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Research Article

Expanding the viewshed: Insights and implications for examining visitor use management across scales and modalities in an Iconic National Forest

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ABSTRACT

The recent increase in demand for outdoor recreation opportunities within parks and protected areas (PPAs) has impacted visitor experiences, natural resources, and resource management. Outdoor recreation research and management practices often employ single survey modalities to assess a recreation issue at a specific location and time. This research approach has historically met the challenge of helping to alleviate strains associated with social and ecological impacts in PPAs. Recent research in the areas of social-ecological systems (SES) and hierarchy theory, however, suggests an adaptive systems approach, spanning various scales (e.g., spatial, temporal, topical) and modalities (e.g., on-site, off-site, big data), may be the most comprehensive approach to recreation research and management. The current study examined visitor perceptions of crowding, use-levels, encounter rates, management preferences, and overall experience quality within spatial and temporal scales and on-site and off-site survey modalities at the White Mountain National Forest (WMNF), USA. Specifically, this study compared data within two distinct WMNF studies: 1) a 2016 on-site study (n = 855) and 2) a 2020 off-site study (n = 642). Respondents within these separate, yet complementary studies, were segmented by both frequency of visitation and distance traveled to the WMNF. Descriptive and inferential statistics determined that while there are indeed commonalities between the two samples, respondent profiles and overall perceptions of crowding, encounter rates, and management preferences have different trend pattens between samples, with significant differences within samples. Study findings suggest the employment of multiple scales and modalities may provide greater context, validity, and nuance to complex SES outdoor recreation issues which, in turn may provide a more comprehensive understanding of visitor needs. This research provides empirical evidence to support both the SES and hierarchy theory frameworks and underscores the importance and utility of employing an adaptive systems approach for sustainable PPA management.

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1. Introduction

Visitation to parks and protected areas (PPAs) has steadily increased over the past 50 years in the United States (U.S.) (National Park Service, 2020; USDA Forest Service-National Visitor Use Monitoring, 2019). More recently, PPA visitation has increased exponentially in the U.S., due in part to the COVID-19 pandemic, people's desire for outdoor recreation, and initiatives to facilitate these experiences (Ferguson et al., 2022a; 2022b; Knapp, 2022; Rice et al., 2020; Outdoor Industry Association [OIA] 2021). Rapid visitation increases, within a finite number of PPAs, are often accompanied by significant social and ecological related impacts (Ferguson et al., 2021; Manning, 2011). Accordingly, PPA resource managers have grown concerned regarding the influence of visitation growth upon the quality of the overall recreation experience. Recreation research and management has historically utilized a narrow approach when assessing phenomena, largely relying on one survey modality to assess a single issue at a specific location and point in time (Anderies et al., 2004; Ferguson et al., 2021; Morse, 2020). Recent developments in the social-ecological systems (SES) and hierarchy theory frameworks, however, suggest a broader systems approach, incorporating various scales (e.g., spatial, temporal, topical) and modalities (e.g., on-site, off-site, big data), may be the most comprehensive approach to recreation resource management (Morse, 2020; Perry et al., 2020).

The current study sought to more comprehensively investigate visitor perceptions of crowding, use-levels, encounter rates, management preferences, and overall experience quality by employing two spatial and temporal scales and on-site and off-site survey modalities, within the White Mountain National Forest (WMNF), U.S. Specifically, this study compared data within two distinct WMNF samples: 1) a 2016 on-site intercept sample (n = 855), and 2) a 2020 off-site population sample (n = 642). Within these separate, yet complementary studies, respondents were segmented by frequency of visitation and distance traveled to the WMNF. Descriptive and inferential statistical analyses determined that while commonalities exist between the two samples, respondent profiles and overall perceptions of crowding, encounter rates, and management preferences have trend patterns and significant differences. Study findings suggest that employing multiple scales and modalities may provide greater context, validity, and representation of complex SES outdoor recreation issues. These findings may ultimately provide resource managers a more comprehensive understanding of visitor needs. This research provides empirical evidence to support both the SES and hierarchy theory frameworks and underscores the importance and utility of employing a broader systems-level approach for sustainable PPA research and management.

2. Literature review

2.1. Social-ecological systems framework

The recent global demand for outdoor recreation has critically strained social and ecological systems within PPAs, which in turn has impacted visitor experiences, conservation efforts, and overall community and economic wellbeing (Cole, 2021; OIA, 2021). Outdoor recreation research and management has historically focused on singular issues within discrete locations at one specific time period, often utilizing one modality of data collection (Ferguson, Mueller, et al., 2018, 2021; Morse, 2020; Perry et al., 2020). Additionally, many recreation studies do not account for interdependent spatial and temporal variability, which can affect the multiple systems and sub-systems interacting with natural resources (Ferguson et al., 2021; Morse, 2020). The social-ecological systems (SES) framework, however, provides a multi-scalar and often hierarchical approach to investigating complex issues more comprehensively across multiple scales (e.g., temporal, spatial, even topical) and modalities (e.g., on-site, off-site) (Anderies et al., 2004; Morse, 2020). The SES framework is well suited to account for a range of both positive and negative social and ecological interactions, between multiple levels and systems, in PPA settings (Miller et al., 2021). For instance, social and ecological systems and sub-systems in PPAs often include site-level interactions (e.g., crowding, conflict; trail degradation, trampling) as well as broader community-, state-, and regional-level hierarchical interactions (e.g., cultural, health, economic; water quality, deforestation, pollution) (Ferguson et al., 2021; Miller et al., 2021). While examples are limited in the outdoor recreation literature, SES has been successfully applied to examine human-wildlife interactions (Lischka et al., 2018), invasive species and ecosystem services interactions (Morris et al., 2018), recreational fisheries and aquatic environment interactions (Arlinghaus et al., 2017), as well as recreation-related ecosystems degradation interactions (Keough & Blahn, 2006).

Moreover, SES lends itself well for integration into various visitor use management frameworks that serve to simultaneously provide high-quality social experiences while also protecting natural resources, such as Limits of Acceptable Change, Visitor Experience and Resource Protection, and most recently, the Interagency Visitor Use Management Framework (Cahill et al., 2018; Manning, 2001; Stankey, Cole, Lucas, Petersen, & Frissell, 1985). For example, the USDA Forest Service hierarchically manages visitor use and resource quality at the local, regional, and national levels, which correspondingly influences social and ecological systems and sub-systems at other proximate PPAs and recreation-related facilities (e.g., local, state, and national parks) (Morse, 2020). Organizing these various recreation planning frameworks within a larger SES may provide a "foundation for integrated land management by resolving issues of incongruent boundaries, mismatched scales, and multiple-scale analysis" (Morse et al., 2009, p. 369). Thus, SES and visitor use management frameworks have natural synergies and can capitalize on these critical relationships and interactions to further understand the complex and hierarchical human-nature connection (Cahill et al., 2018; Cole & Hall, 2010; Marion & Cole, 1996; Outdoor Foundation, 2020).

