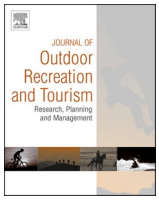
Journal of Outdoor Recreation and Tourism 52 (2025) 100914

Contents lists available at ScienceDirect

Journal of Outdoor Recreation and Tourism

journal homepage: www.elsevier.com/locate/jort



Research Article

Is winter coming? Outdoor recreation voluntary associations and fat biking in Northwestern Ontario and Northeastern Minnesota

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ARTICLE INFO

Keywords:
Outdoor recreation voluntary associations (ORVAs)
Trail management
Volunteering
Fat biking
Winter recreational activities
Northshore Lake Superior

ABSTRACT

Outdoor recreation voluntary associations (ORVAs) such as mountain biking associations play vital roles in the creation, management, and upkeep of trail systems in North America. While research on ORVAs has expanded in the last decade, studies have not sufficiently examined the challenges presented by the impacts of climate disruption on ORVAs, including increased demands on volunteers and event cancellations, nor the potential long-term impacts on the viability of trail-based activities coordinated by ORVAs. Based on interviews and surveys conducted in Northwestern Ontario (NWO) and Northeastern Minnesota (NEM), this study aimed to 1) ascertain the extent of fat biking participation in NWO and NEM and the ridership profiles of those engaged in this recreational activity, 2) assess their levels of engagement as volunteers within local ORVAs, 3) assess their willingness to volunteer in the future, and 4) explore the challenges and opportunities associated with the inclusion of fat biking as a climate change adaptive strategy within regional recreation offerings. Findings revealed that while fat bikers appreciated the volunteer efforts of trail groomers and event/race coordinators more than forty percent were unlikely to volunteer with local ORVAs. Existing ORVA volunteers reported higher demands on their time during heavy snow seasons, as well as burnout associated with a lack of volunteer recruitment and retention strategies. With climate disruption trends expected to continue, Mountain Biking ORVAs (MB-ORVAs) must proactively manage associated and compounded challenges by developing seasonal trail grooming and volunteer recruitment, management, and retention strategies and should consider rotating co-hosting duties for collaborative fat bike events to ensure the provision of safe and well-groomed trails, and regularly occurring events, which support the continued development and growth of regional winter fat biking engagement.

Statement of management implications: By highlighting how fat biking is employed to provide year-round trail riding opportunities, this study expands on current understandings of Mountain Biking Outdoor Recreation Voluntary Associations (MB-ORVAs) in the U.S. and Canada. MB-ORVAs must proactively manage the challenges associated with climate disruptions and the increased demand placed on volunteer groomers and administrative capacities. MB-ORVAs should:

- Continually assess fat bikers' perceptions of natural resource conditions (e.g., snow volume, frequency and severity of snow fall, depth of snowpack, etc.) within provided recreation settings, and the individual adaptive strategies fat bikers and other outdoor recreationists employ when faced with suboptimal conditions;
- Assess the impact of fat bikers' perceptions of natural resource conditions and the severity of climate disruptions on their willingness to volunteer for trail grooming and event hosting initiatives;
- Develop a binational/biannual fat biking event to distribute hosting responsibilities, reduce strain on volunteers and local MB-ORVA resources, and provide a platform to showcase existing and emerging fat biking trails in both regions;
- Develop and implement an annual volunteer engagement and sentiment survey to solicit feedback on perceived volunteer workload, sentiment towards volunteering, and experiences of volunteering from both active and passive ORVA members; and,

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https://doi.org/10.1016/j.jort.2025.100914
Received 6 October 2024; Received in revised form 4 May 2025; Accepted 19 June 2025
Available online 26 September 2025

- Implement volunteer recruitment and retention strategies, including establishing a volunteer recognition program, developing targeted volunteer recruitment and retention plans, and hiring a dedicated volunteer coordinator to lead these initiatives.

Adopting these strategies will position MB-ORVAs in NWO and NEM, and other regions impacted by climate disruptions, to deliver high-quality winter recreational experiences, including safe, well-groomed trails, and regularly occurring events.

1. Introduction

In Canada, much like in the U.S., it is common for multi-purpose and/or mountain bike trails (MBT) to exist either fully or partially on public lands; in both countries this includes national, provincial, state, and municipal parks (Carothers et al., 2001; Chavez et al., 1993) whereas in Canadian provinces, like Ontario, this also includes Crown Lands which are publicly owned and managed by the Ministry of Natural Resources on behalf of the provincial government under the authority provided by the *Public Lands Act* (King's Printer for Ontario, 2024, July 9). Mountain biking can also occur in downhill resorts (e.g., Mont Tremblant, QC, Whistler, BC) with some cross-country skiing centres supporting fat biking (e.g., Canmore, AB); these private lands typically charge access fees like memberships or day/season passes (Neumann & Mason, 2019). As Lu and Schuett (2014), McCormack (2017), McCormack and Osborn (2022), and Schild (2018, 2019) explain, access and management of these trails for mountain bikers is done through partnership agreements between government agencies, private landowners, and Outdoor Recreation Voluntary Associations (ORVAs). In addition to advocacy, trail building and maintenance, mountain biking ORVAs (MB-ORVAs) may also organize and deliver MB events and/or races.

Through a literature review, interviews, a survey, and the authors' firsthand knowledge and experience of trail management along the northshore of Lake Superior in Northwestern Ontario (NWO, Canada) and Northeastern Minnesota (NEM, United States), this study explores the opportunities and challenges associated with including fat biking as an adaptive strategy by MB-ORVAs in these two regions. The objectives of this study were to 1) ascertain the extent of fat biking participation in NWO and NEM and the ridership profiles of those engaged in this recreational activity, 2) assess their levels of engagement as volunteers within local ORVAs, 3) assess their willingness to volunteer in the future, and 4) explore the challenges and opportunities associated with the inclusion of fat biking as a climate change adaptive strategy within regional recreation offerings.

Following a review of the extant literature, an overview of both regions and regional MB-ORVAs provides context to the study. Interview and survey data shed light on the demographic profiles of regional mountain bikers and fat bikers, the nature of fat biking activities undertaken, and levels of engagement in, and barriers to, volunteering within regional MB-ORVAs. Thematic analysis of interviews revealed that cyclists, winter trail users, and MB-ORVA volunteers viewed fat biking as an adaptive tool supporting winter trail activity engagement during unpredictable conditions. Perspectives on the management demands arising from introducing fat biking, particularly for winter trail grooming and event hosting, emerged from the interviews while survey data highlighted appreciation for the volunteer labour of others and shed light on fat bikers' intentions to volunteer in Northwestern Ontario. A discussion of the potential role of fat biking in regional winter recreation and tourism strategies and the future of fat biking in the Northshore Lake Superior region is presented alongside recommendations for collaborative management and marketing strategies. Future directions for fat biking research are also proposed.

2. Literature review

The review of literature commences with a discussion of mountain biking and fat biking, followed by three season mountain biking trails, and four-season management of winter fat biking trails by MB-ORVAs. A discussion of climate change induced impacts on outdoor recreation and nature-based tourism concludes the literature review, setting the stage for a discussion of the study's NWO and NEM context.

2.1. Mountain biking, fat biking, and trails

Since its inception in Marin County, California in the early 1970s (Buning et al., 2019; Chavez et al., 1993), mountain biking has evolved, splitting into various subgroups such as cyclocross, cross-country, enduro, downhill, dirt jumping, and fat biking, each with their own "unique culture, history, equipment, and philosophy" (McCormack & Osborn, 2022, p. 312). Experimental hand-made fat bikes (fatbikes, fat-tire bikes) first emerged in Alaska and New Mexico, with commercially produced fat bikes appearing in 2005 (Monz & Kulmatiski, 2016). Today, diverse recreational fat bikes cater to generalist (day-trippers), trekker (expeditionists), and competitive (racing) fat bikers (Monz & Kulmatiski, 2016) with lower PSI (pounds per square inch) tire inflation helping maintain traction (McCormack & Osborn, 2022). The growth of fat biking has also led to the retail of specialized fat biking equipment (e.g., studded tires, boots), and hosting fat biking events, festivals, and competitions (Monz & Kulmatiski, 2016; Neumann & Mason, 2019). In this article, fat bikes are defined as off-road bikes consisting of wider steel, chromoly, and carbon fibre frames designed to accommodate very wide tires ranging from 96 to 127 mm or 3.8–5 inches (Global Mountain Bikes Network, 2015 December 24; McCormack & Osborn, 2022) while fat biking is defined as riding a fat bike over maintained and/or soft surfaces such as snow and sand (per McCormack & Osborn, 2022).

