The COVID-19 pandemic's transformation of human relationships with nature at multiple scales

Edited by
Sonya Sachdeva, Lindsay Kathleen Campbell, Erika S. Svendsen and
Michelle Leigh Johnson

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Topic editors

Sonya Sachdeva — Northern Research Station, Forest Service (USDA), United States
Lindsay Kathleen Campbell — Northern Research Station, Forest Service (USDA), United States
Erika S. Svendsen — Northern Research Station, Forest Service (USDA), United States
Michelle Leigh Johnson — Northern Research Station, Forest Service (USDA), United States

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Editorial: The COVID-19 pandemic's transformation of human relationships with nature at multiple scales

Sonya Sachdeva[1]*, Lindsay Kathleen Campbell[2], Michelle Leigh Johnson[2] and Erika S. Svendsen[2]

[1]Northern Research Station, United States Forest Service (USDA), Chicago Urban Field Station, Evanston, IL, United States, [2]Northern Research Station, United States Forest Service (USDA), New York City Urban Field Station, Bayside, NY, United States

Editorial on the Research Topic
The COVID-19 pandemic's transformation of human relationships with nature at multiple scales

Introduction

The World Health Organization denotes March 11, 2020, as the official start of the COVID-19 pandemic. Though millions of people worldwide had already been living under severe restrictions by that point, this date marked the start of a global lockdown period that was often described as "unprecedented." This period was marked by pain—the loss of life and suffering of millions, but also fear—of unabated transmission, stressed healthcare systems, and strained and scarce resources. Further, the pandemic intersected with pre-existing vulnerabilities and axes of inequality, including by race, class, geography, and (dis)ability status; the impacts of this tragedy are highly uneven (Fortuna et al., 2020).

Alongside, people's relationship to the natural world was changing in distinct ways. In major cities, reduced air traffic resulted in silence punctuated only by bird calls (Lenzi et al., 2021). While workers deemed "essential" never ceased going to the physical workplace, residents experiencing shelter-in-place, curfews, and restricted mobility reported a reconnection to their homes, neighborhood environments, and hyper-local nature. People rediscovered parks, forests, and other outdoor spaces as safe sanctuaries even as public facilities at these sites closed their doors (Beery et al., 2021). For some, this added attention toward and exposure to local outdoor environments led to greater engagement in stewardship and care including litter removal, engaging in planting/mulching/weeding, and creating outdoor programs. Indeed, the public realm of parks, streets, and sidewalks took on a wide range of functions, including outdoor offices, restaurants, day care, and exercise facilities—as these remained some of the only places

to safely gather (Campbell et al., 2020). Across the world, temporarily curbed emissions from factory shutdowns and fewer vehicles on the road revealed blue skies and clean air, a revelatory experience that some had not had for decades (Crilley et al., 2021).

The idea for this Research Topic arose in April 2020 in the context of these changing and uneven relationships with nature. On the one hand, the levels of waste generated have risen as a consequence of the pandemic – an increase in single-use plastics for personal protective equipment and healthcare, hoarding of perishable food and other consumer goods, and a reduction in the use of reusable items such as mugs and bags due to fears of contamination. Ridership on public transportation systems has also failed to recover after experiencing sharp declines during the pandemic, both as teleworking increased but also due to perceived safety in personal vehicles (Reuters Staff, 2021). However, we also see record visitation to outdoor spaces—though this increase varied by race and class— (Labib et al., 2022), a renewed fervor to combat climate change to sustain a world that seems all the more fragile (Mohommad and Pugacheva, 2022), and an increased recognition that our wellbeing as humans is inextricably tied to the natural world. Now, 2 years later, we recognize that the pandemic is far from over, but this collection of articles captures insights and reflections drawn primarily from the first year of the pandemic.

Going forward, as societies open back up and cities learn to adapt to living with COVID-19, it is a chance to forge a new path founded on recognizing multifaceted human-nature relationships. While the pandemic is global in scale, articles in this issue are drawn primarily from North America and Europe. These 20 articles, contributed by 96 authors in this Research Topic, "The COVID-19 Pandemic's Transformation of Human Relationships with Nature at Multiple Scales," examine the meaning, use, and governance of nature in a disturbance context and explore changing relationships to nature across scales—from the individual, to the household, to the organizational, to the societal.

People's changing relationship to the natural world

The studies reported here provide a robust contribution to the growing literature on the link between mental, physical, and emotional wellbeing and access to and use of nature, whether in public or private space or in high vs. low-population density areas (Maurer et al.). Articles in this issue also begin to untangle and reveal pandemic-related changes in mindsets and behaviors that are critical to fostering transitions to more sustainable lifestyles.

From these studies we see how people accessed nature and the activities they sought while they were in it appear to have been affected by the pandemic. For one thing, where

once people may have traveled hundreds, if not thousands of miles, to immerse themselves in nature, they found similar pleasure in exploring and rediscovering their local environment. As Heilmayr et al. report, the majority of their participants' nature time took place in their yard or neighborhood or at a local park or forest. Korpilo et al. used mobility data to further support these findings showing that people sought nature out near their residences. Safety appears to have been a primary concern throughout as people avoided places and events where they might be likely to encounter crowds.

Social media analyses (Johnson and Sachdeva) further corroborated these results. In spring and summer 2020, during the height of nationwide lockdowns in the United States, the positive impacts of nature on wellbeing came from seeing the wonder in nature, bird-watching, or engaging in gardening but certainly not participating in outdoor events as safety concerns were still top-of-mind. Lockdowns were not beneficial for wellbeing (Johnson and Sachdeva), but they did have some unintended benefits. As Mateer et al. describe, as lockdown measures in cities, particularly, shut down parks, playgrounds, and other outdoor recreation spaces, residents turned to city and neighborhood streets for activities like running, walking, or socializing with neighbors. Further, somewhat counterintuitively, lockdowns improved people's perceived connection to nature (Dobson et al.) by providing a sense of peace and tranquility in parks that may have been overcrowded pre-pandemic.

Several studies reported in this Research Topic also suggested that people's relationship to the natural world also shifted in their mindsets and everyday behaviors. As Mascatelli et al. note, reducing food waste was the most salient pro-environmental behavior for respondents in the early stages of the pandemic compared to pre-pandemic respondents. At the same time, respondents also decreased engaging in other pro-environmental behaviors such as recycling, using alternative transportation to get to work, and checking the air in their tires, compared to pre-pandemic respondents. Some of this may be attributable to an increase in remote working, but Sachdeva et al. also pose the possibility that a shift in mindsets during the pandemic, specifically moving toward a more scarcity-focused mindset, may lead to an increased emphasis on behaviors that sustain primal needs for food, water, and shelter-oriented safety, dovetailing nicely with Mascatelli et al.'s results. Other psycho-social impacts of the pandemic were suggested by Syropolous and Markowitz. They found that the pandemic has potentially made more salient the psychological norms underlying fairness and reciprocity, feelings of gratitude, and consideration of personal legacies. And, as previous empirical work has shown, all of these norms can help promote a consideration of the impacts of our behavior on future generations—a key component of sustainability-oriented decision making. Sardeshpande et al. suggest that urban natural areas could be designed to be more conducive to foraging practices. Foraging can offer people

additional control over and options for their food, health, income, and expenditure. Doing so also requires people to govern their resources more locally and sustainably.

Unequal access to outdoor spaces remains a challenge that intersects with underlying social vulnerability

Although the articles covered in this issue present a compelling case for the positive effects of green space access on wellbeing, they also decisively demonstrate an enduring problem of access and unequal distribution. Flint et al. note that for women, people of color, and for low-income people, access to green spaces decreased over the course of the pandemic and widened previous inequities in the accessibility of green spaces and options for outdoor recreation. Similarly, Larson et al. reported that urban park use declined during the COVID-19 pandemic and that the demographic characteristics of park visitors became more homogenous in the same period. Unsurprisingly, people who used to visit these parks pre-pandemic increased their visitation. More infrequent visitors, such as those from socially vulnerable communities, showed a further decline in visits.

These results are troubling, and results from Pearson et al. further amplify these concerns. In a study with low-income, predominantly African American participants in a major metropolitan area in the United States, they found that while participants expressed an increased desire to engage with nature during the pandemic (relative to before), they had fewer opportunities to do so. Moreover, Pearson et al. found that participants with more access to green space showed higher stress and anxiety. As the authors note, this is an important caveat for all the other literature essentially equating green space with happiness. In fact, the quality of green space available to people matters, and access to low-quality greenspace can be detrimental to health and wellbeing.

Impact of and adaptations to the COVID-19 pandemic among land managers and stewards

The pandemic's impact on individual livelihoods has been well-documented, but the studies reported in this Research Topic shed light on the lesser-known impact of and adaptations to the pandemic among organizations that manage and steward green space. In a case study of natural area land managers in 12 US cities, Plitt et al. found that as organizations were overwhelmed with increased use and visitation to natural areas during the pandemic, close to three-fourths of them reported a concurrent decline in their ability to care for natural areas. Without adequate numbers of volunteers, civic scientists, or public programming, only 17% of these

environmental stewardship organizations felt hopeful about their financial future.

Yet, stewardship organizations also showed remarkable resilience and capacity for adapting to the pandemic and disturbances writ broadly despite a reduced workforce (Landau et al.) and the sort of reduction in resources described by Dacks et al. and Merkle et al. Other approaches to increase capacity in land management organizations are posed by Floress and Cohen who suggest that a tool that we have all become familiar with over the pandemic, i.e., virtual participation, can actually broaden access to meetings and processes and therefore increase civic participation. Similarly, Alizadehtazi et al. demonstrate that citizen scientists can be safely and effectively recruited during a global pandemic and the fair financial compensation provided by researchers to new citizen scientists can cover basic household needs in a time of scarcity.

Adaptive learning at all scales is essential to an organization's ability to respond to the pandemic. Community partnerships play a pivotal role in shaping more localized responses of large land management organizations during this time of social unrest (Svendsen et al.). Furthermore, as Landau et al. demonstrate, experience with disasters and disturbances further builds organizational resilience. It is also worth emphasizing that stewardship organizations benefit from community involvement and are also an essential source of individual wellbeing.

Lessons for the future: How to develop social resilience?

A common theme that the pandemic has laid bare is that green spaces, and access to and use of nature, are critical components of social resilience and human wellbeing at multiple scales—individual, household, organization, and community. These articles point to the lasting impacts of the pandemic and point to how we as a society can chart a new path forward with an increased understanding of the critical role of nature in cities. Yet, key questions remain. How long might the psycho-social impacts of altered mindsets related to nature and sustainability last, or are these permanent shifts? How do we ensure that access to high-quality green space is equitably distributed? What sorts of programming and stewardship opportunities can foster public engagement with green spaces and strengthen inclusion of all residents? How can we avoid rigidly adapting to prior disturbances and build more flexibility and adaptive capacity into environmental governance and land management? What role can urban greenspaces play in providing food and other needed services during such disturbances, to counteract potential societal responses like lockdowns and supply chain interruptions?

Going forward, Svendsen et al. suggest that diversifying land management and environmental stewardship organizations

could help them better react and adapt to changing landscapes and demographics. The articles in this special demonstrate humans' incredible ability to adapt to disruptions like the pandemic by changing their notions of sustainability and relating to one another and their neighborhoods, communities, and other open spaces. Retaining and building upon our social and ecological relationships can help bolster our resilience to the next global—or local—disruption. At the same time, being careful to provide communities with equitable access to resources and governance roles may aid in ensuring that future disruptions do not exacerbate social vulnerabilities.

Author contributions

SS completed a preliminary draft of the manuscript. LC and MJ provided additional text and revisions. ES reviewed the manuscript and provided feedback. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Psychosocial Factors Influencing Outdoor Recreation During the COVID-19 Pandemic

Timothy J. Mateer[1]*, William L. Rice[1,2], Brendan Derrick Taff[1], Ben Lawhon[3], Nathan Reigner[1] and Peter Newman[1]

[1] Department of Recreation, Park, and Tourism Management, Pennsylvania State University, State College, PA, United States, [2] Department of Society and Conservation, University of Montana, Missoula, MT, United States, [3] Leave No Trace Center for Outdoor Ethics, Boulder, CO, United States

The COVID-19 pandemic has created an unprecedented disruption to daily life for large swaths of individuals and resulted in potentially widespread implications for individuals' health and wellbeing. This study utilized an online survey of avid outdoor recreationists to understand the psychosocial factors influencing recreationist behaviors during the COVID-19 pandemic across rural, urban cluster, and urban communities in the United States. Confirmatory factor analyses indicate that the five studied psychosocial factors–perceived risk, social norms, recommendations from authority, health benefits, and lifestyle adjustments–exist as unique constructs influencing individuals' outdoor recreation behaviors. Repeated measures analyses suggest individuals rated seeking benefits to their general health as most important when making outdoor recreation decisions, followed by recommendations from authority, then perceptions of risk, with lifestyle adjustments and social norms rated as least important. Lastly, analysis across community types indicated individuals across the rural-urban gradient weighed perceptions of risk and recommendations from authority differently when making outdoor recreation decisions. Managerial implications and future directions for research are discussed.

Keywords: coronavirus pandemic, COVID-19, health and wellbeing, outdoor recreation, recreation behavior

INTRODUCTION

The COVID-19 pandemic has resulted in a drastically altered way of life for many across the globe. This highly contagious viral disease was deemed a pandemic by the World Health Organization (WHO) on March 11th, 2020 (World Health Organization, 2020). Until new cases and deaths can be reduced to minimal levels, disruptive practices such as aggressive social distancing are necessary to limit the spread of the virus and limit loss of life across broad sectors of society (Stier et al., 2020). While necessary, these mitigation factors coupled with increased risk factors have resulted in profound effects on individuals' mental and physical health (Bao et al., 2020; Stier et al., 2020).

Some have called for outdoor recreation and the use of public spaces to serve as sources of community resilience during the COVID-19 pandemic (Samuelsson et al., 2020). The American Psychological Association (2012) defines resilience "as the process of adapting well in the face of adversity, trauma, tragedy, threats or significant sources of stress." Outdoor recreation and green spaces have been broadly considered to foster resilience in individuals and communities

by providing spaces to facilitate social interaction (Kuo et al., 1998; Mann and Leahy, 2010), supporting mental and physical health (Buchecker and Degenhardt, 2015; Kuo, 2015; Azara et al., 2018; Lackey et al., 2019), and allowing individuals and communities to learn and develop social-ecological knowledge together (Krasny and Tidball, 2009; Smith et al., 2016). Outdoor recreation has supported such outcomes during other previous crises such as the aftermath of Hurricane Katrina in the city of New Orleans (Rung et al., 2011) or the 2003 SARS Epidemic in Hong Kong (Marafa and Tung, 2004). Nierenberg (2020) as well as Maurer and Poniachik (2020) both illustrate how outdoor spaces have already been linked to various forms of resiliency during the COVID-19 pandemic.

To help visitors achieve these outcomes, land managers and policymakers across community types must have knowledge of behavioral characteristics and patterns of visitors to effectively maintain the benefits provided by outdoor recreation. This must be done while also minimizing the unique risks associated with these activities, such as unintentionally contracting COVID-19 when recreating outdoors. These considerations are especially important given that well-crafted policies are key in effectively managing public health during and after this unprecedented time (Tufan and Kayaaslan, 2020).

Behavioral correlates of outdoor recreation prior to the COVID-19 pandemic can help to provide unique insight into recreationists' decision-making processes during this period of stress as well, helping to develop policy and management approaches that maximize health benefits while also mitigating risk factors (Holland et al., 2018). Specifically, understanding psychosocial factors influencing outdoor recreation behavior can result in targeted policies and aligned management that effectively influence recreationists' behavior in positive ways (Heberlein, 2012). The purpose of this study is to utilize a population of avid outdoor recreationists to understand if previously researched psychosocial factors correlated with outdoor recreation behavior exist as unique constructs relating to behavior during the COVID-19 pandemic, and if so, how individuals weigh various psychosocial factors when choosing to make recreation-based decisions. As previous research indicates the COVID-19 pandemic may be affecting these communities differently, the importance of each psychosocial factor is then compared across rural, urban cluster, and urban areas (Rice et al., 2020a; Venter et al., 2020; Templeton et al., 2021). The factors explored are perceived risk, social norms, recommendations from authority, health benefits, and lifestyle adjustments. Given dedicated outdoor recreationists are both highly dependent on outdoor areas (White et al., 2008) and represent a key stakeholder in relation to outdoor recreation area management (Propst et al., 2003), psychosocial constructs influencing behavior within this group must be understood to make effective managerial decisions. Throughout this article, a broad definition of outdoor recreation is utilized to capture the wide-array of activities and spaces utilized in these leisure activities. We adopt Jenkins and Pigram's (2003) definition of outdoor recreation as cited in Lackey et al. (2019), with the term outdoor recreation being used to refer to "all forms of leisure that rely on the natural environment" (p. 2). With this, the present study aims to provide

managerial recommendations for outdoor recreation managers in a variety of settings ranging from urban green spaces to large wilderness areas.

LITERATURE REVIEW

Previous research on psychosocial factors influencing outdoor recreation behaviors provides important insight into what is motivating individuals' actions and decisions during the COVID-19 pandemic. This has been a key focus of previous research aiming to influence user behavior in outdoor recreation spaces (e.g., Marion and Reid, 2007; Hughes et al., 2009). The following literature review covers various relevant theories and concepts influencing outdoor recreation behavior prior to the COVID-19 pandemic and begins to extend this thinking toward this novel crisis across the rural-urban gradient.

Understanding Psychosocial Factors for Outdoor Recreation Management

A variety of psychosocial theories, such as the Theory of Planned Behavior (Ajzen, 1991) and Value-Belief-Norm Theory (Stern, 2000), have been previously utilized to understand outdoor recreationist behaviors and inform corresponding management decisions. Each of these theories utilizes social and psychological constructs that precede a behavior of interest to predict the likelihood that an individual will engage in that behavior (Ajzen, 1991; Stern, 2000). These theories are especially useful as outdoor recreation managers often attempt to utilize "passive" programs such as educational or persuasive messaging in an attempt to influence visitor behaviors (Marion and Reid, 2007). Such efforts have been previously cited as an important element of park and protected area management (Burn and Winter, 2009). For example, the Theory of Planned Behavior has been utilized to understand and develop policies around a variety of recreation-related behaviors such as litter control (Brown et al., 2010), hunting (Hrubes et al., 2001), and bear cannister use when backpacking (Martin and McCurdy, 2009).

Conner and Armitage (1998) state that the Theory of Planned Behavior "details the determinants of an individual's decision to enact a *particular* behavior" (emphasis added, p. 1429). Value-Belief-Norm Theory follows a similar process of predicting rather specific behaviors (Stern, 2000). As the aim of this study is to explore decision-making processes across contexts related to outdoor recreation behavior during the COVID-19 pandemic, we aim to expand upon these predictive theories to understand how avid outdoor recreationists are making general outdoor recreation decisions during this unprecedented time. This aligns with the calls to effectively utilize behavioral science to help mitigate and control the spread of COVID-19 (Lunn et al., 2020) and the purpose of this study in aiming to provide broad recommendations for managers across outdoor recreation. While this study primarily utilizes individualistic theories to understand outdoor recreationist behaviors during the COVID-19 pandemic, further research may also benefit from looking to more complex social-ecological theories to understand behavior during this unprecedented time (e.g., Raymond et al., 2018). It should be

noted, the intent of the present study is not to test these theories, but to use their insights to guide our inquiry.

Psychosocial Factors of Interest

The Theory of Planned Behavior and Value-Belief-Norm Theory mutually utilize three general constructs in predicting individuals' behaviors: social norms, perceived behavioral control, and attitudes (Ajzen, 1991; Stern, 2000). Examining each of these general realms can help provide direction on more focused psychosocial constructs that may be of interest when understanding avid outdoor recreationist behaviors during the COVID-19 pandemic. The following paragraphs build upon these three areas and argue that five specific psychosocial constructs—perceptions of risk, social norms, recommendations from authority, benefits to general health, and lifestyle adjustments—may be most useful in understanding avid outdoor recreationist behavior during this unprecedented time. **Figure 1** outlines how the psychosocial factors of interest relate to and build upon the Theory of Planned Behavior.

Ajzen (1991) defines social norms as the "perceived social pressure to perform or not to perform" (p. 188) a behavior of interest. Extensive previous research has indicated that social norms are strong predictors of behavior both in outdoor recreation settings and otherwise (e.g., Heywood and Murdock, 2002; Anderson and Loomis, 2011; Heberlein, 2012). Both perceptions of behavioral regularities and expectations of others serve as distinct elements of social norms influencing how individuals act (Heberlein, 2012). For example, Heywood and Murdock (2002) found that expectations of negative judgements from others influenced individuals' intention to not litter in public areas. Social norms may be especially important for avid outdoor recreationists as previous research has indicated that involvement in serious leisure can lead to individuals developing "social worlds" within their chosen activities (Scott and Shafer, 2001; Hughes et al., 2016), potentially heightening the influence of social norms. Perceived expectations and behavioral regularities from friends, family, or strangers all may play a role in how individuals act when choosing to recreate outdoors, or not, during the COVID-19 pandemic.

Perceived behavioral control broadly refers to how easy or difficult an individual believes it is to take a specific action (Ajzen, 1991). Participation in outdoor recreation generally requires that individuals negotiate various constraints inhibiting their participation (Godbey et al., 2010). Avid outdoor recreationists are generally able to navigate these varying levels of constraints to regularly partake in nature-based leisure (Alexandris et al., 2007; Lyu and Oh, 2015). Novel factors associated with the COVID-19 pandemic, though, may present additional constraining factors for individuals who participate in outdoor recreation regularly. Specifically, the perception of risk and recommendations from authority could be new and important constraints for avid outdoor recreationists during the COVID-19 pandemic. Initial research has indicated that the COVID-19 pandemic has influenced individuals' perceptions of risk (Torales et al., 2020), a process that may be further amplified by exposure to media coverage on the topic (Garfin et al., 2020). Risk has also been previously identified as a constraining

factor in outdoor recreation participation specifically (Reis et al., 2012). In examining these concepts holistically, research on outdoor education programming during the COVID-19 pandemic supports that possibility of infection presents a novel layer of risk management for outdoor activities during this time (Beery, 2020). Understanding how heavily individuals weigh this perceived risk may be an important element in understanding how avid outdoor recreationists are behaving. Furthermore, as recommendations from authority continue to play a major role in how communities are managing the spread of COVID-19 (Tufan and Kayaaslan, 2020), practices such as social distancing, capacity limits, and park closures all may act as constraining factors that individuals may need to navigate if and when they choose to recreate outdoors as well.

Attitudes within the Theory of Planned Behavior are defined as an individual's positive or negative feelings toward a particular action (Ajzen, 1991). Vaske and Donnelly (1999) expand upon this definition, stating attitudes "represent an individual's consistent tendency to respond favorably or unfavorably toward the object in question" (p. 527). Unlike an individuals' values, attitudes are more situational and less static than broad, more basal value orientations (Vaske and Donnelly, 1999). While it is likely that avid outdoor recreationists already have a positive attitude toward outdoor recreation generally, two primary situational factors may shift individuals' attitudes toward outdoor recreation during the COVID-19 pandemic: seeking out benefits to one's health and lifestyle adjustments associated with the COVID-19 pandemic. While each of these two psychosocial constructs more closely represent motivations or preferences, they likely influence the attitudes avid outdoor recreationist have toward recreating outdoors during the COVID-19 pandemic (e.g., If one is no longer going into their office for work, they may respond more favorably to outdoor recreation as a means to get out of the house). A shift in attitudes toward outdoor recreation during the COVID-19 pandemic may stem from individuals' evolving behavioral beliefs and the corresponding evaluation of the outdoor recreation behaviors (Ajzen, 1991). In describing behavioral beliefs, Ajzen (1991) states "each belief links the behavior to a certain outcome, or to some other attribute such as the cost incurred by performing the behavior" (p. 191). In the context of the COVID-19 pandemic, this may manifest itself as individuals believing that outdoor recreation can provide health benefits or allow them to better negotiate lifestyle changes associated with novel conditions during this time. Such behavioral beliefs are simultaneously paired with an evaluation of the behavior, such as believing that outdoor recreation behaviors are worth carrying out due to their associated benefits (Ajzen, 1991; Greaves et al., 2013).