2.2. Hierarchy theory and enveloping

A systems-based approach to recreation management focuses on the connection and impact of spatial, temporal, and topical scales (McCool & Kline, 2020). The SES framework posits that social and ecological systems and sub-systems are complex, hierarchical, and take place across multiple scales (Morse, 2020). Hierarchy theory complements this, examining complex issues across multiple scales and levels of organization (Allen & Starr, 1982; Berkes et al., 2008; Morse, 2020; O'Neill et al., 1986; Perry et al., 2020). First applied in ecological contexts, hierarchy theory applications now span SES considerations, including PPA issues such as critical habitat areas (Beazley, 1997), tools such as prescribed burns mimicking natural processes (Yamaura, 2004), and simultaneous representation of multiple management values (Norton & Steinemann, 2001). Within hierarchy theory, the concept of 'enveloping' prioritizes a scale of focus and integrates one scale above (context), and one scale below (mechanism) a specific recreation-related issue (Allen & Hoekstra, 1992; Perry et al., 2020). Specifically for resource management such as PPAs, this reduces the bias toward one "fundamental" level of analysis (Fox, 1992) and encourages considering connections of scale.

For example, Morse et al. (2009) centered their examination on the USDA Forest Service's visitor use management framework (Limits of Acceptable Change) and the diversity of recreation pursuits available on multiple scales (Recreation Opportunity Spectrum). The scale (or grain) of focus in this context was how the Limits of Acceptable Change can be construed for Recreation Opportunity Spectrum categories within a forest, with the forest boundaries being the larger scale and trampling impacts on a specific recreation site being the smaller scale. If the forest itself were the scale of focus examining recreation impacts,

then the geographic region or system of USDA National Forests would be the larger scale and the Recreation Opportunity Spectrum categories within the forest would be the smaller scale. Using multiple scales of focus prioritizes the influence of a wide range of interconnected impacts related to the extent, process, or size of an event (e.g., crowding) when assessed over time (e.g., day, month, season) and space (e.g., site, forest, region) (Allen & Hoekstra, 1992; Tabor et al., 2014). This approach aims to understand future phenomena related to social, managerial, and resource components within PPAs (Perry et al., 2020). In addition, a broader conceptualization of recreation related issues is especially helpful in understanding complex human dimension issues across multiple scales such as communities, visitors, and natural resources (Manning, 2011; Morse, 2020). Thus, combining SES and hierarchy theory frameworks allows for a more realistic, comprehensive, and precise approach to sustainable PPA management, yet the integration and application of various modalities of sampling remains challenging.

2.3. Modalities of sampling

Collecting representative data that accurately reflects a larger phenomenon or specific recreation-related issue remains challenging (Lewin et al., 2021; Lupi et al., 2020; Wallen et al., 2016). Data inaccuracies and biases are often due in part to low or sporadic response rates and variations of collection methods or modalities that, in turn, impact the precision needed to assess complex outdoor recreation phenomena (Gundelund et al., 2020; Wallen et al., 2016). Recent outdoor recreation research highlights the need to understand complex issues by assessing and incorporating more robust methodologies (Lupi et al., 2020; Wallen et al., 2016). Study designs that incorporate multiple survey modalities, such as on-site and off-site sampling, often yield higher-quality data by increasing response rates, reducing selection biases, and incorporating a wider variety of respondents (Wallen et al., 2016). Thus, a systematic approach to recreation research, which includes multiple sampling modalities, can result in more comprehensive, representative, and valid data (Lupi et al., 2020; Wallen, et al., 2016).

A primary objective of empirical research is to collect representative and generalizable data to explain a phenomenon (Creswell & Creswell, 2017). The two most common survey modalities applied in outdoor recreation research settings are on-site and off-site sampling techniques (Kim & Shelby, 2006; Lupi et al., 2020). These modalities have been employed in numerous studies, with each having their own benefits and drawbacks, yet the comparability of these modalities remains ambiguous (Kim & Shelby, 2006). Broadly speaking, an off-site survey modality refers to using established secondary data sources such as address-based samples, license holder datasets, or census population data for off-site survey sampling (e.g. mail-back, online) (Bishop & Boyle, 2019; Lupi et al., 2020). This modality is often employed to assess outdoor recreation issues using specific groups of people, relevant topics, or wider geographic locations (Lewin et al., 2021). The primary benefits of employing off-site surveys are ease of administration, low cost, and less interruption and survey fatigue for the respondent (Lupi et al., 2020; Venturelli et al., 2017). The primary drawbacks of off-site survey modalities are their propensity for selection bias, reduction in recall, low response rates, and/or partial responses (Kim & Shelby, 2006; Lupi et al., 2020).

Conversely, an on-site survey modality generally refers to collecting distinct in-person data within a specific recreation area (Lupi, et al., 2020). This modality uses direct site quantification (e.g., trail counting) and in-person surveys to assess spatial (e.g., visitor entry points) and temporal (e.g., weekday, weekend) visitation representation (Lupi, et al., 2021). The primary benefit of using an in-person on-site survey is the accurate representation of visitor experiences, the reduction of recall bias, and precise on-site respondent counts (Kim & Shelby, 2006). The primary drawbacks of employing an on-site survey are the high cost, time consumption, and interference to respondents (Kim & Shelby, 2006; Lupi, et al., 2020). Ultimately, the use and comparison of on-site and off-site survey modalities continues to be a relevant topic among recreation researchers. As outdoor recreation visitation grows, precision and modification of recreation research methods will continue to be vital for understanding various recreation impacts, such as perceptions of crowding, encounters, and use-levels, within PPAs worldwide (Hockings et al., 2020; Spenceley et al., 2021).

2.4. Visitor perceptions of crowding

Crowding, a normative topic extensively researched in outdoor recreation, is defined as a subjective, negative evaluation of visitor use density (i.e., use-levels) (Manning, 2011). Crowding has the potential to negatively influence visitor satisfaction as well as various social (e.g., conflict), situational (e.g., parking, traffic), and ecological (e.g., resource degradation) components of the overall outdoor recreation experience (Ferguson, Burns, & Smaldone, 2018, 2021; Shores et al., 2007). The recent demand for outdoor recreation experiences has created pronounced instances of visitor crowding within PPAs and may serve to further shift societal norms associated with acceptability of crowding and visitor encounters (Siler, 2020; Spenceley et al., 2021; Venter et al., 2020). For instance, recent research has demonstrated that perceptions of crowding may increase in the presence of ever-changing and often inconsistent state and federal pandemic mandates and regulations in PPAs (Derks et al., 2020; Ferguson et al., 2021, 2022b, Langlois, 2020; Venter et al., 2020). Moreover, instances of crowding are often a result of restricted access to certain PPA settings, which can lead to higher-than-average visitation rates within the few PPA settings that remain open (Center for Disease Control [CDC], 2020; Siler, 2020; Venter et al., 2020). Ultimately, crowding, as well as visitor preferences towards encounters and use-levels, can impact visitors and communities which in turn forces resource managers, elected officials, and business owners alike to meet shifting demand on PPA's (Ashenfarb & Walls, 2020; Ferguson, Burns, & Smaldone, 2018).