Considering commercial fat bikes have been around for nearly twenty years, there is a deficit of academic literature on fat biking which may be partially attributed to the highly fragmented nature of the extant mountain biking literature (Kuklinksi et al., 2024). Studies examining fat biking include Phillips' (2015) study of rider performance in Michigan's winter conditions, Monz and Kulmatiski's (2016) examination of the evolution and potential impacts of fat biking in the U.S., and Neumann and Mason's (2019) analysis of land use conflicts among recreational cross-country skiers and fat bikers in British Columbia, Canada. This literature review therefore draws on the extant academic and industry literature on both mountain biking and fat biking, an approach also employed by Kuklinksi et al. (2024), while differing from their work by focusing the literature review on the similarities and differences between these segments of the recreational and touristic cycling community.

As previously stated, mountain bike trails (MBTs) and fat bike trails (FBTs) exist on public lands, in protected areas, and on private property. A MBT is a mountain biking-specific or cycling-optimized "multi-use trail that specifically considers bicycle use through the integration of features like grade reversals, adequate sight lines, and use of natural terrain to enhance the biking experience while ensuring a better experience for all users" (The Trail Research Hub, 2024 May 31, p. 4). Referred to as double-track trails, these multi-use/cycling-optimized trails often consists of gravel, fire, and/or logging roads, decommissioned gravel pathways, rail-trails, or off-season cross-country skiing trails (The Trail Research Hub, 2024 May 31). Work by Hagen and Boyes (2016) and Campbell et al. (2021) highlight mountain biker perceptions of trail features in New Zealand and Europe respectively, while research in Canada by Johansen and Lemelin (2022) suggests that they seek out

'choice' singletrack or flow trail experiences because multi-use trails are intended for mixed-use and therefore have higher traffic levels. Alternatively, more desirable singletracks are narrow MBTs that riders navigate one-at-a-time due to their narrower trailtread being "bordered by vegetation or natural terrain features, which demands a high level of skill and attention" (Bruington, 2024 June 19, par. 5). Alternatively, flow trails provide a smooth, winding, rolling and continuous riding experience with specialized features like berms, rollers and jumps that allow a rider to maintain speed and momentum throughout (Rehook, 2024). These differ from the experiences provided by FBTs, also known as fat-tracks.

While winter FBTs may include a combination of double-track or singletrack trails, they consist of trails or trail networks on snow which are maintained exclusively for winter fat bike use by MB-ORVAs. Winter FBTs may be separate from, or side-by-side other winter trail uses, including Nordic skiing, snowshoeing and snowmobile trails but the trailtread is exclusively used by fat bikers (Monz & Kulmatiski, 2016; Neumann & Mason, 2019). The winter maintenance of these trails is one of the main factors distinguishing FBTs from MBTs. Requiring specialized winter equipment (e.g., snowmobiles, "snowdogs", and customized groomers) and/or snowshoes, essential winter FBT grooming includes plowing, compacting, and removing snow; additional maintenance includes removing snow-laden branches and downed trees (The Trail Research Hub, 2024 May 31). In heavy snowfall years, rider clearance (from trailtread to overhead obstruction) necessitates additional maintenance, as does repeated and heavy snowfall (ibid). Consequently, FBTs often require more labour-intensive routine maintenance than MBTs which are typically groomed seasonally or following one-off severe weather events (ibid). This work is typically undertaken by Outdoor Recreation Voluntary Associations (ORVAs).

2.2. Outdoor recreation voluntary associations and trails

Increased community participation (CP) in outdoor recreation services and maintenance arose in the global North/West following the post-war voluntary movement (Curry, 2000). Often seen as a precursor to the proliferation of Outdoor Recreation Voluntary Associations (ORVAs), various trail management CP initiatives arose in response to urban development pressures on open spaces, efforts to expand forest recreation, and increased funding for rural economic development in the 1970s (ibid). During the 1980s and 1990s, the government's role transitioned from directly controlling CP initiatives to supporting and facilitating CP thereby making community participation in the design, development, and stewardship of outdoor recreation services a formal aspect of public policy (ibid). In Canada and the U.S., it is now common for essential outdoor recreation infrastructure like trails to exist either fully or partially on public lands, such as Crown Lands, and national, state/provincial/territorial, and municipal parks and to be managed by trail organizations, or trail-based ORVAs (Schild, 2018; Schild 2019). Trail-based ORVAs play an essential role in trail construction, grooming, and land stewardship, and negotiate agreements with the appropriate level(s) of government to undertake these tasks (ibid).

Early research found that the higher value placed on access to recreation opportunities on public lands, by outdoor recreationists, combined with higher levels of environmental concern, motivated their membership in ORVAs (Dennis & Zube, 1988). Later work by Caldwell and Andereck (1994) supported this but noted that contributing to society was the most important reason to initially join, and continue membership in, ORVAs, with incentives or material benefits being the least important. However, more recent research (c.f., Lu & Schuett, 2014) found that enduring involvement with an ORVA mediated the relationship between membership motivation and volunteer experiences, with stronger associations paralleling increased involvement.

While ORVAs have received increased academic attention in recent years, including studies on their role in outdoor recreationists' identity formation (Stebbins, 1996), natural resource decision-making (Propst et al., 2003), and civic culture and social capital generation (Glover et al., 2005), research beyond individual-level analyses of ORVA's type, number, or duration of membership is still needed (Lu & Schuett, 2014, p. 69). Research specific to MB-ORVAs is also limited. Taylor and Sand (2021) and Mason and Neumann (2024) explored the work of German and Scottish trail builders and Canadian trail builders, respectively. The role of MB-ORVAs in undertaking trail maintenance and coordinating volunteering is also discussed by Campbell et al. (2021) and Mason and Neumann (2024) but is limited to three-season (spring-summer-fall) mountain biking. As such, research exploring the unique roles of MB-ORVAs or mixed mountain-biking and fat-biking ORVAs in managing volunteers and trails is needed, as is research exploring the unique challenges they face when operating in winter.

2.3. Intra-user group conflicts and management implications

The introduction of fat biking on multi-use trails has created management challenges for ORVAs, private enterprises, and government-based managerial agencies stemming from intra-user group conflicts between fat bikers and cross-country skiers and snowmobilers (Monz & Kulmatiski, 2016; Neumann & Mason, 2019). To address this, managers in some Minnesota state parks established a separate groomed trail and discouraged fat bikers "from riding on snowmobile or cross-country ski trails due to safety and grooming costs" (Monz & Kulmatiski, 2016, p. 23). In other instances, cooperative strategies between ORVAs, private enterprises, and management agencies have resulted in the development of codes of conducts for fat bikers and educational strategies aimed at modifying unacceptable behaviours (Monz & Kulmatiski, 2016; Neumann & Mason, 2019). Additional research on best practice approaches for the management of trail infrastructure by ORVAs, including use of volunteer labour and strategies employed to address conflicting uses, is needed (ibid).

2.4. Climate disruption and the management of winter sport engagement

Studies of the actual and anticipated impacts of climate change on outdoor recreation and tourism include Hewer and Gough's (2018) comprehensive Canadian literature review, Knight and Hao's (2022) general social survey analysis of American recreationists, Askew and Bowker's (2018) modeling scenarios of climate change impacts on outdoor recreation in America, and Ferguson et al.'s (2018) exploration of water recreationists perceptions of and coping strategies for climate change induced impacts on water quality in Lake Erie (Great Lakes Basin, USA). These studies largely concluded that, for recreation and tourism activities to remain sustainable, effective participation in the development and implementation of proactive climate change adaptation and mitigation strategies are needed (Askew & Bowker, 2018) alongside activity-specific coping strategies (Ferguson et al., 2018).

More specifically, studies on cross-country skiing (c.f., Liu et al., 2017; Rutty et al., 2015a) suggest that shortened "seasons and degraded personal experiences due to climate are pushing some skiers to reduce their time participating, travel further distances to viable winter sport venues, or substitute with other sports" (cited in Knowles et al., 2020, pp. 143–44). More general studies on winter recreational activities by Scott and Lemieux (2010) and Knowles et al. (2020) suggest that "warm temperatures, extreme weather, [a lack of snowpack] and unseasonal rain have been a factor in many recent altered or cancelled winter sport events" (pp. 140–41).

