



FAKE FLAKES: AN ANALYSIS OF THE EFFECTS OF SNOWMAKING AT SKI RESORTS

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Abstract:

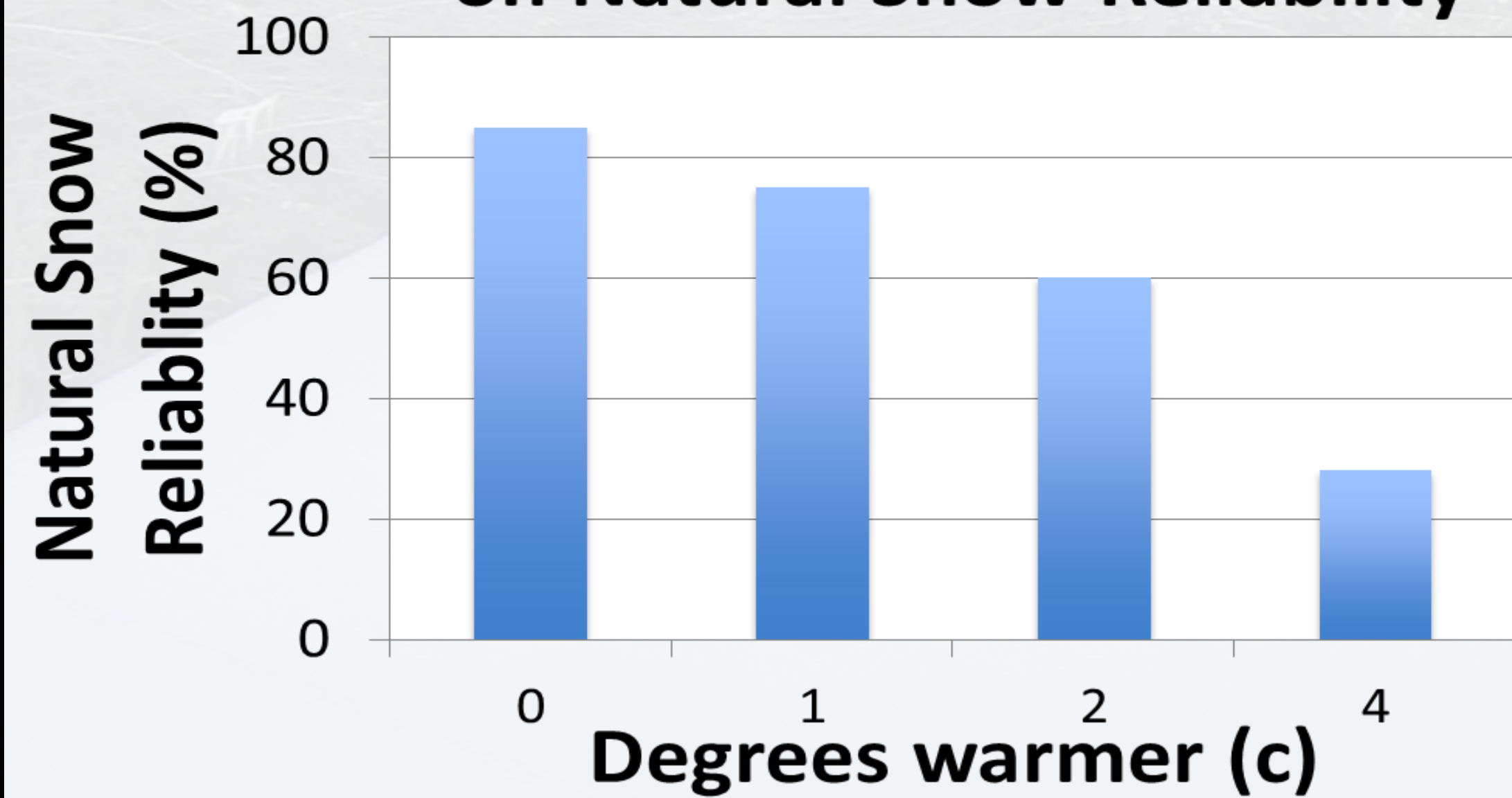
Artificial snowmaking is a strategy that most ski resorts are beginning to embrace to combat the effects of global climate change. Skier expectations for a longer season and better, more reliable snow cover are also driving the need for artificial snow. However, there are many large issues involved with the process of snowmaking such as high energy consumption and water use. Artificial snow can also cause changes and decreases in alpine vegetation, and is associated with many health concerns. In order to conduct this research, I did a literature review of the four snowmaking systems currently used in the United States, and conducted several case studies of ski resorts of different size. I concluded that ski resorts should make efforts to improve snowmaking, but these efforts will vary based on the size of the resort and the amount of money they are willing to spend on snowmaking.