2.5. Visitor preferences towards encounters and use-levels

Visitor perceptions of crowding are complex, as they are often based on a subjective confluence of underlying norms and perceptions assessed on a discrete Likert-type scale (Ferguson, Burns, & Smaldone, 2018; Vaske & Shelby, 2008; Wall & Mathieson, 2006; Zehrer & Raich, 2016). To more thoroughly and objectively assess perceptions of crowding, it is common practice to simultaneously assess visitor encounter preferences (Cole & Stewart, 2002). Encounter preferences refer to the number of visitors an individual has encountered, or is willing to encounter, within a specific timeframe (Heywood, 2000, 2002). For example, visitors are often asked to report the total number of other visitors encountered within a specific location, time, or activity and the acceptability of these encounters (Vaske & Shelby, 2008). The goal of this process is to establish a range of acceptable encounters that have been demonstrated to influence visitor perceptions of crowding, conflict, overall experience quality, and ultimately social norms (Hallo et al., 2018; Vaske & Donnelly, 1997). Moreover, previous research highlights the often-perplexing nonlinear relationship between perceptions of crowding and actual visitation levels (Manning, 2011). Recent research suggests that despite significant visitation increases in various PPAs, visitors often modify or adjust their social norms surrounding crowding and encounter rates in an effort to preserve their overall quality experience (Kainzinger et al., 2016; Kuentzel & Heberlein, 2003; Kyle & Landon, 2021). Given the recent demand for outdoor recreation, a new norm of crowding may bring forth different standards, preferences, and perceptions of encounters, use-levels, and crowding acceptability.

2.6. Summary and research questions

The majority of PPA research has historically assessed issues within a rather limited scope and scale; often employing a single survey modality to assess a single issue at a specific location and time (Morse et al., 2009). A broader methodology, however, incorporating various scales and modalities, may yield more comprehensive and reliable findings while highlighting the nuances of each approach. This concept has been suggested in the literature, but to our knowledge, this is one of the first studies to apply these concepts in a PPA setting in the region of New England, U.S. From a theoretical perspective, parallels were drawn between study finding and the SES and hierarchy theory conceptual frameworks. To be clear, this study did not test specific theories, but sought to provide empirical evidence to inform future research and theory. This study addressed these gaps by assessing visitor perceptions of crowding, use-levels, encounter rates, management preferences, and overall experience quality within spatial and temporal scales and on-site and off-site survey modalities, at the White Mountain National Forest (WMNF). Specifically, this study compared data within two distinct WMNF study samples: 1) a 2016 on-site study (n = 855), and 2) a 2020 off-site study (n = 642). Accordingly, the following research questions were examined:

R1: Who are the WMNF visitors sampled within and across study modalities?
R2: How does frequency of visitation relate to perceptions about social conditions within and across study modalities?
R3: How does distance traveled relate to perceptions about social conditions within and across study modalities?

3. Methods

3.1. Study context- the White Mountain National Forest

Located in northern New Hampshire and western Maine, the approximately 800,000-acre White Mountain National Forest (WMNF) is the largest PPA in New England (USDAFS, 2020). A unique combination of abundant public access, proximity to major population centers, and substantial ecological diversity make the WMNF one of the most visited PPA resources on the East Coast, hosting more than 3.4 million outdoor recreation visitors annually (NFF, 2020; USDAFS, 2020). The WMNF is federally managed by the USDA Forest Service, which provides high-quality and informed natural resource management in addition to an immense number of outdoor recreation resources and opportunities including six wilderness areas, four downhill ski areas, six nordic ski areas, 23 campgrounds, over 1200 miles of hiking trails, more than 550 miles of snowmobile trails, and 45 mountain peaks above 4000 feet (USDAFS, 2020). With a substantial and consistent volume of local, regional, and international visitors spending more than $400 million annually, the WMNF also serves as a major economic hub within New England (NFF, 2020; USDAFS, 2016).

3.2. Data collection

Two separate studies and corresponding datasets, each with their own forms of data collection methods, were analyzed in this study. For ease of reference, the two studies are referred to in this manuscript as: 1) the *on-site sample* and 2) the *off-site sample*. The on-site sample conducted on-site face-to-face surveys with WMNF visitors at four separate management-priority recreation sites on the WMNF from June to August of 2016 (see Reigner et al., 2017 for a complete account). These four sites were selected based upon specific concerns from resource managers: 1) Franconia Ridge Trail, 2) Gulfside Trail, 3) Crawford Path, and 4) Rumney Rocks. The first three sites are hiking destinations while the final site, Rumney Rocks, serves primarily as a rock climbing and bouldering destination. Using a rotating stratified block sampling design, trained field researchers intercepted WMNF visitors at each of the four locations during daylight hours, with survey efforts corresponding to daily and hourly use patterns ascertained through trail counters and managerial observations. This process yielded an 85% overall response rate, with 1006 potential respondents being approached and 855 respondents completing the survey. All surveys were completed in hard-copy with data transcribed daily into a digital format.

The off-site sample collected a population sample of WMNF visitors from June to August of 2020 using a modified drop-off pick-up survey technique referred to as a *knock-and-drop* survey method (Allred & Ross-Davis, 2011; Jackson-Smith et al., 2016). The knock-and-drop method consisted of trained field researchers canvassing predetermined residential neighborhoods, knocking on doors, briefly introducing themselves to homeowners (if available), and then hanging pre-assembled survey kits on the doorknob of each home. Potential respondents were presented two survey modality options: 1) an online survey via Qualtrics, or 2) a paper mail-back survey. Canvassing and survey locations were predetermined based upon secondary analysis of WMNF National Visitor Use Monitoring data, which identified 11 specific New Hampshire communities where a cumulative majority of WMNF visitors (42%) reside (see Ferguson et al., 2021 for a complete account; USDA Forest Service-National Visitor Use Monitoring, 2019). Of the 3000 survey kits distributed, 642 completed surveys were returned, representing a 21% response rate. These survey methods, modality preferences, and response rates are consistent with similar research (Stedman et al., 2019; Wallen et al., 2016).

3.3. Survey instrumentation

The on-site and off-site studies shared commonalities in approach. The first portion of the surveys included trip visitation patterns and characteristics. Next, respondents assessed a series of questions related to perceptions of satisfaction, crowding, encounters with other visitors, site stratums, and management preferences. Perceptions of overall crowding and satisfaction were respectively evaluated on previously validated seven- and nine-point Likert-type scales (Graefe & Fedlar, 1986; Vaske & Shelby, 2008). To assess respondent perceptions of encounters with other visitors, respondents were asked to indicate the maximum number of visitor encounters per day they would prefer to encounter at any one site. This assessment has been empirically validated to accurately assess maximum visitor encounter rates (Kuentzel & Heberlein, 2003; Kyle & Landon, 2021).