While the northshore of Lake Superior has historically experienced long winters (Ozersky et al., 2021), McDermid et al.'s (2015) climate change modeling projected decreased snowfall in Ontario by 2040 ranging from −54 to −97mm, with an accompanying increase in winter temperatures of 1.1–5.2 °C compared to baseline data from 1971 to 2000. If unchecked, this discrepancy could be increased considerably by 2100, with winter temperatures increasing a further 2.6–13.9 °C and snowfall decreasing a further −41 to −158 mmm (McDermid et al.,

2015). Similarly, Kanazawa et al.'s (2018) study found that the impact of climate change on recreational patterns in state parks located along the Minnesotan shore of Lake Superior were "likely to vary dramatically across different times of the year, with the biggest difference being between winter activities (such as alpine and Nordic skiing, snowmobiling and ice fishing) and summer activities (such as hiking, canoeing, swimming, and boating)" (p. 51).

Already struggling with post-Pandemic volunteer shortages, recruitment, retention, and high levels of volunteer burnout and stress (Rodney, 2023), the impacts of climate-induced transitions (Knowles et al., 2020) has flipped some ORVAs into what Orr and Inoue (2018) defined as a 'problem state' where they are "unprepared and unable to mitigate, manage, or adapt to current and future climate impacts" (cited in Knowles et al., 2020, p. 144). Other scholars have argued that as a result of the polycrisis, defined as co-occurring or overlapping global crisis (Lawrence et al., 2024) including but not limited to climate change, financial and energy crises, the recent COVID-19 pandemic, and geopolitical/armed conflicts, recreation managers, tourism destinations, and policy makers face a series of 'wicked problems' with recommended solutions to mitigate such impacts becoming increasingly difficult to implement (c.f. Ioannides & Stoffelen, 2023; Pforr et al., 2024).

With these trends expected to continue into the mid- and late- 21st century (Lawrence et al., 2024; McDermid et al., 2015), a study exploring local fat biker experiences of sport engagement and the impacts of climate change on the nature of these experiences is particularly timely. Pairing this with research which simultaneously explores ORVAs capacities to deliver winter recreational experiences, including safe, well-groomed trails, and regularly occurring events, as well as the relationship between ORVA volunteer and administrative capacity, intentions to volunteer and sentiment towards volunteering among ORVA members, is also warranted.

3. Geographical context

This study is delimited to the northshore of Lake Superior (see Fig. 1). The northshore regions of Northwestern Ontario (NWO) and Northeastern Minnesota (NEM) were selected because of their shared cultural and physical geography, comparable winter activity offerings, and existing bi-national collaborative mountain biking and fat biking strategies.

Furthermore, the different legislative, regulatory and practical environments in which the MB-ORVAs operate, allow for a cross-border comparison of management challenges faced by ORVAs, and regional best practices employed to address them.

3.1. Northwestern Ontario (Canada)

Northwestern Ontario (NWO) is defined as the area inclusive of the boundaries of the Statistics Canada Thunder Bay Census Division (beginning at the Pigeon River Canada-U.S. border crossing, and including the City of Thunder Bay, the Fort William First Nation, the Townships of Conmee, Gillies and O'Connor, the municipalities of Neebing and Oliver Paipoonge as well as outlying municipalities, First Nations Reserves, and Unorganized Areas) eastwards along the north shore of Lake Superior to encompass the Town of Nipigon.

As this study focuses primarily on fat biking activities in or near the

Fig. 1. Northshore region of Lake Superior.

metropolitan area of Thunder Bay, population 123,258 in 2021 (Statistics Canada, 2022), the NWO case study was defined as an urban case study. Although multi-use municipal trails exist in Thunder Bay, and nearby provincial parks like Sleeping Giant Provincial Park, this study focuses on the multi-use Trowbridge Forest Trails. Consisting of approximately 20 km of mountain bike optimized single-track and multi-use trails and 15 km of cross-country skiing double-tracks, this trail network supports multiple recreation and active transportation opportunities, including mountain biking, running, and walking in the summer and cross-country skiing, snowshoeing, walking, and fat biking in winter. The management of this area is guided by the *Trowbridge Forest Recreation Trail Master Plan* while the *Trowbridge Forest Trail Management Agreement* delineates the roles and responsibilities of the City of Thunder Bay and the local MB-ORVA, the Blacksheep Mountain Bike Club or BMBC (Blacksheep Mountain Biking Club, 2021 June; Corporation of the City of Thunder Bay, 2017 April 30; Corporation of the City of Thunder Bay, 2017 April).

The BMBC was founded in 1998 and incorporated as a volunteer not-for-profit organization in 2002 (Blacksheep Mountain Biking Club, 2021 June; Blacksheep Mountain Biking Club, 2024a). Like other MB-ORVAs, the BMBC is composed of an Executive including a President, Vice-President, Secretary, and a series of trail, race, and sponsorship Coordinators (ibid). Since its inception, BMBC membership has increased to almost five hundred members (Blacksheep Mountain Biking Club, 2021 June). The BMBC purview has also expanded to include trail advocacy, development, and maintenance, and hosting race events like the Shuniah Forty Miner Mountain Bike Race, and the Sleeping Giant Fat Bike Loppet (Blacksheep Mountain Biking Club, 2024a, 2024b, 2024c).

3.2. Northeastern Minnesota (USA)

Cook County, Minnesota is located adjacent to the Canadian border, with the Grand Portage First Nation to the east and Schroeder Township to the west; it includes the communities of Hovland, the Gunflint Trail, Lutsen Township, and the village of Grand Marais in the east and extends westward toward the City of Duluth. Focusing primarily on FBTs located near the village of Grand Marais, population 1350 in 2020, and Lutsen Township, population 520 in 2020 (United States Census Bureau, 2020a; 2020b; 2020c), the NEM case study is a rural one. Several state parks (e.g., Cascade River, Judge C.R. Magney, Temperance River) and federal protected areas (Grand Portage National Monument, Superior National Forest, Boundary Water Canoe Area Wilderness) are in Cook County; mountain and fat biking activities largely occur on trail systems (i.e., Pincushion Mountain) on state or federally managed lands like these. The exceptions are trails on municipal or private land in Two Harbors and Duluth. Located near Grand Marais, in the Superior National Forest, the Pincushion Mountain Trail System includes 16 km of mountain bike trails and between 8 and 10 km of winter FBTs. These trails are managed and groomed by the Superior Cycling Association (SCA) in association with the United States Forest Service (USFS). The NEM case study focuses largely on these trails, unless otherwise noted.

Since its inception in 2010, the SCA which is comprised of seven Board Members, has developed and maintained over 35 km of mountain bike trails in the Britton Peak Trail and Pincushion Mountain systems through partnerships with Visit Cook County, the USFS, the International Mountain Bike Association (IMBA), Lifetime Fitness, and local businesses; these trails are located in Tofte and the Pincushion Mountains (Superior Cycling Association, 2024a, 2024b, 2024c). The SCA co-hosts the Sawtooth Mountain Challenge and the Norpine Fat Bike Classic with local partners (ibid).

4. Methods

Due to the limited scope of prior fat biking studies and the study's objectives, a multi-faceted approach was required. A sequential, mixed methods, exploratory case study was therefore undertaken allowing for a comprehensive and comparative investigation of regional fat bikers' experiences. Guided by prior mountain biking research (c.f., Haid et al., 2021; Schild, 2018; Schild, 2019; Taylor, 2010), this study combined an initial qualitative phase consisting of semi-structured interviews with a subsequent quantitative survey-based phase. Per Taylor (2010), themes derived from the literature review – experiences with local fat biking ORVAs, and of events, infrastructure use, and intra-user group conflicts, climate change induced disruptions to fat biking engagement, intention to volunteer and sentiment towards volunteering with local MB-ORVAs - and analysis of the interview data – experiences of regional fat biking and fat biking events, and volunteering – were explored in greater detail in the subsequent survey.

In the initial phase, the semi-structured interview guide was designed to create open-ended yet directed conversations with interviewees (per Rapley, 2001; Schild, 2018; Schild, 2019); interviewees discussed their fat biking experiences, the opportunities and challenges associated with activity participation, and their volunteering engagement the previous year, including volunteering on local MB-ORVA's Boards of Directors, for trail maintenance, and with organizing/hosting events.

A purposive sample of self-identified members of the NWO and NEM fat biking community were recruited in 2015 with assistance from local biking clubs and bike shops and through word of mouth (per Chavez et al., 1993). Interviewees also recommended potential subsequent interviewees, expanding the interview pool through snowball sampling (per Naderifar et al., 2017). Each interviewee was contacted by email and provided a cover letter and the interview guide. A phone call scheduled the interview. Two individuals, out of the 31 contacted, declined to participate. Interviews were transcribed verbatim. Recurrent themes were first noted then tabulated according to larger themes (e.g., similarities, differences). Transcripts were then analysed using a broad qualitative thematic approach (per Vaismoradi & Snelgrove, 2019) based on themes derived from the literature review (as articulated above).

