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Weather Studies in Outdoor Recreation and Nature-Based Tourism: A Research Synthesis and Gap Analysis

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ABSTRACT

The impact of weather on outdoor recreation and nature-based tourism has received increasing attention from the research community during the past ten years. This article synthesizes the results of those inquiries, categorizing their predominant themes and identifying knowledge gaps. One hundred eighty-four weather-related articles drawn from a cross-section of international journals served as the foundation for this work. The research synthesis identified three recurring themes: weather-related variables that influence outdoor recreation and nature-based tourism, the importance of geographic research context, and prevailing activity types. A gap analysis indicated an abundance of underinvestigated topics in weather-related studies in outdoor recreation and nature-based tourism. The article concludes with recommendations for future weather-related studies in outdoor recreation and nature-based tourism developed from the predominant themes uncovered in the research synthesis and research needs discovered in the gap analysis.

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"Climate is what you expect; weather is what you get." — Mark Twain

In 1966, Clawson posited that "even a modest acquaintance with outdoor recreation suggests that it is weather-sensitive—anyone who has had a picnic spoiled by a sudden downpour can testify to that" (Clawson, 1966, p. 184). For more than 30 years, researchers have investigated the influence of weather on tourism resulting in numerous approaches to the topic (Scott et al., 2008). For example, from research in Kafue National Park Zambia (Thapa, 2012), Croatia's Adriatic Coast (Brosy, Zaninovic, & Matzarakis, 2013), Eureka Springs Arkansas in the United States (Chi & Qu, 2008), and others, there is breadth of geographic context in weather research, although some geographic regions are underrepresented. There exists a wide assortment of studies ranging from a focus on weather's impacts on tourism demand at zoos (Aylen, Albertson, & Cavan, 2014) to space tourism (Reddy, Nica, & Wilkes, 2012). The impact of weather on activities such as surfing (Barbieri & Sotomayor, 2013; Ponting

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& McDonald, 2013), golf (Nicholls, Holecek & Noh, 2008; Scott & Jones, 2007), and skiing (Scott, McBoyle, & Minogue, 2007; Yu et al., 2013) have been explored. Methodologically, some studies are based on secondary data (e.g., Becken, 2012; Dawson, Scott, & Havitz, 2013; Dawson & Scott, 2007; Finger & Lehmann, 2012; Jones & Scott, 2006; Martinez Ibarra, 2011; Sabir, Van Ommeren, & Rietveld, 2013; Scott, Jones, & Konopek, 2007; Scott & Jones, 2006; Wilson & Becken, 2011), while others employ case or expert-based designs (e.g., Espiner & Becken, 2014; Geissler, 2008; Hamilton, Brown, & Keim, 2007; Hartz, Brazel, & Heisler, 2006; Kajan, 2014; Karamustafa, Fuchs, & Reichel, 2012; Liu, 2014; Nicholls & Holecek, 2008; Rauken & Kelman, 2012; Scott et al., 2007; Tervo, 2008), and others use qualitative approaches (e.g., Brugger & Crimmins, 2013; Specter, Chard, Mallen, & Hyatt, 2012; Strickland-Munro, Allison, & Moore, 2010).

Although numerous studies have been completed, the research community has not aggregated and analyzed these studies for predominant themes and knowledge gaps. Without a thorough and systematic review of this body of work, future research may lack connection to previous studies and may fail to compare or retest methods and results from previous investigations. Furthermore, without a systematic review of previous work, deficits in knowledge and research approaches may not be illuminated and consequently may not be addressed by future investigations. Given the variability of geographic context, research topics, activities, and research approaches, we deemed it timely to synthesize the empirical studies into one state of knowledge article about weather research in outdoor recreation and nature-based tourism. We accomplished this task using a systematic approach for synthesizing and integrating the research to answer: "What are the themes, trends, and gaps in research examining the influence of weather on outdoor recreation and nature-based tourism?" The results are categorized into three predominant areas: weather-related salient variables, the geographic research context, and activity types. Following the systematic synthesis and grouping of studies into these areas, we used a gap analysis to highlight several recommendations for future research.

Research synthesis process

A research synthesis is a systematic literature review focused on empirical studies and is used to summarize previous research about interconnected or identical topics, and then to draw overall conclusions (Cooper, 2010). A research synthesis is distinctly different from a meta-analysis because the goal is not necessarily a quantitative synthesis of evidence or identification of the strength of relationships between variables (Shelby & Vaske, 2008). Rather, the purpose of a research synthesis is to provide a state of knowledge about the topic and/or variables of interest and to highlight important unresolved issues in the literature (Cooper, 2010).

The research synthesis process evolved from an increase in social science research, new information technologies, and the necessity for trustworthy research reviews (Cooper, 2010). The research synthesis process has enjoyed widespread application in social and developmental psychology, clinical/community psychology, educational psychology, and health psychology. Relative to leisure sciences, the research synthesis process has demonstrated utility in providing a retroactive review of social science research on winter visitor use in Yellowstone National Park (Gatti, Brownlee, & Bricker, in press).

The research synthesis process offers several advantages beyond a standard literature review. First, the process allows for the comprehensive integration of separate research projects into a coherent whole by presenting a state of knowledge and highlighting important unresolved issues (Cooper, 2010). Second, the process requires validity checks on inferences to meet the same rigorous standards applied by the initial researchers. A meta-analysis, while

highly useful, is difficult to apply to new areas of research that employ different methodologies, sampling designs, and measurements (Shelby & Vaske, 2008), which are issues that a research synthesis can address. Consequently, the research synthesis process is well-suited to integrate empirically grounded weather-related research in outdoor recreation and nature-based tourism for summarizing themes and trends. Finally, a research synthesis is replicable due to its systematic process and therefore lends itself to longitudinal comparisons that are not possible with more traditional literature reviews.

There are seven steps in the research synthesis process: 1) define the research questions, 2) collect research data (i.e., systematic literature search), 3) gather information from studies, 4) evaluate the quality of studies, 5) analyze and integrate the outcomes of data, 6) interpret the evidence, and 7) present the results (Cooper, 2010). The research synthesis process is described below with emphasis on searching strategies, inclusion and exclusion criteria, and coding procedures used in this current study.

In this study, the researchers first identified the research question, "What are the themes, trends, and gaps in research examining the influence of weather on outdoor recreation and nature-based tourism?" During this step is was important to distinguish outdoor recreation from nature-based tourism as well as weather from climate. *Outdoor recreation* is physically active leisure time spent in nature or the outdoors (Manning, 2011, p. 4), and *nature-based tourism* is tourism occurring in natural areas and uses natural resources in an undeveloped area to enjoy nature (Scott, Hall, & Gössling, 2012). The distinction between weather and climate is important because the two terms are often inaccurately interchanged (Scott & Jones, 2006). *Weather* is the daily variations in the atmosphere (e.g., temperature, sun, cloud, rain), while *climate* is the long-term average behavior of weather in a specific location (Scott & Jones, 2006). This study focused on weather studies (not climate) in outdoor recreation and nature-based tourism research.

