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Behavioural adaptation of skiers to climatic variability and change in Ontario, Canada

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ABSTRACT

Increasing research highlights the vulnerability of the alpine ski sector to climatic variability and change. The literature has focused predominantly on supply-side vulnerability, with limited insight into tourists' behavioural response to marginal snow conditions and ski resort closures. Using an in-situ survey ($n=2448$), this study examines how skiers in Ontario (Canada) would change their participation patterns if their preferred ski resort were closed due to a lack of snow. The survey focuses on current behavioural responses, rather than decisions based on future scenarios of climate change. Results show that substitution behaviours (i.e., spatial, temporal, activity) differ pending whether the resort is closed for the day, closed until mid-season or closed permanently, with differences ($p < 0.05$) recorded based on skier market segments. The results also indicate that beginner and infrequent skiers, as well as parents with children enroled in ski lessons, are more likely to either ski less and/or stop skiing altogether, while experienced and core skiers are more likely to engage in spatial substitution. Season pass holders and those at large resorts were also more likely to engage in spatial substitution. Managerial implications as a result of a likely shift in ski demand patterns in Ontario are discussed, with future research needs identified to appraise the differential community-level consequences and future climate adaptation strategies of ski tourism.

MANAGEMENT IMPLICATIONS

The behavioural response of skiers to changing climatic conditions will be a decisive factor in the vulnerability and sustainability of ski tourism. Fundamental to assessing the contemporary climate risk of the multi-billion dollar ski industry, as well as to estimate how future climate change could alter demand patterns in regional ski tourism marketplaces, is to understand skiers' behavioural adaptation to inter-annual climate variability. As skiers engage in behavioural substitution (temporal, spatial, activity), a shift in ski demand patterns is likely. Skiers will concentrate at resorts that remain climatically operable, which will have important management implications with respect to individual resort capacity, visitor experience (e.g., crowding), and consequent impacts on surrounding ski area businesses and communities. Climatically advantaged ski areas and communities will need to prepare for development pressures, including investments in ski terrain expansion and infrastructure to increase snowmaking capacity (including water access and storage), as well as ease increased crowding on trails, in parking lots, inside chalets and lift lines. The results from this study offer decision support to ski resort operators and local tourism officials concerned about how their visitors will respond to changing climatic conditions and the implications for local economic development and real-estate.

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1. Introduction

Winter sports tourism is reliant on temperature and snowfall conditions, with inter-annual climate variability impacting the length and quality of ski seasons and thereby skier visits and

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associated revenues. The vulnerability of the international ski industry to climate variability and change has garnered considerable attention, with more than 30 studies in over a dozen countries (Scott, Gössling, & Hall, 2012). The focus on skiing and winter sports tourism is strategic considering this tourism subsector is most directly and most immediately affected by climate change (Scott, 2011). This literature has predominantly focused on supply-side vulnerability, initially aiming to understand the impact of increased average temperature and changing natural snow availability on ski operations, including the reliability of the ski tourism product, operational costs, and sustainability. These studies have consistently found the ski industry to be at risk to climate change, with ski seasons projected to become shorter on average and more variable due to a decrease in natural snow cover (i.e., natural snow reliability), while increased snow-making requirements (and thereby operating costs) will need to occur with decreased opportunities for snow-making (i.e., technical snow reliability) (e.g., Abegg, Agrawala, Crick, & De Montfalcon, 2007; Dawson & Scott, 2013; Hamilton, Brown, & Keim, 2007; Hendrikx, Zammit, Hreinsson, & Becken, 2013; Hennessy et al., 2008; Pons, Johnson, Rosas, & Jover, 2014; Scott, Dawson, & Jones, 2008; Scott, McBoyle, & Mills, 2003; Scott, McBoyle, Mills, & Minogue, 2006; Scott, McBoyle, & Minogue, 2007; Steiger, 2010; Steiger & Stötter, 2013). In every regional ski market assessed (Australasia, North America, Eastern and Western Europe, Japan), the result is a continued contraction in the number of operating ski areas. The implications of this contraction of operating ski areas for community tourism and economic development have only begun to be explored (Scott, Dawson, & Jones, 2008; Dawson & Scott, 2013).