In the second phase, a voluntary online survey was distributed to BMBC members via the Club's member email list; the survey ran throughout July 2020. Similar to Campbell et al.'s (2021) study of European mountain bikers, this study employed the survey to explore the themes which emerged from interviews with the NWO and NEM fat biking community. Due to data collection occurring in July 2020, at the height of the COVID-19 pandemic, the decision was made to use an online survey coupled with membership-specific recruitment facilitated by collaboration with the BMBC Executive who provided temporary access to the Club's member email list. Postal code data was collected to determine eligibility which was delimited to residents of the Thunder Bay District (previously defined). Demographic details and personal characteristics were queried based on previous mountain biking studies (c.f., Arvidsen et al., 2023; Ayala et al., 2020; Haid et al., 2021; Monz & Kulmatiski, 2016) whereas themes emerging from the analysis of the interviews (detailed above) were explored in later survey sections through scale and open-ended questions.

Correlation analysis was performed using Spearman's rank-order correlation to address data scaling issues whereas the non-parametric Mann–Whitney U and Kruskal–Wallis H tests were used to investigate significant differences between groups. Group comparisons were done regarding types of bicycles owned (mountain bike only vs. mountain bike and fat bike), gender (female vs. male), skill level (beginner-intermediate vs. advanced-expert), and length of sport involvement (less than 5 years vs. five years to 10 years vs. 10 or more years).

4.1. Interviewees

Interviews were conducted in person (in-home or in local coffee shops and bike stores), or over the phone based on interviewee preference and lasted between 20 and 45 min. Of the 29 interviewees (see Table 1), 19 were from NWO (F = 2; M = 17) and 10 were from NEM (F

= 2; M = 8).

Interviewees represented diverse types of membership in the fat biking community including club members, volunteers, event organizers, and owners, managers, and employees of local bike shops. Three-quarters of the interviewees participated in fat biking secondary to other recreational activities (e.g., cross-country skiing, trail running and mountain biking). Interviewees had been fat biking for an average of 4.6 years, with most self-identifying as expert, intermediate, and proficient riders. Often the second or third bike purchased, fat bikes owned by interviewees were used for recreational and training purposes during the winter. Interviewees reported fat biking two to three times per week, averaging 2-h rides. Eleven individuals (37.9 %), five from NEM and 6 from NWO, volunteered to maintain trails and to promote local races and regional events like the Norpine Classic or the Sleeping Giant Fat Bike Loppet.

4.2. Survey respondents

In total, 229 survey responses were received, of which 187 were useable. As noted above, survey respondents were recruited using the BMBC member email list; at the time of the survey BMBC membership totaled 510 members, indicating a 36.67 % response rate. Most respondents were between the ages of 25 and 54; 34.76 % were between 35 and 44 years of age, 30.48 % were 25–34 years of age, and 20.32 % were 45–54 years of age. Most self-identified as male (60.75 %), or female (37.63 %), with three respondents (1.62 %) identifying as either Transgender or Non-Binary or preferred not to state their gender.

Most respondents had been mountain biking for ten or more years (47.31 %). Interestingly, 41.39 % of respondents had been riding for less than 5 years, compared to 11.29 % had been riding for 5–10 years, indicating considerable uptake of the sport in the last 5 years compared to the previous five. Female respondents had lower self-reported experience levels than their male age-group peers, with 10 % of female riders having started riding with the last 6 months. Most respondents self-identified as intermediate (45.70 %), advanced (33.87 %) or beginner (15.05 %) riders. Only 4.30 % considered themselves experts with 1.08 % ranking themselves as novices. Of the 187 respondents who reported owing multiple bikes, 47.22 % (N = 55) indicated that they owned a fat

Table 1
Interviewees.

Region	#	Gender	# of FB's	Years FB-ing	Fat biking Activities	Volunteer	Other Winter Rec. Activities	FB Type[1]
NEM	NEM #1	F	3	6	Racer, frequent rider		Cross-country skiing	Expert
	NEM #2	F	*ns*	4	Year-round rider		*ns*	Intermediate
	NEM #3	M	1	2	Occasional rider, Groomer	Yes	Cross-country skiing	Generalist
	NEM #4	M	1	6	Groomer, year-round rider	Yes	*ns*	Intermediate
	NEM #5	M	3	7	Groomer, promoter, enthusiast	Yes	Cross-country skiing	Expert
	NEM #6	M	2	*ns*	Enthusiast, racer		Cross-country skiing	Expert
	NEM #7	M	1	*ns*	Groomer, year-round, commuter	Yes	Runner, cross-country skiing, snowmobiler	Generalist
	NEM #8	M	1	2	Groomer, promoter, racer, year-round rider	Yes	*ns*	Intermediate
	NEM #9	M	1	1	Groomer, frequent rider	Yes	Downhill skiing, snowboarding	Intermediate
	NEM #10	M	2	12	Racer, enthusiast		Skiing	Expert
NWO	NWO #11	F	1	4	Racer		Cross-country skiing, snowshoeing	Expert
	NWO #12	F	0	0	Racer		Runner	Expert
	NWO #13	M	1	4	Groomer, frequent rider, racer	Yes	Cross-country skiing, snowshoeing	Intermediate
	NWO #14	M	3	5	Volunteer	Yes	Snowboarding	Expert
	NWO #15	M	*ns*	6	Former groomer, racer	Yes	*ns*	Intermediate
	NWO #16	M	3	3	Enthusiast	Yes	*ns*	Intermediate
	NWO #17	M	0	0	Non-fat biker, volunteer	Yes	*ns*	Non-fat biker
	NWO #18	M	2	6	Racer, volunteer	Yes	Cross-country skiing, year-round rider	Expert
	NWO #19	M	0	0	Non-fat biker, volunteer	Yes	Cycles, Cross-country skiing	Non-fat biker
	NWO #20	M	*ns*	1	Year-round rider (summer modifications)		Not specified	Generalist
	NWO #21	M	0	3	Occasional rider		Cross-country skiing, snowboarding	Generalist
	NWO #22	M	0	*ns*	Groomer, occasional rider, volunteer	Yes	Climber, cross-country skiing	Generalist
	NWO #23	M	2	3	Racer, enthusiast		Cross-country skiing	Expert
	NWO #24	M	1	3	Racer, enthusiast		Downhill & cross-country skiing, snowshoeing	Expert
	NWO #25	M	*ns*	*ns*	Novice		*ns*	Novice
	NWO #26	M	2	4	Racer, enthusiast	Yes	Runner	Intermediate
	NWO #27	M	3	5	Recreational, commuting, volunteer	Yes	Snowboarding	Novice
	NWO #28	M	2	4	Racer		*ns*	Expert
	NWO #29	M	3	7	Enthusiast		Snowshoeing	Expert

bike.

4.3. Study delimitations

This study was delimited to two proximate northshore Lake Superior regions: NWO and NEM. Regions were selected because of their proximity to one another, shared cultural and physical geography, comparable snowsport development history, and the different legislative, regulatory and practical environments in which ORVAs and volunteers operate, allowing for a cross-border comparison of the challenges associated with climate change induced disruptions to winter outdoor recreation engagement in the form of fat biking, and of the best practices employed in each region to address said challenges. The authors familiarity with biking, hiking, and skiing opportunities in these regions, and connections with the trail communities, including existing ORVAs, volunteer trail crew members and groomers, and local bike shops also provided a deeper understanding of regional fat biking activities.

5. Findings

5.1. Interviewees reported fat biking engagement

Several interviewees observed that a fat bike was one of the most expensive pieces of recreational equipment they had. Beyond the initial bike purchase, monetary investments in fat biking can increase because of the need to purchase additional equipment like specialized winter boots (N = 6), gloves and mitts (N = 4), studded tires (N = 2), and lights (N = 2) which are required for safe winter fat biking. As one interviewee explained, "*I probably spent as much on winter riding gear like lights, goggles, helmet, multiple headlights and battery packs, taillights, frame bags* [… and] *studded tires as I did on the bike*" (NEM#4). Still many interviewees reported that fat biking opens access to "*a lot of places inaccessible in the summer*" (NWO#13) which allowed for more regional exploration, increasing its appeal (NWO#6, #7, #9, #13). One interviewee summed it up saying "*I've noticed that for me, it's more about … experiencing the winter and the trails … It's more about the experience rather than the cycling*" (NEM#4).