To evaluate respondent's site stratum preferences, visitors were presented with the current WMNF definitions of each site stratum: low use sites 0–6 people per day (PPD), medium use sites 7–25 PPD, high use sites 25–50 PPD, and very high use sites 51+ PPD. They were then asked to select which one site stratum they preferred while recreating at the WMNF. This item was developed based on previously validated research and in collaboration with resource managers (English et al., 2020). Next, to assess respondents' management preferences, respondents were asked to indicate the extent to which they supported or opposed two items on a seven-point Likert-type scale: "placing limitations on the number of people allowed to use the WMNF" and "requiring visitors to use public shuttle transportation services at the WMNF". Both of these items were developed based on previously validated research and in collaboration with resource managers (Ferguson et al., 2021; Manning & Valliere, 2001; Stankey, 1980). Finally, respondents were asked a series of socio-demographic questions. The full questions of each survey and their detailed approaches are described in other publications (Reigner et al., 2017; Ferguson et al., 2021).

3.4. Data analyses

All data within both studies were analyzed using Statistical Package for the Social Sciences (SPSS) version 24.0. To assess research question R1, frequencies, percentages, and measures of central tendency were used. To examine research questions R2 and R3, a series of cross-tabulation procedures in combination with Pearson's Chi-Square analyses as well as a series of one-way analysis of variance (ANOVA) procedures in combination with numerous post-hoc analyses were applied.

4. Results

4.1. Research question one

To assess who the visitors are within and across study modalities, respondents in both the on-site and off-site samples evaluated the same socio-demographic, trip characteristic, and perceived social conditions questions. For the on-site sample, 66% of respondents identified as male and 34% as female (Table 1). The average age of respondents within the sample was 35 years. The majority of respondents self-reported their race/ethnicity as White (96%). Over two-thirds (73%) of the sample reported earning either a four-year or graduate/professional degree. Respondents noted hiking/walking, camping, backpacking, and cycling were some of their most common recreation activities.

For the off-site sample, approximately half of respondents (50%) identified as male with the other half identifying as female (Table 1). The average age of respondents within the sample was 57 years. The majority of respondents self-reported their race/ethnicity as White (96%). Over two-thirds (71%) of the off-site sample reported earning either a four-year or graduate/professional degree. Respondents noted hiking/walking, snow sports, sightseeing, and scenic driving were some of their most common recreation activities.

For the on-site sample, the majority of respondents (73%) were non-New Hampshire residents who noted traveling an average distance of approximately 378 miles from their homes to the WMNF (Table 1). These largely non-local and less frequent recreationists noted visiting the WMNF an average of 11 times in the last year-this was driven by a frequently-visiting minority of the sample, with more than and 77% of this sub-sample visiting 10 or fewer times. The majority of the on-site sample reported visiting the WMNF 2–10 times in the last year (46%), with a substantial proportion reporting only visiting the WMNF once in the last year (31%). Further, results of a cross-tabulation procedure in conjunction with Pearson's Chi-Square analyses between visitation frequency and distance traveled suggest that as proximity increases, so does repeat visitation (Table 2). There are not significant differences among visitation frequency categories for locals, but both regional and national visitors were more likely to be infrequent visitors (Table 2).

For the off-site sample, the majority of respondents (91%) were New Hampshire residents who noted traveling an average distance of approximately 60 miles from their homes to the WMNF (Table 3). These largely local and frequent recreationists noted visiting the WMNF an average of 37 total times in the last year. The majority of the off-site sample reported visiting the WMNF 11–30 times in the last year (36%), with a substantial proportion reporting visiting the WMNF 31 or more times in the last year (32%). Further, results of a cross-tabulation procedure in conjunction with Pearson's Chi-Square analyses between visitation frequency and distance traveled suggests local visitors were significantly more likely than non-local visitors to recreate on the WMNF more frequently (Table 3).

Regarding the on-site sample, satisfaction, crowding, use-level preferences, and management preferences were all rated generally high; and higher than the mean levels reported by the off-site sample (Table 4). On-site visitors noted they were highly satisfied with their experience on the WMNF (M = 6.5/7.0) (Table 4). Overall, respondents noted low to moderate levels of perceived crowding (M = 3.3/9.0), a strong preference for *very high use* (47%) and *high use* (23%) site stratums, and a very high threshold (M = 379 visitors) for the maximum number of visitor encounters preferred per day, at any one site on the WMNF. On-site sample respondents also noted moderate levels of support for management preferences related to both limiting overall visitation (M = 5.1/7.0) and expanding shuttle services (M = 4.3/7.0) on the WMNF.

Regarding off-site visitors' perceptions of social conditions, respondents noted they were very satisfied with their experience on the WMNF (M = 6.0/7.0) (Table 4). Overall, respondents noted high levels

Table 1
On-site and off-site samples: WMNF visitors' respondent profiles and trip visitation characteristics.

Variable	On-site M (SD) or %	Off-site M (SD) or %
Gender		
Male	65.9	49.8
Female	34.1	49.3
Age		
Average age	34.62 (12.1) years	56.68 (14.7) years
18–35	62.3	9.8
36–50	20.8	21.0
51–64	15.4	28.2
65+	1.5	33.2
Race/Ethnic Background		
White	96.0	96.0
Black/African American	1.4	<1.0
Spanish/Hispanic/Latino	3.5	<1.0
American Indian/Alaskan Native	2.0	<1.0
Other	4.4	1.8
Education		
Less than high school	1.6	<1.0
High school graduate	8.3	9.0
Some college	12.3	9.8
2-year degree	5.3	9.8
4-year degree	37.0	31.6
Graduate/professional degree	35.6	39.4
Recreation activity participation		
Hiking/walking	92.2	90.5
Sightseeing or viewing natural features/ wildlife	39.3	68.4
Driving for pleasure/Scenic driving	48.1	65.7
Hunting or fishing	34.0	18.8
Backpacking	61.1	29.3
Camping (e.g., developed, undeveloped, primitive)	74.2	30.4
Cycling (e.g., mountain biking or bicycling)	58.1	29.3
Picnicking	37.4	37.2
Snow sports[A] (e.g., downhill skiing, XC skiing)	34.3	80.2
Other[A] (e.g., boating, relaxing, rock/ice climbing)	68.5	91.2
State of Residency		
New Hampshire	26.8	91.2
Non-New Hampshire	73.2	8.8
Distance Traveled to the WMNF		
Average distance	377.82 (472.37) miles	59.51 (50.01) miles
Local (1–50 miles)	5.9	17.1
Regional (51–100 miles)	10.5	51.2
National (101+ miles)	83.6	31.8
Visitation Frequency – Visits to the WMNF in the past year		
Average visits	10.92 (18.73) visits	37.40 (44.13) visits
First (1)	30.5	3.2
Low (2–10 visits)	46.4	28.8
Moderate (11–30 visits)	14.2	36.3
High (31+)	8.8	31.8

*Note. Percentages may not equal 100 because of rounding.
A Note. Activities comprising these categories differed slightly between studies.