To lengthen ski tourism seasons and improve the reliability of snow-based tourism products globally, snowmaking has become an integral climate adaptation of the ski industry (Scott et al., 2012). Studies have found that through the production of snow, the vulnerability of winter sports, particularly during winters with high temperatures and low snowfalls, has decreased substantially since the mid-1980s (Pickering, 2011; Rutty, Scott, Steiger, & Johnson, 2014; Scott & McBoyle, 2007; Steiger & Stötter, 2013; Töglhofer, Eigner, & Prettenthaler, 2011). While this indicates a 'decoupling' of the ski industry from natural snowfall where widespread snowmaking is implemented (Steiger & Stötter, 2013), winter sports tourism remains highly dependant on sufficiently cold temperatures for making snow. Even in regions with extensive snowmaking capacity, the impact of inter-annual climate variability on ski season length and skier visits remains evident. For example, in eastern North America where snowmaking covers nearly 100% of skiable terrain (Scott, Hall, & Gössling, 2012), the anomalous warm winter of 2011–12 led to a 10% decrease in skier visits in Ontario compared to the previous season "due to lack of snow early in the season, no major snow falls, and an early end to the season" (Ontario Snow Resorts Association [OSRA], 2012). During the marginal snow season of 2001–02, declines in average season length and visitation occurred in the Ontario (7%), Quebec (15%) and northeast US ski markets (11%) compared with a climatically normal winter (for the 1961–90 period) (Dawson, Scott, & McBoyle, 2009; Scott, 2006; Scott, Hall et al., 2012). In Austria, an 11% decrease in ski-lift ticket sales was recorded for the record warm winter of 2006–07 compared to the previous three year average (Steiger, 2011). In Australia, the number of visitor days decreased by 69% during the warm and dry year of 2006 compared to the previous nine years (Pickering, 2011). These results are consistent with the findings of Shih, Nicholls, & Holecek (2009) in Michigan (USA) that weather variables (e.g., temperature, snow depth, wind chill) have statistically significant impacts on downhill ski lift tickets. Importantly, these analogue studies indicate a differential vulnerability within the regional ski markets, with smaller ski areas at greater risk to marginal weather seasons compared to the large ski area operations with greater capital and snowmaking capacity (Dawson et al., 2009; Scott, Hall et al., 2012). Therefore inter-annual climate variability, which is anticipated to become more pronounced under future climate change (IPCC, 2013), remains an important present risk for the ski tourism industry, particularly for the smaller operators that may not be able to absorb substantive economic losses from consecutive warm winters.

Comparatively little is known with respect to the influence of weather and climate on skier demand, including tourists' behavioural response to past or projected climatic variability, poor snow conditions, and ski resort closures (Dawson, Havitz, & Scott, 2011; Dawson, Scott, & Havitz, 2013; Pickering, Castley, & Burtt, 2010; Pons, Johnson, Rosas, & Jover, 2014; Putz et al., 2011; Rutty & Andrey, 2014; Scott et al., 2008; Scott, Hall, et al., 2012; Scott & McBoyle, 2007; Shih et al., 2009; Steiger & Abegg, 2013). This limitation exists more broadly with respect to tourist response to climatic and environmental change and was identified as a priority research area by Gössling, Scott, & Hall (2012). Using an in-situ survey, this study examined how skiers in Ontario (Canada) stated they would change their participation patterns if their preferred ski resort were closed due to a lack of snow. Specifically, the survey focused on how individuals would engage in spatial (i.e., travel to a different ski resort), temporal (i.e., alter their frequency of participation) or activity substitution (i.e., switch from skiing to another leisure activity) under three different conditions: (1) if their preferred ski resort was not open on the day of the trip (i.e., "not open today"), (2) had a delayed start to the season (i.e., "not open until mid-January") or (3) was to cease ski operations (i.e., "close permanently"). Similarities and differences in substitution strategies were also examined among segments of the skier market, including socio-demographics (i.e., age), experience (i.e., skill level), participation rates (i.e., frequency of trips) and resort type (i.e., small, large, private). The study aims to provide insight into skiers' behavioural adaptation to inter-annual climate variability and the implications of adverse future conditions for ski demand. This question is fundamental to assessing contemporary climate risk, as well as to estimate how future climate change could alter demand patterns in regional ski tourism marketplaces. Such skier adaptation will be a decisive factor in the vulnerability and sustainability of ski tourism (Dawson et al., 2013; Hendrikx et al., 2013; Pons et al., 2014; Scott, Hall et al., 2012; Scott & McBoyle, 2007; Steiger & Abegg, 2013).

2. Literature review

A limited number of studies have used a survey-based method to understand how skiers may adapt their behaviour in the future due to more frequent marginal snow conditions as a result of climate change. These international studies conducted in Australia, Austria, Switzerland, and the US suggest that the majority of skiers would significantly alter their behaviour. König (1998) found that 75% of respondents in Australia would alter their ski behaviour if the region experienced 'very little natural snow in the next five years', including 31% who would ski less often, 38% who would ski at an overseas location instead, and 6% who would stop skiing altogether. Using the same survey instrument a decade later, Pickering et al. (2010) found an increase in the proportion of Australian skiers who would alter their ski participation behaviour (from 75% in 1996 to 90% in 2007), including 69% who would ski less often, 16% who would ski at an overseas location, and 5% who would stop skiing altogether. Behringer, Buerki, and Fuhrer (2000) similarly asked skiers in Switzerland how they would alter their behaviour if they knew that 'the next five winters would be snow deficient'. Of the responses, 49% would ski at a different/more

snow-reliable resort (21% of which would ski less often), 11% would ski at the same location but less often, and 4% would stop skiing altogether. Unbehaun, Pröbstl, & Haider (2008) asked Austrian skiers what they would do in the future after 'several consecutive years of snow deficiency', 68% responded that they would be willing to continue skiing by travelling to a snow-secure region. When respondents were presented with a choice between two hypothetical resorts, one with and one without snow security, the majority chose the former, with a willingness to pay 10% more and drive two additional hours for this trade-off, while 25% opted to stop skiing altogether.A limitation of these survey-based studies is that it is unclear how the respondents would have perceived and interpreted the descriptive scenarios provided in the surveys. Scott Hall et al. (2012: 327) asked: "How is 'very little snow' to be interpreted? Does that mean snowfall has been so deficient that ski areas did not open at all, or are open only half as long as usual, or are open an average length of time but have poor conditions (e.g. bare patches), or that ski areas are open an average length of time but had to rely heavily on snow-making? Depending on how the respondent perceived this scenario, the (behavioural) response could be very different." Furthermore, these studies did not examine how individuals have responded to marginal snow conditions in the past, so we do not have a reasonable understanding of whether a net difference in behaviour change should be expected in the future (Dawson et al., 2013; Scott, Hall et al., 2012). If a high proportion of respondents are already engaging in certain substitution behaviours, and a similar proportion indicate that they will engage in the same type of substitution behaviour in the future, then the impact on demand would be similar to those observed during contemporary marginal seasons, and we could have confidence that recent record warm seasons (climate change analogue) provide important insights into future demand changes.