Current research has documented the negative impact of the COVID-19 pandemic on individuals' mental and physical health (Bao et al., 2020; Stier et al., 2020). As outdoor recreation offers an opportunity for participants to accrue mental and physical health benefits (Thomsen et al., 2013; Holland et al., 2018), individuals may be turning to outdoor recreation to buffer the negative health impacts of the COVID-19 pandemic. This would align with the benefits outdoor recreation has provided individuals and communities during other times of crisis (Marafa and

FIGURE 1 | Extension of the Theory of Planned Behavior (Ajzen, 1991) to incorporate psychosocial constructs of interest influencing outdoor recreation behaviors during the COVID-19 pandemic.
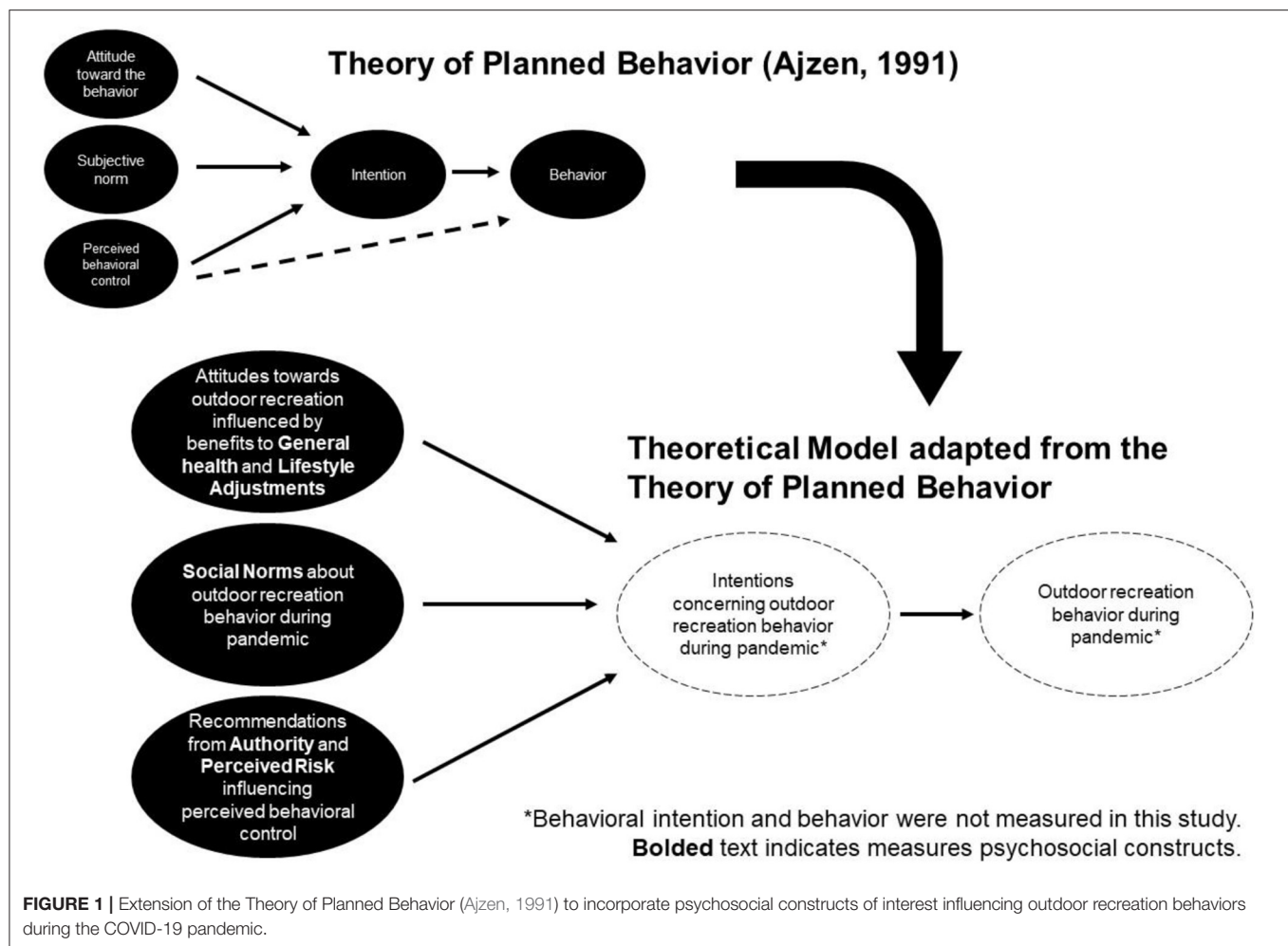
Tung, 2004; Rung et al., 2011; Smith et al., 2016). Additionally, the COVID-19 pandemic has also led to widespread closures (Tufan and Kayaaslan, 2020) which may influence the availability of other leisure activities for individuals. Previous research has indicated that recreationists will go through a process of finding substitute activities if other options become unavailable (Hammitt et al., 2004; Sutton and Oh, 2015). Given certain forms of outdoor recreation may be less impacted by these closures when compared to other forms of leisure, lifestyle adjustments may play an important role in individuals' attitudes and corresponding decisions related to outdoor recreation. These lifestyle adjustments may take the form of participating in outdoor recreation instead of another activity that may be perceived as less safe during the COVID-19 pandemic or more frequent participation in outdoor recreation activities to relieve situation feelings like isolation.

Considering the broad framing provided by previous behavioral theories (Ajzen, 1991; Stern, 2000) and the unique temporal characteristics of the COVID-19 pandemic, there is potential that the five outlined psychosocial factors (perceptions of risk, social norms, recommendations from authority, benefits to general health, and lifestyle adjustments) may be especially influential regarding avid outdoor recreationist behaviors. A brief summary of each and its potential relevance during the COVID-19 pandemic is provided in **Table 1**.

Furthermore, given this study aims to make general managerial recommendations for a broad range of outdoor recreation settings, it is imperative to understand if and how individuals residing in communities across the rural-urban gradient may differ in their orientations regarding these psychosocial factors and how these differences may affect outdoor recreation behaviors. For example, Venter et al. (2020) found that outdoor recreation participation in urban parks throughout Oslo, Norway, increased drastically during the COVID-19 pandemic. Alternatively, Geng et al. (2021) found mixed trends for urban park visitation rates internationally. In comparing trends across the rural-urban gradient in the United States, Rice et al. (2020a) found that urban outdoor recreationists were more significantly impacted by various restrictions during the early stages of the COVID-19 pandemic when compared to individuals residing in more rural communities. Understanding if and how the psychosocial constructs of interest differ across the rural-urban gradient can help provide a more nuanced understanding of potential shifts

TABLE 1 | Previous literature on focal psychosocial constructs.

Psychosocial construct	Previous research in outdoor recreation	Relevance during the COVID-19 pandemic
Social norms	Social norms are recognized as a prominent factor influencing outdoor recreationist behavior (Heberlein, 2012) and have been incorporated into several prominent theories predicting environmentally-related behavior such as the theory of planned behavior (Ajzen, 1991), value-belief-norm theory (Stern, 2000), and social practice theory (Kitchell et al., 2000). Targeted communication strategies influencing norms have also been shown to effectively influence behaviors in a park setting (Reigner and Lawson, 2009; Brown et al., 2010; Schwartz et al., 2018).	It is likely that social norms continue to play an integral role in outdoor recreation behaviors during the COVID-19 pandemic. As posited by Van Bavel et al. (2020), individuals may be looking to others for behavioral cues on how they should be acting during this unprecedented time.
Recommendations from authority	Persuasive communication and messages from authorities influence how outdoor recreationists behave (Marion and Reid, 2007). Such approaches are commonly used in parks and protected areas (Burn and Winter, 2009). These messages have been shown to be successful in certain cases when crafted effectively, such as with wildlife-related issues (Miller et al., 2018) and when promoting environmentalism amongst tourists (Powell and Ham, 2008).	Recommendations from authority have already played an integral role in the global response to the COVID-19 pandemic (Tufan and Kayaaslan, 2020). As outdoor recreationists make decisions during this time, they are weighing multiple directives and behavioral instructions from governments, public health organizations, and land managers. It is possible that these recommendations may be a major influencing factor for behaviors.
Perceived risk	Perception of risk is recognized as a major influence on outdoor recreations behavior (Green et al., 2009; Reis et al., 2012). It is often described as a constraining factor limiting outdoor recreation due to personal safety concerns (Reis et al., 2012). Risk-taking is often conceptualized as a process of mental trade-offs. Individuals can either be willing or unwilling to accept a certain level of risk in return for accrued benefits (Weber et al., 2002).	It is possible that outdoor recreationists may be balancing similar trade-offs when making outdoor recreation decisions during the COVID-19 pandemic, as has been shown in other leisure activities (Jittrapirom and Tanaksaranond, 2020).
Benefits to general health	Benefits related to spending time recreating in the outdoors are well-documented in the academic literature, with outcomes such as decreased stress and anxiety being specifically linked to exposure to natural environments (Kuo, 2015; Larson et al., 2016). Reviews have shown that outdoor recreation results in holistic health benefits, including both mental and physical outcomes (Thomsen et al., 2013; Holland et al., 2018).	Given the potential for increased stress associated with the COVID-19 pandemic, it is possible that outdoor recreationists are turning to the outdoors in search of these benefits, as has been demonstrated through previous research (Caltabiano, 1994; Korpela et al., 2014). Outdoor spaces have already been cited as a potential source of resilience during the COVID-19 pandemic (Samuelsson et al., 2020), while others have indicated that there is a strong need to support mental health during this time (Bao et al., 2020).
Lifestyle adjustments	Outdoor recreationists have been found to go through a process of constraint negotiation when certain leisure opportunities are no longer available (Hammitt et al., 2004; Sutton and Oh, 2015). Previous research has examined this process (Sutton and Oh, 2015) and how it can be leveraged as a management tool (De Valck et al., 2016).	As policy measures have rendered many leisure opportunities unavailable or restricted during the COVID-19 pandemic, there is potential that individuals are going through a similar negotiation processes and are changing their outdoor recreation attitudes and behaviors.

in outdoor recreation behavior and what may be causing them. This is especially important as access to green spaces can foster various forms of resilience across community types (Marafa and Tung, 2004; Krasny and Tidball, 2009; Rung et al., 2011).

Purpose and Research Questions

The purpose of this study is specifically to define these previously identified psychosocial factors in the novel context of the COVID-19 pandemic and understand how they influence avid outdoor recreationist behaviors and decision-making processes across rural and urban communities in the United States. This will help outdoor recreation managers and policymakers develop more effective messaging and aid in proactively managing shifts in visitor volume and behavior. Given this need and the potential relevance of the five psychosocial factors (see **Table 1**) within this process, this study is driven by three primary research questions:

RQ1: How reliable and valid are the developed sub-scales in assessing perceived risk, social norms, recommendations from authority, benefits to general health, and lifestyle adjustments during the early stages of the COVID-19 pandemic?

RQ2: How important are the five outlined psychosocial factors for avid outdoor recreationists when making outdoor recreation-related decisions during the early stages of the COVID-19 pandemic?

RQ3: How does the self-reported importance of the five outlined psychosocial factors differ between individuals residing in rural, urban cluster, and urban areas in the United States?

METHODS

An online survey designed to examine the three outlined research questions was developed and administered to a sample of avid

outdoor recreationists through the Leave No Trace (LNT) Center for Outdoor Ethics email list. Confirmatory factor analyses (CFA) and reliability analyses were utilized to address research question #1 and a repeated measures ANOVA was utilized to address research question #2. Lastly, a series of one-way ANOVA's was utilized to answer research question #3. All methodological procedures were approved by the Pennsylvania State University Institutional Review Board.

Survey Development

The survey was developed utilizing evidence from previous research to measure five primary psychosocial constructs that may influence outdoor recreation during the COVID-19 pandemic. Respondents were asked to respond to the prompt: "How important are the following factors when making outdoor recreation decisions (e.g., frequency of outing, distance from home, activity) during the COVID-19 pandemic?" Previous theoretical and empirical work on behavioral correlates in outdoor recreation as well as temporally relevant work examining the impact of COVID-19 on broader society were reviewed during the scale development phase (see **Table 1**). This work was then used to develop novel scale items that measured the five outlined constructs: perceptions of risk, social norms, recommendations from authority, benefits to general health, and lifestyle adjustments. Additional questions were also asked about frequency of outdoor recreation participation, type of outdoor recreation participation, and areas utilized for outdoor recreation.

Each novel item was designed to load onto one of the five previously outlined psychosocial constructs. Social norms examined perceived behavioral patterns of others in three items. Perceived risk was measured by three items examining how the COVID-19 pandemic existed as a threat to oneself as well as others. Recommendations from authority measured the importance individuals placed on messages from prominent medical authorities such as the Center for Disease Control, state governments, as well as recommendations from land management agencies themselves. This was measured in five items. General health benefits measured benefits sought for both mental and physical health via three items. And finally, lifestyle adjustments such as utilizing outdoor recreation as an outlet for safe leisure activities were measured via three items. Individuals were prompted to rate each measurement item on a five-point scale ranging from "Not at all important" to "Extremely important" when making outdoor recreation decisions.

Survey Administration

An email survey examining outdoor recreation patterns and decision-making processes during the COVID-19 pandemic was distributed via the LNT email mailing list. LNT is a prominent environmental organization in the United States and internationally, partnering with various local, regional, and national land management agencies, non-profits, and other organizations to share pro-environmental messages with audiences (Marion, 2014). Specifically, LNT's online community is composed of largely avid outdoor recreationists—partaking in 8–12 h of outdoor recreation per week—and is primarily based in

the United States (Leave No Trace Center for Outdoor Ethics, 2018). This sample was chosen as it provided an accessible population of avid outdoor recreationists during the height of COVID-19 lockdown measures in much of the United States. Individuals opt into being on the listserv, with members being recruited via events, online outreach, or finding the outlet through their own volition. Both demographic information and information on general outdoor recreation behaviors were collected to explore the representativeness of the sampled population in comparison to the broader population of outdoor recreationists in the United States.

The survey was distributed to 63,890 members of the listserv via the Qualtrics survey platform. The survey was open for 48 h starting at 9 a.m. MST on April 9th, 2020. Having the survey open for a short period of time helped capture a single, initial snapshot into behavioral factors during the volatile time of the COVID-19 pandemic.

Data Analysis

The first research question explored whether the five outlined psychosocial constructs were measured via reliable and valid sub-scales, thus operationalizing these concepts in the novel context of the COVID-19 pandemic. A CFA was utilized to examine convergent and discriminant validity for the developed scales (Brown, 2015). The CFA was carried out in SPSS AMOS utilizing a maximum likelihood estimation model. For the CFA, initial model fit was analyzed using a X^2 value, though it is recognized that this statistic can be sensitive to large sample sizes (Kline, 2016). Given this, the following criteria were also utilized to determine goodness of fit: RMSEA ≤ 0.10 (Kline, 2016); SRMR ≤ 0.08 (Kline, 2016); and CFI ≥ 0.90 (Hu and Bentler, 1998). Bias corrected confidence intervals were utilized in determining significance levels for standardized factor loadings to reduce the likelihood of Type 1 error (Byrne, 2001). Standardized factor loadings were deemed adequate when values were >0.30 and statistically significant (Kline, 1994). The CFA was followed by a calculation of Cronbach's Alpha for each scale (Vaske, 2008), which was utilized to determine the scale reliability. Cronbach's Alpha were deemed to indicate appropriate reliability when >0.65 (Vaske, 2008).

A repeated measures ANOVA was used to compare scale means within respondents and address the second research question. A repeated measures ANOVA was utilized as scale means for each psychosocial factor acted as a within-subjects measure. This was chosen over a traditional ANOVA analysis as each categorical independent variable lacked independence of observations with each analyzed individual providing responses on items contributing to all five scales (Courtney, 2018).

Lastly, to answer the third research question, a series of one-way ANOVA's were conducted to examine how important each psychosocial factor was for individuals residing across the rural-urban gradient. Communities were classified as rural (<5,000 residents), urban cluster (between 5,000 and 50,000 residents), and urban (>50,000 residents) for this analysis (U.S. Census Bureau, 2010; U.S. Department of Transportation: Federal Highway Administration, 2017). A series of one-way ANOVA's was utilized as this research question specifically aimed

to understand how each singular psychosocial construct differed across the three community types. Given the repeated use of this statistical test to answer this research question, a Bonferroni adjustment (Vaske, 2008) was utilized to reduce the likelihood of Type 1 error for each omnibus test (Armstrong, 2014).

RESULTS

Sample Characteristics

Of distributed surveys, 1,012 surveys were completed. This is in relation to 3,003 individuals who opened the email, providing an adjusted completion rated of 33.7% (Blumenberg and Barros, 2018). Individuals with missing data on the psychosocial factor items were deleted listwise as is appropriate after data were determined to be missing completely at random (Little, 1988), an assumption confirmed by Little's MCAR Test ($X^2 = 403.579$, $df = 368$, $p = 0.098$). This listwise deletion resulted in 977 surveys used in subsequent analyses. The sampled individuals were predominantly white (81.2%), female (53.1%), and had a mean age of 44 years old. 31.5% of respondents lived in rural communities (<5,000 individuals), while 23.0% of respondents lived in urban cluster communities (5,000–50,000 individuals), and 37.6% of individuals lived in urban communities (>50,000 individuals). Location of survey respondents were primarily clustered along the east coast, west coast, and the Rocky Mountain regions of the United States; however 48 states were represented in the sample [see Rice et al. (2020b) for more detailed location information]. Further demographic information is presented in **Table 2**.

Prior to the COVID-19 pandemic, survey respondents indicated recreating outdoors an average of 5.00 days per week. A slight reduction was reported after the WHO declared COVID-19 a pandemic on March 11th, 2020, with respondents reporting recreating outdoor an average of 4.68 days per week after this date. Surveyed individuals were also asked to indicate their primary outdoor recreation activity. Hiking was identified as the most common outdoor recreation activity for surveyed individuals (45.1% of respondents). Other commonly identified primary recreation activities included running (9.8% of respondents), downhill skiing or snowboarding (6.0% of respondents), camping or RV'ing (4.6% of respondents), bicycling or triathlon (4.0% of respondents), and Nordic skiing or snowshoeing (3.7% of respondents). Furthermore, survey respondents reported visiting a wide variety of outdoor recreation spaces including state forest land, Bureau of Land Management lands, county or regional parks, neighborhood or city streets, national parks, as well as others. Overall, individuals reported utilizing all areas less frequently during the COVID-19 pandemic except for neighborhood and city streets [see Rice et al. (2020b) for more detailed breakdown of outdoor recreation area use]. The variety of outdoor recreation activities and spaces utilized supports this study's goal of making general policy recommendations for outdoor recreation during the COVID-19 pandemic.

In comparing these findings to those presented by the Outdoor Foundation (2020) on general characteristics of outdoor recreationists in the United States, the sampled population

TABLE 2 | Demographic information of sampled population.

Demographic variables		n	Percentage of sample
Gender	Female	519	53.1
	Male	350	35.8
	Trans-gender	2	0.2
	Non-binary/other	14	1.4
	Prefer not to say/missing	92	12.5
Ethnicity	White	793	81.2
	Hispanic or Latino/Latina/Latinx	30	3.1
	Black or African American	7	0.7
	Native American, American Indian, or Alaska Native	6	0.6
	Asian or Pacific Islander	18	1.8
	Other	15	1.5
	Prefer not to say/missing	108	11.1
Community type	Rural (<5,000 individuals)	308	31.5
	Urban Cluster (5,000–50,000 individuals)	225	23.0
	Urban (>50,000 individuals)	367	37.6
	Prefer not to say/missing	77	7.9

mimics the broader characteristics of avid outdoor recreationist in the United States. The general characteristics reported by the Outdoor Foundation (2020) found the average outdoor recreationist in the United States to be 36.2 years old with 73.7% of respondents being white, making the present study's sample slightly older and slightly whiter. Additionally, the Outdoor Foundation found the majority of their respondents to be male (53.9%), while the majority of respondents in this study were female (53.1%). Furthermore, there may be unaccounted for difference between the sampled population and the broader outdoor recreationist population regarding factors such as knowledge of responsible outdoor recreation given LNT's educational mission. To this end, this sample is not intended to represent the population of the United States as a whole, which may have experienced changing recreation behaviors during the COVID-19 pandemic. Instead, this sample provides a group of avid outdoor recreationists who are highly dependent on outdoor recreation as a means of leisure (see Outdoor Industry Association, 2015).

Defining Psychosocial Constructs

All scales had an appropriate Cronbach's Alpha of 0.65 or greater when measuring reliability (Vaske, 2008). While X^2 values indicated the model did not fit the data well ($X^2 = 770.03$, $df = 109$, $p < 0.001$), this statistic is sensitive to large sample

sizes (Kline, 2016). The data demonstrated appropriate fit across all other outlined measures: RMSEA = 0.079; SRMR = 0.0594; CFI = 0.902. In examining each single-item measure, all satisfied appropriate thresholds with factor loadings being >0.30 and statistically significant (Kline, 1994). The original model was retained without re-specification. Given this, scale means were calculated from the measurement items that loaded onto each unique construct. Calculated means for each scale were Perceived Risk = 3.63 (SD = 1.06); Social Norms = 3.29 (SD = 1.06); Authority = 4.18 (SD = 0.75); General Health = 4.31 (SD = 0.78); and Lifestyle Adjustments = 3.37 (SD = 0.96). Details on psychosocial constructs and related measurement items are outlined in **Table 3**.

General Population Differences in Psychosocial Constructs

In addressing the second research question, results from the repeated measures ANOVA compared differences in importance among each of the latent psychosocial constructs for sampled individuals when making outdoor recreation decisions during the COVID-19 pandemic. The data failed the assumption of sphericity via Mauchly's test [$X^2(9)$ = 487.83; $p < 0.001$]. As a result, the Huynh-Feldt adjustment was utilized to account for this failure (ε = 0.789) (Huynh and Feldt, 1976). Additionally, data for each latent psychosocial construct failed the Shapiro-Wilk test for normality [Perceived Risk: $W(977)$ = 0.94, $p < 0.001$; Social Norms: $W(977)$ = 0.97, $p < 0.001$; Authority: $W(977)$ = 0.89, $p < 0.001$; General Health: $W(977)$ = 0.82, $p < 0.001$; Lifestyle Adjustments: $W(977)$ = 0.97, $p < 0.001$], though no adjustment was utilized as chosen analysis procedures were deemed robust to violations or normality (Norman, 2010). The omnibus test showed there was a significant difference amongst the importance ratings for the five psychosocial factors influencing outdoor recreation decisions for the sampled individuals [$F_{(3.16, 3082.14)}$ = 309.50; $p < 0.001$]. General Health was rated as the most important psychosocial factor relative to the other constructs, followed by Authority, Perceived Risk, Lifestyle Adjustments, and Social Norms in descending order of importance.

Post-hoc pairwise comparisons showed that all psychosocial factors of interest were significantly different from each other (all p-values <0.001) except for lifestyle adjustments and social norms (p = 0.648). Results from the repeated measures ANOVA and subsequent *post-hoc* tests are summarized in **Figure 2**.

Comparison Across Rural-Urban Gradient

In addressing the third research question, a series of one-way ANOVA's were conducted for each psychosocial construct for residents living in rural, urban cluster, or urban communities. Data for each ANOVA satisfied the assumption of equal variances via Levene's F Test (all p-values >0.05). As was done for the repeated measures ANOVA, analyses were conducted despite violations to the assumption of normality as the test is robust to these deviations (Norman, 2010). Additionally, a Bonferroni adjustment was utilized for each omnibus test to reduce the risk of Type 1 error (Vaske, 2008).

The omnibus tests for three psychosocial factors showed no significant difference across community types: Social Norms [$F_{(2, 897)}$ = 0.05; p = 0.951], General Health [$F_{(2, 897)}$ = 0.48, p = 0.622], and Lifestyle Adjustments [$F_{(2, 897)}$ = 0.37, p = 0.688]. The remaining two psychosocial factors did show a significant difference between community type: Perceived Risk [$F_{(2, 897)}$ = 5.23, p = 0.006] and Authority [$F_{(2, 897)}$ = 6.79, p = 0.001]. For Perceived Risk, Scheffé's *post-hoc* test indicated that individuals living in urban communities perceived significantly higher levels of risk when compared to rural (p = 0.035) or urban cluster communities (p = 0.018). For Authority, the *post-hoc* test indicates that urban communities significantly differed from urban cluster communities in valuing recommendations from authority more highly (p = 0.001). Results pertaining to research question three are further outlined in **Figure 3**.