Table 2
On-site Sample: Cross-tabulation based on Visitation Frequency by Distance Traveled to the WMNF.

Variable	1 visit %	2-10 visits %	11-30 visits %	31+ visits %
Distance Traveled to the WMNF[a]				
Local (1–50 miles)	6.4	4.5	7.5	11.1
Regional (51–100 miles)	3.2[a]	13.5[b]	14.0[b]	16.7[b]
National (101+ miles)	90.4[a]	81.9[b]	78.5[b]	72.2[b]

*Note. Percentages may not equal 100 because of rounding.
[a] Chi-Square: 23.777, df: 6, p < 0.001.

Table 3
Off-site Sample: Cross-tabulation based on Visitation Frequency by Distance Traveled to the WMNF.

Variable	1 visit %	2-10 visits %	11-30 visits %	31+ visits %
Distance Traveled to the WMNF[a]				
Local (1–50 miles)	29.4[a]	50.3[b]	66.6[b]	68.0[b]
Regional (51–100 miles)	68.6[a]	43.8[b]	23.5[b]	16.5[b]
National (101+ miles)	2.0[a]	5.9[b]	9.9[b]	15.5 [b]

*Note. Percentages may not equal 100 because of rounding.
[a] Chi-Square: 91.180, df: 6, p < 0.001.

Table 4
On-site and off-site samples: WMNF visitors' perceptions of social conditions.

Variable	On-site M (SD) or %	Off-site M (SD) or %
Overall satisfaction[a]	6.49 (0.89)	5.97 (0.86)
Overall crowding[b]	3.33 (1.64)	5.46 (2.04)
Stratum preferences per day		
Low use site (0–6 PPD)	14.9	49.7
Medium use site (7–25 PPD)	15.1	42.2
High use site (26–50 PPD)	22.7	5.8
Very high use site (51+ PPD)	47.3	2.3
Max encounter preferences per day		
Average max encounters with other visitors per day	379.38 (420.04)	32.63 (47.63)
Management preferences[c]		
Limitation on number of visitors	5.11 (1.76)	4.49 (1.80)
Expand shuttle services	4.34 (1.59)	4.77 (1.82)

*Note. Percentages may not equal 100 because of rounding.
[a] Note. Response Code: 1 = Poor and 7 = Perfect.
[b] Note. Response Code: 1 = Not at all crowded and 9 = Extremely crowded.
[c] Note. Response Code: 1 = Strongly oppose and 7 = Strongly support.

of perceived crowding (M = 5.5/9.0), a strong preference for *low use* (50%) and *medium use* (42%) site stratums, and a relatively low threshold (M = 33 visitors) for the maximum number of visitor encounters preferred per day, at any one site on the WMNF. Off-site sample respondents also noted moderate levels of support for management preferences related to both limiting overall visitation (M = 4.5/7.0) and expanding shuttle services (M = 4.8/7.0) on the WMNF.

4.2. Research question two

To assess the extent to which frequency of visitation relates to perceptions of social conditions within and across study modalities on the WMNF, respondents in both samples evaluated the same perceived social conditions questions as well as the same question asking them to identify how many visits in the last year, they made to the WMNF (Tables 5–8). Two cross-tabulation procedures and two ANOVA procedures were applied to investigate these relationships, respectively. To assess the data, the frequency of visitation variable was re-coded to reflect four distinct visitation segments: 1) 1 visit, 2) 2–10 visits, 3) 11–30 visits, and 4) 31 or more visits.

Table 5
On-site Sample: One-way ANOVA based on Visitation Frequency at the WMNF.

Variable	1 visit M (SD)	2-10 visits M (SD)	11-30 visits M (SD)	31+ visits M (SD)	F Value
Overall satisfaction[a]	6.50 (0.88)	6.56 (0.84)	6.36 (0.85)	6.45 (1.12)	1.40
Overall crowding[b]	3.26 (1.51)	3.35 (1.64)	3.41 (1.64)	3.09 (1.77)	0.61
Max encounter preferences	344.65 (327.29)	399.60 (512.66)	442.18 (412.85)	492.05 (315.57)	0.36
Management preferences[c]					
Limitation on # of visitors	5.09 (1.78)	5.21 (1.74)	5.09 (1.74)	4.89 (1.84)	0.73
Expand shuttle services	4.36 (1.61)	4.41 (1.51)	4.41 (1.58)	4.31 (1.78)	0.87

*Note. Percentages may not equal 100 because of rounding.
*Note. *significant at p < 0.05, **significant at p < 0.01, ***significant at p < 0.001.
[a] Note. Response Code: 1 = Poor and 7 = Perfect.
[b] Note. Response Code: 1 = Not at all crowded and 9 = Extremely crowded.
[c] Note. Response Code: 1 = Strongly oppose and 7 = Strongly support.

Table 6
On-site Sample: Cross-tabulation based on Visitation Frequency by Stratum Preference at the WMNF.

Variable	1 visit %	2-10 visits %	11-30 visits %	31+ visits %
Stratum preferences per day[a]				
Low use site (0–6 PPD)	15.5	17.4	13.6	17.9
Medium use site (7–25 PPD)	15.0	19.4	12.6	10.3
High use site (26–50 PPD)	22.5	21.3	22.6	28.2
Very high use site (51+ PPD)	47.0	41.9	51.3	43.6

*Note. Percentages may not equal 100 because of rounding.
[a] Chi-Square: 6.731, df: 9, p = 0.665.

Table 7
Off-site Sample: One-way ANOVA based on Visitation Frequency at the WMNF.

Variable	1 visit M (SD)	2-10 visits M (SD)	11-30 visits M (SD)	31+ visits M (SD)	F Value
Overall satisfaction[a]	5.35 (1.27)[1]	5.86 (0.80)[2]	5.97 (0.82)[2]	6.00 (0.91)[2]	3.77**
Overall crowding[b]	6.12 (2.36)[1]	5.59 (1.93)[2]	5.69 (1.92)[2]	5.04 (2.06)[2]	3.98**
Max encounter preferences per day	21.95 (21.77)	31.99 (25.87)	33.51 (44.52)	40.91 (41.01)	0.19
Management preferences[c]					
Limitation on number of visitors	4.76 (1.85)	4.48 (1.89)	4.33 (1.66)	4.43 (1.81)	0.40
Expand shuttle services	3.88 (1.49)[1]	4.69 (1.86)[2]	4.85 (1.87)[2]	4.83 (1.65)[2]	1.66*

D Note: All relationships were significant at p < 0.001.
*Note. Percentages may not equal 100 because of rounding.
*Note. *significant at p < 0.05, **significant at p < 0.01, ***significant at p < 0.001.
[a] Note. Response Code: 1 = Poor and 7 = Perfect.
[b] Note. Response Code: 1 = Not at all crowded and 9 = Extremely crowded.
[c] Note. Response Code: 1 = Strongly oppose and 7 = Strongly support.