Searching strategies

In step two, numerous search terms were used to compile these studies. The terms were developed using the table of contents from seminal works in outdoor recreation and nature-based tourism, such as Manning's *Studies in Outdoor Recreation, 3rd edition: Search for Research and Satisfaction* (2011) and Scott, Hall and Gössling's *Tourism and Climate Change: Impacts, Adaptation, and Mitigation* (2012). These texts offered insights into developing Boolean search strings aligning with the Library of Congress Subject Headings (LCSH). The LCSH is considered to be the standard based on its international use and maintenance since 1898 (Library of Congress, 2015). Each Boolean search string included a context word, which was part of "recreat*" or "sustainable tourism" or "leisure" or "tourism." This context word had to appear in combination with two sets of topic words. The first was "weather" or "meteorolog*" and the second was a list of forty-nine related topics. Some examples include "aesthetic*," or "ski*," and "parks." This resulted in numerous search term combinations (e.g., [recreat* OR sustainable tourism OR leisure OR tourism] AND [weather OR meteorolog*] AND aesthetic*). Please see Table 1 for Boolean string search terms. Although this study focuses on weather, outdoor recreation, and nature-based tourism, some climate terms were used to identify articles that included weather-related variables.

A number of search engines and databases, including Academic Search Premier (i.e., EBSCOhost, PsychInfo, and PubMed), Encyclopedia of Atmospheric Sciences, Leisure Tourism, Scopus, Meteorological and Geoastrophysical Abstracts, and WorldCat were selected based on consultation with subject area librarians. Searching strategies were accessed

Table 1. Boolean String Sarch Terms.

Boolean String Search Terms (recreat* OR sustainable tourism OR leisure OR tourism) AND (weather OR meteorolog*) AND[a]				
Aesthetic*	Global environmental change	Recreation areas	Snow augmentation	Weather – effects of mountains on
Dependenc*	Mountaineering	Recreation access	Storm chasers	Wildlife refuges
Decision making	Mountain resorts	Recreation industry	Sustainability	Wildlife resources
Dry slope skiing	National parks and reserves	Recreation agencies	Telemark	Wildland – urban interface
Environmental	Nature trails	Recreational use	Tourist*	Wilderness areas
Forest reserves	Open spaces	Risk	Travel*	Wilderness area monitoring
Forest meteorolog*	Parks	Season*	Weather control	Wilderness area users
Forest management	Perception	Ski*	Weather - effects of human beings on	Wilderness areas
Global climate observing system	Protected areas	Snowmaking	Weather – effects of lakes on	Winter sports

Note. [a]This search string was used with each of the terms listed in this table to conduct unique searches in each database included in this study.

to source English language studies that contained the search terms. As a part of the systematic research synthesis process, primary author searches were also conducted, assembled, and included in the data ($n = 31$). The researchers conducted the searches during April and May 2015. Collectively, the searches yielded 4,886 studies.

Inclusion and exclusion criteria

Step three and four involved the application of inclusion/exclusion criteria and evaluation of data. Studies were included if they were empirically based and peer-reviewed during the past ten years (2005–2015). This date range was selected because a) authors such Becken, Gossling, Hall, and Scott began publishing studies about the impacts of weather on outdoor-recreation and nature- based tourism in 2005, and b) journals such as *Weather, Climate, and Society*, which publish a high rate of studies on the link between weather, recreation, and tourism, did not exist prior to 2009. Conference proceedings and papers, government documents, dissertations, and theses were excluded due to their lack of consistent peer-review processes. More specifically, conference proceedings and papers require less rigorous selection criteria with larger percent acceptance rates than peer-review journal articles with some invitational presentations that are typically not reviewed due to quality assumptions by the invitee (Cooper, 2010, p. 60). There were no geographic limitations on the inclusion of studies.

The researchers evaluated the relevance of the 4,886 studies to the research question identified in step one. Initial evaluations were conducted to determine each article's relevance based on the broad concepts of outdoor recreation and/or tourism and weather while erring toward inclusivity. Early inclusion decisions were made based on study content found in the abstract and title. This evaluation resulted in the exclusion of 90.87% ($n = 4{,}440$) of the 4,886 studies. Most of these exclusions were the result of studies focused on climate rather than weather.

Secondary evaluations were conducted by two screeners and included evaluations of all content within the studies. Secondary evaluations resulted in the exclusion of 65.69% ($n = 293$) of the articles. After the application of inclusion/exclusion criteria, researcher evaluations, and primary author searchers ($n = 31$), 184 articles were included as the data set for this research synthesis.

Coding procedures

The final steps of the research synthesis process included analyzing and integrating the studies, interpreting the data, and presenting the results. In step five of the research process, analyzing and integrating the studies, three stages of semi-inductive qualitative coding were used to develop themes. First, attribute coding began in step three when an annotated bibliography was created as a tool to extract key information from each study. An *a priori* objective attribute coding frame with 11 categories was implemented to extract information from each article (Cooper, 2010), including database location, document citation, journal title, article purpose, context, sample, methods and analysis, findings and results, implications, salient constructs, and gaps as cited by the source. These attribute codes provided basic descriptive information of the studies (Saldaña, 2013).

Second, descriptive codes were applied to develop categorized lists within the attribute codes. These descriptive codes helped the research team to establish an organizational grasp of the contexts, samples, and salient constructs found within the articles. During the third stage, researchers applied conceptual codes, which are authorities that cover and account for groups of descriptive codes generated in the second stage coding. Table 2 provides an overview of this coding and categorization by displaying the research synthesis code map used in this study.

Table 2. Research Synthesis Code Map.

Code Map		
Stage 1: Attribute Codes	Stage 2: Descriptive Codes	Stage 3: Conceptual Codes (n)[d]
Database location Document Citation Journal title Article purpose Context[a] Sample Methods and analysis Findings and results Implications Salient constructs[b] Gaps cited by the source	*Context* North America, Mexico, Europe, Scandinavia, land-based, winter-tourism, islands marine-based tourism *Sample* Secondary data, managers, operators, owners, community-based, residential, destination, indigenous populations, sport *Salient Constructs*[c] Temperature, precipitation, relative humidity, wind speed, Physiological Equivalent Temperature, extreme weather events, climate variability, transportation mode, length of stay, route traveled (distance at site and covered topography), activity day, site infrastructure, community infrastructure, vulnerability, adaptive capacity, resources to support extreme weather events, weather perceptions, expectations and preferences, encountered weather, behavioral reactions to weather, weather and climate information, natural and institutional seasonality, regional climate variability, resource dependency, natural environmental, management practices, demographic information, experience use history, place attachment, quality and satisfaction of recreation experiences, recreation specialization, beliefs in climate change, recreation experience preference	*The Importance of Geographic Research Context* North American land-based context (89) European winter and land-based context (46) Islands marine-based (41) *Prevailing Activity Types* Nature-based tourism (62), skiing (39), residential and/or community oriented (25), visitor (14) *Weather-related Salient Factors* Weather conditions (184), trip characteristics (107), site characteristics (86), experiences with weather (82), season (78), resource characteristics (29), personal characteristics (17)

Note. [a]Setting of the study including geographic location, institution, or organization/destination particularly for tourism studies [b]All variables under investigation with specific attention to weather variables [c]Representative sample of the hundreds of variables examined throughout the 184 articles [d]Frequency of each code is reported in parentheses and the codes are not mutually exclusive.