DISCUSSION

Study results provide important insight into how avid outdoor recreationists make decisions during the COVID-19 pandemic across community types. By better understanding which psychosocial factors influence outdoor recreation decisions, outdoor recreation managers and policymakers can make more informed decisions that maximize safety and wellbeing for those utilizing outdoor recreation spaces during this time and during potential future health crises. In examining the first research question, analysis indicates that perceptions of risk, social norms, recommendations from authority, promoting general health and wellbeing, and lifestyle adjustments all exist as unique constructs influencing outdoor recreationist behavior during the COVID-19 pandemic. Furthermore, in addressing the second research question, findings indicate that promoting one's personal health matters most to outdoor recreationists during the pandemic. This is followed, in order of relative importance, by recommendations from authority, perceived risk, lifestyle adjustments, and social norms. Lastly, communities along the rural-urban gradient significantly differed in how strongly they weighed perceived risk and recommendations from authority when choosing to recreate outdoors.

Perhaps most notably, these results underscore the importance avid outdoor recreationists are placing on the benefits of recreating in the natural world during the early stages of the COVID-19 pandemic. While there was a slight decrease in the use of outdoor recreation spaces, surveyed individuals were still recreating outdoors an average of 4.68 days per week during the early stages of the COVID-19 pandemic across community types. With health outcomes of outdoor recreation being well-documented in the academic literature (Kuo, 2015; Larson et al., 2016; Azara et al., 2018), these data suggest that outdoor recreationists continue to highly value these benefits despite other novel pressures such as potentially increased health risks associated with visiting outdoor recreation spaces. This value individuals are placing on health benefits is also consistent across rural, urban cluster, and urban communities. These findings align with the assertions of Samuelsson et al. (2020), who posit

TABLE 3 | Scale development indices and single-item/scale means.

Psychosocial construct	How important are the following factors when making outdoor recreation decisions (e.g., frequency of outing, distance from home, activity) during the COVID-19 pandemic?	Λ	Bootstrap standard error	Mean*	SD
Perceived risk				3.63	1.06
	How severe I perceive the COVID-19 pandemic to be in the area I am recreating.	0.68	0.03	3.76	1.17
	The likelihood that I will unintentionally spread COVID-19 to others while recreating outdoors.	0.77	0.02	3.70	1.27
	How likely I believe I am to contract COVID-19 while participating in my outdoor recreation activity.	0.79	0.02	3.39	1.33
	Cronbach's Alpha	0.79			
Social norms				3.29	1.06
	The outdoor recreation behaviors of my neighbors and surrounding community.	0.86	0.02	3.51	1.24
	The outdoor recreation behaviors of my friends or family.	0.81	0.02	3.36	1.31
	The discussion I see on social media about recreating outdoors during the COVID-19 pandemic.	0.51	0.03	3.02	1.32
	Cronbach's Alpha	0.76			
Authority				4.18	0.75
	The open/closed status of public lands or public lands facilities.	0.51	0.04	4.42	0.85
	The orders and regulations of my state of residence regarding allowed behavior during the COVID-19 pandemic.	0.74	0.03	4.28	0.89
	The behavioral recommendations provided by the Center for Disease Control.	0.86	0.02	4.14	0.95
	Recommendations from land management agencies regarding outdoor recreation during the COVID-19 pandemic.	0.67	0.04	4.12	0.95
	The behavioral recommendations provided by the World Health Organization.	0.79	0.03	3.93	1.15
	Cronbach's Alpha	0.84			
General health				4.31	0.78
	The desire to support my overall health by spending time in the outdoors.	0.89	0.02	4.34	0.89
	The desire to relieve stress and support my mental health.	0.73	0.03	4.34	0.88
	The desire to support my physical health through exercise.	0.81	0.02	4.26	0.92
	Cronbach's Alpha	0.85			
Lifestyle adjustments				3.37	0.96
	The desire to partake in safe leisure activities during the COVID-19 pandemic.	0.76	0.04	3.96	1.06
	To fill the time I normally spent doing other recreation activities that I cannot do during the COVID-19 pandemic.	0.56	0.04	3.19	1.26
	To have a reason to leave home during the COVID-19 pandemic.	0.55	0.04	2.97	1.40
	Cronbach's Alpha	0.66			

Global Fit Indices for CFA: $X^2 = 770.03$, df = 109, $p < 0.001$; RMSEA = 0.079; SRMR = 0.0594; CFI = 0.902.

*Scale: 1 = Not at all important, 2 = Slightly Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely important.

that parks and open space can serve as a source of resilience during the COVID-19 pandemic and other future crises. To maintain a resilient society, these desired health benefits and the priorities placed on them by avid outdoor recreationists must be acknowledged and maximized across the rural-urban gradient.

This study also helps to illuminate the value avid outdoor recreationists place on guidance provided by public health agencies and land management agencies during the COVID-19 pandemic. Avid outdoor recreationists may adapt their recreation patterns in order to continue to seek out similar experiences to support health benefits in light of park closures or other constraints (Suwa, 2008), especially considering avid outdoor recreationists in this study continued to report recreating outdoors frequently despite novel threats from COVID-19. In further support of this, lifestyle adjustments during the COVID-19 pandemic were rated as being relatively low in importance when making outdoor recreation decisions when compared to other measured psychosocial constructs. This further implies
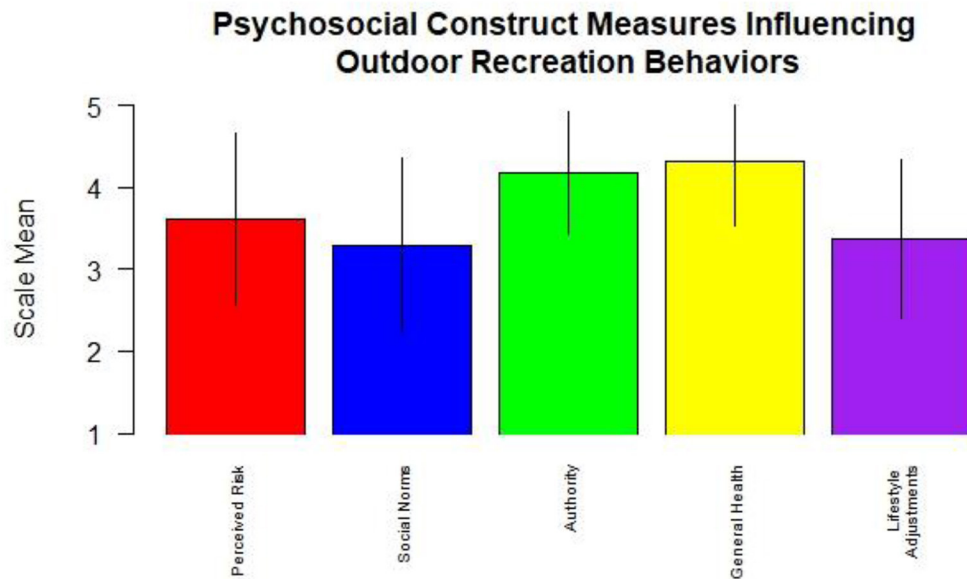
FIGURE 2 | Importance ratings for each psychosocial factor influencing outdoor recreation behavior analyzed through a repeated measures ANOVA [$F_{(3.16, 3082.14)}$ = 309.50, p-value < 0.001]; all means are significantly different from each other (p < 0.001) excluding Lifestyle Adjustments and Social Norms (p = 0.648); error bars represent the standard deviation for each psychosocial construct.
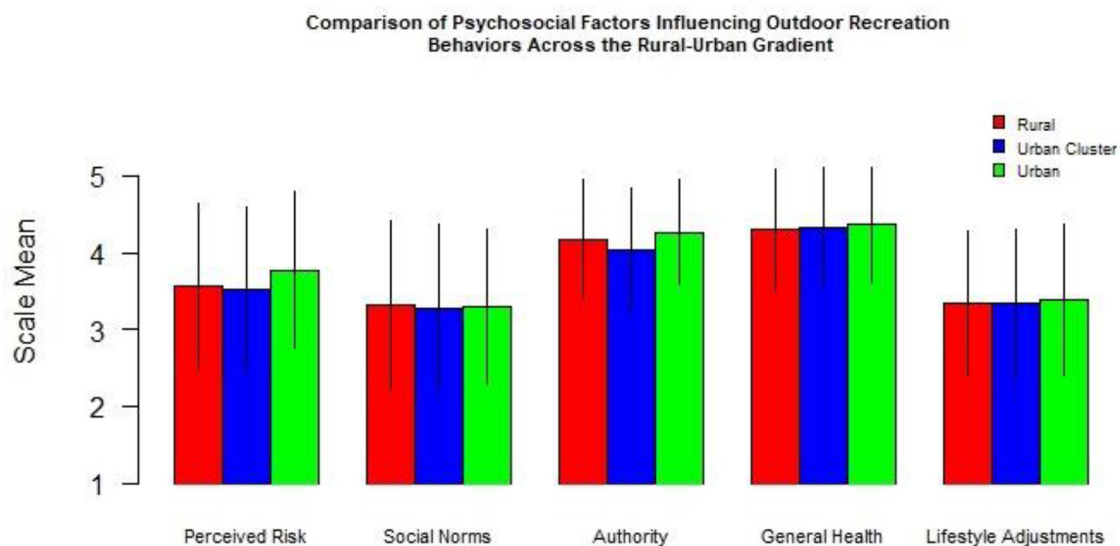
FIGURE 3 | Results from the one-way ANOVA's examining differences amongst scale means across three community types (rural, urban cluster, and urban); omnibus tests for one-way ANOVA's were significant across community types for Perceived Risk [$F_{(2, 897)}$ = 5.23, p = 0.006] and Authority [$F_{(2, 897)}$ = 6.79, p = 0.001]; error bars represent the standard deviation for each psychosocial construct.

that avid outdoor recreationists maintained high levels of motivation to participate in outdoor recreation despite novel pressures from COVID-19. Initial information provided by respondents provides interesting insight on this, with individuals reporting an increase in recreation on neighborhood and city streets and a decrease in recreation in all other outdoor spaces. This is especially insightful as urban communities

valued recommendations from authority significantly higher than those in urban cluster communities. This increase in use of neighborhood and city streets may represent a form of constraint navigation by those residing in urban communities specifically. Given recommendations from authority may have closed outdoor recreation spaces or dissuaded individuals from visiting these areas, individuals may have turned to city and

neighborhood streets as an alternative outlet for outdoor recreation activities. Furthermore, as the COVID-19 pandemic continues to evolve, outdoor recreation managers of sites that remain open should be prepared to mitigate crowding as avid outdoor recreationists seek out areas where they can improve their mental and physical health despite existing limitations and recommendations from authority. This could parallel a similar process to what was found during the 2003 SARS outbreak in Hong Kong (Marafa and Tung, 2004). Such dynamics could be especially important as the nature of recommendations from authority, perceived risk, or social norms change over the course of the COVID-19 pandemic.

Recommendations from authority were also ranked higher than all other psychosocial factors aside from seeking out benefits to one's own mental and physical health. With this in mind, land managers and policymakers can expect that changes in recommendations from the World Health Organization, Center for Disease Control, or other authorities will likely have an appreciable influence on outdoor recreation behavior amongst outdoor recreation enthusiasts, more so than personal perceptions of risk held by individuals or social norms. Furthermore, avid outdoor recreationists valuing these orders and directives demonstrates that communication from authorities is effective at influencing outdoor recreationist decisions. As demonstrated in previous studies, effective communication (e.g., well-designed signage) should continue to be used as a potentially useful means of encouraging safe behavior in outdoor recreation areas (Walkosz et al., 2008; Miller et al., 2018). The strong influence recommendations from authority had on avid outdoor recreationists during the early stages of the COVID-19 pandemic may be especially pronounced given a similar scenario had not been experienced by many individuals residing in the United States at the time. These novel stressors may result in individuals relying on expert opinions (i.e., recommendations from authority) rather than social norms as little collective knowledge on navigating pandemics existed within the United States during April 2020.

This study also helped to develop an understanding of how perceptions of risk, social norms, recommendations from authority, promoting general health and wellbeing, and lifestyle adjustments exist as unique factors influencing avid outdoor recreationist behaviors across rural, urban cluster, and urban communities. Monitoring and understanding these concepts across the rural-urban gradient can play an integral role in developing effective policy measures over the course of the COVID-19 pandemic and beyond, especially given the role similar policy measures have already played in the global pandemic response (Tufan and Kayaaslan, 2020). In examining the three psychosocial factors that have not been extensively discussed thus far (perceptions of risk, social norms, and lifestyle adjustments), it is notable that urban communities weighed perceived risk significantly higher than other community types when choosing to recreate outdoors. Various factors such as dense populations, lack of access to green space, or being transportation hubs may contribute to this higher risk perception by avid outdoor recreationists in urban communities (Peters, 2020; Hubbard et al., 2021). This differential in risk perception

between rural, urban cluster, and urban communities should be acknowledged and incorporated into messaging and managerial decisions by land managers in these various communities.

LIMITATIONS AND FUTURE RESEARCH

When interpreting findings from this study, several limitations should be acknowledged and considered. The sampled population was quite homogenous, being mostly white, female, and made up of avid outdoor recreationists. Though the study's sample is overwhelmingly composed of non-Hispanic white individuals, this composition aligns with other estimates of overall outdoor recreation participation (Askew and Walls, 2019; Outdoor Foundation, 2020). However, the female majority within the sample is not consistent with outdoor recreation participation at large (Outdoor Foundation, 2020). Additionally, the lack of other socio-demographic measures within this study presents the possibility of additional biases within the sample. For example, higher socioeconomic status can potentially allow individuals to more effectively navigate constraints during the COVID-19 pandemic and continue to recreate frequently in the outdoors (Ghimire et al., 2014). The surveying of members within the LNT email list also presents a potential bias, as the sample may be more educated about responsible outdoor recreation and therefore more disposed to following regulations in comparison to the larger outdoor recreation community.

Care should be taken in extending these findings to the average park or protected area visitor in the United States or internationally. The frequency of outdoor recreation represented by participants in this study is considerably higher than the average outdoor recreationist in the United States (Leave No Trace Center for Outdoor Ethics, 2018). Additionally, LNT and those involved in the organization are primarily based in the United States and thus inextricably linked to the unique social, cultural, and managerial forces shaping outdoor recreation patterns of the country. Those surveyed as part of the LNT listserv have a very specific conceptualization of responsible outdoor recreation that may not translate easily to how other countries perceive their relationship with outdoor recreation spaces. Additionally, some demographic trends represented by this research, such as avid outdoor recreationists having relatively high incomes, may not be representative of avid outdoor recreationists in other countries. Future research has the opportunity to build upon this initial study and expand this exploration of psychosocial factors influencing outdoor recreation decisions during health crises to a broader, more holistic population. This could help land managers better understand how outdoor recreation patterns are shifting as a result of the COVID-19 pandemic on a broader scale.

Further research also has the opportunity to explore psychosocial factors influencing outdoor recreation decisions in more specific environments or regarding more specific outdoor recreation behaviors. This study primarily aims to make broad recommendations across outdoor recreation settings and behaviors. While this is valuable during the unprecedented and rapidly evolving context of the COVID-19 pandemic, future

research can explore more nuanced behaviors (e.g., those relating to a specific type of outdoor recreation activity) and their psychosocial drivers during these times. It should also be noted that the psychosocial constructs of interest were not explicitly linked to actual or self-reported behavioral changes in this study. Future research could explicitly link the measured psychosocial constructs to outdoor recreation behavioral changes.

Additionally, while initial metrics indicate that the developed scales had appropriate reliability and validity, further work should be done to develop these measurement tools. Expanding the studied population beyond the relatively homogenous sample for this project could help develop an understanding of whether these scales are useful in measuring psychosocial factors within the broader public. Furthermore, there is an opportunity to refine the measures used in this study to further establish reliability and validity in future studies.

Lastly, this study represents an initial snapshot into the dynamic nature of outdoor recreation during the COVID-19 pandemic. The volatile nature of this pandemic and future pandemics may result in rapid shifts in public opinion, environmental conditions, or other influential factors measured here. Findings from this study exist as a single point of reference during the early COVID-19 pandemic, and future research has the opportunity to track and understand how the measured psychosocial factors may change moving forward or during other forthcoming health crises.

CONCLUSION

The COVID-19 pandemic has drastically altered daily life for individuals across the globe, but public lands and other areas used for outdoor recreation have the opportunity to serve as sources of resilience and strength for individuals and communities (Bedimo-Rung et al., 2005; Pretty et al., 2005; Samuelsson et al., 2020). To proactively manage and steward these recreation resources during current and future

health crises, the psychosocial factors driving outdoor recreation behaviors must be understood. Data indicate that avid outdoor recreationists highly value benefits to their mental and physical health when making decisions to go outside for recreation during the COVID-19 pandemic. Additionally, these avid outdoor recreationists indicated they are weighing recommendations from authority more heavily than most other measured factors. Taken together, this indicates that land managers, government agencies of all levels, and public health organizations have the responsibility of making recommendations to keep individuals safe while also allowing them to obtain the necessary health benefits of outdoor recreation. Achieving this difficult balance as the COVID-19 pandemic continues to evolve and upend the status quo in parks and protected areas is a necessity, both in the United States and globally.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Pennsylvania State University Institutional Review Board. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

TM: project formulation, survey development, data analysis, and manuscript writing and review. WR: project formulation, survey development, and manuscript writing and review. BT, BL, NR, and PN: project formulation, survey development, and manuscript review. All authors contributed to the article and approved the submitted version.

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Contact With Nature as a Mental Health Buffer for Lower Income Communities During the COVID-19 Pandemic

Amber L. Pearson[1]*, Teresa Horton[2], Karin A. Pfeiffer[3], Rachel Buxton[4],
Joseph Gardiner[5], Wei Liu[1], Ruth F. Hunter[6] and Mathew P. White[7]

[1] Department of Geography, Environment and Spatial Sciences, Michigan State University, East Lansing, MI, United States,
[2] Department of Anthropology, Northwestern University, Evanston, IL, United States, [3] Department of Kinesiology, Michigan
State University, East Lansing, MI, United States, [4] Department of Biology, Carleton University, Ottawa, ON, Canada,
[5] Department of Epidemiology and Biostatistics, Michigan State University, East Lansing, MI, United States, [6] Centre for
Public Health, Queen's University Belfast, Belfast, Ireland, [7] Cognitive Science HUB, University of Vienna, Vienna, Austria

Despite a growing number of research outputs on the importance of nature contact during the COVID-19 pandemic, we know of no longitudinal research conducted prior to and during the pandemic among low-income and minority ethnicity populations, i.e., those that might be most affected. Furthermore, we have scant information about how and to what degree contact with nature might protect mental health or mitigate worsening of mental health during the pandemic. We filled these gaps using a subset of a longitudinal study of $n = 86$ individuals in low-income, predominantly African American, neighborhoods in Detroit, MI, USA. The study addressed the following research questions: (1) did self-reported use and perceived value of nature change during, vs. prior to, the pandemic; (2) did perceived access to outdoor spaces buffer people against mental health issues such as stress, anxiety and depression symptoms; or (3) did objectively measured quality of nature views from home buffer people against mental health issues, taking into account relevant covariates and pandemic experiences (e.g., loss of employment, death of a friend/relative)? While attitudes to nature improved slightly from pre- to during the pandemic, we also observed significant decreases in most types of outdoor physical activity and passive enjoyment of nature (e.g., smelling plants/rain). We found a positive association between visibility of greenspace and perceived stress and anxiety, which not only contradicts previous research findings, but was especially surprising given that overall there was a decrease in perceived stress from 2019–2020. We did not detect associations between perceived access/use of nature and mental health. However, higher depressive symptoms were associated with exposure to more COVID-19-related stressors (lost employment, death of friends from COVID-19, etc.). Taken together, our results indicate that COVID-19 may serve to prolong or exacerbate mental health issues, rather than create them, in this population and that low quality greenspace may perhaps limit the ability for nature view to buffer mental health during the pandemic.

Keywords: green space, viewshed, equity, African American, stress, parks, anxiety

INTRODUCTION

During the early months of the pandemic, stories about increased wildlife in urban spaces, usage of parks in record numbers, and even conflict related to accessing public open spaces abounded in the popular media. For example, beaches and national parks have been sites of contestation related to accessibility of sites, crowded conditions, and deterioration of natural spaces due to over-use. Such record accounts of usage of natural spaces implies these areas may be important to the public during times of crises like a pandemic (Volenec et al., 2021). Indeed, at a time when being indoors with others is not recommended to limit the spread and potential exposure to COVID-19, many people have sought refuge in public, outdoor spaces. However, many national parks and large natural areas are not easily accessible to urban residents, particularly communities of color (Xiao et al., 2017).

Also during the pandemic, many people report higher stress and anxiety related to COVID-19 infection risk and the cascading effects of the pandemic on economic and social conditions (Ettman et al., 2020). What is less understood is how and to what degree contact with nature might protect mental health during the pandemic. Understanding whether mental health outcomes appear to be better for those who are able to engage in outdoor activities or have better views of nature from home may provide insights into strategies to improve mental health during crises, such as the COVID-19 pandemic.

Building on several decades of research on the physical and mental health benefits (e.g., cognition, blood pressure, stress, sleep) of contact with nature (Berman et al., 2008; Kuo, 2015; Shanahan et al., 2016; Cox et al., 2017; Frumkin et al., 2017; Taylor et al., 2017), emerging COVID-19 research indicates that contact with nature may also buffer against the stress associated with pandemic conditions, including lockdown (Pouso et al., 2020). Investigators showed that, in Europe, those with a self-reported view of nature from home (green and/or blue space) had lower anxiety and depression, compared to those with self-reported views of built-up areas. Moreover, those who reported lost employment and had lower access to shared outdoor spaces had higher anxiety and depression than other groups. In contrast, evidence from Scotland did not detect associations between spending time in nature and changes in health from pre-lockdown levels (Corley et al., 2021). Likewise, the number of nature interactions was also not associated with loneliness, while living far from nature was in the Netherlands (van Houwelingen-Snippe et al., 2020), suggesting that passive exposure to nature may be important.

Other research has shown increased nature-related activities in and value of nature in the US (Morse et al., 2020) and significant changes in patterns of visiting nature as a result of the COVID-19 pandemic in the UK (Robinson et al., 2021). Not only did frequency of nature-related activities change, but so did the locations, with some research reporting increased usage of nearby or neighborhood natural areas (Randler et al., 2020; Portegijs et al., 2021). Poor quality neighborhood conditions, thus, appear to be important factors in exacerbating mental health disparities during the pandemic (Yang and Xiang, 2021).

Taken together, the emerging research touches upon two primary pathways through which contact with nature is believed to influence health: (1) passive exposure (e.g., visual, auditory) and (2) active exposure (e.g., ability to use the space). Although this emerging research is compelling and involves a large sample size and wide swathe of countries, there are several missing components that would advance our understanding of the role of nature in decreasing the adverse impacts of stress. Research is needed, namely, on the importance of nature contact among low-income populations and communities of color, given the disproportionate impact of COVID-19 on these communities (Abedi et al., 2020; Mackey et al., 2020; Tirupathi et al., 2020), inclusion of data from before and during the pandemic about usage behaviors, and objective quantification of visual contact with nature.

Given this background, this paper addressed the following research questions: (1) did self-reported use and perceived value of nature change during, vs. prior to, the pandemic; (2) did perceived access to outdoor spaces buffer people against mental health issues such as stress, anxiety and depression symptoms; or (3) did objectively measured quality of nature views from home buffer people against mental health issues, taking into account relevant covariates and pandemic experiences (e.g., loss of employment, death of a friend/relative)?

MATERIALS AND METHODS

Ethical Approval

The study was approved by the Michigan State University's Institutional Review Board (IRB Approval #STUDY00000587; date 03/21/2019 and modified for COVID conditions 05/26/2020). Informed consent was obtained in writing from all participants.

Sample, Recruitment, and Retention

This study involves a subset of participants in a larger, longitudinal study of the benefits of park restoration on health (see Pearson et al., 2020 for more details). Sampling for the parent study was conducted in two stages. First, neighborhoods ($n = 9$) were selected that contain a park not currently maintained by the Detroit Parks and Recreation Department as a conventional park. Second, to recruit participants, we mailed postcards and conducted recruitment activities (e.g., information booths) in each selected neighborhood (defined as 500 m^2 with a park as the center). Participants were recruited from within a 16-cell grid (120 m^2/cell) around each park. Longitudinal data collection for the parent study is scheduled to occur every May–October until 2023.

