figure 3: Hours below 28 F in November 2010.

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After this data was transformed to predict the number of hours below 28 F in November 2060, we see a decrease in the number of hours below this temperature, and therefore snowmaking potential decreases.
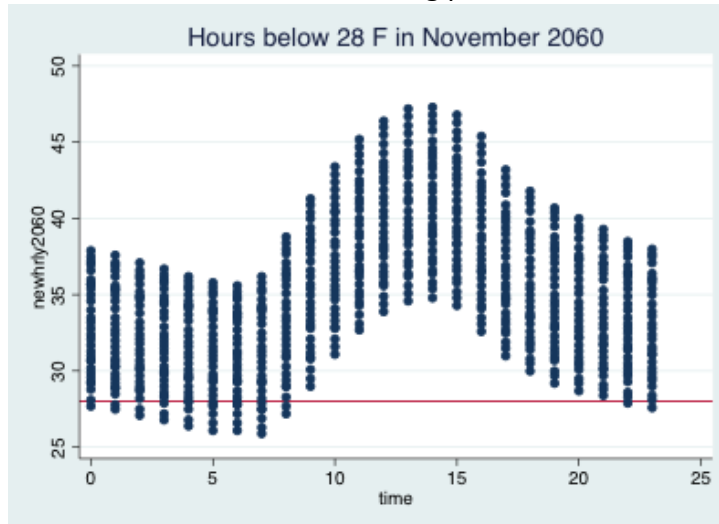

Figure 4: Hours below 28 F in November 2060

The number of hours below 28 F in November 2060 decreases to 35, a large change from the previous 131 hours that were totaled in 2010. Therefore, northern Maine has potential to suffer from extreme climate change, affecting the seasonal temperature and the ability for ski areas to operate in the same length of time as they have in the past.

4. *Potential Investment in High-Efficiency Snowguns*

Sugarloaf's ability to open mid-November gains them the reputation of high-quality skiing and increased value for a season pass holder. If they were to have a goal to open 50% of their 1230 skiable acres by the end of November it would confirm their status as one of the largest, most skied mountains in the East. This reputation keeps season pass holders buying each year. With the current 300 snowguns, and an average of 131 hours below 28 F, Sugarloaf would need to invest in 540 new high-efficiency equipment in order to cover 50% of the terrain by the end of November.

This would leave a minimal deficit of -$101,099. Replacing less efficient equipment saves costs mainly in electricity. Compressed air is combined with water to create snow, and electricity is needed to generate the compressed air, the most expensive portion of the costs to snowmaking. High-efficient snowguns

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have the ability to use less compressed air, even at higher temperatures in order to produce the same amount of snow in less hours.

Table 3:	
Open in by end of November	
Hrs below 28 F	131
% of terrain available	0.00592
Sugarloaf would need to invest in 540 new High-Efficiency Guns	
Goal of 50% in Nov.	
Cost ($)	1,800,000
Payback per acre using new snowguns	2762.44
Payback for 50% terrain cover	1,698,900.60
Deficit	**-101,099.00**
Sugarloaf in 2060 after investment in 540 High-Efficiency Guns	
Payback per acre in 2060 (50 yr later)	138,122.00
Payback for 50% terrain cover in 2060	84,945,030.00
Gain	**83,145030.00**

In 2060 there will potentially only be about 35 hours of temperatures below 28 F. This greatly diminishes the hours of available snowmaking. Only about 27% of the hours remain to attempt to make the same amount of snow. The investment in snowmaking equipment would be about 2,000 snowguns in order to produce enough snow to cover 50% of the mountain with a 2-foot base. This would be a $6,000,000 investment, which may be too large for Sugarloaf to handle. There is potential that the guns can be moved to other parts of the mountain, but this increases labor costs and set up costs to install the pipeline on trails that may not already have it. However, we need to note that these are future temperatures predicted by the most recent linear increase in temperature determined by the University of Maine's Climate Change Report. Temperature increases are inevitable due to greenhouse gas accumulation, but Maine may also be more subject to extreme weather patterns than warmer weather patterns. Extreme weather patterns would include large snowstorms and freezing temperatures as well. As these climate changes are unpredictable, the investment in snowmaking would prevent revenue loss during times of unfavorable weather.

Sugarloaf may be able to avoid the $6,000,000 initial cost with appropriate financing. The mountain could potentially purchase 100 new guns over the next 20 years in order to alleviate the high cost in one year. Also, Sugarloaf has developed a relationship with the snowmaking company; therefore, the mountain could be able to cooperate in a deal as a long-time

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customer. Lack of snow due to climate change is a long-term problem, and the gains from snowmaking in the long-run may be higher than the payment of interest over the years. If Sugarloaf were to make an initial investment of 540 new high-efficiency snowguns, the gains from electricity savings would near $83,145030.00; however, this figure would decrease due to maintenance and labor costs. The potential to save a large sum on electricity costs provides incentives to make these investments overtime. Sugarloaf could complete its investment in snowmaking equipment in installments over the years that we see the temperature increasing.

5. Conclusion

The unpredictability of climate changes questions the potential of investment: are the costs incurred going generate enough revenue to alleviate the investment? With the climate change predicted for Northern Maine, the investment will be necessary potentially to not open in November, but to open in December as the temperatures rise over the years. If Sugarloaf continues to receive grants like they did from Efficiency, Maine, it will be more likely that the mountain invests. The mountain is looking to continue their goal of Sugarloaf 2020 to become a year round resort by constructing a golf course. However, their recreational value remains in their skiing, where they have maintained a reputation as the one of the largest mountains in the East, as well as one that stays open the longest.

The threat of revenue loss due to inconsistent weather patterns is larger than the risk of investing in snowmaking equipment. By investing in high-efficiency snowmaking equipment, they can alleviate their costs as energy costs could increase as well. However, some things to consider are that this analysis does not take into account natural snowfall, which could aid snowmaking in reaching goal. Snowfall is obviously more unpredictable with climate change, and more subject to extremes.

This study also assumed that all valves would be operating (there are four) to make equipment most efficient, and that all equipment is running at all possible hours. This may not be viable due to technical problems or labor shortages. Also, maintained and labor do incur extra costs that are not predictable. However, the technology continues to evolve. New automation technology allows labor costs to decrease, as all snowguns can be operated from a control center. It is in Sugarloaf's best interest invest in the new technology now to replace older equipment. Although the effects of climate change will still likely cause a decrease in revenue, these effects may be alleviated.

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The potential lack of snow due to climate change is not a challenge solely faced by Sugarloaf, but the entire ski industry. If Sugarloaf is to remain competitive with large East Coast ski resorts, it is necessary for the mountain to maintain its ski season length despite the possible challenge brought by unpredictable weather. Sugarloaf will benefit from investing in the new technology in order to remain competitive and uphold its reputation as a successful ski area.

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