Throughout data analysis, articles were categorized by factors (or constructs) and variables into nonmutually exclusive categories. Factors are comprised of individual yet related measurable elements termed variables (Vaske, 2008). Frequency counts were based on the number of times a variable appeared within the articles. If the variables appeared more than once in a given article, the article was counted once.

To ensure the credibility and trustworthiness of the data, both peer debriefing and intercoder reliability were implemented. Peer debriefing relied on expert responses to coding themes, and intercoder reliability consisted of developing definitions for each code and applying the definition to check for consistency in meaning and application between two coders (Marshall & Rossman, 2011). Intercoder agreement was also used as a reliability check to verify the stability of responses between two coders (Cresswell, 2015). After descriptive coding of several articles, codes were examined to ensure congruency. We sought to establish an 80% agreement of coding on these passages (recommend by Miles & Huberman, 1994). The interpretation of data, step six of the research synthesis process, is presented in the results section of this article.

Gap analysis process

Cooper, Hedges, and Valentine (2009) suggest research syntheses "try to resolve conflicts in the literature, and attempt to identify central issues for future research" (p. 6). We extended the authors suggestion and employed a gap analysis as a systematic approach to highlighting important unresolved issues.

We followed a four-step semi-inductive process to conduct the gap analysis. First, we collected the conceptual codes generated from stage three of the research synthesis (see Table 2). Second, we used secondary sources such as literature reviews, books, and book chapters to judge the research synthesis results. These types of sources are recommended for use in highlighting unresolved issues (i.e., gaps) because they help identify themes, deficits, and trends in the research (Cooper, 2010). Specifically, we conducted the research gap analysis by consulting 1) Scott, Hall, and Gössling's (2012) *Tourism and Climate change: Impacts, adaptation, and mitigation*; 2) Sewell's (1966) *Human dimensions of Weather Modification*; 3) Gomez-Martin's (2005) *Weather, Climate, and Tourism*; 4) Scott and Lemieux's (2010) *Weather and Climate Information for Tourism*; and 5) Manning's *Studies in Outdoor Recreation, 3rd edition: Search for Research and Satisfaction* (2011). We used chapters and key subtopics across these sources. Third, researchers independently compared the research synthesis results against these secondary sources to determine research gaps that were understudied or unidentified themes in the research synthesis. Finally, following this independent comparison by the researchers, the research team participated in iterative constant comparisons of the independently identified gaps to highlight deficits in the literature that are potentially most promising for future investigations (Saldaña, 2013). These iterative constant comparisons allowed the research team to resolve disagreements and reach consensus regarding gaps (Cooper, 2010).

It is important to note that this four-step gap analysis process is largely inductive, relies on researcher interpretation and positionality, and does not follow a strict deductive formula. Ultimately, the research team selected this inductive process with iterative constant comparisons to add depth to the description of the identified gaps, position the gaps firmly in a larger research and cultural context, and leverage the unique insight and expertise offered by the research team (Marshall & Rossman, 2011).

This team-based inductive process for the gap analysis offers many advantages beyond a pure deductive approach (Creswell, 2015). First, this inductive approach is appropriate for

exploring topics that may have limited presence in the literature or knowledge bases (i.e., gaps) or, in the case of this project, the absence of insight concerning key weather-related research in outdoor recreation and nature-based tourism (Creswell, 2015). Second, in keeping with inductive qualitative approaches, the process enables researchers to situate themselves within this study, leveraging their existing strengths and experiences (Johnson & Parry, 2015). Third, the process helps reveal potentially new insights that may not have the freedom to emerge if a purely deductive approach was embraced (Levy, 2015). As a result, the gap analysis findings are born from well-recognized qualitative approaches and ultimately expose deficits in knowledge and illustrate opportunities for further inquiry.

Validity of the research synthesis and gap analysis process

Lincoln and Guba (1985) propose four criterion for determining the validity of qualitative research: credibility, transferability, dependability, and confirmability. Through adherence to a strict, documented research protocol, utilization of multiple researchers, and use of a wide array of sources, the research synthesis process employed in this study aligns with Lincoln and Guba's criteria. In the design stage of the research synthesis process, we determined appropriate strategies to implement throughout the study and relied on triangulation, employing multiple sources of data to build codes and themes. The use of disconfirming evidence was another technique that enabled us to endorse the accuracy of the results through evaluating divergent themes. For this study, the disconfirming evidence is presented in the gap analysis portion of the results. In addition to qualitative strategies to ensure validity, Cooper (2010) proposes that a checklist of questions be employed to ensure validity in each step of the research synthesis process. The checklist should include a) proper and exhaustive search terms derived in consultation with an expert subject area librarian, b) procedures to ensure the unbiased and reliable application and retrieval of relevant studies, and c) standard qualitative methods including the development and discussion of codes among the researchers for use in determining relevant themes, the combination of data from studies used in the research, and the comparison of results across the studies. This study benefited from such a checklist as well.

Results

The results of the articles reviewed yielded 184 weather studies, published in 84 unique journals from 2005 to 2015. Figure 1 provides a visual representation of the distribution of articles by publication year ($n = 184$). As the figure depicts, between 2006 and 2009 there was a decrease in publications about weather, outdoor recreation, and nature-based tourism. After 2009 and through 2014 there has been a steady increase in weather-related publications. Despite the pre-2009 decrease in publications, on average there have been an additional 2.84 published articles per year.

A visual display of the 84 unique journals publishing the articles is provided in Figure 2. *Tourism Management* published a high concentration of research on the topic, approximately 14% ($n = 26$) of the 184 articles. Conversely, 61 different journals published only one article in the final dataset. [1]

Next, two sets of results are presented and discussed. The first set of results report the themes and trends in weather research related to outdoor recreation and nature-based tourism. Three themes emerged from the research synthesis: 1) weather-related factors and

[1] The full reference to each study is available upon request from the first author.