For the on-site sample, no statistically significant differences were found (Tables 5 and 6). However, patterns in the highly variable data suggest some trends. Notably, respondents who visited the WMNF more

Table 8
Off-site Sample: Cross-tabulation based on Visitation Frequency by Stratum Preference at the WMNF.

Variable	1 visit %	2-10 visits %	11-30 visits %	31 + visits %
Stratum preferences per day[a]				
Low use site (0–6 PPD)	50.30	46.20	45.60	42.21
Medium use site (7–25 PPD)	47.20	46.12	43.40	34.40
High use site (26–50 PPD)	1.50	6.20	8.80	14.30
Very high use site (51 + PPD)	1.00	1.50	2.20	9.10

*Note. Percentages may not equal 100 because of rounding.
[a] Chi-Square: 13.956, df: 9, p = 0.124.

frequently were generally more accepting of social conditions, especially crowding, as compared to those who visited the WMNF less frequently. For instance, respondents in the on-site sample who visited the WMNF more frequently perceived less crowding and were willing to encounter more visitors (Table 5).

For the off-site sample, significant differences by frequency of visitation in perceived crowding, satisfaction, and management preferences were found (Table 7). The cross-tabulation analysis (Table 8) yielded no statistically significant differences, but again some patterns are seen. Respondents who visited the WMNF more frequently were generally more tolerant across all social conditions, especially satisfaction and crowding, as compared to those who visited the WMNF less frequently. Specifically, respondents who visited the WMNF more frequently had higher levels of satisfaction, perceived lower levels of crowding, were willing to encounter more visitors, preferred higher use site stratums, and were less likely to support management actions aimed at limiting visitation (Tables 7 and 8).

4.3. Research question three

To assess the extent to which distance traveled relates to perceptions of social conditions within and across study modalities on the WMNF, respondents in both samples evaluated the same perceived social conditions questions as well as the same question asking them to identify (in miles) how far the WMNF was from their home (Tables 9–12). Two cross-tabulation procedures and two ANOVA procedures were applied to investigate these relationships. To segment the data, the frequency of visitation variable was recoded to reflect three common distance segments applied in National Forest settings: 1) local visitors: 1–50 miles, 2) regional visitors: 51–100 miles, and 3) national visitors: 100 or more miles (English et al., 2020; USDA Forest Service-National Visitor Use Monitoring, 2019).

Table 9
On-site Sample: One-way ANOVA based on Distance Traveled to the WMNF.

Variable	Local (1–50) M (SD)	Regional (51–100) M (SD)	National (101 +) M (SD)	F Value
Overall satisfaction[a]	6.45 (0.82)	6.34 (1.01)	6.50 (0.90)	1.12
Overall crowding[b]	2.83 (1.33)[a]	3.43 (1.74)[b]	3.32 (1.64)[b]	2.04
Max encounter preferences per day	352.93 (354.21)	432.28 (352.20)	386.92 (440.90)	0.14
Management preferences[c]				
Limitation on number of visitors	5.19 (1.86)	5.29 (1.51)	5.08 (1.79)	0.48
Expand shuttle services	3.87 (1.77)	4.31 (1.72)	4.37 (1.58)	1.71

*Note. Percentages may not equal 100 because of rounding.
*Note. *significant at p < 0.05, **significant at p < 0.01, ***significant at p < 0.001.
[a] Note. Response Code: 1 = Poor and 7 = Perfect.
[b] Note. Response Code: 1 = Not at all crowded and 9 = Extremely crowded.
[c] Note. Response Code: 1 = Strongly oppose and 7 = Strongly support.

Table 10
On-site Sample: Cross-tabulation based on Distance Traveled by Stratum Preference at the WMNF.

Variable	Local (1–50) %	Regional (51–100) %	National (101 +) %
Stratum preferences per day[a]			
Low use site (0–6 PPD)	16.7	13.6	16.0
Medium use site (7–25 PPD)	33.3	13.6	14.6
High use site (26–50 PPD)	16.7	22.7	22.1
Very high use site (51 + PPD)	33.3	50.0	47.3

*Note. Percentages may not equal 100 because of rounding.
[a] Chi-Square: 3.038, df: 6, p = 0.804.

Table 11
Off-site Sample: One-way ANOVA based on Distance Traveled to the WMNF.

Variable	Local (1–50) M (SD)	Regional (51–100) M (SD)	National (101 +) M (SD)	F Value
Overall satisfaction[a]	6.04 (0.79)	5.95 (0.87)	5.93 (0.87)	0.35
Overall crowding[b]	5.34 (2.16)[1]	5.67 (1.66)[2]	5.78 (1.86)[2]	2.63*
Max encounter preferences per day	41.35 (64.10)	32.16 (50.72)	31.05 (27.43)	0.76
Management preferences[c]				
Limitation on number of visitors	4.67 (1.78)[2]	4.42 (1.74)[2]	3.48 (1.79)[1]	10.94***
Expand shuttle services	4.82 (1.81)	4.68 (1.84)	4.46 (1.93)	1.08

*Note. Percentages may not equal 100 because of rounding.
*Note. *significant at p < 0.05, **significant at p < 0.01, ***significant at p < 0.001.
[a] Note. Response Code: 1 = Poor and 7 = Perfect.
[b] Note. Response Code: 1 = Not at all crowded and 9 = Extremely crowded.
[c] Note. Response Code: 1 = Strongly oppose and 7 = Strongly support.

Table 12
Off-site Sample: Cross-tabulation based on Distance Traveled by Stratum Preference at the WMNF.

Variable	Local (1–50) %	Regional (51–100) %	National (101 +) %
Stratum preferences per day[a]			
Low use site (0–6 PPD)	54.50[a]	46.10[b]	39.20[b]
Medium use site (7–25 PPD)	38.40[a]	42.50[b]	45.30[b]
High use site (26–50 PPD)	5.30[a]	8.30[b]	11.60[b]
Very high use site (51 + PPD)	1.80	3.10	3.90

*Note. Percentages may not equal 100 because of rounding.
[a] Chi-Square: 13.55, df: 6, p = 0.035.

For the on-site sample, significant differences by distance traveled in perceived crowding were found (Table 9). The cross-tabulation analysis (Table 10) found no statistically significant differences. However, a pattern in the data, though not statistically significant at p < 0.05, prevailed: Local respondents were generally more tolerant and accepting across social conditions, as compared to non-local respondents. For example, local respondents perceived lower levels of crowding, were willing to encounter less visitors, preferred lower use site stratums, and were less likely to support management actions aimed at expanding public shuttle services (Tables 11 and 12).