5.2. Interviewees perspectives on climate disruptions and fat biking as an adaptive strategy

As climate change is an increasingly contentious issue and using the label has been shown to introduce respondent bias (Ferguson et al., 2018), interviewees were asked about their experiences of climate disruptions, like changing snow conditions, and their impact on riding conditions. Interviewees who were dedicated fat bikers noted that increased freeze and thaw periods led to ice build up under the snow and the need for studded tires (NWO#11, #14, #17; NEM#1, #2, #3), whereas warming conditions resulted in snow build up on tires, reducing the enjoyability of the ride, and contributing to increased exertion and the need to remove heavy snow from the bike repeatedly during rides (NWO#8, #11, NEM#2). Still, others expressed frustration about seasonal changes in snow volume (NWO#7, #9, #11, NEM#2, #9), noting that "*this winter has been odd, we've had too much snow*" (NEM#9), "*this year sucked because of the snow because it was horrible*" (NWO#7), and that with "*too much snow,* [the trails] *don't get packed*" (NWO#9), which makes it "*hard to ride and enjoy yourself*" (NEM#2). Reflecting on these changes, one interviewee also noted that "*we received it different, very small dumps then a big one in February, so we could ride most of the season, now we're getting hammered every week* [and can't ride as often]" (NWO#11).

As fat biking was seen as a secondary recreational activity for three quarters of the interviewees, many also framed it as an adaptive strategy to address climate disruptions (e.g. unpredictable environmental and trail conditions, and seasonal variability in snowfall volume and length of season) either a) impacting engagement in their preferred outdoor sport or b) as an adaptive training strategy. For example, interviewees reported being initially attracted to fat biking "*partially due to climate change*" (NEM#7) and by "*poor skiing conditions and unpredictable weather*" (NWO#11, sentiments echoed by NWO#13 and NEM#9). Others reported being 'converted' to fat biking when ski races were canceled due to poor conditions, noting that they were "*registered for the Birkie* [a Nordic Ski Race] *and we were 99 % sure it was cancelled. We knew there was no snow, so I bought the Fatbike and brought it on the trip instead"* (NWO#10). Still, others reflected on the impacts of climate change on downhill skiing and snowboarding, predicting that "*… the way conditions are with climate change, the downhill season has been hit and miss in the last 5 years so I have a feeling people will start to reconsider whether it's worth going to Colorado to find out snow conditions aren't good because climate change makes it a lot more variable then it used to be*" (NEM#7).

In response to climate disruptions, interviewees in both case study locations reported that they "*can't only have one sport*" (NWO#11) and "*had to become less specialized and more well-rounded* [outdoor recreationists]" (NEM#10) choosing to ski or snowshoe initially because there was too much snow for mountain biking, and then when they could not ski because of a lack of snow, they transitioned to fat biking or trail running. Others choose to employ fat biking as an adaptive training strategy, either for shoulder season riding prior to the start of the ski season (NWO#9, #10, #18, NEM#7) noting that "*around the Northshore and Superior … if the snow is bad for skiing it might be ok for fat biking*" (NEM#2), or to help prepare for the summer biking and racing seasons (NWO#6, #7, NEM#7, #8).

5.3. Interviewees reported volunteer grooming engagement and burn-out

Grooming fat bike tracks requires collaborative efforts between snowshoers, mechanical groomers (who operate machinery), and trail maintenance crews (who remove drooping or fallen trees, branches, and snow from sections of the trail, or fill in post-holes, with hand tools), as well as maintenance of grooming equipment. Although fat bike track grooming has been occurring along the Northshore of Lake Superior for just over a decade, concerns regarding volunteer burn-out and the lack of a coordinated approach to grooming were expressed by 11 interviewees from both regions (NEM#3, #4, #5, #8, and #9; NWO#11, #15 #17, #24, #26, and #27). In heavy snowfall years, some interviewees reported spending about 1–2 h a week grooming (NEM #9, NEM #4). Reflecting on the labour involved in grooming, one interviewee noted that "*there are three-quarters of us in the winter who have done most of the grooming, it isn't a huge burden but if you're doing it once a week and doing the full trail system that's 3 h out of your day. It is not relaxing, its pulling snowmobiles out of snow drifts and smelling like 2 stroke engine oil. That is the biggest stressor*" (NEM#3). As some respondents (NEM#4, NEM#5) reported, volunteer fatigue, whether due to "*aging club members and/or understaffed agencies"* (NEM#8), is to be expected. Interviewees felt that outreach strategies informing riders and other recreationists about who grooms the trails and why would help, because few people *"have any idea about the grooming, they probably think it's just the City that is doing it*" (NWO#24). Among those who spoke about volunteer burnout and attrition, one interviewee noted that they were no longer grooming because it demanded too much time with little, to no, recognition (NWO#15).

Interviewees in NEM suggested that "*a better management approach based on better evidence or ridership, and volunteer contributions*" (NEM #8) was required. This is because "*once you know who is riding the trails, how far they are riding, and when they are riding, you can develop a fat-track grooming strategy that is appropriate for fat bikers and manageable for local volunteers*" (NEM#8). Another option put forward was the possibility of a paid grooming position, "*especially if you want to grow fat biking in the region and host national and/or international events*" (NEM#4).

5.4. Survey respondents perspectives on volunteering and trail grooming

While 40.86 % of survey respondents were unlikely to volunteer (or held a neutral perspective on volunteering) with the BMBC, many, through the open-ended questions, praised the BMBC and its volunteers. For example, SR#23 stated, "*I find the attention to the trails by club members and volunteers exceptional … bravo*!" while SR#53 said, "*due to the tremendous efforts of local volunteers the trails are excellent!*". Similarly, SR#35 expressed their gratitude to the Club saying, "*thanks so much for all the awesome trail work you guys do!!!!* ☺". SR#11 praised the Club's winter trail maintenance, saying "*appreciate winter maintenance*" while SR#68 said, "*the snow groomer is such a beautiful addition*". Despite these improvements, SR#98 felt that the "*focus on winter grooming* [still] *needs to improve in Thunder Bay*". SR#71, an avid road cyclist also praised the Club, saying "*While I ride my bike year-round, the majority of my rides in the summer take place on the roads whereas the majority of my time on the Shuniah Trail* [in the Trowbridge Forest] *is during the winter on my Fat Bike for cross-training*".

5.5. Interviewees perspectives on facilitating fat biking events

Several interviewees also spoke about their experiences volunteering for local races and regional events such as the Norpine Fatbike Classic (NEM#4, #5, #8) or the Sleeping Giant Fat Bike Loppet (NWO #13). One interviewee (NEM#8) highlighted the importance of developing an annual volunteer strategy to support retention, while another spoke to a lack of alignment between the 10-year trail building and organizational growth plans of locals ORVAs reflecting that "*we don't have it as volunteers to take care of all of that now, but we are hoping with growth and* [more beginner-friendly] *trails that we'll have growth in finance and volunteers*" (NEM#4) to support this level of trail expansion and event hosting. Considering the ongoing challenges associated with hosting the Norpine Fat Bike Classic in NEM and the cancellation of the Sleeping Giant Fat Bike Loppet in NWO in the winter of 2024 (Rinne, 2024 February 7), effective management solutions to address infrastructure growth, trail maintenance and grooming pressure, climate disruption, and volunteer recruitment and retention are needed.

5.6. Survey respondents reported engagement in fat biking events

Survey respondents were asked a series of questions about their engagement in mountain biking events, including winter fat biking events and cycle tourism, including: 1) 'do you typically travel to ride/experience new mountain biking trails, or attend mountain biking events?', 2) 'how likely are you to attend a mountain biking event in the next year?', and 3) 'how much do you typically spend on mountain biking events per year?'. Of the 186 respondents to answer these questions, 57.22 % indicated they typically traveled to attend mountain biking events or to engage in mountain biking tourism, whereas 66.84 % were likely to attend a mountain biking or fat biking event in the next year compared to 11.76 % who were neither likely nor unlikely, and 21.39 % who were unlikely to do so. Of those respondents who indicated they spent money on events, races, and competitions each year (N = 88), 54.55 % spent less than $100 CAD per year, whereas 45.45 % spent more than $100 on events, races and competitions per year.

6. Discussion and recommendations

Research by Ferguson et al. (2018) found that outdoor recreationists employ cognitive and behavioural coping mechanisms when faced with suboptimal recreation setting conditions. Cognitive coping mechanisms fall into two categories: 1) rationalization and 2) product shift(s) while behavioural coping mechanisms fall into five main categories: 1) resource substitution, 2) activity substitution, 3) temporal substitution, 4) absolute displacement, and 5) direct action (Ferguson et al., 2018, p. 58). In response to climate disruptions, avid fat bikers, and outdoor recreationists who considered fat biking a secondary activity, employed several adaptive strategies. These most often included: *resource substitutions* (riding different trails to avoid icy or wet conditions), *activity substitutions* (opting for Nordic skiing or snowshoeing during periods of high snowfall, and fat biking during times of low snow volume or when existing snow was firmly packed), and *temporal substitutions* (extending their winter recreation season by transitioning from Nordic skiing to fat biking as snow conditions evolved and vice versa). Conversely, fat bikers were less inclined to take *direct action* (volunteering to assist with grooming after heavy snowfall). They also showed lower levels of *product shift* (continuing to engage in their preferred snowsport as though climate disruptions had not occurred) and *absolute displacement* (leaving their home region to engage in their preferred snowsport elsewhere). Among reported adaptive responses, *rationalization* (whether attributing suboptimal conditions to 'odd years' or enjoying the activity without resource substitutions despite prevailing conditions) was the least frequent.