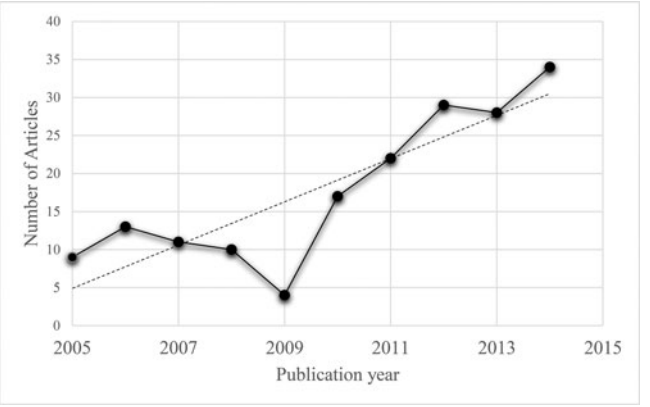

Figure 1. Distribution of articles by year.
Note: It is possible that the decrease in publications in 2009 was a result of the 2008 global economic crisis, resulting in outdoor recreation and tourism industries focusing attention and research on the economic impacts rather than on weather-related research. Several primary journals (e.g., *Tourism Management, Global Environmental Change, Climate Research, Annals of Tourism Research*, and *International Journal of Biometeorology*) received significantly less publication submissions during 2009, which also could account for the variability (Scopus, 2015). While data were collected in 2015, only articles published from January to May were captured (n = 5), contributing to an incomplete representation of weather-related articles from 2015; therefore, 2015 is not displayed in this figure. The dashed line above represents the trendline for increases in article publications since 2005. The beta value (B = 2.84) indicates for every additional year, 2.84 more weather-related articles were published.

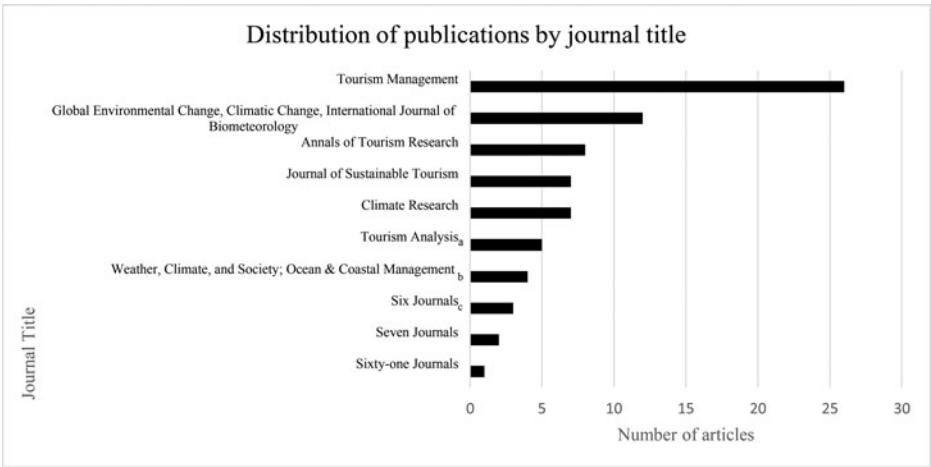

Figure 2. Distribution of publications by journal title.
Note. [a, b, c, d] The journals are grouped by the number of articles within the publication. [a] Six journals including *Current Issues in Tourism, Journal of Leisure Research, Journal of Travel Research, Scandinavian Journal of Hospitality and Tourism, Tourism Geographies*, and *Tourism in Marine Environments* contained three articles each; [b] Seven journals including *Environmental Science & Policy, International Journal of Climatology, Journal of Environmental Psychology, Journal of Parks and Recreation Administration, Tourism and Hospitality Planning & Development*, and *Tourism Review International* included two articles each; c 61 journals included one article each.

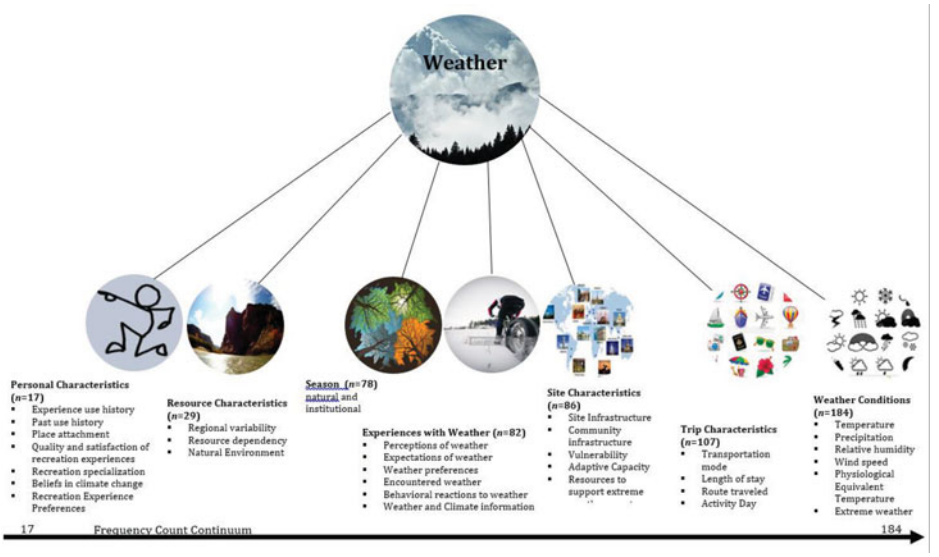

Figure 3. Frequency continuum of salient factors and variables of weather research in outdoor recreation and nature-based tourism.

variables, 2) the importance of the geographic research context, and 3) prevailing activity types. The second set of results derived from the gap analysis are presented alongside research trends. The gap analysis points to deficiency in knowledge about weather within outdoor recreation and nature-based tourism research and are organized within each emergent theme.

Research synthesis discussion—emergent theme one: Weather-related salient variables

The first theme emerged from reoccurring weather-related salient variables throughout the literature. These variables were categorized into larger groups, referred to as "factors." The salient factors include 1) weather conditions (most prevalent variable); 2) trip characteristics; 3) site characteristics; 4) experiences with weather; 5) season; 6) resource characteristics; and 7) personal characteristics (least prevalent factor; see Figure 3).

Weather conditions

Weather conditions were studied in a variety of contexts, using a variety of research designs, while investigating different activity types, making it the most prevalent factor uncovered in the research synthesis. Temperature and precipitation were the two most common variables used in tourism-based weather impact studies (Matzarakis, Hämmerle, Koch, & Rudel, 2012); relative humidity, wind speed, and physiological equivalent temperature (PET) were sometimes measured alongside temperature. The overwhelming majority of the studies used secondary meteorological data as sources to distill weather condition data (e.g., Becken, 2012; Brosy, Zaninovic, & Matzarakis, 2013; Jackie Dawson & Scott, 2007; Gómez-Martín & Martínez-Ibarra, 2012; Jones & Scott, 2006; Matzaraki et al., 2012a; Sabir, van Ommeren, & Rietveld, 2013; Scott & Jones, 2006; Zhang & Wang, 2013). Occasionally field measurements were taken to observe key weather conditions (Andrade et al., 2011b; Pantavou & Lykoudis, 2014).