Recognizing that past substitution behaviour could inform future substitution patterns under climate change, studies have begun to examine responses to recent poor ski seasons. Dawson et al. (2013) asked skiers in the US Northeast to reflect on how they responded to marginal snow conditions that occurred in two recent ski seasons. Multiple behavioural adaptation responses were possible and the study found that 51% had engaged in an alternative leisure activity, 60% had skied elsewhere within the region, while 67% had skied outside of the region, and 38% had chosen to ski less often. Respondents were then asked how they might react if the similar marginal conditions occurred in the future. Little difference was reported in activity and temporal substitution strategies, while fewer indicated they would engage in spatial substitution. The reduction in spatial substitution may be related to past experience with ski conditions at nearby resorts (i.e., they may have substituted spatially in the past and the substitution "failed" because the alternative site also had marginal conditions) (Dawson et al., 2013). In the same region, Vivian (2011) presented skiers with a descriptive scenario that reflected conditions during the record warm winter of 2001–02 that most of the survey respondents had experienced. When asked how they would respond if another such winter were to occur, 87% stated they would ski their usual frequency (but with fewer days skied in total), 11% would ski more often than normal to make up for a shorter season, and 1% would stop skiing for the entire winter. None of the nearly 1000 respondents indicated they would stop skiing altogether. When asked where they would ski, 60% stated they would wait until their usual ski area(s) were open, 23% would travel further within the region to find better snow conditions, 9% would take a ski holiday outside of the northeast US, and 3% would engage in an alternative leisure activity.

The findings from both Dawson et al. (2013) and Vivian (2011) differ from the earlier survey-based studies that only asked about hypothetical climate change scenarios (i.e., Behringer et al., 2000; König, 1998; Pickering et al., 2010; Unbehaun et al., 2008), with the results indicating a less severe outlook for ski areas with marginal snow conditions. The differential responses with respect to activity substitution (i.e., far fewer respondents indicating they would stop skiing altogether) is particularly noteworthy, and suggests ski demand under adverse conditions may be more robust than earlier studies suggested, which is consistent with the results of the analogue studies (i.e., Dawson et al., 2009; Scott, 2006; Steiger, 2011). However, an important difference between recent climate change analogue seasons and future ski seasons under climate change is that when skiers respond to contemporary record warm winters these are single anomalous seasons, whereas in the future, these adverse conditions would be the norm (rather than the exception) and potentially occur multiple seasons in a row. While the impact of a single record warm winter on ski demand appears moderate (a 10–15% reduction of skier visits), the response to repeated or prolonged poor conditions remains uncertain.

Important differences in the substitution behaviours of key skier market segments have also been noted in the literature. Behringer et al. (2000) and König (1998) found that beginner-level skiers were disproportionately more likely to indicate that they would stop skiing as a result of marginal snow conditions compared to expert skiers, whereas Dawson et al. (2013) found that expert skiers were more likely to stop skiing and participate in alternative leisure activity compared to beginner-level skiers. Other cited reasons for limited or ceased participation among alpine skiers include having responsibility for children who are too young to ski (i.e., ability and time constraint) (Williams & Dossa, 1995), high costs involved in participation (i.e. economic constraint) (Riddington, Sinclair, & Milne, 2000), and lack of snow (i.e., physical and/or time constraint) (Gilbert & Hudson, 2000). The limited and inconsistent research findings underscore the need for further investigation, with additional survey research important to better understand behavioural adaptation among segments of the skier market to marginal snow conditions and shorter ski seasons.

3. Materials and methods

3.1. Study area

Canada offers approximately 274 operating ski areas, with 18.5 million skier visits during the 2011–12 season (Canadian Ski Council, 2012). The largest share of national skier visits occur in the provinces of British Columbia (35%) and Quebec (32%), followed by Ontario (16%) (CSC, 2012). However, with its large population, Ontario has the largest market of active skiers in Canada (1.4 million) and the highest skiing participation rate in the country (12%) (CSC, 2012). Forty-four alpine snow resorts are in Ontario, the majority of which are concentrated in southern Ontario near major population centres. The Ontario ski market reported 3 million annual skier visits in recent years and generated an estimated CAD$228.3 million in total revenues during the 2011–12 season (OSRA, 2012).). The average ski season in Ontario is 100 days between December and March (Bruce Haynes, personal communication), with January to February accounting for more than two-thirds of annual skier visits (62–72%) and March accounting for an additional 10–15% (OSRA,2012).).