Taken alongside the other interview and survey findings, this suggests that fat biking in NWO and NEM are in the early stages of a '*climate-induced transition*' (Knowles et al., 2020). According to Ferguson et al. (2018), resource managers need to understand how outdoor recreationists perceive natural resources within recreation settings, as well as the coping responses they employ to mitigate suboptimal conditions, to effectively and consistently provide high-quality outdoor recreation experiences.

Currently, regional MB-ORVAs in NWO and NEM are "unprepared and unable to mitigate, manage, or adapt to current and future climate impacts" (Knowles et al., 2020, p. 144) due to the additional pressures they face from a) increased demand for fat biking arising from outdoor recreationists adaptive strategies, b) the need for increased grooming due to amplified wear and tear on trails, and variable snow conditions, and c) volunteer burn-out associated with the increased grooming and event hosting. Interview findings were reinforced by survey results highlighting appreciation for event hosting and grooming by other MB-ORVA members, while simultaneously flagging low levels of intentions to volunteer and negative sentiments towards volunteering among MB-ORVA members.

While MB-ORVAs along the northshore of Lake Superior face comparable challenges to what has been reported by other ORVAs elsewhere (c.f. Lu & Schuett, 2014; McCormack, 2017; McCormack & Osborn, 2022; Schild, 2018; Schild 2019), our findings, and the wider discussion they contribute to, highlight the extensive roles and responsibility of MB-ORVAs. Extending far beyond trail building, grooming, routine maintenance, and advocacy, to include planning and hosting mountain and fat biking events and races, management strategies are required to adapt to and overcome the '*climate-induced transition*' without straining local MB-ORVAs' volunteer and administrative capacities to deliver safe and enjoyable winter recreational fat biking experiences and fat biking events.

6.1. Developing seasonal trail grooming strategies for increased use and event hosting pressure

While it is important to recognize how individual recreationists adapt their engagement when faced with climate disruptions (as discussed above), it is equally crucial to recognize how MB-ORVAs and their voluntary board members, groomers and event staff respond to the added pressures these challenges present. The recent incorporation of planning and hosting fat biking events into the portfolio of responsibilities of MB-ORVAs like BMBC and SCA necessitates the development of seasonal trail grooming strategies that reflect the increased use and accompanying wear and tear on trails generated during events. This is particularly true when event hosting expands from three to four seasons which requires additional equipment and training while simultaneously impacting routine trail maintenance which is often conducted in the shrinking shoulder season.

Furthermore, repercussions from year-round trail use, including increased trail management demands, exacerbate burnout associated with the extent of trail grooming required during high snowfall years and compounds volunteers' frustrations over spending more time grooming trails than riding them (see discussion below). Trail grooming partnerships with other land managers, and regularly training new groomers, may help to alleviate some of these concerns, as may hiring paid groomers. Incentives in the lead up to large events, such as reduced registration fees, may also help to temporarily offset the higher grooming needs associated with event hosting.

As the winter trail grooming strategies developed by the Cyclists of Gitchee Gumee Shores (COGGS), in collaboration with the City of Duluth, demonstrate incorporating grooming strategies into comprehensive trail management plans is highly beneficial, allowing for end-of-use financial planning for grooming equipment, and budgeting for regular maintenance of grooming equipment as well as volunteer training and equipment-use certifications.

6.2. Developing regional collaborative efforts to facilitate fat biking events

To overcome challenges related to event hosting, the two regions could alternate hosting responsibilities for an annual weekend race/event held in NWO one year and NEM the following. Developing a binational, biannual, weekend-long fat biking event/race could alleviate the hosting stress placed on volunteers and local MB-ORVA finances and sponsors while creating opportunities to showcase existing and new FBTs in each region (e.g., those in Sleeping Giant Provincial Park and on the Mount Baldy and Loch Lomond ski hills in NWO and at Spirit Mountain, a NEM ski hill). These events would also provide an opportunity for shared management discussions, and to thank sponsors, and recognize volunteers.

Cultivating partnerships with local college and university programs and outdoor clubs could also support event facilitation and activate funding opportunities from local economic development corporations interested in the development of cycling tourism and municipal event hosting. Supportive funding could be accessed, for example, from Municipal Accommodations Taxes (MATs) such as those charged by hotels in the City of Thunder Bay and which are dedicated to supporting "vital community projects, helping to improve city infrastructure, enhance tourism, and enrich the local experience for both residents and visitors" (Corporation of the City of Thunder Bay, 2025, par. 1).

6.3. Developing volunteer engagement and management strategies

As access and management of local trails is done in both regions through partnership agreements between government agencies, private landowners, and ORVAs (paralleling the findings of Lu & Schuett, 2014; McCormack & Osborn, 2022; Schild, 2018; Schild, 2019), MB-ORVAs in NWO and NEM need to invest in their volunteers. While board members may take other volunteers for granted, this lack of recognition compounds burn-out, and as our findings illustrate, leads to volunteer attrition and negative sentiment towards volunteering among both volunteers and non-volunteers. These findings draw attention to the importance of developing local and regional volunteer engagement and management strategies which convert passive or token members (those paying annual membership fees) to active members (those regularly attending meetings, volunteering within an ORVA, and supporting event hosting) through purposeful recruitment, recognition, retention, and succession planning (per Lu & Schuett, 2014).

As volunteers spent countless hours grooming trails and volunteering at hosted events, and while recognition is not why most of these individuals donate their time, it was not clear how either region acknowledged and/or recognized their contributions. Recognition goes a long way towards retaining valuable active ORVA members (Lu & Schuett, 2014) as does providing opportunities to contribute to society (Caldwell & Andereck, 1994). Lack of recognition may also have contributed to volunteer burn-out among interviewees. The extant academic literature highlights numerous volunteer incentive strategies, including material benefits like volunteer discounts at local retailers and reduced event participation fees (Lu & Schuett, 2014).

Furthermore, as Arvidsen et al. (2023) note, understanding what motivates volunteers to become active ORVA members, engaged in developing, maintaining, and managing trails as well as hosting events, is "vital for managing volunteer recruitment and retention" (p. 1). Therefore, development of an annual volunteer engagement and sentiment survey, in which active and passive ORVA members are invited to share their experiences and perceptions of volunteering, could be used to solicit this essential information. Adopting these strategies, alongside creating a volunteer recognition program, developing volunteer recruitment and retention strategies, and introducing a designated paid volunteer coordinator position to steward these initiatives, would go a long way to addressing issues related to volunteer sentiment, engagement, and burn-out.

7. Conclusion

While this study is not intended to be representative of all regions across North America in which fat biking occurs, it highlights region-specific challenges along the northshore of Lake Superior associated with climate disruption, the potential for fat biking introduction to serve as a climate change adaptation strategy, and collaborative strategic development and event hosting opportunities for regional ORVAs. Nonetheless, these findings may be geographically generalisable to regions with similar climates and comparable snowsport development and engagement histories, such as areas of Canada (e.g., the Laurentian Highlands, Quebec), the United States (e.g., areas of Northern Wisconsin, the Upper Peninsula region of Northern Michigan, and Upstate New York), and the Nordic countries (e.g., the Finnish Lakeland Region, Finland; Jämtland and Västerbotten in Sweden; and the Nordland and Troms regions of Norway).

Findings raise managerial concerns for MB-ORVAs associated with the risks inherent in depending on volunteers for trail grooming and event facilitation in an era of climate transition. MB-ORVAs must proactively manage the challenges associated with climate disruptions, including increased and diversified trail use and the increased demand placed on volunteer groomers and administrative capacities. Development of proactive volunteer recruitment, retention, and recognition strategies, alongside succession planning for key voluntary board member positions, is needed to ensure they can continue to deliver high-quality winter recreational experiences, including safe, well-groomed trails, and regularly occurring events.