Researchers have widely examined the effects of key weather conditions on outdoor recreation and nature-based tourism. The reviewed literature has examined the influence of

weather on the number of rounds played at golf courses (Scott & Jones, 2006), tourists' participation in scenic flights (Becken, 2012), and the effects on outdoor recreation activities compared to commuting (Helbich, Böcker, & Dijst, 2014). Participation in daily outdoor activity has been linked to weather conditions (Wolff & Fitzhugh, 2011). This includes daily activities such as beach recreation (de Freitas, 2015), and predictions of beach related traffic (Sabir et al., 2013). Tourism visitation trends at Khaoyai National Park were evaluated based on temperature and precipitation (Pongkijvorasin & Chotiyaputta, 2013). Weather was used to investigate visitors' willingness to pay for trips to key national parks in the United States (Richardson & Loomis, 2005) in an attempt to partially predict future recreation demand.

Human-biometeorological relationships (i.e., human-atmosphere interactions) were used to understand and predict future outdoor recreation and nature-based tourists' participation decisions (Gómez-Martín & Martínez-Ibarra, 2012; Lindner-Cendrowska, 2013). Human-biometeorological relationships were also used to inform future outdoor recreation plans and to develop adaptation strategies (Matzarakis et al., 2012b). Biometeorological data have been interpreted through relationships to personal characteristics (Andrade et al., 2011b) and used to predict thermal sensation by creating thermo-physiological models (Pantavou & Lykoudis, 2014; Rutty & Scott, 2014a, 2014b).

One common thermal measurement index, PET (i.e., human bio-meteorological index), has been used to assess comfort and discomfort based on four key weather conditions, including air temperature, relative humidity, wind speed, and cloud cover (Höppe, 1999). PET has been used to assess tourism's dependency on weather conditions (Brandenburg et al., 2007; Zhang & Wang, 2013), examine beach users' preferences for weather and ocean conditions (Zhang & Wang, 2013), and to assess patterns of temporal use of daily frequency of recreational and commuting cyclists (Brandenburg et al., 2007). Weather simulation models have also used the PET and weather conditions to estimate the thresholds of acceptability for tourism based on secondary data (Endler & Matzarakis, 2011; Matzarakis, 2014).

Other important weather conditions examined in the literature include extreme weather events and climate variability. Investigations include the effects of extreme weather events on the ski industry (Dawson & Scott, 2013, 2007; Haanpää, Juhola, & Landauer, 2014; Hamilton, Rohall, Brown, Hayward, & Keim, 2003; Scott, Dawson, & Jones, 2008; Scott, McBoyle, Minogue, & Mills, 2006), tourists' perceptions (Hübner & Gössling, 2012), holiday destination selection (Windle & Rolfe, 2013), and resource users' vulnerability (Marshall, Tobin, Marshall, Gooch, & Hobday, 2013). Climate variability[2] was typically examined through climate modeling and scenario-based research that incorporated weather conditions into planning for outdoor recreation and nature-based tourism. Some research has quantified the climate tourism potential of specific regions to predict future participation (Brosy et al., 2013; Matzarakis et al., 2012). Climate scenario-based research has been used to evaluate the influence of weather conditions on golfing, and its season length, operations, adaptation costs, and water requirements (Scott et al., 2006). Planning research has used weather conditions and climate scenario-based research to identify desirable tourism destinations (Matzarakis et al., 2012; Topay, 2013), and to assess resource use, risk management, and adaptation strategies for the Artic Bay Inuit population (Ford et al., 2006).

[2] Climate variability refers to variations in the mean state and other statistics, such as standard deviations and statistics of extremes, of the climate on all temporal and spatial scales beyond that of individual weather events.

Trip characteristics

The second salient factor was *trip characteristics* and included the variables of transportation mode, length of stay, route traveled (i.e., distance at site and covered topography), activity day, and distance. Throughout the data, transportation mode signified the mode of transport employed to access and then engage in recreation at a destination (Becken et al., 2003; Reddy, Nica, & Wilkes, 2012); often categorized as motorized (i.e., vehicle traffic) or nonmotorized (i.e., on foot or by bike; Manning & Anderson, 2012). Length of stay was measured by the amount of time spent onsite or at the destination during the current visit and was paired with weather data (Barbieri & Sotomayor, 2013; Becken & Wilson, 2013; Coghlan, 2012; Dawson, Havitz, & Scott, 2015; Pongkijvorasin & Chotiyaputta, 2013; Woodside, Caldwell, & Spurr, 2005).

Route traveled was operationalized as a path or series of elements traveled to reach a single destination or connect multiple destinations and typically joined resources and attractions, varied in length, and influenced visitor numbers (Becken & Wilson, 2013; Lackstrom, Kettle, Haywood, & Dow, 2014). Route traveled metrics included distance traveled during activity and topography, while weather was treated as a situational factor influencing route decision-making (Becken & Wilson, 2013). Activity day indicated the day of the week including work days, weekends, and holidays recreationists and nature-based tourists engage in outdoor recreation and the relationship among weather conditions (Brandenburg, Matzarakis, & Arnberger, 2007; Shih, Nicholls, & Holecek, 2008). Assessing activity days allowed for an understanding of the day-to-day variations in recreation use paired with weather data. Distance, a proxy for travel costs and travel time and calculated in kilometers and/or miles from residential city to holiday destination location, was used to assess the effect of weather in tourists' residential city on holiday destination selection (Bigano, Hamilton, & Tol, 2006).

Site characteristics

The third most prevalent factor, *site characteristics*, encompasses the variables of site infrastructure, community infrastructure, vulnerability, adaptive capacity, and resources to support extreme weather events. In the literature, site infrastructure was often conceptualized as the operations and development at specific recreation or tourism areas (Barbieri & Sotomayor, 2013; Lemieux, Beechey, Scott, & Gray, 2011). Site infrastructure included transportation infrastructure (e.g., parking lots and roadways) and facility infrastructure (e.g., restrooms, visitor centers, campgrounds, trailheads). Community infrastructure referred to the ability of surrounding communities to support tourism or recreation development (e.g., support services, water, and energy supply; Bennett, Lemelin, Koster, & Budke, 2012).

Espiner and Becken (2014) treated vulnerability in a geographic context, including conditions contributing to a sector's vulnerability such as distance from mass markets, increasing fuel costs, global financial forecasts, and a diverse range of physical environmental variables. Meanwhile, Dawson and Scott (2010) relied on a supply and demand approach to assess vulnerability by proposing models to project future climate change impacts (i.e., supply) and behavioral responses to historic and expected conditions (i.e., demand).

Related to vulnerability, adaptive capacity was examined throughout the literature, specifically in relationship to climate change impacts. Scott, Simpson, and Sim (2012) found that the following key variables determined the adaptive capacity of coastal destinations to cope with weather variations: policy and planning frameworks, resort property ownership and local taxation structures, insurability and insurance costs, and structural protection and recurrent beach nourishment affordability. Another common variable of interest in this data was

resources to respond to extreme weather events. This included the physical built infrastructure and data processing infrastructure designed to support or withstand extensive damage resulting from extreme weather events (Perch-Nielsen, 2010; Scott & Lemieux, 2010).