Ten ski resorts were selected to collect a representative sample of the Ontario ski market, based on geographic location and proximity to major urban markets. These are both important factors for this study area, as the majority (77%) of Canadian skiers not only live in large urban cities with populations greater than 100,000 (CSC, 2012), but also because the vast majority (85%) of Ontario ski areas (and subsequently total share of provincial

skiers) are concentrated in southern Ontario. Of the ten ski resorts, two are classified as large ski resorts in the region, with high uphill capacity (≥ 12 chairlifts and T-bars), numerous groomed ski trails (≥ 40) and skiable acres (≥ 170 acres). One resort is private, with high membership costs and annual fees to ski on-site. The remaining seven resorts are classified as small, including five that are representative of urban feeder resorts (I.e., small ski resorts close to urban centres) and two that are surrounded by rural communities.

3.2. Survey distribution and design

A 37-question survey was developed to examine respondents' ski resort preferences (e.g., the importance of various factors on deciding where to ski), behavioural adaptation if the ski resort was to be closed (temporarily or permanently) as a result of poor snow conditions, as well as demographic and ski participation profile (e.g., level of experience, ski trip patterns, ski resort property ownership). The self-administered survey was distributed to skiers at the 10 resorts in February and March 2014. The surveys were disseminated electronically on tablets between 9 a.m. and 6 p.m. (local time), with all available skiers seated inside resort chalets and cafeterias approached to participate. A total of 2448 surveys were filled out, with 19 considered invalid/incomplete and were not used in the analysis. The final sample was 2429, with 1491 (61%) collected at small sized resorts (as classified by OSRA), 790 (33%) at large sized resorts, and 148 (6%) at a private ski resort, with an overall response rate of approximately 60–65% at the 10 resorts.

The survey builds on Dawson et al. (2013), similarly incorporating Iso-Ahola's (1986) theory of recreation substitution to understand how people change their participation habits if they are no longer able to participate in skiing due to poor snow conditions or closure of a ski resort. The theory proposes that when people are unable to participate in a given activity, they may substitute that activity with another (i.e., activity substitution), change the timing or intensity with which they participate in that activity (i.e., temporal substitution) or alter the location of practice (i.e., spatial substitution). Based on this, respondents were presented with a list of possible behavioural adaptations (i.e., multiple choice format), including to ski more or less during a shortened season (i.e., temporal substitution), travel to another resort within or outside of Ontario (i.e., spatial substitution) or to stop skiing altogether (i.e., activity substitution). For those who indicated spatial substitution as their most likely response (versus temporal or activity substitution), they were then asked where the spatial substitution would occur. The survey questions that examined skier behavioural response to a closed resort on the day of ski participation (i.e, closed today) or for a prolonged part of the ski season (i.e., closed until mid-season) used mutually exclusive nominal categories. The questions were designed to record the respondent's most likely behavioural response to the ski conditions posed to them rather than measure the intensity of their feelings related to ski area closure, which is a core objective of this study. Multiple choice is an efficient and effective measurement alternative to Likert scales (Dolnicar, Grun, Leisch, & Rossiter, 2011; Peabody, 1962). Moreover, the survey is consistent with previous studies (Behringer et al., 2000; Dawson et al., 2011, 2013; König, 1998; Pickering et al., 2010; Unbehaun et al., 2008; Vivian, 2011), facilitating needed comparisons across international studies.

Unlike previous survey-based studies examining skier adaptation to climate change, this study did not ask respondents how they would react to hypothetical future scenarios (Behringer et al., 2000; König, 1998; Pickering et al., 2010; Unbehaun et al., 2008) nor ask respondents how they responded to past marginal conditions (Dawson et al., 2013; Vivian, 2011). Rather, this survey asked respondents how they would react in the present if their in-situ resort was closed. For example, respondents were asked "if you could not ski at this resort today due to lack of snow, what would you do?" or "if this resort did not open until mid-January due to lack of snow, what would you do?" or "if this resort was to close permanently due to lack of snow, what would you do?". In so doing, this study attempted to limit interpretation errors that may result from providing respondents with descriptive future scenarios, as well as control for recall bias related to their behavioural response to adverse ski seasons several years in the past. The survey also focused on current weather variability rather than projected climate change scenarios, an approach advocated in the tourism literature because tourists' may have a negative emotional connection to the issue of climate change and associate it with threat scenarios or pessimism (e.g., Saarinen & Tervo, 2010; Tervo-Kankare, 2011; Trawöger, 2014).

4. Results

4.1. Sample characteristics

Respondent profiles are summarized in Table 1. The sample was closely split between males (49%) and females (51%). In terms of age, the largest share of respondents were between the age of 35 and 49 years (48%), followed by 15–24 years (20%), 50–64 years (16%), 25–34 (14%), with the lowest share of respondents 65 years or older (2%). It is possible that older skiers may have been less inclined to respond to a digital survey and thereby potentially contributed to their underrepresentation in this study. The majority of respondents considered themselves to be expert skiers/snowboarders (53%), with the smallest share of respondents rating themselves as beginners (12%). The sample spent an average of 7.4 days skiing per year, with the majority of respondents (53%) indicating that they are occasional skiers (i.e., ski 3–9 times per year). More than two-thirds of the respondents (70%) are not season pass holders (excluding respondents from the private ski resort, which requires membership to ski).

Table 1
Demographic and trip characteristics of sample (n=2429).

Variable	Subcategory	Respondents (%)
Gender	Male	49
	Female	51
Age	15–24	20
	25–34	14
	35–49	48
	50–64	16
	65+	2
Experience	Beginner	12
	Intermediate	35
	Expert	53
Frequency	Average	7.4
	Infrequent (≤ 2)	20
	Occasional (3–9)	53
	Core (≥ 10)	27
Season pass[a]	Yes	30
	No	70

[a] Excludes private ski resorts.