A limitation of this study is its use of a convenience sample of fat bikers during the interviews; however, this was due to the exploratory nature of the study and the limited academic research on fat biking (also acknowledged by Neumann & Mason, 2019), including research specific to the identified regions. Additionally, the study was undertaken in conjunction with industry representatives (e.g., managers, operators, bike shop owners, and local bike clubs) whose networks provided access to regional fat biking communities. A second limitation of this study is the administration of the survey exclusively in NWO; this resulted from the small population of fat bikers in NEM which would have rendered statistical analysis of survey responses, beyond descriptive statistics, challenging. Nonetheless, the NWO survey data shed light on the percentage of cyclists who participate in fat biking in NWO, their intentions to volunteer with local ORVAs, and their event/race participation. The comparative sizes of the fat biking communities also had implications for interview participation and emergent themes. As NWO's fat biking community is much larger, conflicts may not have come to light in the NEM data due to the small close knit and relatively homogenous fat biking community there compared to the much bigger and more diverse NWO community.

Furthermore, the large snowfall experienced by the entire

Northshore Lake Superior region in the winter of 2019, and the additional voluntary trail grooming efforts it necessitated, may have influenced participants (interviewees and survey respondents) feelings about volunteering, while the onset of the COVID-19 pandemic in March 2020 likely impacted self-reported fat biking and volunteer engagement levels reported in the July 2020 survey. To address this, the survey asked about prior and contemporary sport and volunteer engagement, the impact of the COVID-19 pandemic on engagement levels, and the likelihood of sport engagement, event attendance, and volunteering in the future. Longitudinal research on volunteer sentiment is needed for comparative purposes.

Lastly, the concerns of other multi-use trail users (e.g., cross-country skiers, snowmobilers, snowshoers, dogwalkers and trail runners), including their perspectives on ORVA volunteer trail crews, grooming, and trail maintenance, and on intra-user group conflicts, were beyond the scope of this exploratory study. As Neumann and Mason (2019) noted fat biking research is growing, and research on non-fat biking trail users' perspectives on the sport, including trail-based conflict, best practices for managing multi-use trails that include fat bikers, and the co-management of multi-use trails by ORVAs should be undertaken. This study lays the foundation required to undertake this next phase of research locally.

CRediT authorship contribution statement

Kelsey M. Johansen: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal Analysis - Quantitative Data, Conceptualization. **Raynald Harvey Lemelin:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal Analysis - Qualitative Data, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We are grateful for the collaboration of the Blacksheep Mountain Bike Club and Superior Cycling Association, and the contributions of the interviewees and survey respondents. Survey data collection and analysis was supported by the Trail Research Hub.

The first author received financial support from the UEF Water research program, which is jointly funded by the Saastamoinen Foundation, the Jenny and Antti Wihuri Foundation, and the Olvi Foundation for the writing of this article.

Data availability

The data that has been used is confidential.

References

Arvidsen, J., Kristensen, M. S., & Iversen, E. B. (2023). Why build Mountain bike trails? An exploratory mixed-methods study of volunteer motives in Danish MTB-Trail building. *Journal of Outdoor Recreation and Tourism, 43*(100671), 1–12. https://doi.org/10.1016/j.jort.2023.100671

Askew, A. E., & Bowker, J. M. (2018). Impacts of climate change on outdoor recreation participation: Outlook to 2060. *Journal of Park and Recreation Administration, 36*(2), 97–120. https://doi.org/10.18666/JPRA-2018-V36-I2-8316

Ayala, E. E., Waniger, K. J., Faulkner, K. P. A., & Riley-Schmida, A. (2020). Experiences that affect participation of women and gender diverse athletes in competitive cycling. *Journal of Outdoor Recreation, Education, and Leadership, 12*(1), 10–26. https://doi.org/10.18666/JOREL-2020-V12-I1-9912

Blacksheep Mountain Biking Club. (2021 June). *2021 Sponsorship Information Package*. [Report]. (7 pages).

Blacksheep Mountain Biking Club. (2024a). *About – Ride. Build. Repeat*. [Website]. https://www.blacksheepmtb.com/about/.

Blacksheep Mountain Biking Club. (2024b). *2024 XCM Canadian Championships*. [Website]. https://xcmtbay.com/.

Blacksheep Mountain Biking Club. (2024c). *Ozzy 8 Endurance Relay presented by KBM Outdoors*. [Website]. https://www.blacksheepmtb.com/2024/05/01/ozzy-8-endurance-relay-presented-by-kbm-outdoors-2/.

Bruington, K. (2024). Singletrack 101: Your ultimate guide to Mountain biking trails. *The Cyclist Choice*. [Blog]. https://thecyclistchoice.com/what-is-singletrack/.

Buning, R. J., Cole, Z., & Lamont, M. (2019). A case study of the US Mountain bike tourism market. *Journal of Vacation Marketing, 25*(4), 515–527. https://doi.org/10.1177/1356766719842321

Caldwell, L. L., & Andereck, K. L. (1994). Motives for initiating and continuing membership in a recreation-related voluntary association. *Leisure Sciences, 16*(1), 33–44. https://doi.org/10.1080/01490409409513215

Campbell, T., Kirkwood, L., McLean, G., Torsius, M., & Florida-James, G. (2021). Trail use, motivations, and environmental attitudes of 3780 European Mountain bikers: What is sustainable? *International Journal of Environmental Research and Public Health, 18*(24). https://doi.org/10.3390/ijerph182412971

Carothers, P., Vaske, J. J., & Donnelly, M. P. (2001). Social values versus interpersonal conflict among hikers and Mountain bikers. *Leisure Sciences, 23*(1), 47–61. https://doi.org/10.1080/01490400150502243

Chavez, D. J., Winter, P. L., & Baas, J. M. (1993). Recreational Mountain biking: A management perspective. *Journal of Park and Recreation Administration, 11*(3), 29–36. https://research.fs.usda.gov/treesearch/46296.

Corporation of the City of Thunder Bay. (2017 April). *Trowbridge forest recreation trail master plan – Mountain biking, multi use, Nordic* (p. 101 pages). [Report]. https://www.thunderbay.ca/en/city-hall/trowbridge-forest-recreational-trail-master-plan.aspx.

Corporation of the City of Thunder Bay. (2017 April 30). *Trowbridge Forest Trail Management Agreement*. [Draft Legal Agreement]. (14 pages).

Corporation of the City of Thunder Bay. (2025). *Municipal Accommodation Tax (MAT)*. [Website]. https://www.thunderbay.ca/en/city-hall/municipal-accommodation-tax.aspx.

Curry, N. (2000). Community participation in outdoor recreation and the development of millennium greens in England. *Leisure Studies, 19*(1), 17–35. https://doi.org/10.1080/026143600374815

Dennis, S., & Zube, E. H. (1988). Voluntary association membership of outdoor recreationists: An exploratory study. *Leisure Sciences, 10*(4), 229–245. https://doi.org/10.1080/01490408809512194

Ferguson, M. D., Mueller, J. T., Graefe, A. R., & Mowen, A. J. (2018). Coping with climate change: A study of Great Lakes water-based recreationists. *Journal of Park and Recreation Administration, 36*(2), 52–74. https://doi.org/10.18666/JPRA-2018-V36-I2-8296

Global Mountain Bikes Network (GMBN). (2015). What is a fat bike? GMBN explains fat bikes. *YouTube*. [Video]. https://www.youtube.com/watch?v=1-nWHkqTV2s. (Accessed 10 May 2020).

Glover, T., Shinew, K., & Parry, D. (2005). Association, sociability, and civic culture: The democratic effect of community gardening. *Leisure Sciences, 27*(1), 75–92. https://doi.org/10.1080/01490400590886060

Hagen, S., & Boyes, M. (2016). Affective ride experiences on mountain bike terrain. *Journal of Outdoor Recreation and Tourism, 15*, 89–98. https://doi.org/10.1016/j.jort.2016.07.006

Haid, M., Nöhammer, E., Albrecht, J. N., Plaikner, A., Stummer, H., & Heimerl, P. (2021). Health promotion as a motivational factor in alpine cycling. *International Journal of Environmental Research and Public Health, 18*(5), 2321. https://doi.org/10.3390/ijerph1805232

Hewer, M. J., & Gough, W. A. (2018). Thirty years of assessing the impacts of climate change on outdoor recreation and tourism in Canada. *Tourism Management Perspectives, 26*, 179–192. https://doi.org/10.1016/j.tmp.2017.07.003

Ioannides, D., & Stoffelen, A. (2023). Can tourism impact studies become more meaningful? *Tourism Geographies*, 1–10. https://doi.org/10.1080/14616688.2023.2269544

Johansen, K.M. & Lemelin, R.H. (2022). *The status of mountain biking in Thunder Bay: local ridership profile – riding and spending patterns*. [Report]. (50 pages). The Trail Research Hub. Thunder Bay, ON.