In August–October 2019 (late funding led to a truncated field season), field staff visited homes in each study neighborhood to brief potential participants on the study, request participation, and screen for inclusion. We recruited only one English-speaking male or female ($\geq$ 18y) without mobility issues per household, which was at the household's discretion ($n = 145$ participants). In 2020, however, due to IRB restrictions during the COVID-19 pandemic, no new recruitment took place. Instead, we modified our protocol to collect contactless data. In 2020, we contacted and

obtained data for a subset of 86 of the participants from the 2019 wave (52%) from June 15th to July 29th. To retain participants between 2019 and 2020, we employed a set of strategies including: (1) sending holiday cards with neighborhood-level study results; (2) sending birthday cards; and (3) adding news items and updates through the study website (www.stand-detroit.org).

Survey and Anthropometrics

In 2019, a paper survey was given to participants at enrollment, and anthropometrics were taken at a scheduled office health appointment. At the appointment, height was measured twice using a stadiometer (SECA Corp), and weight was measured twice using a scale with bioelectric impedance capability (Tanita TBF-300). Measures were then averaged, and BMI was calculated as a ratio of weight and height (kg/m^2). The paper survey was returned during the health appointment.

In 2020, a paper survey was provided in a packet along with a sanitized scale, both placed on a participant's front porch/apartment entry door, while a field staff member waited in a car nearby and watched as the participant retrieved the packet and took their weight on the scale. The participant then phoned or texted their weight and went indoors while the field staff member retrieved and sanitized the scale. Staff returned 3–5 days later to retrieve the paper survey.

Throughout this study, the paper survey was self-administered and completed in the privacy of participants' own homes. The survey included basic demographic data information (age, sex, ethnicity, employment, household composition, length of residence), income, perceptions of the neighborhood (Saelens et al., 2003; Forsyth et al., 2009; Schroeder and Wilbur, 2013; Prouse et al., 2015; Ramos et al., 2016), disease and prescription medication history [National Eye Institute, 2000; Cantor et al., 2009; Audiometry Questionnaire (AUQ), 2018; NHANES, 2018], diet (NHANES, 2010; Nebeling et al., 2017), perceived stress or PSS (Cohen et al., 1983), anxiety and depressive symptoms (Cella et al., 2007; Hays et al., 2009), and attitude toward nature (Nature-relatedness 6, NR-6) (Nisbet and Zelenski, 2013).

In 2020, we also included pandemic-related questions including before and during COVID-19 outdoor physical activities, value of nature, perceived access to nature, and social and economic effects of COVID-19. These questions were registered in the COVID-19 PhenX Toolkit (Community Access module at https://www.phenxtoolkit.org/toolkit_content/PDF/MSU_CWC_Community.pdf). Using a similar approach to Ettman et al. (2020), we generated a "stressor score" which summed all positive agreement for the effects of COVID-19 on life conditions into one value (variables included in **Table 1**), which ranged from low stressors (0) to high stressors (Ettman et al., 2020) (mean = 1.4, sd = 1.5).

Viewshed Analyses

The viewshed, or area visible from participants' homes, was assessed objectively using previously described methods (Nutsford et al., 2015). In brief, we first defined the visibility analysis study area (VASS) as the city boundary of the city of Detroit plus a 12 km buffer. We clipped the VASS using the US/Canada border so that only the area within the US

TABLE 1 | Sample demographics and health status in 2019 and 2020.

Characteristic	2019	2020	p-value[‡]
Income, % <$10,000	32.1	40.5	0.375
Employed, %	17.9	23.8	0.424
Married/partnered, %	15.5	33.3	<0.001
Own home, %	27.4	35.7	0.375
Sick in past two weeks, %	17.9	9.5	0.302
Age (in years), mean (sd)	56.0 (14.3)	56.8 (14.6)	—
Number of children living at home, mean (sd)	0.4 (1.1)	0.3 (1.0)	0.159
Attitude toward nature, mean (sd)	3.0 (0.8)	3.3 (1.1)	0.010
Current smokers, %	51.2	38.1	0.250
Overweight or obese, %	73.8	67.9	>0.999
BMI, mean (sd)	31.2 (8.2)	31.5 (8.9)	0.170
PSS score, mean (sd)	19.8 (5.1)	15.8 (5.4)	0.001
Anxiety t-score, mean (sd)	55.5 (9.7)	53.9 (10.1)	0.266
Depression t-score, mean (sd)	52.7 (10.0)	51.8 (10.2)	0.418
My employment has stopped.[§]		2.7 (1.3)	
My income has stopped.[§]		2.2 (1.1)	
I have not paid rent.[§]		2.0 (1.0)	
My eating habits have changed.[§]		2.9 (1.3)	
My household members have changed.[§]		2.3 (1.1)	
I think I had COVID-19 and was very sick.[§]		1.7 (0.9)	
I have family members who have died of COVID-19.[§]		2.0 (1.2)	
I have friends who have died of COVID-19.[§]		2.6 (1.4)	
I can no longer get the support of family I once had.[§]		1.9 (1.0)	
I can no longer get the support of friends I once had.[§]		2.1 (1.1)	

[‡]differences in means tested using paired t test, differences in percentages tested using McNemar's test.
[§]higher values = stronger agreement (1 to 5).

was kept for our analysis, due to data availability (note the clipping did not affect viewshed). A 1 m digital elevation model (DEM) was downloaded from USGS, mosaicked, and clipped to the VASS. To account for the influence of building structures on visibility, building footprint data were downloaded from SEMCOG (https://semcog.org/) and checked against project field maps and Google Earth to make sure building footprints were up to date. Building footprints were then rasterized and added to the DEM to create VASS elevation data. To reduce computation load in visibility analysis, we resampled the VASS elevation data to 3-m resolution. The observer locations were generated from the front door of participants' home locations using building footprints. To locate green space in VASS, we used all parks in the metro-Detroit area, and rasterized them to a 1 m-resolution binary raster where a value of 1 indicated parks. Only parks were used due to concerns that vacant lots vs. parks may have different effects on mental health (Nisbet and Zelenski, 2013). **Figure 1** illustrates how the viewshed from a participant's home was assessed using these digital data.

Visibility analysis was conducted in ArcGIS Pro 2.6. The observer offset was set to 1.67 m, which is the average height of participants in our study. To quantify the visibility of parks in

FIGURE 1 | Viewshed analysis process for capturing visibility of greenspace for a participant.
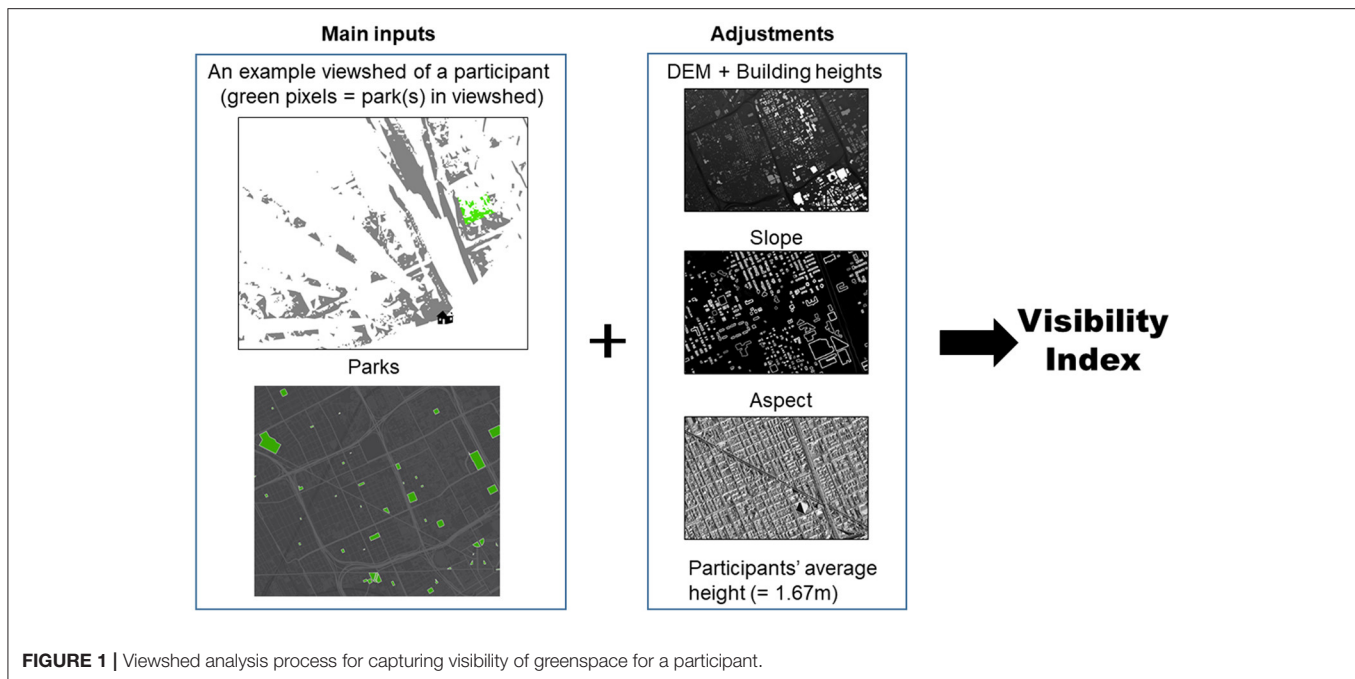
viewsheds from a human perspective (Nutsford et al., 2015), we calculated a Vertical Visibility Index (VVI) from each observer location, whereby we accounted for vertical dimensions of visibility (slope, aspect and elevation). The VVI of parks is calculated as the sum of the weighted pixel values of each visible park cell in the viewshed by adjusting for the vertical degrees of visibility between the eye-level of a human and the top and bottom point of each visible park cell. These values were then grouped into tertiles, to represent each 33% higher values in visibility of greenspace in our sample (1 = none or low visibility; 3 = high visibility).

Statistical Analyses

To understand our sample, we first conducted descriptive statistics on the demographics, self-reported effects of COVID-19 on life conditions, and health status of participants, using data from 2019 and 2020. Only data from participants who participated in both years were included in the analysis ($n = 86$). To assess potential differences in the full sample from 2019 (including those who did not participate in 2020) and the sample from 2020, we conducted t-tests for differences in demographic and health characteristics. We did not detect significant differences in the proportion of females, income, number of children living at home, length of residence, BMI, PSS scores, anxiety or depressive symptoms across the two samples. We did find significantly higher nature-related scores for the full 2019 sample (mean = 3.37 vs. mean = 3.03, $p = 0.019$) compared to the 2020 sample.

Next, to explore self-reported use and perceived value of nature changes during, vs. prior to, the pandemic, we tested for significant differences in values over time using a paired t-test for continuous data and McNemar's test for paired proportions. We then calculated descriptive statistics on the use and value of nature before (typical month before COVID-19) and during the

pandemic (last month) and tested for significant differences using a paired t-test.

To explore whether perceptions of access to and use of nature were associated with mental health measures, we first evaluated correlations between our measures and selected only those with $r < 0.6$ for model inclusion. Thus, we fitted separate linear regression models for each mental health outcome and included (i) perceived use of neighborhood sidewalks and parks; (ii) perceived accessibility of parks; and (iii) perceived accessibility of sidewalks/shared spaces in the neighborhood. We adjusted for sex, age, married/partner status 2020, stressor score, and the previous year's mental health value (for PSS, anxiety or depression symptoms, respectively).

To explore whether views of greenspace from home were related to mental health outcomes, we first looked descriptively at word clouds of an open response to the survey prompt, "If you have experienced a major stressor in the past 12 months, please let us know what it was," stratified by whether participants had any view of greenspace from home or none. Next, we fitted separate linear regression models for each of the three mental health outcomes and included visibility of greenspace as the independent variable of interest. These models were adjusted for sex, age, married/partner status in 2020, stressor score, and the previous year's mental health value. We selected this small subset of potential confounders because of the small sample size and due to their well-established associations with mental health (Kessler et al., 2007; Scott et al., 2010). All statistical analyses were performed using Stata v16 (Statacorp, College Station, TX, USA).

RESULTS

The study sample was 83% African American, 57% female, and 53% had an income under $10,000 in 2020. From 2019 to 2020, we observed a significant increase in the

	Pre-COVID		Last month		
	Mean	**sd**	**Mean**	**sd**	**_p_-value‡**
How often have you engaged in active transportation (commuting by bike or walking)	3.2	1.4	2.9	1.4	**0.034**
How often have you spent time riding a bicycle for leisure	2.3	1.3	2.0	1.3	**0.001**
How often have you spent time walking in neighborhood for leisure	3.1	1.1	2.9	1.3	**0.003**
How often have you spent time walking on trails for leisure	2.1	1.2	2.1	1.3	0.402
How often have you spent time walking in parks for leisure	2.4	1.2	2.2	1.3	0.191
How often have you used trails (>15 min from your house)	1.9	0.9	1.8	1.0	0.754
How often have you used neighborhood resources (sidewalks, parks)	2.7	1.1	2.6	1.0	**0.034**
How often have you used home-based activity (workouts, housework, yard work, playing outside)	2.9	1.0	2.8	1.0	**0.032**
How often have you used time outdoors with animals	2.0	1.2	1.9	1.2	0.203
How often have you watched birds through a window	2.7	1.1	2.7	1.1	>0.999
How often have you listened to birdsong	2.6	1.1	2.6	1.1	0.658
How often have you smelled rain or plants	2.7	1.0	2.6	1.1	**0.038**
How often have you looked at greenery and plants through a window	2.9	1.0	3.0	1.1	>0.999
How often have you spent time in your backyard, porch or balcony	2.9	1.1	2.9	1.1	0.698

Higher values = higher frequency over the past month (1 to 5).
‡ differences in means tested using paired t test.
Bold font = significant at p < 0.05 level.

percentage married/partnered (15% to 33%), and attitude toward nature (Nature Relatedness 6 (NR-6) scale, 3.0 to 3.3) (**Table 1**). Unexpectedly, we also observed a significant decrease in perceived stress scores (PSS) (19.8 to 15.8). PSS scores ranging from 14–26 are considered moderate stress. All other demographic and health status measures did not differ significantly over time. In terms of the effects of the pandemic on life conditions, the highest agreement was found for changes in diet, followed by employment stopping and having friends die of COVID-19.

Changes in Self-Reported Use and Value of Nature

When exploring changes in self-reported outdoor physical activities and passive enjoyment of nature before COVID-19 and during the last month (during COVID-19), we observed significant decreases in active transport, riding a bicycle for leisure, walking in the neighborhood for leisure, use of neighborhood sidewalks and parks, use of home-based activity, and smelling rain or plants (**Table 2**). We observed an average increase in value of nature (mean = 3.4, sd = 1.1, not shown in tabular form) and a significant increase in attitudes toward nature (**Table 1**).

Perceived Access to Outdoor Spaces as a Buffer Against Poor Mental Health

When evaluating associations between perceived access to nature and mental health, none of the perceived access measures significantly predicted PSS, anxiety or depressive symptoms (**Table 3**). Being female, older, and having a higher stressor score were significantly associated with higher depressive symptoms. Similar to **Table 4** results, PSS, anxiety and depression scores in 2019 all significantly predicted these same outcomes in 2020. We note however that the association for anxiety and depression (in

Table 3) is somewhat stronger than for PSS, possibly reflecting the more 'trait' like measures of anxiety and depression which tend to remain more stable over time than the more state like measure of PSS which may be more influenced by short-term and recent issues and thus less stable over time.

Nature Views From Home as a Buffer Against Poor Mental Health

When evaluating associations between visibility of greenspace from home and health outcomes, we found that higher visibility of greenspace was associated with higher perceived stress (**Table 4** Model 1, $\beta = 1.54$, $p = 0.079$) and anxiety ($\beta = 3.97$, $p = 0.025$). Females also had significantly higher depressive symptoms. Across all three models, the previous year's mental health was a significant predictor of mental health measures in 2020.

Prior to the pandemic, among both those with and without views of greenspace, death and issues with family were common major stressors (**Figure 2**). After the onset of the pandemic, we can see a clear addition of COVID-19 as a major stressor among those with and without views of greenspace. Those without views of greenspace also showed a clear addition of fear as a major stressor. In contrast, those with views of greenspace had more consistent trends in other major stressors including birth, children, and specific family members (especially mother, brother, and sister).

DISCUSSION

In this predominantly low-income, African American sample, we found that household composition changed during the COVID-19 pandemic. Specifically, the proportion of participants who were married or partnered doubled when comparing conditions

TABLE 3 | Regression modeling results predicting Perceived Stress Scores (PSS), anxiety, and depression symptoms in 2020, inclusion of perceptions of access to nature.

	Model 1: PSS (R^2 = 0.26)				Model 2: Anxiety (R^2 = 0.36)				Model 3: Depression symptoms (R^2 = 0.77)			
	β	se	95% CI	p-value	β	se	95% CI	p-value	β	se	95% CI	p-value
Perceived use of neighborhood sidewalks and parks	−0.44	0.69	−1.84 0.96	0.531	0.68	1.32	−1.98 3.33	0.611	0.81	0.80	−0.80 2.42	0.319
Perceived accessibility of parks	0.42	0.55	−0.69 1.54	0.449	−0.14	0.98	−2.11 1.83	0.884	0.17	0.60	−1.04 1.39	0.773
Perceived accessibility of sidewalks/shared spaces in neighborhood	−0.82	0.58	−1.99 0.35	0.164	0.11	1.04	−1.97 2.20	0.913	−0.16	0.62	−1.40 1.08	0.801
Female	1.22	1.34	−1.48 3.92	0.369	−1.50	2.58	−6.70 3.70	0.564	3.14	1.57	−0.02 6.30	0.051*
Age	0.01	0.05	−0.10 0.11	0.895	0.03	0.09	−0.16 0.22	0.771	0.16	0.06	0.05 0.28	0.008**
Married/partnered 2020	−1.33	1.47	−4.29 1.63	0.369	−3.57	2.54	−8.68 1.54	0.166	−1.39	1.56	−4.51 1.74	0.377
Stressor score	0.03	0.53	−1.04 1.09	0.960	−0.06	0.99	−2.05 1.93	0.952	1.05	0.57	−0.08 2.19	0.069*
PSS 2019	0.35	0.13	0.09 0.62	0.011**								
Anxiety 2019					0.56	0.12	0.31 0.80	<0.001**				
Depression 2019									0.87	0.08	0.72 1.03	<0.001**

**significant at p < 0.05 level, *significant at p < 0.10 level.

TABLE 4 | Regression model results, predicting Perceived Stress Scores (PSS), anxiety and depression symptoms in 2020.

	Model 1: PSS (R^2 = 0.29)				Model 2: Anxiety (R^2 = 0.39)				Model 3: Depression symptoms (R^2 = 0.70)			
	β	se	95% CI	p-value	β	se	95% CI	p-value	β	se	95% CI	p-value
Visibility of parks from home	1.54	0.86	−0.18 3.26	0.079*	3.97	1.72	0.53 7.41	0.025**	0.90	1.13	−1.37 3.16	0.430
Female	0.47	1.17	−1.89 2.82	0.693	−1.95	2.18	−6.31 2.41	0.375	2.66	1.55	−0.44 5.75	0.091*
Age	0.02	0.04	−0.06 0.11	0.610	−0.06	0.07	−0.20 0.09	0.432	0.08	0.05	−0.02 0.19	0.129
Married/partnered 2020	−0.82	1.29	−3.42 1.77	0.525	−3.20	2.28	−7.75 1.36	0.166	−2.47	1.65	−5.77 0.84	0.140
Stressor score	0.48	0.42	−0.37 1.32	0.261	0.40	0.84	−1.28 2.07	0.635	0.55	0.54	−0.53 1.63	0.312
PSS 2019	0.41	0.12	0.17 0.64	0.001**								
Anxiety 2019					0.48	0.11	0.27 0.70	<0.001**				
Depression 2019									0.80	0.07	0.65 0.94	<0.001**

**significant at p < 0.05 level, *significant at p < 0.10 level.

prior to and during the pandemic. In addition, the number of children living at home decreased somewhat. It is unclear from the current literature how widespread such changes in household composition are. We also observed a significant decrease in perceived stress. In some respects, the decrease in perceived stress might seem surprising, given that a recent study (65% non-Hispanic whites) showed that depression prevalence during COVID-19 was several-fold higher than prior to the pandemic (Ettman et al., 2020). However, we note first, that perceived stress is not the same as depression symptoms and more reactive to current contexts and situations, and secondly that symptoms of anxiety and depression in a large longitudinal UK cohort also tended to fall over the course of the pandemic as people became more used to the situation (Fancourt et al., 2021). It is therefore possible that the first lockdown (spring 2020) led to some relaxing situations (e.g., less time commuting, ban on evictions and moratorium on water shut-offs) and potentially reduced stress, compared to subsequent waves and on-going pandemic conditions. Other evidence suggests that

quality relationships were protective factors for mental health during the pandemic (Pieh et al., 2020). Given the large increase in married/partnered status of our participants, this could contribute to improvements in perceived stress, if such relationships were high quality.

Although participants reported an increase in the value of nature, they also reported decreased contact with nature and/or outdoor physical activity in the form of bicycling or walking in neighborhoods for leisure, active transportation, use of sidewalks and parks, and smelling rain or plants. In contrast to our findings, among a majority white (92%), high-income sample of residents of Vermont, participation in nature-related physical activity increased for many categories (gardening, hiking, jogging, walking, watching wildlife), and that these changes in activity engagement were associated with demographic characteristics (income, sex, employment) (Morse et al., 2020). Likewise, a survey among educated, older, primarily residents of England (96%) found that respondents significantly changed their patterns of visiting nature as a

FIGURE 2 | Word clouds for major stressors in 2019 and 2020, stratified by visibility of greenspace from home.
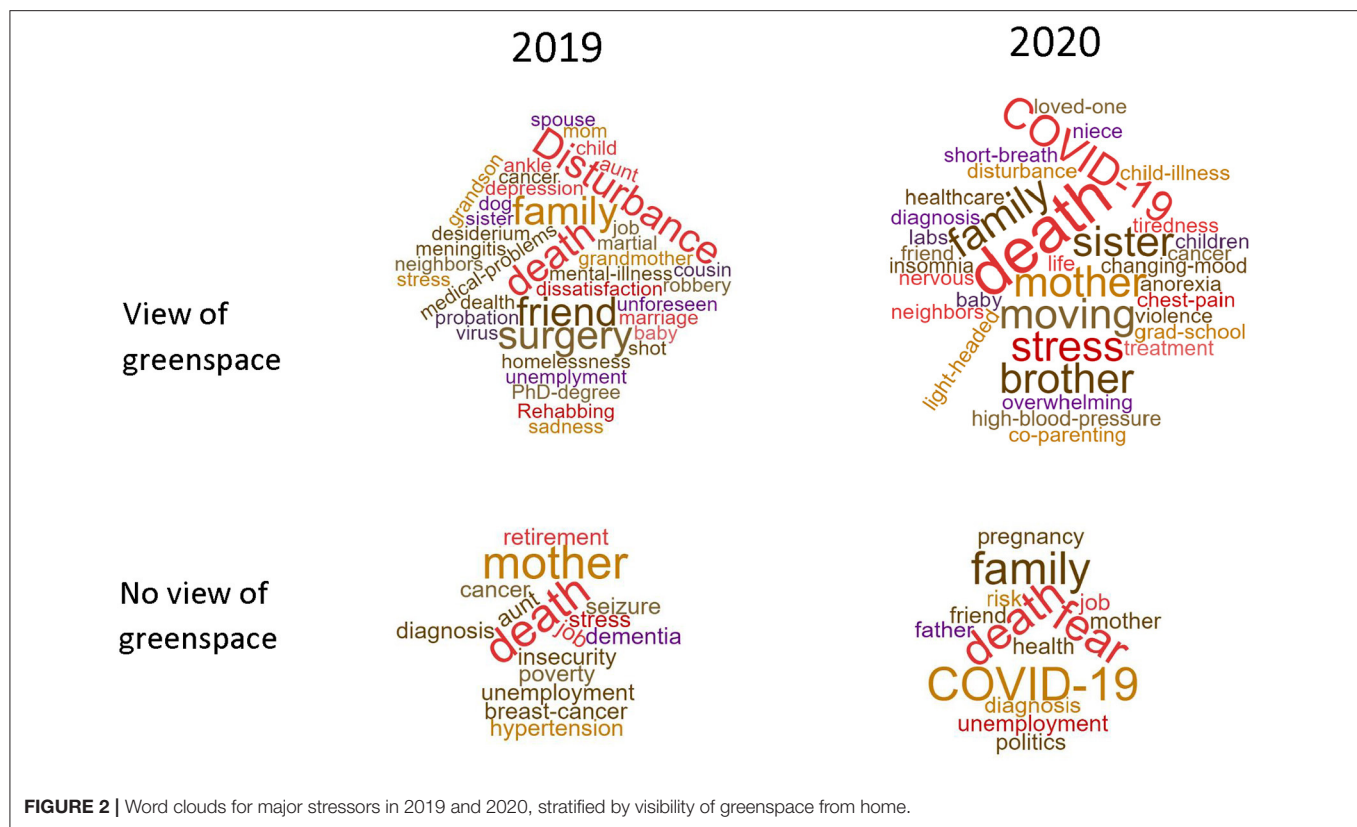
result of the COVID-19 pandemic, whereby people spent more time in nature and visited nature more often during the pandemic (Robinson et al., 2021). Similar to our findings, however, a global study with respondents from 97 countries, restrictions related to COVID-19 found reductions in nature-related leisure activities (e.g., birding) (Randler et al., 2020). Another study also showed lower levels of time spent outdoors (Cindrich et al., 2021). Similar to our findings, another US-based study has also shown increased value of nature since the start of the pandemic (Morse et al., 2020). It is worth noting that our 2020 sample of participants had significantly lower nature-relatedness scores compared to the full 2019 sample.