Experiences with weather

The factor *experiences with weather* characterizes the research about recreationists and tourists' connections to weather. Important variables investigated throughout the research related to *experiences with weather* including weather perceptions, expectations and preferences, encountered weather, behavioral reactions to weather, and weather and climate information.

Tourists' perceptions, expectations, and preferences of weather were intertwined concepts throughout many studies. Perceptions of weather were investigated by assessing tourists' responses to meteorological conditions (i.e., weather conditions) such as temperature, precipitation, and humidity (Andrade, Alcoforado, & Oliveira, 2011; Denstadli, Jacobsen, & Lohmann, 2011). Researchers investigated tourists' expectations of weather through predetermined understandings of local weather conditions at a destination (Becken & Wilson, 2013; Coghlan, 2012; Hübner & Gössling, 2012). Weather preference assessments were based on subjective and self-reported preferences for specific weather conditions (Førland et al., 2013).

While the three concepts of perceptions, expectations, and preferences are distinct, often these variables were investigated in some combination within one questionnaire or interview, presenting challenges in differentiating measurement uniqueness. For example, weather perceptions, most often measured as a single item (e.g., Denstadli et al., 2011, Hübner & Gössling, 2012) have been conflated with measurements of tourists' experienced weather and expectation congruence (Hübner & Gössling, 2012). Similarly, weather expectations, typically a single item measurement, was paired with encountered weather measurements to predict tourists' behavioral changes (Becken & Wilson, 2013). Weather preference measurements often required tourists to predict changes in plans due to unexpected weather (Denstadli et al., 2011) or to assess the relationship between bioclimatic comfort through weather preferences (Andrade, Alcoforado, & Oliveira, 2011). Only very unique studies combined self-reported weather preferences with present and future climate conditions at select destinations (Førland et al., 2013), indicating a need for consistent and distinct measurement items for weather perceptions, expectations, and preferences.

A variety of studies found strong links between behavioral reactions to weather, encountered weather, and available weather and climate information. Aggregate data suggest that encountered weather (Denstadli, Jacobsen, & Lohmann, 2011), coupled with prior and concurrent engagement with weather information, often resulted in behavior change (i.e., travel itinerary adaptation; Becken & Wilson, 2013). Research also suggested destination selection is based on encountered or expected weather conditions and perceptions of weather conditions at a destination (Gössling & Hall, 2006).

Season

The fifth most prevalent factor was *season*, which was examined in the literature through the lens of natural seasonality and institutional seasonality. Natural seasonality, defined as the length and quality of tourism and recreation seasons (Butler, 2001), was based on unstable weather patterns resultant from climate influences on the physical resources that provide foundations for outdoor recreation and nature-based tourism (Jones & Scott, 2006). Studies

on natural seasonality targeted the lengthening of warm weather recreation and tourism seasons as a result of climate change (Yu, Schwartz, Walsh, Schwartz, & Salmon, 2009, 2013). Studies also examined the implications for park visitation and golfing toward projecting regional impacts of winter tourism (Dawson & Scott, 2010), as well as the influx of natural capital as a result of seasonal tourism products and experiences reliant on weather (Bennett et al., 2012). Institutional seasonality was characterized by systematic fluctuations of visitation around summer school holidays (Scott, Jones, & Konopek, 2007). Increases in visitation to tourist locations typically occur around institutional seasons, partially based on residential and destination weather (De Freitas et al., 2008; Scott, Jones, & Konopek, 2007).

Resource characteristics

Research in the area of *resource characteristics* often included regional climate variability, resource dependency, natural environment, and management practices. The *resource characteristics* factor largely focuses on the environmental and managerial environments, whereas the *site characteristics* factor generally refers to variables related to infrastructure development at specific recreation or tourism areas (e.g., Barbieri & Sotomayor, 2013; Lemieux, Beechey, Scott, & Gray, 2011).

Regional climate variability was assessed in relation to the impacts of weather on skiing and the ski economy (Scott, McBoyle, & Minogue, 2007), the length of outdoor skating season (Damyanov, Damon Matthews, & Mysak, 2012), and increasing energy costs and extreme weather events (Brugger & Crimmins, 2013; Espiner & Becken, 2014). Resource dependency was used to characterize the strength of linkages between social and ecological systems, which also included an activity's dependency on certain resources. For example, the concept of resource dependency assesses individuals' sensitivity to changes in resource conditions (e.g., weather variations) of the Great Barrier Reef—resources on which communities, industries, and systems depend (Marshall et al., 2013).

The natural environment variable was often separated into push and pull factors, representative of natural site characteristics rather than human built infrastructure. Previous research suggested that push and pull factors influence travel in diverse ways. Push factors motivate travel (i.e., social psychological factors that motivate travel) and are represented by weather at a trip's origin. Both climate and recreation have been reported as push factors (Pomfret, 2006). Pull factors influence destination or site selection (e.g., landscapes, the geography, and ecosystem features; Pomfret, 2006). For example, the natural mountain environment draws mountaineers to areas with suitable resources (Pomfret).

Lastly, management practices at recreation and tourism sites were a key topic related to resource conditions. Management practices were studied in relationship to weather-related challenges such as environmental sustainability at ski resorts (Spector, Chard, Mallen, & Hyatt, 2012), seasonally based personnel management (Lackstrom et al., 2014), risk management strategies (Becken & Hughey, 2013; Ford, Smit, & Wandel, 2006), and snow production amounts and timing (Scott, McBoyle, & Minogue, 2007).

Personal characteristics

Although *personal characteristics* existed in 17 studies, it was the least prevalent factor. These personal characteristics are in addition to standard demographic information and include experience use history, past use history, place attachment, quality and satisfaction of recreation experiences, recreation specialization, beliefs in climate change, and recreation experience preferences. Because these are commonly examined concepts in outdoor recreation

Table 3. Personal Characteristics Factor.