Kanazawa, M., Bruce Wilson, B., & Holmberg, K. (2018). Local consequences of climate change: State park visitations on the north shore of Minnesota. *Water Resources and Economics, 22*, 50–61. https://doi.org/10.1016/j.wre.2018.01.003

King's Printer for Ontario. (2024). Crown Land management. https://www.ontario.ca/page/crown-land-management.

Knight, K. W., & Hao, F. (2022). Is outdoor recreation associated with greater climate change concern in the United States? *Sustainability, 14*(6), 3520. https://doi.org/10.3390/su14063520

Knowles, N., Scott, D., & Steiger, R. (2020). Chapter 8: Winter sports and climate changes. In G. Dingle, & C. Mallen (Eds.), *Sport and environmental sustainability: Research and strategic management* (pp. 140–161). Routledge. https://doi.org/10.4324/9781003003694-8.

Kuklinksi, K. P., Coleman, K. J., Leahy, J. E., Perry, E. E., Reinhardt, E., & Briccetti, L. (2024). Scoping the lines: Assessing the Mountain biking research terrain and calling for a holistic scholarship agenda. *Journal of Outdoor Recreation and Tourism, 46*, Article 100748. https://doi.org/10.1016/j.jort.2024.100748

Lawrence, M., Homer-Dixon, T., Janzwood, S., Rockström, J., Renn, O., & Donges, J. F. (2024). Global polycrisis: The causal mechanisms of crisis entanglement. *Global Sustainability, 7*(6), 1–16. https://doi.org/10.1017/sus.2024.1

Lu, J., & Schuett, M. A. (2014). Examining the relationship between motivation, enduring involvement and volunteer experience: The case of outdoor recreation

voluntary associations. *Leisure Sciences, 36*(1), 68–87. https://doi.org/10.1080/01490400.2014.860791

Mason, C. W., & Neumann, P. (2024). The impacts of climate change on tourism operators, trail experience and land use management in British Columbia's backcountry. *Land, 13*(1), 69. https://doi.org/10.3390/land13010069

McCormack, K. M. (2017). Inclusion and identity in the Mountain biking community: Can subcultural identity and inclusivity coexist? *Sociology of Sport Journal, 34*(4), 344–353. https://doi.org/10.1123/ssj.2016-0160

McCormack, K., & Osborn, B. (2022). Off-road cycling. In G. Norcliffe, U. Brogan, P. Cox, B. Gao, T. Hadland, S. Hanlon, Jones, N. Oddy, & L. Vivanco (Eds.), *Routledge companion to cycling* (pp. 310–317). Routledge. https://doi.org/10.4324/9781003142041.

McDermid, J., Fera, S., & Hogg, A. (2015). *Climate change projections for Ontario: An updated synthesis for policymakers and planners* (pp. 1–40). Peterborough, ON. http://www.climateontario.ca/MNR_Publications/CCRR-44.pdf.

Monz, C., & Kulmatiski, A. (2016). The emergence of "fat bikes" in the USA. Trends, potential consequences, and management implications. *Journal of Outdoor Recreation and Tourism, 15*, 20–25. https://doi.org/10.1016/j.jort.2016.04.001

Naderifar, M., Goli, H., & Ghaljaie, F. (2017). Snowball sampling: A purposeful method of sampling in qualitative research. *Strides in Development of Medical Education, 14*(3), 1–4. https://doi.org/10.5812/sdme.67670

Neumann, P., & Mason, C. W. (2019). Managing land use conflict among recreational trail users: A sustainability study of cross-country skiers and fat bikers. *Journal of Outdoor Recreation and Tourism, 28*. https://doi.org/10.1016/j.jort.2019.04.002

Ozersky, T., Bramburger, A. J., Elgin, A. K., Vanderploeg, H. A., Wang, J., Austin, J. A., et al. (2021). The changing face of winter: Lessons and questions from the Laurentian Great Lakes. *Journal of Geophysical Research: Biogeosciences, 126*(6), Article e2021JG006247. https://doi.org/10.1029/2021JG006247

Pforr, C., Pillmayer, M., Joppe, M., Scherle, N., & Pechlaner, H. (2024). Wicked problems: Implications for tourism policy-making. In C. Pforr, M. Pillmayer, M. Joppe, N. Scherle, & H. Pechlaner (Eds.), *Tourism policy-making in the context of contested wicked problems: Sustainability paradox, climate emergency and COVID-19 (advances in culture, tourism and hospitality research, 17A* pp. 3–16). Leeds: Emerald Publishing Limited. https://doi.org/10.1108/S1871-31732024000017A001.

Phillips, K. C. (2015). *Intensity and performance. Aspects of snow biking through the use of a fat bike*. Northern Michigan University Master's Theses. https://commons.nmu.edu/theses/65.

Propst, D. B., Jackson, D. L., & McDonough, M. H. (2003). Public participation, volunteerism and resource-based recreation management in the U.S.: What do citizens expect? *Loisir et Société/Society and Leisure, 26*(2), 389–415. https://doi.org/10.1080/07053436.2003.10707628

Rapley, T. J. (2001). The art(fulness) of open-ended interviewing: Some considerations on analysing interviews. *Qualitative Research, 1*(3), 303–323. https://doi.org/10.1177/146879410100100303

Rehook. (2024). Flow trail definition and meaning. *Rehook blog*. [Online]. https://rehook.bike/blogs/saddle-slang-the-dictionary-of-cycling-lingo/flow-trail.

Rinne, G. (2024 February 7). *Sleeping Giant Loppet is officially cancelled*. TBnewswatch.com. [Online]. https://www.tbnewswatch.com/local-news/sleeping-giant-loppet-is-officially-cancelled-8221391.

Rodney, Y. (2023). Volunteerism: In crisis or at a crossroads? *The Philanthropist Journal* [Online]. https://thephilanthropist.ca/2023/03/volunteerism-in-crisis-or-at-a-crossroads/.

Schild, R. (2018). Fostering environmental citizenship: The motivations and outcomes of civic recreation. *Journal of Environmental Planning and Management, 61*(5–6), 924–949. https://doi.org/10.1080/09640568.2017.1350144

Schild, R. (2019). Civic recreation: Outdoor recreationists as advocates, stewards, and managers of natural resources. *Environmental Management, 63*, 629–646. https://doi.org/10.1007/s00267-019-01151-0

Statistics Canada. (2022). *Focus on geography series, 2021 census of population Thunder Bay, census metropolitan area*. [Report]. https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/page.cfm?lang=E&topic=1&dguid=2021S0503595.

Stebbins, R. A. (1996). Volunteering: A serious leisure perspective. *Nonprofit and Voluntary Sector Quarterly, 25*(2), 211–224. https://doi.org/10.1177/0899764096252005

Superior Cycling Association. (2024a). *Who we are*. [Website]. https://superiorcycling.org/about-us/.

Superior Cycling Association. (2024b). *The Norpine Fat Bike Classic*. [Website]. https://superiorcycling.org/norpine/.

Superior Cycling Association. (2024c). *Sawtooth Mountain Challenge*. [Website]. https://superiorcycling.org/sawtooth-challenge/.

Taylor, S. (2010). 'Extending the dream machine': Understanding people's participation in Mountain biking. *Annals of Leisure Research, 13*(1–2), 259–281. https://doi.org/10.1080/11745398.2010.9686847

Taylor, S., & Sand, M. (2021). Doubles, drops and ditches: Deconstructing the art of the Mountain bike trail-builder. *Journal of Outdoor Recreation and Tourism, 33*(December 2020), Article 100364. https://doi.org/10.1016/j.jort.2020.100364

The Trail Research Hub. (2024 May 31). *Trails: A Glossary of Terms*. (18 pages). Toronto, ON.

United States Census Bureau. (2020). Cook County, Minnesota. https://data.census.gov/profile/Cook_County,_Minnesota?g=050XX00US27031.

United States Census Bureau. (2020b). *Grand Marais City, Cook County, Minnesota*. https://data.census.gov/profile/Grand_Marais_city,_Cook_County,_Minnesota?g=060XX00US2703124992.

United States Census Bureau. (2020c). *Total population in Lutsen Township, Cook County, Minnesota*. Website. [online]. https://data.census.gov/profile/Grand_Marais_city,_Cook_County,_Minnesota?g=060XX00US2703124992.

Vaismoradi, M., & Snelgrove, S. (2019). Theme in qualitative content analysis and thematic analysis. *Forum for Qualitative Social Research, 20*(3). https://doi.org/10.17169/fqs-20.3.3376