When evaluating associations between perceptions of access/use of nature and mental health, none of the perceived access/use variables were associated with stress, anxiety or depressive symptoms. Yet, demographics and COVID-19-related stressors were associated with depressive symptoms. We found the most common COVID-19-related stressors were changes in diet, employment stopping, and death of friends from COVID-19. Echoing our findings, a recent study of COVID-19-related stressors and mental health (Ettman et al., 2020) found that exposure to more COVID-related stressors (employment loss, death of a friend or family member, financial problems) was associated with higher risk of depressive symptoms during COVID-19.

When evaluating associations between visibility of nature and mental health, we found significant associations between higher PSS and anxiety and higher visibility of greenspace from home. Compared to the only similar study of its kind to date, Europeans with a self-reported green-blue nature view showed fewer symptoms of depression and anxiety, compared to those with built-up views (Pouso et al., 2020). One of the possible reasons for our finding that higher visibility of greenspaces was associated with poorer mental health is that the quality of the greenspaces within view may be low in these neighborhoods. Specifically, each neighborhood in this study contains an unmaintained park, where the only care is an annual mowing. Therefore, vegetation may be overgrown, usage for conventional purposes may be limited, and these spaces may not promote feelings of relaxation or restoration. Much of the existing research on greenspaces and health during the pandemic involves settings where the quality of parks and their amenities may be much higher. The parent study with which the current analysis is associated will examine the effects of improving park quality on mental health (Pearson et al., 2020).

Other global research noted that nature-based recreation became more directed more toward nearby sites during the pandemic (Randler et al., 2020), and a scoping view recently concluded that the pandemic underscored the importance of accessing green local spaces to engage in physical exercise to improve mental health (Spencer et al., 2020). None of our other measures of access to or use of nature showed significant associations with mental health. Similarly, emerging evidence from older adults in Scotland has also shown that spending

time in nature (gardening) during the pandemic lockdown, was not associated with changes in health from pre-lockdown levels (Corley et al., 2021).

Taken together, our results indicate that COVID-19 may serve to prolong or exacerbate mental health issues, rather than create them, in this population and that COVID-19-related stressors on life conditions may exacerbate depressive symptoms. Our findings also suggest that views of nature, on their own, may not protect mental health. Future research is needed to understand whether low quality greenspace may limit the ability for nature view to buffer mental health during the pandemic.

Strengths and Limitations

Strengths of this study include its longitudinal design in low-income, minority populations and ability to collect high-quality data in a timely manner during the pandemic. We obtained multiple mental health measures and objectively measured views of greenspace, utilizing geospatial techniques. However, several limitations warrant discussion.

First, our small sample size (largely due to pandemic conditions) limits our ability to adjust for multiple potential confounders and to detect significant associations. Also, we did not obtain objective measures of stress (e.g., blood pressure) in 2020, due to restrictions on contact with participants. We also did not collect objective measures of physical activity changes over time (including where activities occurred or how frequently) using accelerometers and GPS devices, due to research restrictions during the pandemic and mobility restrictions placed on residents in efforts to control disease transmission. Our visibility analyses are sensitive to designation of the viewpoint. We used the front door of participants' apartments/houses as the viewpoint. However, even though the analysis involves the 360-degree possible viewshed, when using the front door as the viewpoint, views behind the house may be blocked. In reality, the back of the building could be just within a few steps where a park may be visible. In other words, the visibility analysis calculates the visibility from a single observation point, but in reality, participants' viewing locations can vary (e.g., different sides of their home, facing of windows, etc.). There may be seasonality effects that influence our results in two ways. First, the survey included questions about activities and perceptions during the past month and during a typical month pre-COVID. As such, one may have considered November to be a typical month pre-COVID, while the last month during the survey was May 2020. Environmental conditions, including birdsong, may vary during different months of the year. Second, the 2019 study wave was conducted August–October, while the 2020 study wave was conducted June–July, which may affect responses. Last, we only quantified views of parks, rather than all forms of greenspace, including street trees or vacant lots. We decided not to capture all greenspace using metrics such as NDVI because, in theory, we were concerned that vacant lots vs. parks may have different effects on mental health (Sivak et al., 2021). But, given our findings related to the negative effects of visibility of parks on mental health, future research could specifically examine quality of greenspaces within view.

Policy Implications and Future Research

Already researchers are grappling with the ways in which COVID-19 might re-shape the ways we use public spaces, city planning and equity into the future (Honey-Roses et al., 2020). Many countries and regions have begun discussions about pedestrian- or bicycle-centered roads, designation of more city greenspaces, or the funding of "green new deals" focused on pandemic economic recovery in areas that could also improve the natural environment and public health. For example, in New Zealand, in May 2020, the government committed to over a billion dollars for "nature jobs," including over 10,000 jobs in environmental work, biodiversity and environmental conservation. In Europe, the Green Deal, aimed at improving the economy in ways that better serve people and bolster resilience, had already been adopted at the time of the pandemic. Its implications go beyond environmental regulation and include social justice and public health issues: "[The deal] aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. At the same time, this transition must be just and inclusive" (European Commission, 2019). However, both the EU Green Deal and pandemic economic recovery call for thinking about longer term trends, re-thinking hegemonic sources of funding and investment, and fostering global interdependence and governance. Given the findings of our study, it is important for policy makers to consider heterogeneity in the effects of COVID-19, neighborhood characteristics and cascading life conditions based on sex, ethnicity and income. It is important to remember that poor mental health is not a new issue and that efforts to leverage the pandemic's changes to our everyday lives need to consider core causes of marginalization and income inequality, while advancing efforts to improve environmental conditions and access to high quality greenspace, particularly in racially or ethnically minoritized and lower income neighborhoods.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The study was approved by the Michigan State University's Institutional Review Board (IRB Approval #STUDY00000587; date 03/21/2019 and modified for COVID conditions 05/26/2020). Informed consent was obtained in writing from all participants.

AUTHOR CONTRIBUTIONS

AP conceived of the study, conducted analyses, with help from JG, and drafted the manuscript. AP, KP, RB, JG, and RH secured funding for this research. WL conducted geospatial analyses,

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Coping With Crisis: Green Space Use in Helsinki Before and During the COVID-19 Pandemic

Silviya Korpilo [1,2]*, Anna Kajosaari [3], Tiina Rinne [3], Kamyar Hasanzadeh [3], Christopher M. Raymond [1,2,4] and Marketta Kyttä [3]

[1] Ecosystems and Environment Research Program, Faculty of Biological and Environmental Sciences, University of Helsinki, Helsinki, Finland, [2] Helsinki Institute for Sustainability Science (HELSUS), University of Helsinki, Helsinki, Finland, [3] Department of Built Environment, Aalto University, Espoo, Finland, [4] Department of Economics and Management, Faculty of Agriculture and Forestry, University of Helsinki, Helsinki, Finland

The COVID-19 pandemic has encouraged a deeper exploration about how people deal with crisis. This paper presents one of the first pre- and during-pandemic assessments of urban green infrastructure (UGI) use across the same individuals with the aim of better understanding how people's use of different types of urban green and blue spaces changed during the pandemic. A baseline Public Participation GIS survey ($N =$ 1,583 respondents) conducted in August 2018 was followed up in May 2020 ($N = 418$ identical respondents) during the COVID-19 pandemic in Helsinki, Finland. We found that residents were more likely to visit UGI closer to their home during the pandemic compared with before the pandemic. Patterns of use of UGI were associated with the quality of residential green areas, for example, people sought out forests nearby one's domicile and tended to avoid parks and recreation areas in order to escape the pressures of lockdown, socially distance and avoid overcrowding. However, spatial cluster analyses also revealed that the places mapped by intensive users of natural recreational areas and more outdoor oriented users became more dispersed during the pandemic, suggesting their active search for new types of UGI, including use of agricultural land and residential areas with high tree density cover. Our results further highlighted that some types of UGI such as more distant natural and semi-natural areas and blue spaces serve as critical infrastructure both before and during the pandemic. Natural and semi-natural areas experienced very little change in use. The presented results have implications for how planners design and manage green spaces to enable residents to cope with crises like pandemics into the future.

Keywords: urban green spaces (UGS), recreational use, outdoor behavior, COVID-19, Public Participation GIS (PPGIS), coping behavior

INTRODUCTION

Interaction with both people and nature is essential to humans. Urban green infrastructure (UGI) supports everyday individual and group recreation, physical exercise and mental health (see reviews by Konijnendijk et al., 2013; Kabisch et al., 2015; Collins et al., 2020), including opportunities to cope with urban life through stress reduction (Hartig et al., 2003; Jiang et al., 2014; Ibes et al., 2018) and improved mood (Huynh and Torquati, 2019; Nisbet et al., 2019). The benefits people

enjoy from nature may have been even more vital during the COVID-19 pandemic and associated lockdown and social restrictions. Various studies from cities around the world have indicated that physical exercise, spending time outdoors and restoration from increased mental stress, anxiety and feeling of isolation during lockdown, were essential for citizens in order to cope with the crisis (Grima et al., 2020; Lopez et al., 2020; Venter et al., 2020). For example, in a global survey, Pouso et al. (2020) found that while the pandemic detrimentally affected mental health, contact with nature helped people to cope, particularly those subject to extreme lockdown. Urban green spaces also have the potential to mitigate some of the negative health effects of COVID-19 restrictions on mobility and social interaction when combined with social distancing (Kluge et al., 2020), and enhance resilience of urban populations during the pandemic (Samuelsson et al., 2020).

Despite these benefits, there is a lack of clear signals concerning the changes in the importance of green spaces during the pandemic and how this translates into changes in the recreational use of UGI. The most evident and frequently reported change relates to the general increase in green space use (e.g., Derks et al., 2020; Rice et al., 2020). Notably, studies have also identified mixed results in visitation patterns in terms of frequency, activity types, temporal distribution of visits and distances travelled to recreate. A global analysis of urban park visitation highlighted that overall visits increased during the pandemic compared with a baseline before the outbreak, and areas that restricted social contacts were most strongly associated with increased park visitation (Geng et al., 2021). However, some cities faced no restrictions but continued to see marked increases in green space usage. For example, Oslo, Norway, has seen a 291% increase in outdoor recreation activity during the pandemic relative to a three year rolling average for the same days, particularly for pedestrians (walking, running, hiking) and cyclists (Venter et al., 2020). While increases tend to be most marked on remote trails, urban green spaces also increased in pedestrian activity (Venter et al., 2020). Initial Google COVID-19 Community Mobility Reports revealed that while urban park visitation has changed, the nature of change varies across cities (Ritchie et al., 2020). In Bonn, Germany, Derks et al. (2020) found changing patterns in visitation in urban forests with emergence of novel visitors, usage peaks in the afternoons and less clear distinction between weekdays and weekends. Other cities in the US, Israel, Italy, Slovenia and Spain experienced reduced usage of urban green spaces measured as decrease in frequency, duration and distance travelled to recreate (Rice et al., 2020; Ugolini et al., 2020). In the United States, a preliminary survey of access and usage of outdoor spaces during the pandemic showed that respondents significantly reduced their time spent recreating and tended to recreate closer to home, often in a 2 mile radius (Rice et al., 2020). The desire to socially distance was cited as the main reason for changing usage patterns. At the same time, in some large urban areas, residents were willing to travel long distances to access urban natural areas (Derks et al., 2020; Ugolini et al., 2020). Behavior changes were also observed in terms of outdoor activities undertaken with relative increase in some activities (e.g., physical exercise, relaxing and walking) and decrease in

others considered risky or non-essential activities (e.g., meeting people or observing nature) (Morse et al., 2020; Ugolini et al., 2020).

In addition to being dependent on the user and activity type, outdoor recreation can be affected by urban density structure (e.g., Baró et al., 2015; Liu, W., et al., 2017) and realized through different spatial patterns situated in and influenced by a specific time and place (Andkjær and Arvidsen, 2015; Korpilo et al., 2018). However, few studies exist that examine changes in outdoor recreation during the COVID-19 pandemic in relation to different green space types. For example, Ugolini et al. (2020) found that some citizens in Spain, Israel and Croatia started using more tree-lined streets and urban gardens as potential refuge during the pandemic. In addition, there is still a lack of understanding of the variations and complexity in use among different user groups. Results from a study in Vermont, the U.S. indicated that although nature plays an important role in coping with crisis, engagement with nature through different activities and perceived importance of these interactions differed among populations (Morse et al., 2020). Activity preferences and values were significantly affected by geographical area, gender, income and employment status. Further, closures of urban parks during the pandemic tended to affect vulnerable groups more than others. Another report from the U.S. showed that stay-at-home orders have affected vulnerable groups who live in highly dense areas more than less vulnerable groups who have access to urban nature close to their homes (Slater et al., 2020). People who live in lower socio-economic areas tend to be more sedentary and face greater issues with access to green spaces (see Spencer et al., 2020 for a review). Also, vulnerable populations tend to contract COVID-19 at higher rates than less vulnerable people (Slater et al., 2020) and are disproportionately dying from the disease (Centers Disease Control Prevention., 2020; Yancy, 2020). In Finland, young adults were more concerned about the effects of the COVID-19 pandemic on their mental well-being, career/studies and economic situation than older people, and females were more concerned about their mental well-being than males (Ranta et al., 2020).

Variation in green space use during the COVID-19 pandemic could be also the result of individual behavior change or it can be influenced by variations in environmental quality. Thus, there is a critical need for research that assesses visitation behavior across the same individuals before and during the pandemic, and its association with urban green space type or quality. In this article, we aim to contribute to the growing amount of empirical studies that examine urban green space use for understanding how residents have coped with the COVID-19 crisis under particular governmental restrictions and socio-ecological contexts. The focus is on UGI because of the diverse social benefits of nature exposure. We present an empirical longitudinal study from Helsinki, Finland, in order to help fill in this important gap. We examine changes in citizens' outdoor recreational behavior before and during the COVID-19 pandemic and how these changes are affected by green space type, socio-demographics and perceived health. We question not only if citizens use different types of green spaces more or less, but also if they use green spaces in new ways. Understanding such emerging behavior can help gain

better insight into the complexity of human engagement with nature during pandemics or other abrupt events. This knowledge is also becoming crucial in order to co-design more resilient green spaces and societies in the face of future pandemics. For example, it has recently been argued that the COVID-19 pandemic is changing our relationship with public space and it is projected to initiate changes in temporal and spatial patterns of daily use, potentially leading to new designs, uses and practices in green spaces (Honey-Rosés et al., 2020).

MATERIALS AND METHODS

Study Area and COVID-19 Pandemic Restrictions During Data Collection

The Helsinki Metropolitan Area (HMA) consists of four independent municipalities, Espoo, Helsinki, Kauniainen and Vantaa (**Figure 1**). Helsinki is the capital of Finland and forms with its surrounding three cities the capital region with a population of 1.2 million inhabitants (Statistics Finland, 2021).

During spring 2020, the Finnish government started applying recommendations and restrictions based on a special Act in order to delay the spreading of COVID-19. Finnish residents were urged to restrain from social contacts and travel only within Finland for essential reasons, maintain over a 1.5-meter safe distance to other people, wash hands, stay home if sick, follow distant working and avoid using public transport. Finnish government declared emergency powers legislation and public places, such as libraries, swimming halls and other sport places were closed from March 17, 2020 onwards. All public gatherings were limited to 10 persons and the majority of the sport clubs were also shut down. Schools moved to distance education, excluding pre-school education. All 70 and above year old residents were advised to self-quarantine. The borders of the Uusimaa region, which HMA is part of, were closed to restrict travelling between Uusimaa and the rest of the country. Restrictive measures started to deregulate in stages from 14 May 2020 onwards.

Sampling and Survey Design

Data used in this study were collected in two consecutive Public Participation GIS (PPGIS) surveys. The first phase (baseline survey, before the COVID-19 pandemic) took place in August 2018. Participants were recruited using a random sampling technique by sending postal invitations and a postcard reminder to 10,000 adults aged 18–65 years and living permanently in the HMA (data provided by Finnish Population Register Centre). Altogether 1,583 respondents participated in the survey resulting in a response rate of 16%.

Respondents of the baseline survey were then invited to participate in a follow-up survey in May 2020 during the COVID-19 pandemic. Respondents in both the baseline and the follow-up study were requested to map places that they frequently visit in their leisure-time, their primary residential location, questions related to socio-demographics, perceived health and well-being, and the financial and mobility influences of the COVID-19 pandemic (see **Supplementary Material**; **Table 1** for list of all items). Respondents were also asked three open questions

regarding the effect of COVID-19 pandemic on their outdoor recreation and active transportation. Overall, 490 respondents completed both the baseline and the follow-up surveys. In this study, respondents who had not mapped their home location and respondents who had relocated between the two surveys were excluded, resulting in a final sample of 418 respondents. These respondents were 57% female compared to 50% of the same age group in the HMA (Statistics Finland, 2021). In addition, respondents with tertiary education were over-represented, comprising 66% of the study respondents compared to 46% in the HMA (Statistics Finland, 2021).

Analysis

Initial data cleaning of the mapped points was conducted in ArcGIS Pro 2.5. Respondents mapped altogether 2,386 and 1,849 outdoor locations in the baseline (before the COVID-19 pandemic) and follow-up (during the COVID-19 pandemic) survey respectively. Points located outside HMA were excluded from the analysis (150 at baseline or 6.3% and 146 at follow-up = 7.8%). Then, data analysis was performed in three steps: overall spatial trends in changes in outdoor behavior, group-specific trends in changes in outdoor behavior and analysis of the qualitative data.

Analysis of Overall Spatial Trends

First, we examined changes in recreational behavior of all respondents (before and during the pandemic) including:

1) Change in use of green/blue spaces by examining the distribution of outdoor recreational points on different types of UGI
2) Change in network distance of recreational points to one's home in relation to UGI type.

To analyses change in green/blue space use, we classified the point data according to the urban green infrastructure type they are located in. The UGI classification included several categories adapted from Pauleit et al. (2019): *Natural and semi-natural areas, Agricultural land, Parks and recreational areas, Residential green with low/high tree cover density (TCD),* and *Blue spaces* (see **Figure 1**; **Table 1**). All categories were based on ready-made available datasets from Urban Atlas 2018 (EEA, 2021) and the Finnish Environmental Institute (2020) except the Residential green with low/high tree cover density (TCD), which was created to investigate in more detail the role of different types of residential green spaces during the COVID-19 pandemic. This category was derived using the Urban Atlas land use and Tree Cover Density data. From the Urban Atlas land use data, we extracted the "Urban Fabric" land use category, which includes polygons of urban areas with dominant residential use or inner-city areas with central business district and residential use. Furthermore, we used the TCD data, which is a raster product providing information on the proportional tree crown coverage per 10 * 10 m raster. We chose all the tree cover raster cells with value higher than zero and finally calculated the share of these raster cells within each Urban Fabric polygon. This category was then divided into two sub-categories of Residential green with low/high tree cover density (TCD) based on the 12.01% median

FIGURE 1 | Map of the study area (Helsinki Metropolitan Area) and green infrastructure types used in the analysis.
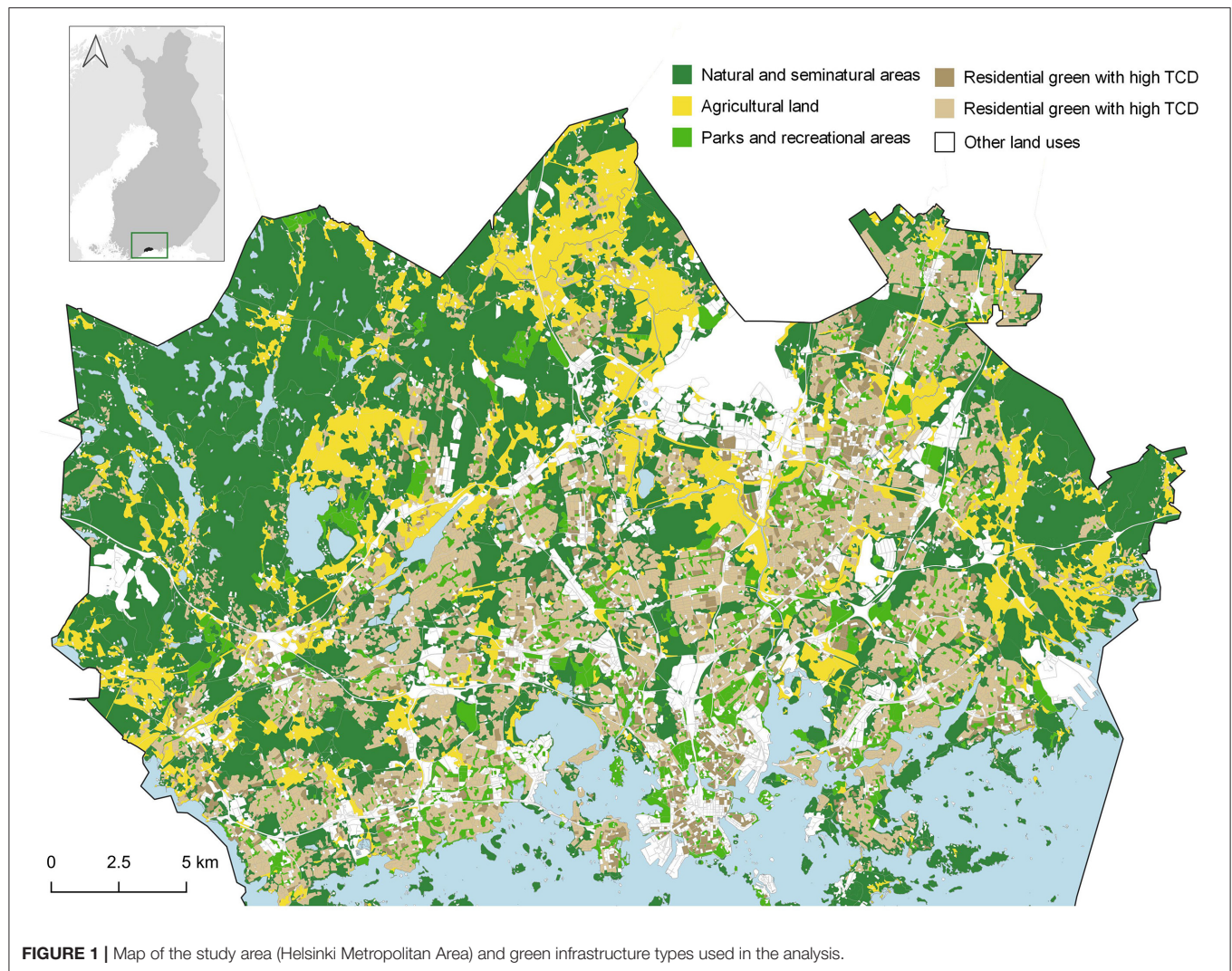
TABLE 1 | Green infrastructure classification used in the analysis.

Green infrastructure category	Description	Dataset
Natural and semi natural areas	Points located within natural and semi natural areas such as forests, open spaces with little or no vegetation, and wetlands	Urban Atlas 2018, classes 31000, 32000, 33000, and 40000
Agricultural land	Points located in agricultural land, such as arable land, permanent crops, and pastures	Urban Atlas 2018, classes 21000, 22000, and 23000
Parks and recreational areas	Points located in urban parks and outdoor sports and leisure facilities	Urban Atlas 2018, classes 14100 and 14200
Residential green with low/high tree cover density (TCD)	Points located in urban fabric areas (mostly residential and commercial) with associated vegetation (in-between parks, gardens and planted areas). This category is divided into two sub-categories based on low/high tree cover density (threshold derived from the baseline median 12.02%)	Urban Atlas 2018; classes 11100, 11210, 11220, 11230, 11240 and Tree Cover Density (TCD) 2018
Blue spaces	Points located within 50 m of sea, river, or lakeside and not included in the other categories	Shorelines 2020, The Finnish Environment Institute

value. Visual inspection of the data confirmed this threshold to be appropriate for the analysis since it was able to differentiate between residential green spaces with low vegetation and tree

cover (e.g., street trees, urban gardens, grass lawns and other low vegetation spaces between and around residential areas) and larger nearby forests around apartment building-dominant

residential areas (in Finnish "metsälähiö"), which are typical for Helsinki's peri-urban structure.