Snowmaking system	Advantages and Disadvantages	Capital Cost (per gun)	Efficiency at 20°C Wet Bulb Temperature (kW/gpm)
Internal mix	Advantages: Less affected by wind; allows high wet bulb temperature; light and portable unit; covers wide trails; ability to adjust snow consistency Disadvantages: Inefficient due to its reliance on compressed air.	\$750 to \$900	1.2 kW/gpm
External mix	Advantages: More energy efficient than internal mix because less compressed air is required (lower air to water ratio) Disadvantages: Highly affected by wind forces; typically requires colder temperatures; difficult to move; little adjustment of snow consistency	\$1200 to \$3500 (plus installation which can cost anywhere from \$500 to \$2000)	0.4 kW/gpm
Fan gun	Advantages: Uses minimal compressed air; can adjust snow consistency Disadvantages: Difficult to adjust position (increased labor requirement).	\$15,000 to \$40,000	About 25 kW is required to operate a small compressor and fan at any temperature
Waterstick	Advantages: Eliminates the need for compressed air; most energy efficient system Disadvantages: Reliant on cold temperatures; difficult to move; uses biological additives	\$2500 to \$3500	0.4 kW/gpm



The picture above shows Snomax, a biological additive that aids in snow crystallization. The table on the left shows the advantages and disadvantages of each snowmaking system.

The Effects of Warming Temperatures on Natural Snow Reliability



Above: This table shows the need for snowmaking with the continuing threat of global climate change. Below: Two types of snowmaking systems (the fan gun system is shown on the right, the external mix system is shown on the left).



Methods:

To answer the question, how can ski resorts make artificial snowmaking more economical and environmentally friendly, I conducted a literature review. I looked at the history of artificial snow and how it is made, the reasons it is being used, the problems associated with its continued use, and the possible solutions to these problems. I did case studies of the Giants Ridge ski resort in Minnesota and the Aspen Ski Resort in Colorado to determine the ways that ski resorts are currently making snow and their specific environmental and economic concerns. I also looked at two ski resorts that have experienced public backlash due to their harmful snowmaking practices. Finally, I analyzed the four separate snowmaking systems and their advantages and disadvantages.

Conclusion:

I concluded that the largest problems facing ski resorts in regards to snowmaking are their energy consumption and water use. The best way to combat these problems is by using a combination of techniques on a case-to-case basis. Each ski resort must assess their snowmaking needs and the amount of money they are able to spend on snowmaking systems. Larger changes include updating snowmaking systems to make them more energy and water efficient, as well as switching to reservoir systems instead of taking water from alpine streams. Smaller changes include monitoring snowmaking systems for inefficiencies such as air or water leaks and fixing these issues. The most important thing that a ski resort can do is to monitor their energy and water use and look for ways to make their snowmaking systems more efficient. Due to global climate change, artificial snowmaking is necessary for the future of alpine skiing. However, as climate change continues, at some point artificial snow will no longer be a viable solution to the lack of snow cover. Although artificial snowmaking is a relatively short-term solution, it is important to take steps to make it more environmentally friendly and economical.

Images: <http://deepcreeklakeproperty.com/2011/11/snow-making-wisp-resort/>
<http://blog.gowintergreen.com/2008/12/05/wintergreen-skiing-on-eagles-swoop-this-weekend/>
http://www.snomax.ch/englisch_Preisliste.html