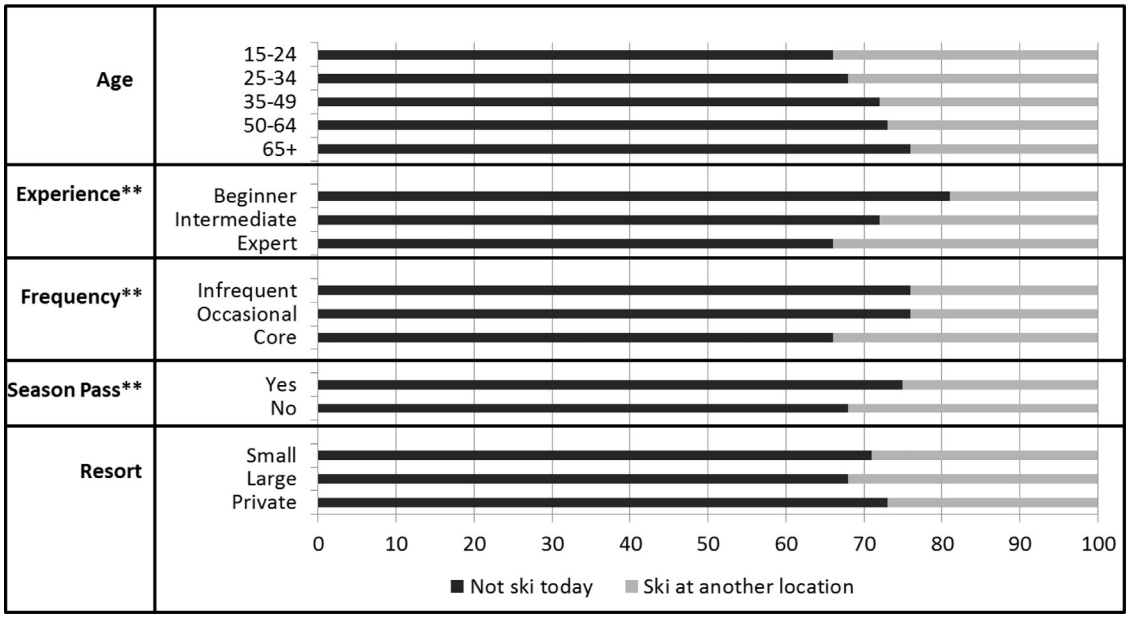

Fig. 1. Behavioural adaptation (substitution) if resort was not open today (% of respondents). $^{**}p \leq 0.01$.

4.2. Behavioural adaptation (substitution)

When respondents were asked what they would do if the resort they were currently skiing at was not open today due to lack of snow, 70% stated that they would not ski today (temporal substitution), with the remaining 30% stating they would travel to another ski resort (spatial substitution). As highlighted in Fig. 1, a number of statistically significant differences were recorded among the sample group. For example, differences were recorded based on experience ($\chi^2 = 27.668$, $p = 0.000$), with beginner skiers statically less likely to engage in spatial substitution compared to expert skiers who are likely to travel to another resort. Differences were also recorded based on ski frequency ($\chi^2 = 26.696$, $p = 0.000$), with occasional skiers less likely to engage in spatial substitution compared to core skiers who are more likely to travel to another ski location. Behavioural adaptations also differed based on ticket type ($\chi^2 = 13.157$, $p = 0.000$), with season pass holders less likely to travel to a different ski resort where they would incur additional costs to ski. Similarly, parents with children taking ski lessons were less likely to travel to a different ski resort if their resort was closed today, compared to those parents who did not have their children enroled in lessons (79% vs. 64%, $p = 0.000$).

Fig. 2 provides a summary of respondents' stated behavioural adaptation if their current resort was not open until mid-January due to lack of snow. The largest share of respondents (48%) stated that they would engage in spatial substitution by skiing as often as they currently do, but at other locations until their resort opened. Almost half of the respondents would engage in temporal