We further calculated frequencies of mapped points per UGI type and mean distances of mapped points to one's home using Network Distance Analysis in ArcGIS Pro. Euclidean distance from each point to the nearest road network (using the ArcGIS online HERE map as network data) was calculated and added to the measured network distances as a snap distance correction. Then, non-parametric Mann-Whitney U test in SPSS was used to compare frequencies of mapped points in UGI type and the network distances of mapped points to home between the baseline and follow-up surveys.

Analysis of Group-Specific Trends

As a next step, we explored if respondents can be grouped according to the above changes in recreational behavior using a K-means clustering analysis on the standardized values of change variables (see **Supplementary Material**; **Table 2**). The initial number of clusters ($k = 2$) was visually determined using a plot of WSS-vs.-k (Within-Cluster-Sum of Squared Errors (WSS) for different values of k). Other values of k were also tried in the clustering analysis and the $k = 2$ was verified as an appropriate number of clusters (i.e., groups of respondents). Following the identification of the two clusters (hereafter named as "groups"), we used Mann-Witney U tests to analyses differences in the mapping activity (i.e., number of mapped points) between the two groups and Wilcoxon signed-rank tests to analyses how this mapping activity changed before and during the COVID-19 pandemic. We also tested for differences between the two groups according to changes in the number of mapped points in the different types of green/blue spaces and the distance of these points to one's home using One-way ANOVA.

We then used a N-1 Chi-squared test (Campbell, 2007) to examine how the two groups differ in terms of a variety of individual variables gathered in the PPGIS survey. These included a number of socio-demographic variables: *age, gender, income, occupation, education, household type, car ownership* and a number of situational variables: *personal finances affected by COVID-19, being in quarantine, distance working, stated physical activity* and *perceived mental and physical health*. We also tested if there are significant differences between the urban zone types at place of residence for respondents in the two clusters. The urban zone layer was derived from the classification provided by Finnish Environment Institute (YKR). This dataset includes a 250×250 m grid based classification that divides urban regions into zones according to their location in the urban form (e.g., in relation to the center), and travel-relevant variables, population characteristics, public transportation supply, building stock, and jobs (Söderström et al., 2015). Classes include: *car zone, public transport zone, intensive public transport zone, fringe of central pedestrian zone, pedestrian zone*, and *center* or *sub center*. Mann-Whitney U tests were used to assess median differences in perceived health outcomes between the two groups at baseline (before the COVID-19 pandemic) and follow-up (during the COVID-19 pandemic) and Wilcoxon signed rank tests—to identify median changes in health outcomes between baseline and follow-up for each group.

As a last step, we implemented a density-based clustering method in ArcGIS Pro to analyses and visualize differences in the spatial distribution of mapped places for outdoor recreation between the two groups of respondents. This method spatially locates areas where respondents had mapped the highest density of places (i.e., clusters), while showing trends in dispersion of all other points that do not fall within these clusters (Muñoz et al., 2019). To identify the clusters, a defined distance (DBSCAN) algorithm provided by ArcGIS Pro was used, which found clusters of points that are in close proximity based on a search distance of 500 m and a minimum number of 10 points per cluster. The search radius was selected based on the mean Euclidean distance between all points and a heuristic approach of testing different distances that provide the optimal visual representation.

Qualitative Data Analysis

To gain further insight into the reasons why some changes in outdoor recreation have occurred during the pandemic, we further analyzed the three open questions included in the survey: "*Has the COVID-19 pandemic affected your leisure-time physical activity? If so, how, and why?,*" "*Has the COVID-19 pandemic affected your use of active transportation? If so, how, and why?* and "*Has the COVID-19 pandemic affected the way you perceived or use you near-by-green and nature areas? If so, how, and why?*". The majority of respondents, 308 out of 490 (62.9%) answered the two open questions by giving some information how their use of green spaces had changed during the COVID-19 pandemic. Using thematic analysis (Corbin and Strauss, 2008), we analyzed and classified the responses to these three open questions into the following categories:

1) Changed frequency of use: (Increased use/Use stayed the same level/Decreased use)
2) Changed relationships with other users (Avoid other people in green spaces/Meet people in green spaces)
3) Changed ways of use (Explore new types of green spaces/New recreational experiences).

We further compared the two identified groups from the K-means cluster analysis (see Analysis of group-specific trends) according to responses in these three categories (changed frequency of use, changed relationships with others and changed ways of use) and then tested for significant differences using a Chi-squared test.

RESULTS

Overall Changes in Outdoor Behavior Before and During the COVID-19 Pandemic

Several general trends in changes of recreational behavior during the COVID-19 pandemic could be observed among all survey respondents (**Table 2**). First, there was a significant decrease in distance of recreational points to one's home from 5.43 to 4.07 km ($p < 0.001$). Decrease in distances were found for all UGI categories suggesting that respondents were recreating in areas closer to home during the pandemic. In addition, use of Parks and recreational areas significantly decreased both in terms of

TABLE 2 | Changes in distribution of mapped outdoor points and distances of mapped points to ones' home between baseline survey (before the COVID-19 pandemic) and follow-up survey (during the COVID-19 pandemic).

UGI category	Respondents		Mapped points		Network distance	
	Frequency		Frequency		Mean (km)	
	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Total	418	418	1561	1434	**5.43***	**4.07***
Natural and semi natural areas	226	207	477	486	5.69	4.91
Agricultural land	60	62	78	92	3.35	4.06
Parks and recreational areas	**229***	**189***	**504***	**381***	**5.25***	**3.57***
Residential green with low TCD	**105***	**67***	**171***	**82***	4.52	3.63
Residential green with high TCD	**118***	**157***	**170***	**268***	4.14	2.87
Blue spaces	92	82	161	125	**8.53***	**5.16***

Bolded values are significant ($p < 0.05$). Chi–square tests were used for categorical variables.
Mann-Whitney U test was used to compare network distances between baseline survey and follow-up survey.

number of mapped points ($p = 0.001$) and distances travelled ($p < 0.001$). The travelling distances to Blue spaces also decreased significantly ($p < 0.001$). Strong preferences for residential green areas with high TCD (i.e., nearby forests) were indicated by a significant increase of mapped points during the pandemic ($p < 0.001$). To the contrary, respondents mapped a significantly lower number of points in residential green areas with low TCD ($p < 0.001$).

Group-Specific Changes in Outdoor Behavior

The K-means clustering analysis (based on the place variables as in Table 2 in the **Supplementary Material**) identified two distinct clusters of respondents (hereafter referred as Group 1 and Group 2). Respondents in Group 1 ($N = 98$) mapped on average 6.45 (SD 4.46) places at baseline and 4.46 (SD 3.93) at follow-up, while Group 2 ($N = 332$) respondents - on average 2.91 (SD 2.56) at baseline and 3.12 (SD 2.62) at follow-up. Respondents in Group 1 mapped significantly more places than Group 2 both at baseline ($U = 7890.50$, $p < 0.001$) and at follow-up ($U = 12784.50$, $p = 0.007$). Respondents in Group 1 also mapped significantly fewer places for outdoor recreation at follow-up than at baseline ($z = -3.92$, $p < 0.001$), while there was no significant change in the mapping activity of respondents in Group 2 ($z = 1.59$, $p = 0.111$).

Group 1 showed high variation and an average decrease in green/blue space use (-0.200 of standardized score), except for Agricultural land and Residential green areas with high TCD. On the contrary, Group 2, which the majority of the respondents fell into, showed low variation and an average increase in green/blue space use (0.061), except for Agricultural land and Residential green areas with high TCD, similar to Group 1 (**Figure 2**). Results from the One-way ANOVA showed that these changes in recreational behavior between the two groups were significant for all green infrastructure categories, with the exception of residential areas with high TCD (both for number of mapped points and distances travelled) (see **Supplementary Material**; **Table 2**). The distance of mapped places in Parks and recreational areas category from respondents' home also did not differ

significantly between the two groups (**Supplementary Material**; **Table 2**).

In terms of socio-demographics, significant differences were found between the two groups in relation to several variables: age (30–39 years old $= 3.967$, $p = 0.040$; 50–59 years old $= 9.463$, $p = 0.002$; 60–66 years old $= 4.917$, $p = 0.026$), having children (6.97, $p = 0.008$), employment (3.811, $p = 0.050$), physical activity (Baseline) (4.63, $p = 0.031$), perceived health compared to the other in the same age group (follow-up) and overall physical health (baseline) (see **Table 2**; **Supplementary Material**; **Table 3** for results for all variables). No statistically significant differences were observed for other socio-demographic variables or the urban zone type around one's domicile (**Supplementary Material**; **Table 3**).

Respondents in Group 1 were generally older than those in Group 2 (>50 years old $= 51.5\%$, and 45.6% respectively), had higher proportion of employed individuals (69.4% compared to 58.4% for Group 2), and more often reported to live together with a partner and child/children (37.8 % for Group 1 and 24.4% for Group 2). In addition, respondents in Group 1 had higher median scores in all self-reported health variables both before and during the COVID-19 pandemic (**Table 3**). Significant differences were observed between self-rated physical health at baseline ($U = 10588.50$, $p = 0.025$) and self-rated general health compared to others of the same age at follow-up ($U = 10028.00$, $p = 0.001$). For both groups, life satisfaction decreased significantly between baseline and follow-up (Group 1: $Z = -2.21$, $p = 0.027$; Group 2: $Z = -3.87$, $p < 0.001$). Self-rated physical health decreased significantly for Group 2 ($Z = 2.08$, $p = 0.037$).

The density-based spatial clustering illustrated further the differences between the two groups of respondents. Overall, the spatial distribution of mapped recreational places for Group 1 was very dispersed both before and during the pandemic. For Group 1, eight clusters including one middle size cluster ($N = 192$ points) and seven small size clusters ($N = 10$–15) were identified based on the spatial data before the pandemic, while the total number of sparse, not clustered points contributed to 66.4% of all data ($N = 552$). During the pandemic, clustering decreased even further and only two small clusters ($N = 11$–12 points) were
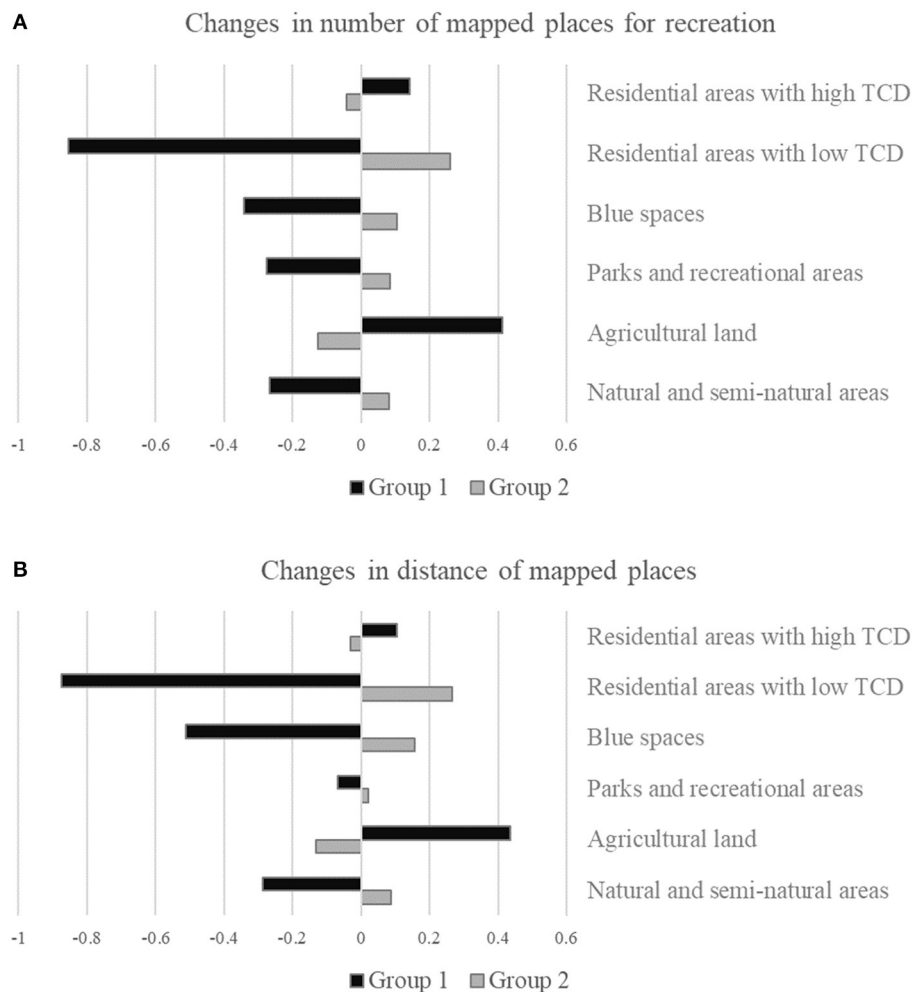
FIGURE 2 | (A) Changes in number of mapped places for outdoor recreation and **(B)** Changes in mean distances (in meters) of mapped places to one's home per group. X-axis refers to standardized scores of changes, where values <0 show decrease and >0 increase in numbers/distances during the COVID-19 pandemic.

TABLE 3 | Differences in changes of self-reported health variables between the two respondent groups.

	Before COVID-19 pandemic			During COVID-19 pandemic		
	Group 1	Group 2	*p*-value	Group 1	Group 2	*p*-value
Life satisfaction[a] (median)	8.08	7.88	-	7.68	7.48	-
General health[b] (median)	3.94	3.84	-	4.04	3.84	-
General health compared to others in the same age group[c] (median)	3.84	3.64	-	**3.64***	**3.33***	**p = 0.001**
Physical health[d] (median)	**3.54***	**3.43***	**p = 0.025**	3.84	3.74	-
Feeling of loneliness during the COVID pandemic[e] (median)	N/A	N/A		3.33	3.23	-

[a] *"Overall, how satisfied are you with life as a whole these days?" Measured on a scale from 1 ("not at all") to 10 ("completely satisfied").*

[b] *"How would you rate your general health?" Measured on a scale from 1 ("very poor") to 5 ("very good").*

[c] *"How would you rate your general health compared to that of others of your own age?" Measured on a scale from 1 ("much worse") to 5 ("much better").*

[d] *"How would you rate your physical health?" Measured on a scale from 1 ("very poor") to 5 ("very good").*

[e] *"Have you experienced feelings of loneliness during the COVID-19 pandemic?" Measured on a scale from 1 ("much less than before the pandemic") to 5 ("much more than before the pandemic").*

*Bolded values are significant (p < 0.05).

identified, while the number of not clustered points increased to 95.6% of all points ($N = 502$).

A higher number of density-based clusters were located for Group 2 compared to Group 1. In total 20 clusters of mapped places were identified before the COVID-19 pandemic including one large size ($N = 461$) and 19 small clusters ($N = 10–28$), while the number of points not in clusters contributed to 45.8% of all data ($N = 643$). Similar to Group 1, the spatial data during the pandemic showed higher number of sparse points $N = 708$ (60.1% of all points), while the number of clusters decreased to 15 including one medium size ($N = 210$) and 14 small clusters ($N = 10–33$).

Figure 3 below visualizes the result of the density-based clustering analysis with a close-up view of the central part of Helsinki. Mapped recreational places of Group 1 mostly clustered in the city centre before the COVID-19 pandemic, yet mapping and spatial clustering of places in the city centre decreased during the pandemic. A similar trend can be observed for Group 2 however, the spatial patterns are different. For example, during the COVID-19 pandemic there was more clustering of mapped points in Parks and recreational areas like in Helsinki's Central park (**Figure 3**). Such increase in use of Parks and recreational areas for respondents in Group 2 was also indicated from the results of the K-means clustering analysis (see **Figure 2**).

Stated Reasons for Changes in Outdoor Behavior During the COVID-19 Pandemic

Table 4 summarizes the proportional differences among respondents in Groups 1 and 2 who reported changing use patterns during the pandemic related to the three identified categories (changed frequency of use, changed relationship with other users, changed ways of use). Significant difference was found only for changed ways of use of green spaces. Group 1 was more likely to search for new types of green spaces given that 18.8% of respondents reported this kind of behavior change. This further complements the results of the spatial and cluster analysis that indicated more variation in the types of green space used by Group 1 compared to Group 2 during the pandemic. On the other hand, respondents from Group 2 reported more often (11.0%) to have found new experiences in natural settings during the pandemic.

In addition, the increased importance of nature and especially nearby forests was often mentioned by respondents in both groups. For example, respondents stated:

> *"Covid pandemic has helped find new natural settings close to home. The importance of nature has also grown, because in addition to home, it is pretty much the only place where you can spend your free time."* (Respondent, Group 1)
> *"Nearby nature has become more familiar to me and enriched my life."* (Respondent, Group 1)
> *"Nearby nature gives a lot of strength and it is so calming to walk in nature. I have found many new paths"* (Respondent, Group 1)
> *"I use and follow more intensively the nearby natural environment. I enjoy views from windows and birds singing more than normally."* (Respondent, Group 2)
> *"I visit almost daily the nearby forest"* (Respondent, Group 2)

DISCUSSION

The overarching aim of this paper was to examine how, under particular governmental restrictions and socio-ecological context, residents in the Helsinki Metropolitan Area have coped with the COVID-19 crisis by using different urban green and blue spaces in terms of both distance from domicile and quality of space. The results suggest that residents were more likely to visit UGI closer to their home during the pandemic compared to before the pandemic, complementing previous research (e.g., Rice et al., 2020; Ugolini et al., 2020). However, unlike previous work, we found that patterns of use of UGI were associated with the quality of residential green areas (here measured by tree cover density [TCD]). Residents were more likely to visit residential areas nearby their home with high TCD during the pandemic compared to before the pandemic, highlighting the importance of forests nearby one's domicile to coping behavior. It supports recent wider studies were old-grown, tree-rich parks are used more frequently for experiencing nature while less tree-rich parks are used more for socializing and having barbeques (Kabisch et al., 2021). The qualitative results further suggest that nearby forests become focal points for recovery and escape during pandemics. People also tended to avoid parks and recreation areas in order to escape the pressures of lockdown, ensure social distance and avoid overcrowding that was reported by Finnish media during the pandemic, while also stated by many respondents in our PPGIS survey (**Table 4**). These findings expand *prospect refuge theory* which posits that people derive feelings of safety and pleasure from inhabiting environments that offer both views and a sense of enclosure (Appleton, 1984; Millward and Appleton, 1988; Ellard, 2015). This theory has been used in preference studies to justify why nearby nature is commonly found to be more preferred than primary or within refuge nature. In other words, edges are preferred (Ruddell and Hammitt, 1987). In our case, nearby nature, not necessarily edges of forests, are preferred in times of the pandemic.

Our results further highlighted that some types of UGI such as more distant natural/semi-natural areas and blue spaces serve as critical infrastructure both before and during the pandemic. Natural and semi-natural areas experienced very little change in use. This suggests their fundamental role for human well-being both in everyday life (Andkjær and Arvidsen, 2015) and under exceptional circumstances such as the global COVID-19 pandemic (Derks et al., 2020). Similarly, we found no significant difference between the number of mapped places for recreation in or near blue spaces before and during the pandemic. Both before and during the pandemic, the average distance travelled to recreate in/near blue areas was highest among all UGI types (8.55 and 5.16 km respectively), which is in line with previous research by Laatikainen et al. (2015), who found average road network distance (home to mapped places near water) of 6.29 km mapped by 2,151 Helsinki Metropolitan Area citizens. Both of these result highlight the importance of large public blue infrastructure like recreational coastal areas and the willingness of residents to travel to such areas, especially when owning a car (Laatikainen et al., 2015).

FIGURE 3 | A close up map of Helsinki's city centre showing the density-based clusters of mapped recreational places identified for the two groups of respondents. Different clusters and their sizes are represented by different colours. Points not in clusters refers to the number of sparse points, not part of any clusters.
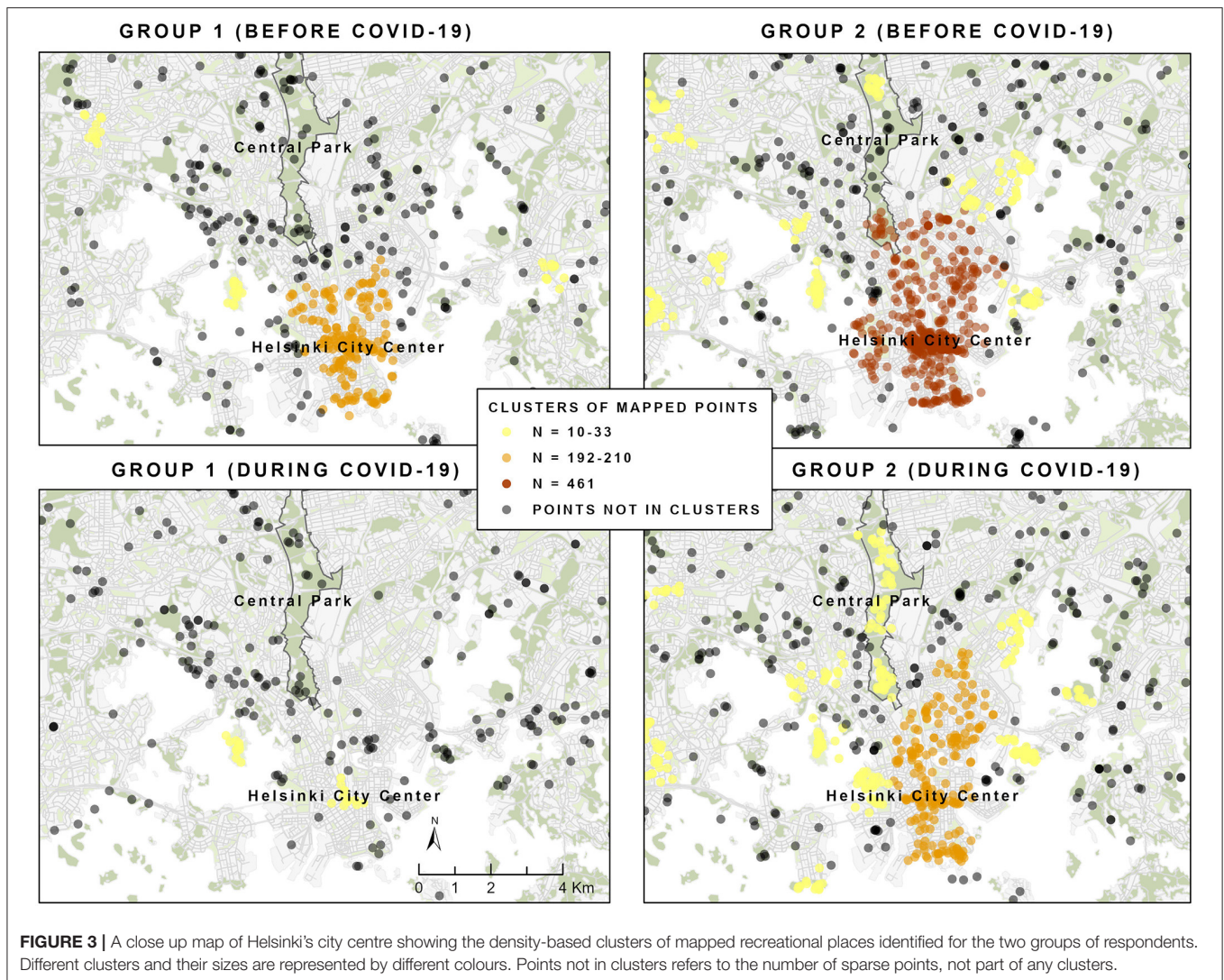
A significant strength of this study is the use of a longitudinal dataset capturing changes in UGI use across the same individuals. To analyses individual behavior changes, we developed a unique clustering approach to assess COVID-19 coping behavior and response to crisis, which considers the varying ways of use of UGI, socio-demographic factors, urban zone type and well-being indicators. The identified two groups were associated with a spectrum of differences in coping behavior and socio-demographics. The majority of respondents belonged to Group 2. These green space users showed no significant change in mapping recreational places before and during the COVID-19 pandemic, but started to find new ways to use UGI. Their recreational use was concentrated in popular places in Helsinki (such as the City Centre or Helsinki's Central park), although during the pandemic they also searched for green areas outside of them. The self-rated health of this group decreased during the pandemic.