For the off-site sample, significant differences by distance traveled in perceived crowding and management preferences were found (Table 11) while cross-tabulation analysis also yielded significant differences by distance traveled in site stratum preferences (Table 12). Within these analyses, a similar trend prevailed. Local respondents were generally more tolerant and accepting across all social conditions, as compared to

non-local respondents. For example, local respondents had higher levels of satisfaction, perceived lower levels of crowding, were willing to encounter more visitors, preferred lower use site stratums, and were more likely to support management actions aimed at limiting visitation and expanding public shuttle services (Tables 11 and 12).

5. Discussion

This research focused on understanding the outdoor recreation visitor experience in the White Mountain National Forest (WMNF) and what multi-scalar and multi-modal inquiries could lend to expand this understanding. This study compared two distinct, yet complementary datasets concerning visitor experiences in the WMNF: a 2016 on-site sample and a 2020 off-site sample. The differences within and amongst the datasets are striking. Though visitors in both samples reported high-quality experiences, the distance traveled, frequency of visitation, and preferences for use-levels (assessed by multiple measures) varied substantially. This study and its findings present detailed knowledge for WMNF managers, managers of similar PPAs, and the advancement of visitor use management theory and research. The most salient and applicable takeaways for both researchers and managers are discussed below.

5.1. Theoretical implications

This work advances two frameworks necessary to examine visitor use management complexities in and beyond PPAs. First, this study lends itself to the SES conceptual framework by synthesizing information for a particular context across spatial and temporal scales and modalities. Integrating formerly disparate data points in this way serves to better understand how SES functions within a PPA at both the micro- (e.g., the on-site sample) as well as the macro-level (e.g., the off-site sample). Second, the related concept of hierarchy theory helps to understand scalar interplay, relationships, and feedback loops by examining the focal scale of analysis and nestling this scale within additional scales. Specific to these two frameworks, this research examined how visitor demographics, behaviors, and management preferences may vary substantially when only considering one scale. For example, frequency of visitation, preferences for site use-levels, and perceptions of crowding all varied substantially amongst the two datasets. By examining multiple scales, this research begins to account for spatial and temporal patterns and variations on a macro level (e.g., forest, region) while simultaneously retaining the nuances inherent at the micro level (e.g., site). Managing for multiple audiences in a PPA setting is challenging, but necessary.

For example, on-site respondents indicated visiting the forest approximately 11 times per year versus the off-site respondents' 37 times per year. Similarly, the average age of respondents was 34 years of age in the on-site sample, yet 57 years of age in the off-site sample. These differences speak to the advantages of multi-scale investigations and how enveloping and SES can elicit differences within hierarchical systems and populations that affect PPA visitor use and management dynamics. Moreover, managing visitor use and resource quality hierarchically at the local and regional levels can result in corresponding downstream social and ecological interactions and implications. For example, amongst the on-site (i.e., site-level) sample, perceptions of crowding were low to moderate (M = 3.3/9.0), yet for the off-site (i.e., regional) sample, perceptions of crowding were high (M = 5.5/9.0). This suggests that while perceptions of crowding may be manageable at specific sites, as a whole/region, visitors may be approaching, if not exceeding, their thresholds of tolerance. Consistently high levels of perceived crowding in PPA settings often result in the employment of various coping behaviors (e.g., resource and temporal substitution), which in turn can influence the visitors, ecosystems, and communities surrounding PPAs (Ferguson et al., 2021; 2022a). For instance, the employment of resource substitution often shifts visitation from high-to low-use areas, leading to significant social and ecological impacts (Ferguson et al., 2021; 2022a; Lucas, Cole, & Stankey, 2019). While the employment of temporal substitution often shifts visitation to different times of the day, week, or year, leading to significant community impacts as conventional high-use visitation patterns (e.g., summers, holiday weekends) become unpredictable (Ferguson et al., 2021, 2022a; Rutty et al., 2015).

Thus, study findings suggest that both the hierarchy and SES frameworks lend themselves well to comprehensive visitor use management, which can yield a more integrated and complete account of these PPA audiences and their differences. Recent research suggests these types of investigations are necessary to advance an integrated model of visitor use management beyond singular, cross-sectional studies (Ferguson et al., 2021, 2022b; Morse, 2020; Morse et al., 2009; Perry et al., 2020). Though the approach taken in this work is retroactive, the data highlight the complexities of scales and modalities and represent a tangible contribution toward populating an integrated model with empirical data. As a related point, these types of SES and hierarchy inquiries often necessitate collaboration. The research teams worked with WMNF resource managers on their specific inquiries for each of the two studies. These teams also collected data through similar measures for contextualization beyond each specific study. By sharing their study-specific data across the joint research efforts, the research teams demonstrated how SES and hierarchy inquiries can be practiced in meaningful ways that transcend singular research efforts. Future research should consider incorporating elements of repeated measures and multi-modal methodologies specifically to identify and assess which measures have greater or lesser integrity at different scales and how to creatively address the questions that multi-scalar inquiries present.

5.2. Management implications

This work offers a suite of managerial considerations. The above theoretical implications are of note for resource managers as well, as these types of applied research efforts are only possible through conversation with and support from PPA managers. Considering how SES and hierarchy theory may be beneficial to previously collected or upcoming data collection efforts can help address some of the complexities of visitor use management and scaled approaches. A primary consideration stemming from the comparison amongst datasets focuses on visitation frequency and tolerance of higher use-levels. Within this, multiple considerations are explored.

First, for the on-site sample, satisfaction, maximum encounter preferences, and management preferences for visitor limitations and shuttle services were generally high, and higher in comparison to the means and use-levels reported in the off-site sample. Perceived crowding was also rated as moderate in the on-site sample and was much higher in the off-site sample. It must be noted at this juncture that crowding related norms, expectations, and associated perceptions may have been notably different for the on-site sample due to the COVID-19 pandemic and associated increase in WMNF visitation (Ferguson et al., 2022b). A more in-depth investigation reveals that perceptions of crowding and maximum encounter preferences per day increased with frequency of visitation. This suggests that those who are more frequent visitors to the WMNF are more accepting of higher use-levels. This may be contradictory to common beliefs (e.g., more invested visitors often exhibit lower thresholds of acceptability for use-levels) (Ditton et al., 1983; Schreyer & Roggenbuck, 1978). However, it may also represent the sample of visitors to the high and very high use sites examined in the on-site study: those who enjoy the forest, know what use-levels to expect, and continue to recreate on the WMNF. In this way, inferences from the on-site sample of visitors at these centerpiece sites speak to a generally tolerant and potentially even high-use seeking population of visitors.

Second, at the other end of visitation frequency levels, geographic visitor origin patterns also provide managerial insight. Respondents with lower visit frequencies tended to be from more than 50 miles away (i.e., regional, national visitors). This distance traveled and the inherent travel investment required suggests those visiting only once, or a limited number of times, may either have expectations of high visitation (e.g., from hearing other visitors' experiences, from comparison to urban residencies) or may be justifying high use-levels as acceptable due to the travel investments (e.g., time, money, effort) made in pursuit of their recreation experience (i.e., product shift). Together, these results imply that those surveyed while recreating on-site may be aligning their preferences and/or expectations with actual conditions encountered, and thus enjoying a quality recreation experience. The sites selected for this study were of managerial concern due to high use and the consequent potential for crowding and other negative conditions. As such, study findings should be affirming to forest management regarding visitor experiences and current visitor use management techniques.

