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Nature-based tourism challenges with climate change: A look at the future of the ski industry

Sustainability and climate change are intrinsic concerns with any nature-based tourism or recreation, but especially present when looking to the future of the ski industry. As climate change and global warming occurs, winter is getting shortened – with later first snow and earlier last snow (Hopkins, 2014). Utah is a place warming faster than many global averages and is expected by the end of the century to have daily minimum winter temperatures increase by 6 to 6.6 degrees C (Wilkins et al., 2021). Even small changes in temperature can have drastic effects on snowpack and snowfall, critically important for hosting skiers and ski resort operations. Despite the warming winters, there is no sign people will stop pursuing skiing. Queenstown is one of New Zealand's main ski towns, and international traveler amounts were double in winter than summer in 2011 (Hopkins, 201 Ski resorts will have to and are going about adapting to a changed climate in two main wa shifting to man-made snow supplements, and turning to year-round tourism. While these methods may create industry and social resilience, they do so at the compromise of parts of the environment and quality of social expectations, questioning their long-term sustainability to mountain environments.

In response to altered natural snowfall patterns, ski resorts are turning to man-made snow. While snowmaking is something that has already been utilized in the industry, it previously had been in addition to natural snow, not trying to make up or replace lacking natural snow (Hudson, 1996; Hopkins, 2014). Man-made snow does help this deficit and allow resorts to maintain

relatively normal season operation dates, but at several costs. Man-made snow is energy and water-intensive due to the rapid freezing of water and then blasting outwards onto the slope (Wilkins et al., 2021). This is not the most efficient process, as snow or water is lost when blasted outwards and if temperatures are not low enough, the snow melts (Wilkins et al., 2021; Hopkins 2014). The water involved oftentimes comes from local watersheds, and can be considered replaceable by the end of season meltage, but water rich watersheds are something not all resorts have access to (Hudson, 1996). Artificial snow typically has chemical additives to increase the efficiency of freezing and reduce initial melt (Wilkins, et al., 2021). This can also stretch the end of season melting period, leaving less time for alpine grass regrowth, though the additives are not typically seen as a concern for ecosystem water health (Hudson, 1996; Wilkins, et al., 2021). Lastly, man-made snow is poorer quality, due to the artificialness of it, and generally without enough natural snow, prevents skiers from visiting these destinations (Wilkins, et al., 2021). While this won't stop all skiers, it disproportionately reduces higher level skiers who are pickier on conditions, and oftentimes the ones spending more time throughout a season on the mountains (Wilkins, et al., 202 Snowmaking provides an option for continuing the ski industry, but at high resource demand, skier compromise and reliance on global warming not altering seasonal temperatures above a snow retention threshold.

Ski resorts have also begun pursuing a different pathway that does not meet skier needs, but instead the economic interest of resorts and resort towns. With winters shrinking, resorts have shifted to keep steady cash flow year-round by creating summer recreation or tourism draws (Gilani, Innes & De Grave, 2018). This shift in operations allows money to come in and jobs to be had all year, not just seasonally, which can make up for or be in addition to low winter economic gains (Gilani, Innes & De Grave, 2018). However, the continual tourism cycling can

lead to environmental and social issues in these communities. Popular summer additions to ski resorts are alpine coasters, mountain bike trails and hiking (Markovic and Petrovic, 2013). Without a period of rest for the forest ecosystems where ski trails and summer recreation takes place, this can be disruptive to wildlife and plant regrowth (Briggs, 2000: Markovic and Petrovic, 2013). This can change the ecosystems and alter species inhabitation, as well as contribute to erosion and pollution in already extremely fragile alpine ecosystems (Briggs, 2000). Additionally, summer occupation increases housing needs, as historically many winter rentals were then occupied by the owners in the summer. More properties are turning to year-long rentals as it's more profitable, and resort towns are unable to have proper staffing due to housing shutouts (Markovic and Petrovic, 2013). More people in these locations for longer is rapidly reaching a higher capacity than the town infrastructure can support or keep up with, limiting the time resort towns can operate under these constraints (Markovic and Petrovic, 2013). While summer shifts can give economic opportunities beyond the limitations facing winter profits, it is also creating environmental damage, social changes and infrastructure limitations.

While it is undeniable the ski industry cannot survive without making adaptations to navigate climate change, the two main pathways forward may not be overall correct long term solutions for the industries, people and environments involved. However, they do offer some guidance and short-term alterations ready for further improvements with sustainability at the center.

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