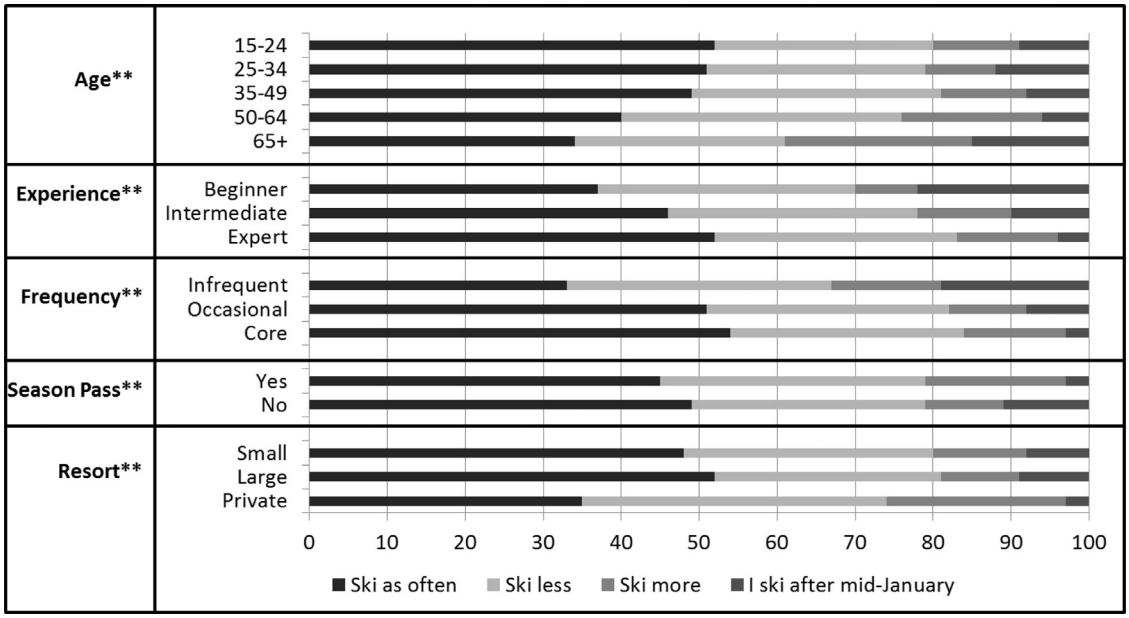

Fig. 2. Behavioural adaptation (substitution) to mid-season opening (% of respondents). $^{**}p \leq 0.01$.

substitution, with 31% opting to ski less often and wait for the resort to open and 12% who would wait for their resort to open and ski more frequently in the shortened season. The remaining 9% stated that they do not currently ski until after mid-January, and so this would not impact annual ski participation. Statistically significant differences were found between age groups ($\chi^2=42.309$, $p=0.000$), with 50–64 and 65+ year olds less likely to travel to another resort and statistically more likely to wait for their resort to open and ski more during the shortened season. Behavioural adaptation also differed based on experience ($\chi^2=106.480$, $p=0.000$), with expert skiers more likely to travel to another ski resort in order to ski as often and beginner skiers less likely to engage in spatial substitution. Moreover, both beginner and intermediate skiers were more likely to ski after mid-January compared to expert skiers. Differences between season pass holders and non-pass holders were also recorded ($\chi^2=82.659$, $p=0.000$), with the former statistically more like to ski more in the shortened season and less likely to ski after mid-January. Behavioural adaptation also differed based on resort type ($\chi^2=32.925$, $p=0.000$), with private club members more likely to wait for their resort to open and ski more often in the shortened season and less likely to engage in spatial substitution or ski after mid-January. Parents with children taking lessons were also statistically more likely to not ski until mid-season and wait for their resort to open compared to parents who did not have their children enroled in lessons (39% vs. 29%, $p=0.007$). The findings of the season pass holders, private club members, and ski lessons are consistent with level of commitment to the activity, cost as a participation constraint, and place loyalty (Dawson et al., 2011, 2013).

When respondents were asked what they would do if their current resort was to close permanently due to lack of reliable snow, the majority (61%) would engage in spatial substitution and ski at another locations, of which 83% would ski at another resort in Ontario, with the remaining 17% travelling outside of the province to Quebec (12%) and New York state (5%). Skiing less often was selected by 36% of respondents. Of those who indicated they would ski less over the season, 23% stated they would ski 25% less frequently than they do currently, 43% indicated they would ski half as much as they currently do, and 35% would ski 75% less frequently than they currently do. Activity substitution (i.e., stop skiing altogether) was selected by only 3% of respondents. Similar to the response to a mid-January opening, behavioural adaptation differed based on age ($\chi^2=20.197$, $p=0.010$), with respondents aged 50–64 less likely to engage in spatial substitution and more likely to ski less (Fig. 3). Differences were also recorded based on experience ($\chi^2=49.882$, $p=0.000$), with beginners less likely to ski as often and more likely to stop skiing altogether. Expert skiers were also less likely to engage in activity substitution. Behavioural adaptation varied based on ski frequency ($\chi^2=39.689$, $p=0.000$), with infrequent skiers less likely to ski as often and more likely to either ski less or stop skiing altogether. Statistically significant differences were also found based on ticket type ($\chi^2=11.120$, $p=0.004$) and resort ($\chi^2=16.374$, $p=0.003$), with seasons pass holders more likely to ski less often and respondents at large resorts more likely to travel to another resort and less likely to reduce the amount they currently ski. These findings are also consistent with level of commitment to the sport and place loyalty.

5. Discussion

The results indicate that skiers will engage in different temporal, spatial and activity substitution depending on whether the ski resort is closed for the day, closed until mid-season, or closed permanently. Compared to the literature, there are a number of similarities and differences. For example, 36% of respondents in this study stated they would engage in temporal substitution if the resort closed permanently, which is comparable to König (1998) (31%), Behringer et al. (2000) (32%) and Dawson et al. (2013) (34–38%), but very different from Pickering et al. (2010) (69%). With respect to activity substitution, 3% of respondents stated they would stop skiing if the resort were to close, which is similar to Behringer et al. (2000) (4%), Pickering et al. (2010) (5%) and Vivian (2011) (1%), but very different from Unbehaun et al. (2008) (25%). Perhaps the most divergent from the literature was spatial substitution, with the results from this study indicating that up to 61% of respondents would travel to another resort if their resort were to close versus 16–49% in other studies (Behringer et al., 2000; Pickering et al. 2010). Interestingly, the results indicate that spatial substitution was least likely if the snow resort was closed on the day the respondents were surveyed (30%), but increased if the resort would not be open until mid-season (48%), and was the