A third implication emerges, however, centered on displacement, when the scale of inquiry is expanded to include the off-site sample. Comparing the above findings with the tenor of results from the off-site sample presents a more complex narrative for managers. Within the off-site sample, those with increased frequency of visitation reported higher levels of satisfaction and lower levels of perceived crowding. The reasons for this may be two-fold. First, those who recreate at the WMNF more frequently are more apt to discover sites in the forest that meet their definition of a quality experience. Through sheer repetition (and, as they tend to be more local, the proximity to allow such repetition), these respondents are thus more likely to align their satisfaction and crowding norms with the experiences they have repeatedly encountered; this is particularly relevant and applicable when considering off-site data were collected during the COVID-19 pandemic. Second, those who have visited only once and are significantly less satisfied and more crowded than those who have visited two or more times, may represent a population of visitors who have been displaced from the WMNF after a single, unsatisfactory visit. This extrapolation is supported by their weaker support of an expanded shuttle system, indicating their personal crowding norms may have been violated on their singular visit and thus, they would not likely want to attract even more visitation to the WMNF with a shuttle service. These findings corroborate previous research which suggests a substantial proportion of WMNF visitors are permanently displaced on an annual basis due to various social and ecological conditions (Ferguson et al., 2021; 2022b). Thus, it appears that the off-site sample captured potentially two populations of recreationists: 1) those who have lower tolerances for high use-levels and have actively sought out compatible WMNF experiences and 2) those who have lower tolerances for higher use-levels and have been permanently displaced from WMNF experiences after a single unsatisfactory visit.

In combining these findings at different scales of response, managers at the WMNF and similar PPAs may consider how to contend with these issues related to use-levels and overall experience quality. At least four specific visitor populations are present in this work: 1) first-time visitors with high-use tolerance, 2) repeat visitors with high-use tolerance, 3) first-time visitors without high-use tolerance, 4) and repeat visitors without high-use tolerance. These distinct visitor segments would not have been identified through the application of a single survey modality and/or scale. Because both studies synthesized within this work sought to inform WMNF management plans, considering these scales and populations is crucial to inform adequate and appropriate managerial responses. For example, this information could help managers account for visitors' coping behaviors when encountering high use levels as visitors may seek different locations, activities, and/or times for their visits to the WMNF. This is especially pertinent given management policies proscribing purposeful shifting visitor use from high-use to low-use locations in the forest. Further promoting this type of messaging campaign also serves to potentially alleviate much of the travel investment burden necessary for a visitor to engage in repeated excursions to find their preferred conditions and therefore may assist in overall equity, stewardship, and multi-use goals.

5.3. Implications for future research

This study assessed data concerning one context (WMNF visitation) at different scales and modalities. With this integrated approach came the opportunity to provide empirical research to inform SES and hierarchy theory, but also the caveat of differences among data. Some of the differences amongst the samples could be more pronounced due to issues inherent in scales, modalities, and methods, but also due to the dramatic change in visitation and social norms during the four-year window in question (2016–2020) on the WMNF; especially considering the influence of the COVID-19 pandemic upon outdoor recreation. Partly in response to this caveat, this research only statistically compared data *within* samples. Future research should aim to statistically compare data *across* samples as well. Constructing a matrix of spatial and temporal scales of analysis and gathering data for each cell in that matrix may provide opportunity for such a statistical spatial-temporal comparison or clustering. The data presented in this work are an attempt to advance that broader narrative framing with two of four cells completed in this study's matrix: two time points and two location points (i.e., the diagonal of the matrix), and future research should expand this to at least a three-by-three matrix (scale of focus, one above, and one below) to further consider hierarchical SES connections (Cumming, 2016). Even with such caveats, however, the strength of the data integrity and the ability for retroactive comparison remain.

Researchers should capitalize on this approach in other contexts; spatial, temporal, and topical scales, and modalities to examine other comparisons and form the collaborations necessary for such work. This approach can aid in advancing scales of PPA inquiry and contribute to SES and hierarchy considerations for past work while planning future research that collects such information simultaneously. Furthermore, future research should consider a more thorough application of SES and hierarchy theories. Study findings lend themselves to certain components of the SES and hierarchy theory framework; however, this study did not explicitly examine and test SES nor hierarchy theory. Future research may consider specifically examining the multiple interconnected subsystems associated with SES such as social, ecological, economic, and community impacts as well as the multiple enveloping techniques suggested inherent in hierarchy theory. Again, we suggest that naming scales in a context-specific matrix and examining data across the cells of such a matrix is a means to further contributions to these concepts. Another suggestion for future research is the integration of predictive modeling (e.g.., regression, structural equation modeling) analysis to revel more detailed and nuanced, patterns, variations, and relationship between study variables. Finally, these data represent an initial inquiry. Study data were not weighted as the goal of this research was to maximize the number of respondents who were frequent users of the WMNF. Thus, study data should be interpreted with caution as it is not representative of and/or generalizable to *all* WMNF visitors.

6. Conclusion

This work demonstrates the utility of assessing PPA visitor use management within a multi-scalar and multi-modal framework. The samples used in this work are different yet similar, with both samples focusing on management-specific aims at the times of collection. However, when synthesized across common measures, study results present a narrative of complex SES and multiple points of theoretical and managerial consideration. Study findings suggest different modalities of data collection provide substantially different results within the same geographic region and, together, may provide a more precise understanding of the area and related recreation impacts. In this context, the com-

plementary aspects of each study emerged and the opportunity for more comprehensive consideration of scope were highlighted. With continued efforts to synthesize data across scales and modalities, PPA researchers and managers alike can more comprehensively understand the layered and intricate narrative of visitor use and expand the viewshed to encompass multiple scales of inquiry when understanding complex human-nature relationships.

Management implications

Results from this study found general commonalities between the on-site and off-site study samples. However, respondent profiles and overall perceptions of crowding, encounter rates, and management preferences have different trend pattens between samples, with significant differences within samples. Respondents in the on-site study sample were predominantly non-locals who visited the WMNF infrequently, perceived moderate levels of overall crowding, preferred higher-use site stratums, and had a very high threshold for maximum visitor encounters per day. Respondents in the off-site study sample, however, trended toward the opposite. Results indicate different modalities of data collection provide substantially different results within the same geographic region and, together, may provide a more precise understanding of the area and related recreation impacts. Study findings suggest recreation researchers and resource managers should consider applying multiple scales and modalities in order to comprehensively assess and understand complex human-nature relationships.

Uncited references

Warren, 2005.

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.

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