Weather-related Factor: Personal Characteristics		
Variable	Operationalized variable	Study Citation
Experience use history or travel behavior	Surfing behavior – number of times a year an individual has been surfing, number of days a week, weeks in the last year	(Barbieri & Sotomayor, 2013)
	Traveler behavior – likelihood to return based on weather conditions	(Denstadli, Jacobsen, & Lohmann, 2011)
Past use history	Surfing behavior – number of trips in the last five years, trip length, and variety	(Barbieri & Sotomayor, 2013)
	Traveler behavior – likelihood to return based on weather conditions	(Denstadli et al., 2011)
Place attachment	Examined to determine recreational tourism potential	(Yang, Madden, Kim, & Jordan, 2012)
	Social component of a natural resource system	(Marshall, Tobin, Marshall, Gooch, & Hobday, 2013)
Quality and satisfaction of recreation experiences	Weather quality Trip satisfaction Environmental quality Human-built destination specific infrastructure Quality of overall experiences Recreation season Overall satisfaction with wildlife encounters, recreation experiences, and destination specific attributes	(Hipp & Ogunseitan, 2011; Richardson & Loomis, 2005; Scott & Jones, 2006; Sutton, 2005; Thapa, 2012; Yu, Schwartz, Walsh, Schwartz, & Salmon, 2013)
Recreation specialization	Touristic skill construction	(Tsaur, Yen, & Chen, 2010)
	Effects of extreme weather on climbers	(Bassi & Fave, 2010)
Beliefs in climate change	Anthropogenic causation Occurrence	(Brownlee & Verbos, 2015; Brownlee, Hallo, Wright, Moore, & Powell, 2013)
Recreation experience preferences	Traveler motivations	(Denstadli, Jacobsen, & Lohmann, 2011)
	Weather influences on likelihood of return visitation	(Laing & Crouch, 2011)
	Participation in frontier tourism Desert trekking Motivations for sun, sand, and sea travel	(Hübner & Gössling, 2012)

literature (see Manning, 2011, for a review), research on personal characteristics and weather are listed in Table 3.

Research trends and gaps for weather-related factors and variables

Temperature has been the most studied variable throughout weather-related research, appearing in all of the 184 articles. In most articles, temperature data were commonly paired with participation in tourism activities to predict future participation (e.g., Yu et al., 2013; Zhang & Wang, 2013). Despite urging from researchers to pair temperature data with other weather variables (Scott & Lemieux, 2010; Scott et al., 2012), the research synthesis reveals that the majority of studies only used temperature to predict outdoor recreation and nature-based tourism participation, which highlights an important gap. As a result, our suggestion echoes Scott et al. (2012); that is, researchers should use additional weather variables beyond temperature when evaluating the influence of weather on outdoor recreationists' and nature-based tourists' behavior.

It is apparent that previous research has focused investigations on the influence of weather information on tourist behavior. For example, weather information has been linked to encountered weather and tourists' behavioral reactions to weather (e.g., Becken & Wilson, 2013; Denstadli, Jacobsen, & Lohmann, 2011). However, although Scott et al. (2012) suggest that tourists' *processing* of weather information is important, the gap analysis results indicate that there are limited investigations evaluating *how* outdoor recreationists' process

and integrate weather information. Technological advances and new communication mechanisms (e.g., social media platforms, weather information websites) provide new and potentially accessible avenues for researchers to investigate how outdoor recreationists' process and integrate weather information.

Although Scott et al. (2012) indicate that the effects of weather on tourists' decision making, weather-related traveling motivations, and activity participation is important, the results of the gap analysis suggest this area is still relatively uninvestigated. Therefore, future research can investigate the process of *how* nature-based tourists and outdoor recreationists engage with weather to understand touristic and recreation behavior.

The gap analysis revealed a lack of diversity in research methods with an overwhelming majority of the studies relying on secondary meteorological data. Most commonly, the qualitative methods were case-based, expert-based, and descriptive, while the quantitative methods traditionally used secondary weather data to predict future participation in activities or visitation to destinations. Less commonly, researchers paired secondary weather data with in situ questionnaires to compare recreationists and tourists' perceptions of different weather scenarios. In future investigations, recreationists' perceptions of weather could be measured and coupled with climate prediction modeling data or used to holistically understand the weather dependency of key outdoor recreation and nature-based tourism activities.

Although Scott et al. (2012) and Manning (2011) both highlight seasonal visitation patterns as important in nature-based tourism and outdoor recreation, limited research has focused on the relationship among trip characteristics and weather variables to understand increasing visitation to popular areas during shoulder seasons. Furthermore, Manning (2011) suggests that outdoor recreationists' perceptions, expectations, and preferences are critically important for managers and researchers to understand. However, results from the gap analysis indicate that scholars might lack mechanisms and measurements to distinguish between these three constructs in relation to weather. Researchers might consider multiple item scales to assess weather perceptions, expectations, and preferences that could provide consistent and distinct measurement.

Emergent theme two: The importance of geographic research context

Research theme two revealed the importance of geographic research context. The data fit into three larger categories that are not necessarily mutually exclusive due to the nature of comparative study designs and overlapping geographic research contexts: 1) North American land-based context, 2) European winter and land-based context, and 3) marine island-based context.

Well over 50 articles (approximately 30%) were situated in the North American land-based context and these studies most commonly examined aspects of winter tourism. The majority of these studies come from a Canadian and United States ski-based context. This is evidenced by the sheer volume of studies conducted on the effects of a changing weather on the ski industry (e.g., Scott et al., 2008; Scott, McBoyle, & Minogue, 2007).

About half of the articles originated in a European winter- and land-based context. Studies in this category were conducted in places like Finnish Lapland's Artic tourism context (Dawson, Johnston, & Stewart, 2014; Huntington et al., 2007; Kajan, 2014; Jacobsen, Denstadli, Lohmann, & Førland, 2011) and the French Mediterranean coast (Balouin, Rey-Valette, & Picand, 2014). Lastly, about a quarter of the articles originated in a marine island-based context. This includes studies conducted in Australia's Great Barrier Reef Marine Park (Coghlan, 2012; Marshall et al., 2013; Sutton, 2005), as well as along New Zealand's coasts

(Becken, 2012; Becken & Hughey, 2013; Becken, 2013; Espiner & Becken, 2014; Hughey & Becken, 2014; Jeuring & Becken, 2013; Perch-Nielsen, 2010; Wilson & Becken, 2011), and in other popular places such as Hawaii (Nelson, Dickey, & Smith, 2011) and the Caribbean Islands (Becken, 2014; Hübner & Gössling, 2012; Nelson et al., 2011; Rutty & Scott, 2014b; Rutty, 2013; Weaver, 2005).

Research trends and gaps for the importance of geographic research context

The trend for theme two unequivocally points to the growing body of research originating from the European ski tourism context. Climate prediction models suggest that under certain weather conditions, the availability of snow will be concentrated in specific geographic areas, resulting in a greater concentration of tourists in higher altitude areas (Gilaberte-Burdalo, Lopez-Martin, Pino-Otin, & Lopez-Moreno, 2014). Weather and climate prediction model research has also resulted in a focus on high altitude ski tourism, and the growing body of research is focused on the ski tourism industry in Europe.

As Gomez-Martin highlights, geographic context is important, but the results from the gap analysis indicate that few studies occurred in developing nations, which has limited the number of studies about indigenous populations' outdoor recreation and weather. Only a few studies, published in the English language, have investigated weather, outdoor recreation, and nature-based tourism in Central and South America, Asia, and Africa. There potentially exist studies published in other languages (e.g., Spanish, French) that were not included as a part of this review. The data for our study contain only one investigation from each aforementioned area and no studies from the Middle East and Russia. Scott and Lemieux (2010) acknowledge this gap and recommend weather studies be conducted in developing nations (p. 146). Therefore, future inquiries about the weather in outdoor recreation and nature-based tourism can focus on underresearched geographies such as the Middle East, Russia, Asia, and developing nations. Finally, researchers can build capacity by extending their research community outside of Europe and North America. For example, if author location is an indicator for the number of studies originating out of geographic research contexts, diversifying collaboration opportunities may aid in building a larger community of researchers studying weather, outdoor recreation, and nature-based tourism.