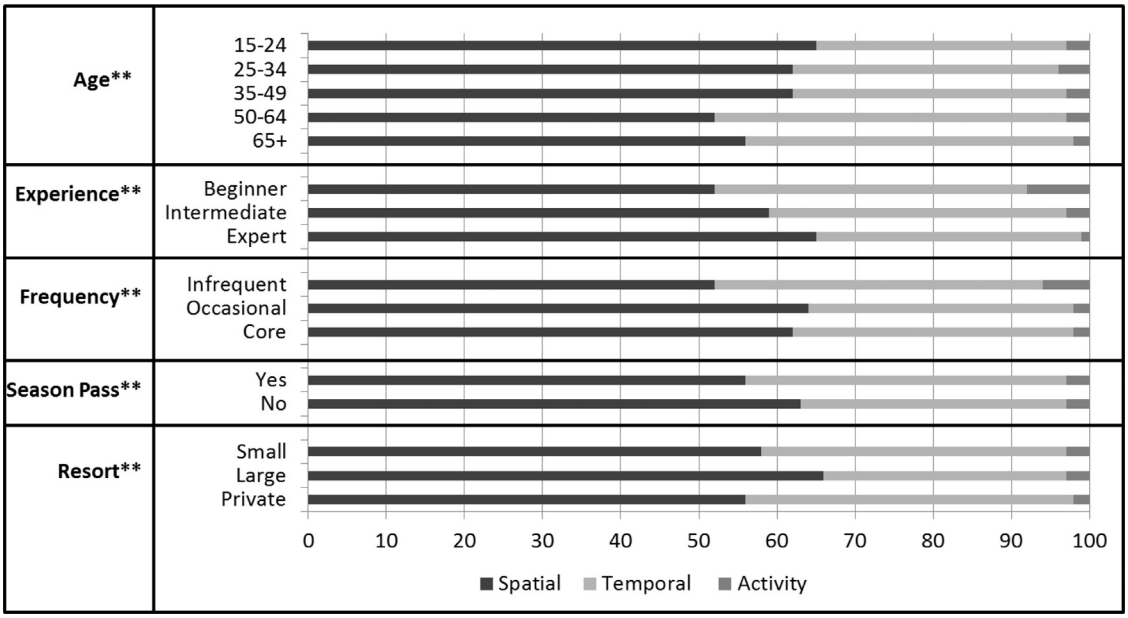

Fig. 3. Behavioural adaptation (substitution) to resort closure (% of respondents). $^{**}p \leq 0.01$.

greatest if the resort were to close permanently (61%). Skiers are willing to forego a day of skiing, but not half a season or give up the sport. A possible explanation for the divergence in spatial substitution in this study compared to the literature is that this survey was based on the present and not future climate change scenarios. Respondents may have assumed that although their current resort would be closed due to marginal conditions, another Ontario resort would still be open versus in climate change scenarios presented in the other studies, respondents may have assumed that if their current resort was closed, all surrounding resorts would also be closed.

Similarly, the weather at the time of the study is an important contextual consideration. Research has shown that tourists' perceptions are linked to personal experiences of past and current weather conditions, which can thereby influence reactions and responses (Gössling, Scott, & Hall, 2012; Shih et al., 2009; Rutty & Scott, 2015). Such contextual influence has also been recorded among supply-side winter tourism operators, with anomalously warm/snow-poor winters triggering heightened awareness of climate change and cold/snow-rich winters reducing concerns about climate change (Saarinen & Tervo, 2010; Trawöger, 2014). During the survey, Ontario was experiencing one of its coldest winters in the last 20 years. It is possible that this would decrease respondents' risk perception of their resort being closed and increase their optimism for maintaining their current ski behaviour by travelling to another nearby resort. Increased optimism links to the previous point that although the respondents' current resort was hypothetically closed due to marginal conditions, the perception may have been that the surrounding resorts would still be open. Literature on tourist risk perceptions underscores that people tend to be unrealistically positive about the future, with high levels of perceived personal control, low personal risk estimates, and increased risk denial (Trawöger, 2014). As such, people tend to underestimate future negative events (i.e., their ski resort closing) and in turn, view the future in a way that makes them most comfortable (i.e., to maintain current ski behaviour). Such perceptions are evident among most ski area managers in North America, Australia and Austria, whereby high confidence in advanced snowmaking has resulted in a wide gap between the climate change risk perceptions of the ski industry versus the impending doom generally portrayed in the media (Bicknell & McManus, 2006; Hoffman, Sprengel, Ziegler, Kolb, & Abegg, 2009; Scott & Jones, 2005; Wolfsegger, Gössling, & Scott, 2008).

According to Scott et al. (2008, 2012) spatial substitution is one of the best-case scenarios for the future of the ski industry because it enables those resorts that remain operational (due to climatic and/or business competitive advantages) to take advantage of increased visitation (market share). However, for ski areas to take advantage of a potential shift in spatial demand, skiers must be willing to travel variable distances to reach an operating resort. This study found that skiers at private and small resorts were statistically less likely to engage in spatial substitution, suggesting that place loyalty may be a possible consideration among this market segment; a finding consistent with Dawson et al. (2011, 2013). When asked, 75% of respondents stated the maximum number of hours they were willing to drive for a day trip was two hours, which is the same as respondents in Austria (Unbehaun et al., 2008) or three hours for a weekend trip, which is two hours less than respondents in the US Northeast (Vivian, 2011). Perhaps extended ski holidays may become more desirable over time if the distance between urban markets and operable ski areas increases as a result of predicted closure of some ski areas because of climate change.