Group 1 members were older, more likely to be employed and having a partner and children than members of the other group. Respondents in Group 1 mapped clearly more green places both

before and after the COVID-19 pandemic. Their perceived health was also higher and it did not decrease during the pandemic. The members of this group were probably more intensive users of natural recreational areas and more outdoor oriented users. It was therefore somewhat surprising to see the number of mapped places of this group decline during the pandemic. The decrease in use might be due to social distancing and search for solitude nature experiences being more important for this group. Although both groups expressed concerns toward other users of UGI, Group 2 also used green areas for socialization. Whether the groups differ in terms of risk tolerance during the pandemic (see Landry et al., 2020) and crowding tolerance (Arnberger and Haider, 2005) would warrant further research.

The mapped recreational places of Group 1 were very spatially dispersed already before the pandemic and this trend together with their active search for new types of green areas suggests a higher flexibility and variation in terms of using different types of UGI e.g., agricultural land and residential green areas with

TABLE 4 | Reported changes in green space use among respondents in Group 1 and Group 2.

	Group 1		Group 2		Pearson chi-square	Examples of respondents' statements
	N	%	N	%		
Changed frequency						
Decreased	3	3.8	18	7.9	–	"Covid hasn't really changed the ways I use nature except for reduced number of evening walks." (Respondent, Group 2)
Stayed the same	34	42.5	93	41.0		"Not really changed, we go to forest more than going to shopping malls or cinemas which might be potential hotspots for spreading virus at the moment." (Respondent, Group 2)
Increased	38	47.5	90	39.6		"I used to go to green areas a lot already before Covid but now I really go even more." (Respondent, Group 1)
Changed relationship with other users						
Avoid people	11	13.8	32	14.1	-	"I avoid parks with a lot of people. Also in jogging routes I keep distance to other people." (Respondent, Group 1) "Yes, usual nature areas are now packed with people so I have to visit them outside the "rush hours" (Respondent, Group 2)
Meet people	1	1.3	7	3.1		"Walking outdoors is the only way to meet my parents, so we take long walks in the nature every week." (Respondent, Group 2)
Changed way of use						
New types of green spaces	15	**18.8***	28	**12.3***	**2.9, df = 1, p = 0.086**	"Covid pandemic has helped finding new natural settings close to home." (Respondent, Group 1)
New recreational experiences	5	**6.3***	25	**11.0***		"I think that I now observe more the progress of spring and the singing of birds." (Respondent, Group 2)

The percentages have been calculated based on the number of respondents in groups 1 (N = 80) and 2 (N = 227) who had responded to the open questions.
*Bolded values are significant (p < 0.10).

high TCD. Several potential factors may be associated with the higher "coping flexibility" of Group 1. Being generally in better mental and physical health could mean higher resilience to crisis, as supported by wider scholarship on social resilience. Social resilience is used as a way to measure the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change (see Adger, 2000). Being resilient and having the ability to adapt contributes to positive life choices during the COVID-19 pandemic (Dorado Barbé et al., 2021). When faced with threats, stressors or adversity, resilient people can improve their adaptation and well-being strategies (Luthar et al., 2015).

Limitations and Future Research

Our study has several important limitations. First, in this article, the use of green space is analyzed only through the number of mapped recreational points and the distance of these points to one's home. However, we did not have data on actual time spent, the frequency of visits or the actual use of these places in terms of activity, all of which can contribute to deeper understanding of changes in individual and user group behavior. The lack of such data could also explain some discrepancies in findings between our quantitative and qualitative results. For example, most respondents in Group 1 stated that their frequency of recreational visits stayed the same or increased, while results of the UGI spatial analysis indicated that these respondents mapped significantly less recreational points. A possible explanation could be that people belonging to this group

visited less places during the pandemic, but used them more frequently and more intensively.

Although we found no significant difference between the two user groups in terms of the urban zone type they live in, another important factor that is worth further investigation is green space accessibility and its role as a moderator of recreational use during the pandemic especially across different socio-demographic groups (see e.g., Kabisch and Haase, 2014; Kabisch et al., 2016; Kronenberg et al., 2020; Suárez et al., 2020). Future research also needs more longitudinal studies like the one we have presented here, possibly expanding beyond several years after the COVID-19 pandemic in order to examine whether changes in recreational behavior actually sustain, a key point for our own further work in this field.

Implications for UGI Management

The study suggests UGI's role as critical urban infrastructure during the COVID-19 pandemic providing opportunities of recreation, restoration and escape during the pandemic. UGI planning and management should take a nuanced and adaptive approach that caters for the diverse needs, activities and preferences of users that, similar to the two groups in our study, can be identified even in small geographies and among relatively homogenous populations (Morse et al., 2020). This would allow UGI to be better utilized to promote psychological restoration and a level of remoteness or solitude that could remain key priorities in future pandemics, but also to provide opportunities for social interaction and group activities as part of everyday life.

Restoration and escape are often associated with spaciousness i.e., the feeling of being and moving in nature without feeling boundaries (e.g., Kaplan and Kaplan, 1989; Van Herzele and Wiedeman, 2003). Spaciousness could be sought for in large open spaces such as agricultural land for some users (Group 1 in this study) and water areas for others (Group 2). Similarly, Kajosaari and Pasanen (2021) found that in the Helsinki Metropolitan Area, restorative experiences took place most often near blue areas and in large (>30 ha) recreational forests. In the light of restrictions on everyday movement, the mental construction of forests as the recovery of agency and control plays an important role in high visitation of forests (Weinbrenner et al., 2021), and these factors may also play a role in higher rates of visitation to areas of high tree cover density.

Spaciousness could be also cognitive i.e., experienced as being away from everyday life (Kaplan and Kaplan, 1989) and forgetting about spatial and temporal limits even in large-treed forests (Grahn, 1991). However, urban fragmentation interrupts the perception of space as a whole and built infrastructure such as tall or large buildings can disrupt continuity in visual perception and the sense of place as a whole (Van Herzele and Wiedeman, 2003). It is therefore crucial from a planning and management perspective to maintain current or establish new corridors to enable both habitat and social connectivity between different types of UGI and blue spaces which are accessible by different user groups.

Accessibility and use of areas with different types of TCD may be influenced by other factors beyond the scope of this study including employment status, basic value orientations, childhood experience in nature, environmental conditions and socialization processes. Therefore, future work would benefit from the development of multi-level models for explaining green area visitation during times of shock, taking account of individual and collective processes that influence behavioral intentions and actual behavior. One option would be to further explore the role of multi-level values on green space visitation (building on van Riper et al., 2019). Another option would be to integrate individual, organizational, and interpersonal/relational factors in models of green space visitation in addition to environmental factors such as proximity of leisure facilities, road connectivity, population density, seasonal changes, altitude and traffic speed (see (Liu H. et al., 2017) for overview; Rice and Pan, 2021). Also, it would be worthwhile repeating this same study by exploring a range of different leisure activities, recognizing that park visitation is influenced by leisure motivation (Kabisch et al., 2021).

Our study also exemplifies the need to monitor the spatial-temporal aspects of recreational use to reconcile conservation of natural resources and high demand for recreation (Korpilo et al., 2018) also in exceptional circumstances such as future

pandemics. For example, during the COVID-19 pandemic Helsinki's residents started to use nearby urban forests more than before the pandemic, but they were often perceived as overcrowded. This coupled with the fact that small urban forests generally experience heavy pressure from fragmentation and intense everyday recreational use (Lehvävirta et al., 2014; Korpilo et al., 2017) can exacerbate negative ecological and social impacts such as trampling, creation and spatial dispersion of informal paths, and overcrowding and conflicts among different users (Arnberger and Haider, 2005; Lehvävirta et al., 2014; Santos et al., 2016; Korpilo et al., 2017). Here, a connectivity approach that considers the quantity, quality and spatial organization of UGI and nature access can also play a role in relieving intense use from some areas under specific conditions, while also increasing overall social and ecological resilience in future pandemics (Lopez et al., 2020; Samuelsson et al., 2020).

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SK: conceptualization, formal analysis, methodology, writing—original draft preparation, review, and editing. AK, TR, and MK: data curation, formal analysis, methodology, writing—original draft preparation, and review. CR: conceptualization, writing—original draft preparation, and review. All authors have read and agreed to the published version of the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2021.713977/full#supplementary-material

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Urban Park Use During the COVID-19 Pandemic: Are Socially Vulnerable Communities Disproportionately Impacted?

Lincoln R. Larson[1]*, Zhenzhen Zhang[2], Jae In Oh[1], Will Beam[1], S. Scott Ogletree[3], Jason N. Bocarro[1], KangJae Jerry Lee[1], Jonathan Casper[1], Kathryn T. Stevenson[1], J. Aaron Hipp[1,4], Lauren E. Mullenbach[5], Matt Carusona[6] and Michelle Wells[6]

[1] Department of Parks, Recreation and Tourism Management, North Carolina State University, Raleigh, NC, United States, [2] Department of Forestry & Environmental Resources, North Carolina State University, Raleigh, NC, United States, [3] OPENSpace Research Centre, School of Architecture and Landscape Architecture, University of Edinburgh, Edinburgh, United Kingdom, [4] Center for Geospatial Analytics, North Carolina State University, Raleigh, NC, United States, [5] Department of Geography & Environmental Sustainability, University of Oklahoma, Norman, OK, United States, [6] North Carolina Recreation & Park Association, Raleigh, NC, United States

The COVID-19 pandemic altered human behavior around the world. To maintain mental and physical health during periods of lockdown and quarantine, people often engaged in outdoor, physically distanced activities such as visits to parks and greenspace. However, research tracking outdoor recreation patterns during the pandemic has yielded inconsistent results, and few studies have explored the impacts of COVID-19 on park use across diverse neighborhoods. We used a mixed methods approach to examine changes in park use patterns in cities across North Carolina, USA, during the COVID-19 pandemic, with an emphasis on impacts in socially vulnerable communities (based on racial/ethnic composition and socioeconomic status). First, we surveyed a demographically representative sample of 611 urban residents during August 2020 to assess their use of outdoor park spaces before and during the pandemic. Second, we used cell phone location (i.e., geo-tracking) data to document changes in park visits within 605 socioeconomically diverse urban census tracts before (July 2019) and during (July 2020) the pandemic. Data from both methods revealed urban park use declined during the pandemic; 56% of survey respondents said they stopped or reduced park use, and geo-tracked park visits dropped by 15%. Park users also became more homogenous, with visits increasing the most for past park visitors and declining the most in socially vulnerable communities and among individuals who were BIPOC or lower-income. Our results raise concerns about urban park use during the COVID-19 pandemic and suggest pre-existing health disparities in socially vulnerable communities might be exacerbated by inequitable access and utilization of parks and greenspace.

Keywords: coronavirus, COVID-19, environmental justice, equity, greenspace, health, outdoor recreation, race

INTRODUCTION

In early 2020, a novel coronavirus (COVID-19) rapidly spread across the world, creating a global pandemic that altered human behavior and negatively impacted humans' physical health and mental health in unprecedented ways (Bao et al., 2020; Holmes et al., 2020). In many countries, early responses to the pandemic focused on comprehensive "lockdowns" or "stay-at-home" orders designed to prevent social contact that fuels virus transmission (Atalan, 2020). As research began to reveal that COVID-19 transmission risk was significantly lower in outdoor settings (Bulfone et al., 2020; Rowe et al., 2021), many cities began to re-open outdoor spaces with physical distancing mandates and other precautions (e.g., face coverings) in place (Venter et al., 2020). Following the elimination of popular indoor recreation activities, many urban residents around the world elected to spend time in places that remained accessible despite COVID-19 restrictions, such as public parks and greenspaces (Kleinschroth and Kowarik, 2020).

Parks and greenspaces improve quality of life for urban residents in many ways (Hartig et al., 2014; Larson et al., 2016). In terms of physical health, park use promotes active lifestyles that reduce the risk of cardiovascular disease and other chronic health conditions (Lachowycz and Jones, 2013; Twohig-Bennett and Jones, 2018). With respect to mental health, contact with parks and greenspace has been linked to improved cognitive functioning (Bratman et al., 2019), attention restoration (Kaplan, 1995), stress reduction (Hunter et al., 2019), emotional well-being (Capaldi et al., 2015), and social relationships (Jennings and Bamkole, 2019). The health promotion potential of urban parks, which was widely recognized before COVID-19 (Maller et al., 2006; van den Bosch and Ode Sang, 2017), is even more conspicuous during times of crisis. Across continents, public parks have been recognized as a unique source of community resilience during prolonged periods of lockdown and quarantine associated with COVID-19 (Grima et al., 2020; Samuelsson et al., 2020; Slater et al., 2020). Urban residents are more likely to suffer health impacts from the pandemic (Rader et al., 2020; Hubbard et al., 2021), and parks offer some respite from COVID-19 transmission risk and socially distanced life in cities (Johnson et al., 2021). Youth (Jackson et al., 2021) and adults (Cindrich et al., 2021; Poortinga et al., 2021) who maintained outdoor activity during the pandemic reported better health outcomes than those who did not go outside. With few alternatives available in cities around the world, park-based activities were one of the only options for urban residents hoping to sustain or enhance their health and well-being in early stages of the crisis (Ugolini et al., 2021).

Despite the health promotion value of parks during the pandemic, it is not yet clear how urban park use patterns shifted in the wake of COVID-19. Anecdotally, many park managers (especially in the US) reported a substantial increase in visitation [Pregitzer et al., 2020; The Trust for Public Land, 2020a; National Recreation Park Association (NRPA), 2021]. However, multiple studies tracking park use around the world during the pandemic have yielded inconsistent results. In an international survey across 49 US states and 14 countries, researchers found that frequency of outdoor recreation participation for adults in urban areas declined sharply throughout the first few months of the pandemic (Rice et al., 2020). Similar patterns have been documented for adolescents in the US (Jackson et al., 2021). However, in specific US states, some survey respondents have reported a rise in nature-based activity participation (Grima et al., 2020; Morse et al., 2020). A study using cell phone location data across the US found significant decreases in urban park visitation from the start of the pandemic through November 2020 (Jay et al., 2021), but another global study using a similar approach from February–May 2020 found general increases in urban park use across most countries (Geng et al., 2021). In both cases, patterns varied substantially based on local context due to different levels of disease prevalence and government-imposed closures and restrictions. In Norway, researchers found a rise in pedestrian activities in city parks and peri-urban forests during the pandemic (Venter et al., 2020). A study in the UK found slightly decreased park visitation during the first COVID-19 lockdown, but significantly increased park use in the second lockdown (Day, 2020). In Italy, urban park use declined during the pandemic and many residents lamented their limited access to greenspace (Ugolini et al., 2021). This conflicting evidence highlights the need for more research investigating the impact of the COVID-19 pandemic on urban park use.

Even less is known about if, or how, shifting recreation patterns during the pandemic varied across diverse communities. From a health perspective, communities with low socioeconomic status and communities with large populations of BIPOC (Black, Indigenous, or People of Color) residents are more likely to be negatively impacted, both physically and psychologically, by COVID-19 (Fortuna et al., 2020; Kim and Bostwick, 2020). Racial disparities in COVID-19 infection rates have also been documented, but those disparities are reduced in counties that have a higher ratio of green space (Lu et al., 2021). Even before the pandemic, however, environmental justice research has shown that low-income or BIPOC neighborhoods typically experienced limited access to parks, greenspaces, and other outdoor recreation resources (Sister et al., 2010; Rigolon, 2016; Nesbitt et al., 2019). If parks are located in low-income communities of color, they often tend to be of lower quality (Rigolon et al., 2018). Thus, the potential benefits of parks are not realized equitably across all segments of society (Jennings et al., 2016). As research in countries such as Russia and Australia has shown (Dushkova et al., 2021), disparities in urban park use and access might be magnified in the era of COVID-19. Pre-existing disparities, coupled with inequitable access to parks (a critical health promoting resource) during the pandemic, could exacerbate suffering and negative health outcomes in socially vulnerable populations.

Our study employed a mixed methods approach with two distinct datasets to examine shifting urban park use patterns during the COVID-19 pandemic from different angles and explore potentially magnified impacts on socially vulnerable communities. First, we used a survey of residents living in cities across North Carolina (NC), USA, to examine self-reported changes in park use during the pandemic and how they varied based on demographic attributes such as race/ethnicity and

income. Second, we used a separate sample of cell phone location (i.e., geo-tracking) data from urban areas across NC to examine shifts in park use before and during the COVID-19 pandemic, exploring links between park visitation and the social vulnerability of communities at the census tract level. By comparing these self-reported and overt measures of outdoor recreation behavior across different periods of time, we aimed to improve understanding of urban park use during COVID-19 across diverse communities.

STUDY SITE

Our mixed-method approach used primary data (in the form of a survey) and secondary data (in the form of geo-tracking data) to focus on residents of urban areas within the state of North Carolina (NC), USA. NC is the 9th most populous state in the US, and features two of the country's fastest growing cities, Raleigh and Charlotte (Ordonez, 2020). A majority (roughly 60%) of the state's 10.5 million residents live in urban areas. Furthermore, the NC population is racially and ethnically diverse (e.g., 71% White, 22% African American, 9% Hispanic/Latinx; US Census Bureau, 2021), and pronounced income disparities and inequality within the state were rapidly growing even before the pandemic (deBruyn, 2017). The state is also known for its popular and extensive network of state and municipal parks [NC Department of Natural Cultural Resources (NCDNCR), 2021]. For all of these reasons, NC is an ideal location for exploring how COVID-19 impacted urban park use of different groups and whether certain communities are more negatively impacted by the pandemic.

STUDY 1: SURVEY OF URBAN RESIDENTS

Methods

In August 2020, approximately six months after the start of the pandemic (and pandemic-related lockdowns) in the US, we conducted a web-based survey of residents across NC. The survey instrument, designed in collaboration with the NC Recreation and Parks Association, aimed to understand the influence of the pandemic on public outdoor recreation patterns. Using a *Qualtrics XM* panel, we collected data over a 1-week period from a demographically representative sample of approximately 900 adults (age 18 or older) across the entire state. *Qualtrics* draws potential respondents from a list of residents who sign up as paid online survey-takers through the *Qualtrics* website, allowing for rapid data collection while still approximating a probability sample at the appropriate scale (in this case, statewide; Boas et al., 2020). After data quality checks, 819 responses were considered valid based on survey completion rates of 100% and absence of straight-line responses. Because our analysis in this study only focused on residents of urban (45% of our sample) and suburban (30% of our sample) counties, we excluded responses from participants living in rural regions of the state. This yielded an effective sample size of 611 NC urban residents.

The survey instrument contained questions about outdoor recreational park use and factors affecting use. In this paper, our analysis focused specifically on the use of outdoor park spaces.

To understand how people used parks, both before and during the pandemic, we asked respondents two related questions. First, we asked "Over the past year, prior to the COVID-19 pandemic, how often did you use open spaces/trails?" Response options based on scales used in previous studies of outdoor recreation participation frequency (Larson et al., 2011) included (1) "Never use," (2) "Rarely (annually, or a few times each year)," (3) "Occasionally (monthly or several times a month)," (4) "Often (weekly or several times a week)," and (5) "Very often (5 times or more a week)." In addition to open spaces and trails, we asked the same question about other types of recreation facilities (i.e., indoor facilities, aquatic facilities, programming and camps, outdoor fields and courts). However, at the time we collected data during Phase 2 of the pandemic (July–August 2020), many of those facilities in NC (e.g., indoor gyms, outdoor courts and fields, day camps, public playgrounds) remained closed or at limited capacity due to the Governor's statewide stay-at-home orders (Executive Order No. 155., 2020). Therefore, we chose to focus our analysis on the only park resources that were available to most residents: parks, nature preserves, greenways, and trails. To assess changes in park use during the COVID-19 pandemic, we asked, "During the COVID-19 pandemic (March to August 2020), how has your use of open spaces/trails changed?" Response options included (-2) "Stopped using altogether," (-1) "Used less," (0) "No change," and (1) "Used more."

TABLE 1 | Summary of demographic attributes for survey respondents ($n = 611$) from urban areas in North Carolina (NC), relative to all urban residents in NC.

	Proportion of survey sample	Urban census tracts in NC[a]
Age (in years)		
18–34	42.6%	31.0%
35–54	40.5%	26.0%
55+	16.9%	43.0%
Gender		
Male	41.1%	47.8%
Female	58.9%	51.9%
Race/Ethnicity		
White	65.3%	51.6%
Black	18.2%	29.7%
Hispanic	3.6%	11.6%
Other	12.9%	6.9%
Education		
High school or less	23.2%	32.9%
College/undergraduate	58.8%	53.9%
Graduate	18.0%	12.9%
Household Income		
$49,999 or less	37.9%	46.1%
$50,000-$99,999	37.5%	27.6%
$100,000 or more	20.7%	26.2%
Prefer not answer	3.9%	-

[a]*Demographic ratios for census tracts within urban boundaries across North Carolina calculated based on data from the American Community Survey (US Census Bureau, 2019).*

TABLE 2 | Results of multinomial logistic regression model[a] predicting demographic variables associated with sporadic and frequent park use (relative to non-use) among urban residents ($n = 611$) in North Carolina (NC), USA, prior to the COVID-19 pandemic.

Variable	Sporadic users				Frequent users			
	B	SE	OR	Sig.	B	SE	OR	Sig.
Income								
Ref = $49,999 or less								
$50,000–$99,999	0.648	0.276	1.91	0.010	0.887	0.301	2.43	0.003
$100,000 or more	0.847	0.401	2.33	0.030	1.534	0.412	4.64	<0.001
Education								
Ref = High school or less								
Undergraduate/College	0.719	0.279	2.05	0.010	0.861	0.311	2.37	0.006
Graduate	1.186	0.486	3.27	0.010	1.764	0.503	5.83	<0.001
Race/ethnicity								
Ref = White								
Black	−0.954	0.306	0.39	0.001	−1.025	0.335	0.36	0.002
Hispanic	−0.584	0.696	0.56	0.401	−0.019	0.691	0.98	0.978
Other	−0.078	0.394	0.93	0.842	−0.099	0.417	0.91	0.813
Gender								
Ref = Male								
Female	−0.102	0.269	0.90	0.704	−0.219	0.286	0.80	0.445
Age (in years)								
Ref = 18–34								
35–54	−0.440	0.292	0.64	0.131	−0.630	0.308	0.53	0.040
55+	−1.174	0.358	0.31	0.001	−2.013	0.407	0.13	<0.001

[a]*Reference category for dependent variables = Non-user; Nagelkerke's pseudo-R^2 = 0.238; B, parameter estimate; SE, standard error of B; OR, odds ratio; Sig. = p-value.*

We asked respondents to provide a variety of demographic information including gender (Man, Woman, Identify another way, Prefer not to say), age in years (18–24, 25–34, 35–44, 45–54, 55–64, 65 and over), education (Less than high school, High school graduate, Some college, Associate's degree, Bachelor's degree, Post-college/graduate degree), and race/ethnicity following common categories used by the US Census Bureau (American Indian or Alaskan Native, Asian, Black or African American, Hispanic/Latino or Spanish origin, Middle Eastern or Northern African, Native Hawaiian or Pacific Islander, White, Other, Prefer not to say). Respondents also provided their approximate annual household income in 2019 based on condensed categories used by the US Census Bureau (<$49,999, $50,000-$99,999, $100,000 or more, Prefer not to say), with the $50,000 threshold approximating the median household income for NC at the time of data collection (US Census Bureau, 2021). Respondents noted the county in which they lived (one of 100 in NC), and we used this information to determine if they were a resident of an urban (750+ people per square mile), suburban (250–750 people per square mile), or rural county (<250 people per square mile) based on NC demographic data (NC Rural Center, 2021).