Emergent theme three: Prevailing activity types

There were four primary activity types investigated throughout the research. General nature-based tourism was the most prevalent activity category and included undertakings such as "sun and beach tourism" (Martinez-Ibarra, 2011), surf tourism (Ponting & McDonald, 2013), and golf package vacationers (Geissler, 2008).

Skiing was the second most prevalent activity category but the most prevalent single activity type. The ski industry, under certain climate scenarios and subsequent weather changes, will likely be the most influenced, bringing the study of weather and skiing to the forefront. Weather studies centered around skiing collectively examined the ski industry holistically from stakeholder interviews (Scott et al., 2006), ski operator focus groups (Bank & Wiesner, 2011), and ski and snowboard participant surveys (Buller et al., 2012).

Third, was the residential- and/or community-oriented category of activities. Roughly 15 studies examined one aspect of residential or community recreation activity. For example, one study asked 950 residents over the age of 18 to complete travel diaries on randomly assigned days based on their recreation and commuting activity (Helbich et al., 2014). This category

also included studies of Inuit communities as well (Ford, Pearce, Duerden, Furgal, & Smit, 2010; Ford et al., 2006).

The final category was defined by the visitor experience in park and protected areas around the world. While not activity-specific, the visitor experience in relation to weather is placed in this emergent theme as it includes an assortment of activities that make up the visitor experience. This relation has been examined in numerous environments such as Canada's National Parks (Jones & Scott, 2006), Rocky Mountain National Park (Loomis & Richardson, 2006) and Kenai Fjords National Parks (Brownlee, Hallo, Wright, Moore, & Powell, 2013) in the United States, and Kafue National Park in Zambia (Thapa, 2012).

Research trends and gaps for prevailing activity types

Despite the importance of each activity type (Manning, 2011), the trend for theme three is overwhelmingly skiing and, to a lesser extent, golf, leaving a large portion of outdoor recreation activities underresearched. Intuitively, golf and skiing are weather dependent but no more than other outdoor recreational activities such as hunting, hiking, mountain biking, sailing, surfing, and kayaking. Manning (2011) suggests that some outdoor recreation activities are more reliant on specific resource conditions than others, but our gap analysis results indicate that activity diversity in weather studies is lacking. Therefore, the "weather dependency" of specific outdoor recreation activities is an interesting area where future inquiries can focus attention. For example, research could investigate the weather dependency of backcountry skiing, ungulate hunting, and hiking in a particularly weather-sensitive research context. Additionally, very little is known about the weather dependency of urban outdoor recreation, and that is another area research can explore.

As climate scenarios suggest, skiing and other winter sports are highly susceptible to changes in the weather. Related, Manning (2011) highlights that substitutability is outdoor recreationists' ability to interchange resources, activities, and the timing of those activities so that equivalent outcomes can be achieved with minimal loss of satisfaction. Manning (2011) also indicates that substitutability research has received significant attention in the outdoor recreation management literature. However, the results from the gap analysis suggest that substitutability is under researched in respect to weather. Substitutability research can inform tourism and outdoor recreation managers by identifying activities that recreationists are most likely to engage in given a situation where their primary activity, or resource, is not available.

Conclusion

We started with the simple yet unanswered question: "What are the themes, trends, and gaps in research examining the influence of weather on outdoor recreation and nature-based tourism?" Employing a research synthesis and gap analysis process, we uncovered what the literature suggests are common themes in weather-related outdoor recreation and nature-based tourism research as well as gaps in knowledge. The 184 empirical studies from which the research synthesis and gap analysis findings were drawn were summarized into emergent themes, including the most salient factors and variables, the importance of geographic research context, prevailing activities, and resultant gaps in knowledge. Many points for discussion emerged from this study and we highlight six here.

First, while experts acknowledge that weather exists as a backdrop to outdoor recreation and nature-based tourism, it is only in the last decade that researchers have begun to seriously investigate weather's multidimensional influences on outdoor recreation and nature-based tourism (e.g., de Freitas, Matzarakis, & Scott, 2007; Lise & Tol, 2002; Lohmann & Kaim, 1999;

Scott & Lemieux, 2010). Overall, this research synthesis illustrates that despite some literature about weather in outdoor recreation and nature-based tourism, the number of weather studies has increased steadily since 2009. As the impact of weather on outdoor recreation and nature-based tourism continues to receive increasing attention, it will be necessary to fill several of the knowledge gaps revealed by this study.

Second, the research synthesis and gap analysis process used in this study is replicable, and should be revisited, in perhaps a decade. Researchers can use the search terms, inclusions and exclusion criteria, coding schemes and processes, and steps in the gap analysis process used in this study to compare these results to future investigations. Such replication would allow the research community to understand how research related to outdoor recreation, nature-based tourism, and weather has evolved, and what specific gaps may exist.

Third, this research synthesis identified a need to investigate behavioral responses and weather information processing to expand our understanding about existing and new tourism markets. For example, following the work of Gössling and Hall (2006) researchers can investigate tourists' perceptions of weather conditions coupled with level of engagement with weather and climate information in high-use tourism markets. Given such analyses and strong connections between behavioral responses to the aforementioned variables, researchers may identify new and emergent tourism markets under favorable climate scenarios. Alternatively, areas that might suffer the most can be identified. Further, investigations of these variables might also be expanded to outdoor recreation markets.

Fourth, the findings from this study also indicate that future studies could benefit from investigating recreationists' and tourists' perceptions of weather alongside climate and weather prediction models data to broaden our understanding of the weather dependency of outdoor recreation and nature-based tourism activities. Such examinations may help us understand the specific outdoor recreation activities that are more or less dependent on specific weather and resulting conditions.

Fifth, this study also indicates that such research may benefit from the use of multiple data sources, which could lead to a heightened scientific understanding of recreation participation and recreation prediction patterns based on a multitude of indicators. Sixth, future investigations may also evaluate the effects of technology on outdoor recreation and nature-based tourism, potentially providing insight into technology-based adaptation strategies (i.e., wearing a Gortex rain jacket may extend the human capacity for previously intolerable conditions).

The connection between weather and outdoor recreation is extensive, complex, and will continue. Research investigating the connection among outdoor recreation, nature-based tourism, and weather appears equally complex and will presumably continue as well. The other certainty is that outdoor recreation, nature-based tourism, and weather will change (potentially dramatically) in the decades to come, as will the relationships among the three. During such change, it is our hope that this inaugural state-of-knowledge article will provide an important foundation to gauge the alterations.

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