The results from this study also found statistically significant differences based on skier experience. Beginner skiers were more likely to stop skiing due to a lack of snow and expert skiers were more likely to travel to another resort. Therefore the more specialized the skier, the less they are willing to change their skiing behaviour, which is consistent with commitment and the findings of Behringer et al. (2000) and König (1998), but in contrast with the findings of Dawson et al. (2013). Similarly, this study found that infrequent skiers were more likely to stop skiing compared to core skiers, which further support the notion that those respondents that are most committed to the sport are less likely to abandon the sport.

While core skiers are a key component of the ski market because they represent the majority share of skier visits, infrequent and occasional skiers are a critical target market. From a marketing perspective, it is easier to try and convince these skiers to participate more often than it is to attract brand new customers to the sport (CSC, 2012). In all three temporal scenarios, infrequent skiers were the most likely to either not ski (if the resort was not open today), ski less (if the resort was not open until mid-season) or stop skiing altogether (if the resort were to close permanently). Moreover, parents who had children enroled in ski lessons were more likely to either not ski (if the resort was not open today) or ski less (if the resort was not open until mid-season) compared to those parents who did not have children enroled. Parents may therefore be less likely to spatially substitute the location of their children's ski lessons, probably due to the additional time commitments required to go further for a relatively short lesson. The introduction of children to the sport via lessons may become more concentrated in time (e.g., lessons over an entire weekend or spring school break ski camp as opposed to weekly lessons), but further insight into this dedication to expose their children to skiing is needed. Nevertheless, activity substitution can be considered one of the worst-case scenarios, as the economic viability of the ski industry would subsequently decrease if individuals opted to either ski less or stop skiing. With 30% of respondents indicating that they would not ski if their resort was not open on the day of the survey, it underscores the vulnerability of the Ontario ski industry to climatic variability. On a positive note, only 3% of respondents stated that they would stop skiing altogether if their resort was to close permanently, indicating that ski demand in Ontario is fairly robust. Such robustness is consistent with analogue studies (e.g., Dawson et al., 2009; Scott et al., 2012) that suggest that there are climate change market opportunities for climate-resilient ski resorts as supply contracts. However, this raises a host of questions with respect to visitor experience as a result of increased crowding and congestion (e.g., at the lifts, in parking lots, inside chalets, etc.) as skiers begin to concentrate at those resorts that are climatically sustainable.

6. Conclusion

Overall, our results show that behavioural adaptation to ski resort closures in Ontario differ depending on skier market segments, including age, experience, ski frequency and the type of resort visited. Apparently a shift in ski demand patterns in Ontario is likely as a result of climatic variability and will require additional research to better understand the implications of this change. Additional research is needed to understand the geography of spatial substitution, including where Ontario skiers plan to go and how far they are willing to travel in order to ski at an operational ski area. Thus far, the relative vulnerability of regional ski markets has been assessed based on the supply-side climatic suitability of resorts relative to one another (Abegg et al., 2007; Dawson & Scott, 2013; Hamilton et al., 2007; Hennessy et al., 2008; Hendrikx et al., 2013; Pons, 2014; Scott et al., 2008, 2003, 2006, 2007; Steiger, 2010; Steiger & Stötter, 2013). Therefore future research is needed to understand how demand will respond to supply-side variability

and contraction which will be a key factor in determining the future distribution of ski area demand patterns under climatic variability and change. In addition to marginal snow conditions, research in this area should also include an examination of other recreational constraints that may further explain travel behaviour choices (e.g., resort loyalty, income, family dynamics).

Furthermore, as skiers engage in spatial substitution, skiers will concentrate at those resorts that remain climatically operable. As skiers concentrate, there will be important management implications with respect to individual resort capacity, visitor experience (e.g., crowding), and consequent impacts on surrounding ski area businesses and communities. Climatically advantaged ski areas and communities will need to prepare for development pressures, including investments in ski terrain expansion and infrastructure to increase snowmaking capacity (including water access and storage), as well as ease increased crowding on trails, in parking lots, inside chalets and lift lines. While the literature has focused on supply-side assessments to define the relative vulnerability of ski tourism destinations (i.e., snow availability/climatic suitability, water access for snowmaking), skiers' subjective perceptions and experiences remains poorly understood (Dawson et al., 2013; Gössling et al., 2012; Scott, Gössling et al., 2012; Scott, Hall et al., 2012). Research is needed to examine how skiers will respond to increased congestion as a result of supply-side contraction and whether or not climatically advantaged resorts have the capacity (current or potential) to cope with increased skier visits in the long-term or whether degraded system capacity of Ontario ski areas will result in demand going unmet.

Both supply- and demand-side response of the ski market to climatic variability and change requires continued multi-disciplinary research attention. A valuable way forward is to couple supply- and demand-side responses through a comprehensive systems approach. An integrated model that is capable of simulating the evolution of operating ski areas and evolving patterns of skier demand would offer further decision support to ski resort operators and local tourism officials concerned about how their visitors will respond to changing climatic conditions and the implications for local economic development and real-estate. The system or marketplace scale perspective is needed to advance discussions of the role of private–public partnerships to bolster adaptation of winter tourism to climate change in support of local economic development.

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