To investigate demographic correlates of self-reported park use before and during COVID-19, we constructed two separate multinomial logistic regression models. We first reclassified pre-COVID-19 use of outdoor park spaces into three categories: no use (never), sporadic use (rarely or occasionally), and frequent use (often or very often). We then reclassified changes in park use during COVID-19 into three categories: decreased use (stopped using or using less), same use (no change), and increased use (using more). In both the before and during COVID-19 models, we examined associations between park use and socioeconomic attributes including gender, age, education, race/ethnicity, and income. We condensed demographic categories with small sample sizes to facilitate interpretation of results (e.g., combined certain income and racial/ethnic categories with smaller representation). Pre-COVID-19 park use was also included as an independent variable in the during COVID-19 model. We assessed model fit using Nagelkerke's pseudo-R^2, and we assessed statistical significance and effect size using odds ratios. To visually depict key demographic differences among variables of interest, we used bar charts and Chi-square tests to graphically represent park use before and during the pandemic. All analyses were conducted in R (R Core Team, 2014) using package nnet (Ripley and Venables, 2021).

Results

Demographic attributes of survey respondents suggested that our data collection approach yielded a diverse sample of NC residents that approximated the urban population in the state (**Table 1**). For example, 35% of respondents were BIPOC, 23% did not have a college degree, and 38% reported annual household incomes below $50,000. Overall, survey respondents were slightly more
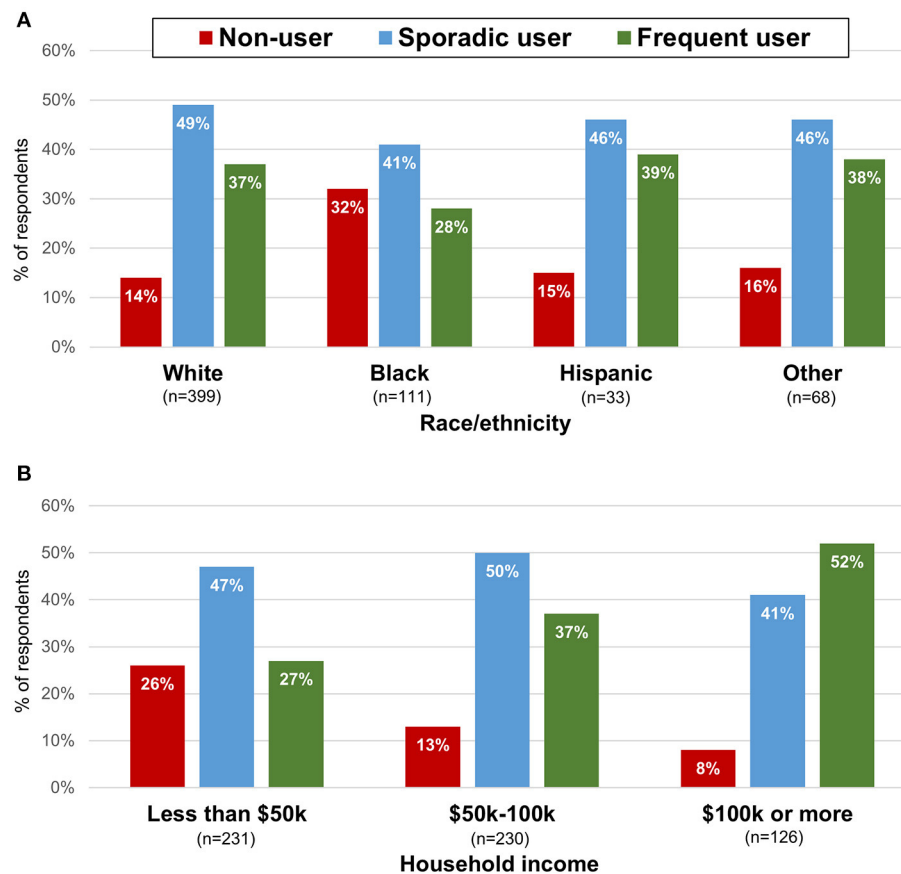
FIGURE 1 | Differences in pre-COVID-19 use of outdoor park spaces by **(A)** race/ethnicity ($X^2(6) = 18.5$, $p = 0.002$, Cramer's $V = 0.123$), and **(B)** household income ($X^2(4) = 35.5$, $p < 0.001$, Cramer's $V = 0.174$). Data are based on an August 2020 survey of urban residents in NC ($n = 611$).

likely to be 18–34 years old, female, white, and middle-income than average NC urban residents (**Table 1**).

According to self-reported survey data, 35.4% of respondents said they used parks frequently prior to COVID-19; 46.9% of respondents said they used parks sporadically and 17.7% never used parks before the pandemic. When examining demographic factors associated with pre-COVID-19 park use, we found that higher income and education levels were positively associated with park use (**Table 2**). Compared to the low-income reference group, respondents from the higher income groups were nearly five times as likely to be frequent park users. Pre-COVID-19 park use also varied by race. Before the pandemic, white respondents were more likely to be frequent or sporadic users of parks than any other racial/ethnic group, and they were significantly more likely to frequently use parks than Black respondents (**Table 2**). Respondents in the older age group were less likely to visit parks frequently compared to respondents in the youngest age group (**Table 2**). Bivariate comparisons of pre-pandemic park use with race/ethnicity and income highlight these demographic patterns (**Figure 1**).

During the COVID-19 pandemic, 55.7% of respondents reported stopping or decreasing use, 27.7% said their park usage did not change, and only 16.6% reported increased park use. The during COVID-19 regression model revealed many similar demographic patterns. Higher income park users were the least likely to stop using parks (**Table 3**). Relative to white respondents, BIPOC individuals were less likely to increase use of parks, though these differences were not statistically significant. Older respondents were less likely than younger respondents to increase use of parks. The most significant changes in park use during COVID-19 were linked to pre-pandemic park use patterns. Compared to non-users, frequent park users before the pandemic were 23 times as likely, and sporadic park users were nine times as likely, to increase their park use during COVID-19 (**Table 3**). In other words, any observed increases in park use during COVID-19 appeared to be driven by people who were already using parks regularly before the pandemic. Bivariate comparisons of park use changes during the pandemic with race/ethnicity, income, and pre-COVID park use frequency highlight these patterns (**Figure 2**).

TABLE 3 | Results of a multinomial logistic regression model[a] predicting demographic variables associated with changes in park use (increasing use or same use relative to stopping/decreasing use) among urban residents (*n* = 611) in North Carolina (NC), USA, during the COVID-19 pandemic.

Variables	Same use/no change				Increased use			
	B	SE	OR	Sig.	B	SE	OR	Sig.
Income								
Ref = $49,999 or less								
$50,000–$99,999	0.760	0.239	2.14	0.001	0.136	0.292	1.15	0.641
$100,000 or more	0.722	0.298	2.06	0.010	0.480	0.338	1.62	0.156
Education								
Ref = High school or less								
Undergraduate/college	−0.132	0.250	0.88	0.597	0.358	0.337	1.43	0.287
Graduate	−0.849	0.357	0.43	0.010	−0.121	0.430	0.89	0.779
Race/ethnicity								
Ref = White								
Black	−0.360	0.283	0.69	0.203	−0.732	0.360	0.48	0.044
Hispanic	0.242	0.527	1.27	0.646	−0.499	0.242	0.61	0.473
Other	0.037	0.302	1.04	0.901	−0.660	0.394	0.52	0.050
Gender								
Ref = Male								
Female	−0.086	0.215	0.92	0.691	0.001	0.261	1.00	0.990
Age								
Ref = 18–34								
35–54	0.080	0.234	1.08	0.734	−0.488	0.266	0.61	0.050
55+	0.296	0.300	1.34	0.324	−0.998	0.447	0.37	0.025
Pre-COVID								
Ref = Never use								
Sporadic users	−1.046	0.266	0.35	<0.001	2.151	1.032	8.60	0.010
Frequent users	−0.957	0.296	0.38	0.001	3.120	1.031	22.64	0.001

[a]*Reference category for dependent variables = Stopped or decreased use; Nagelkerke's pseudo-R^2 = 0.245; B, parameter estimate; SE, standard error of B; OR, odds ratio; Sig. = p-value.*

STUDY 2: GEO-TRACKING OF URBAN PARK USE

Methods

The second part of our study used cell phone location data, aggregated to the census tract level, to compare park use patterns within diverse urban neighborhoods at two different points in time: July 2019 (before the COVID-19 pandemic) vs. July 2020 (during the pandemic). We used location data originally collected by SafeGraph (www.safegraph.com), a commercial organization that measures frequency of visits to 4.4 million Points-of-Interest (POI) across the US at the census block level which include locations such as grocery stores, restaurants, and retail stores (Chang et al., 2021; SafeGraph, 2021a). The anonymized location data are primarily used for business (Hu et al., 2021), but SafeGraph also allows access for research purposes. SafeGraph derives precise geo-location data from 45 million smartphone devices in the US, yet protects the anonymity of public users by withholding personal information (Gao et al., 2020). SafeGraph assigns a code to each POI based on the North American Industry Classification System so that users can extract POIs based on specific business categories. Overall, the data from SafeGraph

covers mobility patterns of 10% of the entire population in the US (SafeGraph, 2021b). During the COVID-19 pandemic, many researchers have explored shifting mobility patterns and disparities across diverse urban environments using SafeGraph data (Gao et al., 2020; Chang et al., 2021).

We were specifically interested in one type of POI: parks. Parks were first identified within the larger SafeGraph data category of "Nature Parks or Similar Places." We then filtered data to focus only on POIs with "park" in their name, with the goal of eliminating POIs, such as museums, that did not constitute outdoor public spaces and were likely to be closed during the pandemic. This resulted in 1773 unique park POIs across North Carolina. Based on location data for the geometric center (i.e., centroid) of each park, we assigned each park POI to a single US census tract (US Census Bureau, 2020). We used urban cluster boundaries for NC (n = 66; US Census Bureau, 2010) to exclude POIs in census tracts outside of urban areas. The total number of urban census tracts included in the analysis was 606, and the total number of urban park POIs across NC was 1,167 (**Figure 3**). At each urban park POI, SafeGraph used geo-tracking data to record the number of park visits (for visitors who used cell phone location services during their park visit). We examined
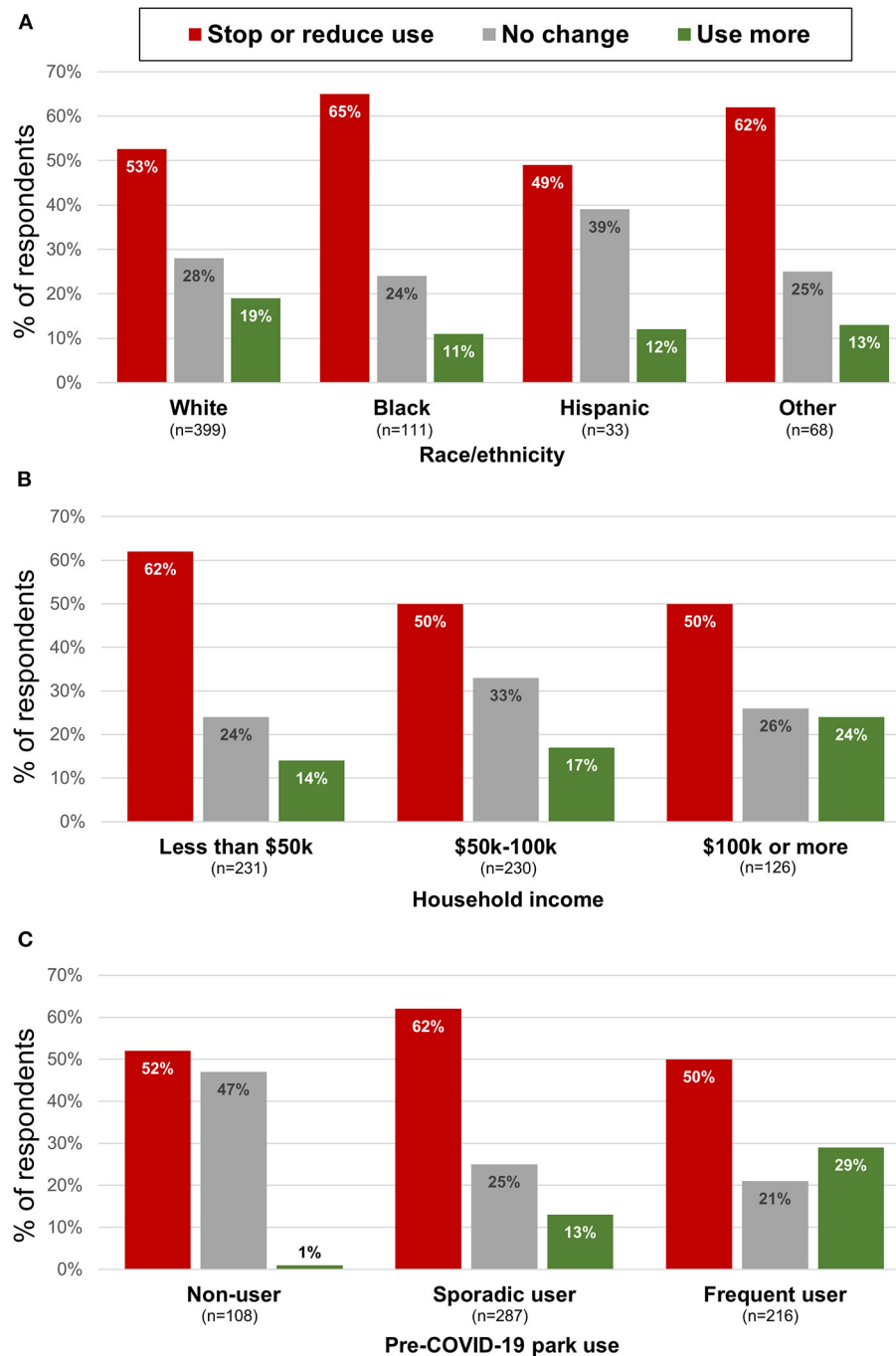
FIGURE 2 | Differences in outdoor park use changes during COVID-19 by **(A)** race/ethnicity ($X^2(6) = 10.2$, $p = 0.116$, Cramer's $V = 0.091$), **(B)** household income ($X^2(4) = 11.1$, $p = 0.025$, Cramer's $V = 0.097$), and **(C)** pre-COVID-19 park use levels ($X^2(4) = 60.7$, $p < 0.001$, Cramer's $V = 0.223$). Data are based on an August 2020 survey of urban residents in NC ($n = 611$).

data recorded during two different time periods: the entire month of July 2019 (from 12 a.m. on July 1 to 11:59 p.m. on July 31), which represented the pre-pandemic time block, and the entire month of July 2020, which occurred during the COVID-19 era. We focused on July because that month often represents the peak of summer park visitation. We used the sum of park visits for the entire month to represent park use at each individual POI in both years, and we aggregated park visits associated with individual POIs to the census tract level to match the spatial scale for other demographic variables. Thus, if there was more than one park

FIGURE 3 | Map of North Carolina (NC), USA, depicting park "points of interest" (POI) data used to geo-track park visits across urban clusters in the state in July 2019 and July 2020.
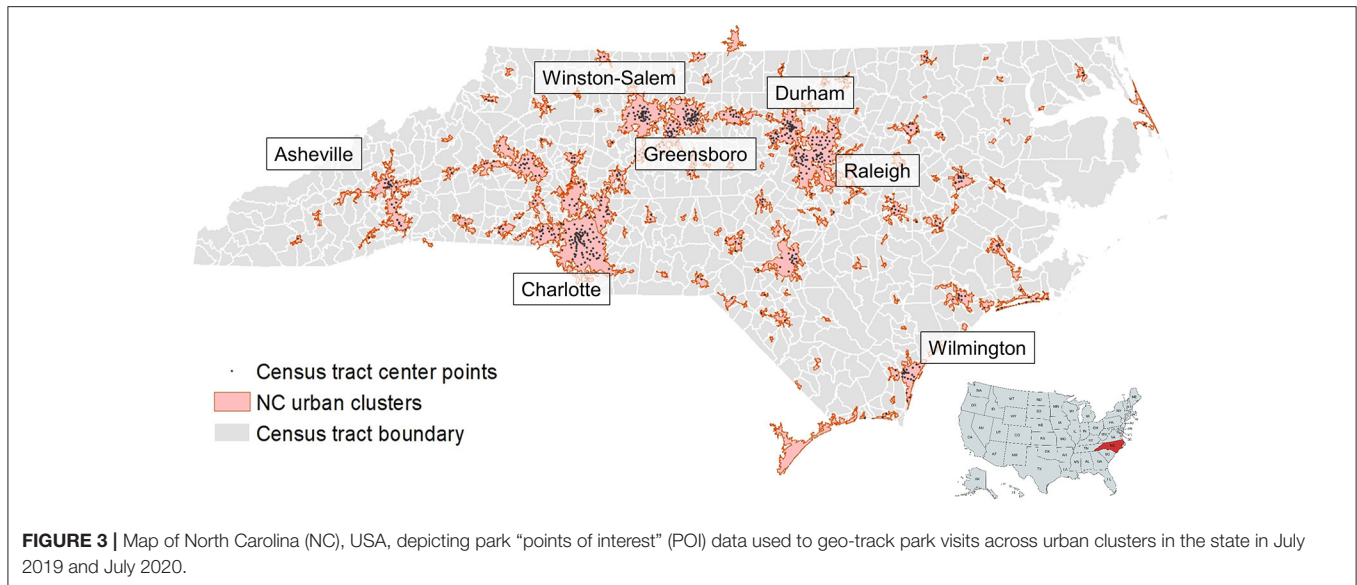
POI in a census tract, we added those visits together to represent the total number of park visits within that tract for each year (July 2019 vs. July 2020).

We used the social vulnerability index (SVI) [Centers for Disease Control Prevention (CDC), 2018] to characterize the socio-demographic attributes of urban neighborhoods. SVI is a spatial measure of vulnerability that accounts for factors such as socioeconomic status (SES), household age composition, and race/ethnicity. It is a compound index composed of 15 social factors based on data from the American Community Survey (ACS) (Flanagan et al., 2011). SVI measures have been used to predict community vulnerability and health risks due to COVID-19 [Centers for Disease Control Prevention (CDC), 2020]. Use of SVI enabled us to capture different components of social vulnerability simultaneously, thereby reducing the risk of multi-collinearity in regression models. We used three themes, or dimensions, of SVI that roughly aligned with demographic variables in our self-reported survey (Study 1). Although the survey and the geo-location data measured different aspects of park use at different times, both contained similar demographic variables that facilitated parallel exploration of park use patterns. For example, *socioeconomic status* included information about the ratio of residents below the poverty level, unemployment, income levels, and educational attainment (e.g., no high school diploma), aligning with education and household income variables on our survey. *Household age composition* included variables associated with age such as the number of minors and seniors in a house as well as disability metrics, aligning with the age variable on our survey. *Race/ethnicity/language* included information about the ratio of residents considered minorities due to racial and ethnic identity and those who speak English "less than well," aligning with the race/ethnicity variable on our survey. SVI scores for socioeconomic status and household age composition ranged from 0 to 4, and SVI scores for race/ethnicity/language ranged from 0 to 2, with higher

scores indicating communities that are more vulnerable. We used SVI scores at the census tract level, matching the scale of park visitation data.

Because park use patterns are likely linked to park access and proximity (McCormack et al., 2010; Moran et al., 2020), we also integrated data regarding the number of parks within a census tract and the park ratio within the tract (i.e., the percentage of land within a census tract designated as parks). The data used to calculate park ratio was derived from ParkServe (The Trust for Public Land, 2020b), a geodatabase providing information about park size and park access to the public.

To examine overall changes in park use before and during the pandemic, we first compared average park visits across all urban census tracts in July 2019 vs. 2020 using a paired *t*-test. After these initial comparisons, we used a negative binomial regression model (for zero-truncated count data) to examine pre-COVID-19 park visits (July 2019) as a function of the three SVI themes (i.e., socioeconomic status, household age composition, and race/ethnicity), number of parks, and park ratio at the census tract level. We then applied the same model to examine park visits during COVID-19 (July 2020). To further explore how COVID-19 altered the park use, we ran a mixed effects logistic regression model that included the same independent variables, with binary park use change as the response variable. For that response variable, we subtracted pre-pandemic park visits from during-pandemic visits within each census tract and recoded change in use as 1 = increasing or no change (i.e., post—pre > 0), and 0 = decreasing (i.e., post—pre < 0). Although COVID-related physical distancing guidelines and restrictions remained in place in NC at the time of data collection (Executive Order No. 155., 2020), some degree of politically-driven variability in COVID-19 restrictions across municipalities in the state was still present (Adolph et al., 2021). We therefore added a random effect in each model to represent unique urban clusters (n = 66). We assessed model fit using McFadden's or Nagelkerke's

TABLE 4 | Results of negative binomial regression models[a] investigating associations between various census tract-level measures of social vulnerability (based on the social vulnerability index, SVI) and total park visits before and during the COVID-19 pandemic in North Carolina (NC), USA.

Variables	Parks visits before COVID-19				Park visits during COVID-19			
	B	SE	β	Sig.	B	SE	β	Sig.
SVI-SES[b]	−0.110	0.046	−0.13	0.017	−0.151	0.050	−0.17	0.003
SVI-AgeComposition[c]	−0.144	0.064	−0.10	0.030	−0.003	0.068	0.00	0.959
SVI-Race[d]	0.088	0.099	0.04	0.374	−0.171	0.103	−0.09	<0.001
Number of parks[e]	0.418	0.032	0.50	<0.001	0.315	0.034	0.38	<0.001
Park ratio[f]	4.776	0.668	0.28	<0.001	4.916	0.72	0.29	<0.001
McFadden's pseudo-R^2	0.478				0.403			

[a]B, parameter estimate; SE, standard error of B; β, standardized estimate; Sig. = p-value; SVI scores based on Flanagan et al. (2011) and Centers for Disease Control Prevention (CDC) (2020).
[b]SVI-SES considers vulnerability based on socioeconomic status (below poverty, unemployed, income, no high school diploma).
[c]SVI-AgeComposition considers vulnerability based on household composition & disability (age 65 or older, aged 17 or younger, civilian with a disability, single-parent households).
[d]SVI-Race considers vulnerability based on minority status by race and ethnicity & language (minority, speaks English "less than well").
[e]Number of parks refers the total number of parks located within a census tract.
[f]Park ratio refers to the total proportion of land area within a census tract designated as park land.
Model includes a random effect for different urban areas in the state.

pseudo-R^2, and we assessed statistical significance and effect size using parameter estimates and odds ratios. To visually depict differences in park use changes across neighborhoods with low and high social vulnerability (based on SVI scores), we created bar charts and conducted Chi-square tests comparing SVI level and park use change based on the following categories: more than 10% decrease in visits during COVID-19, no change in visits (visits remained within 10% of pre-pandemic levels), and more than 10% increase in park visits during COVID-19. We selected the 10% threshold to minimize the likelihood of misinterpreting random fluctuations around zero (i.e., changes in annual visitation between −10 and +10%). All analyses were conducted in R (R Core Team, 2014) using package lme4 (Bates et al., 2020).

Results

Across the 605 census tracts belonging to 66 urban clusters in North Carolina, we found an average of 1.9 ($SD = 1.2$) parks in each tract. The average size of park land in each census tract was 0.3 ($SD = 0.6$) km^2, and the average size of a tract was 9.4 ($SD = 11.1$) km^2, resulting in an average park ratio of 4.02% ($SD = 5.92$%).

Before the pandemic, the average number of total park visits within a census tract during July 2019 was 736.9 ($SD = 1018.4$). During the pandemic urban park visits dropped to 624.6 ($SD = 955.8$) per tract. Overall, park visits within each census tract during COVID-19 decreased by an average of 112.3 ($SD = 838.2$) compared to pre-COVID-19 park visits, a statistically significant decline [$t_{(604)} = −3.30, p = 0.001$] of over 15%. The average *socioeconomic status* SVI score across all urban census tracts was 2.1 ($SD = 1.1$), the *household age composition* SVI score was 1.9 ($SD = 0.7$), and the *race/ethnicity* SVI score was 1.2 ($SD = 0.5$).

Before the COVID-19 pandemic, our negative binomial regression model showed that higher SVI scores for *socioeconomic status* and *household composition* were negatively associated with park visits at the census tract level, while the

TABLE 5 | Results of mixed effects logistic regression model[a] investigating associations between various census tract-level measures of social vulnerability (based on the social vulnerability index, SVI) and changes in park visits before and during the COVID-19 pandemic (1 = increase or no change in visits, 0 = decrease in visits) in North Carolina (NC), USA.

Variables	Increase in park visits during COVID-19			
	B	SE	OR	Sig.
SVI-SES[b]	−0.050	0.128	0.94	0.676
SVI-AgeComposition[c]	0.263	0.180	1.30	0.144
SVI-Race[d]	−0.583	0.260	0.56	0.025
Number of Parks[e]	−0.289	0.089	0.75	0.001
Park ratio[f]	−1.179	1.820	0.31	0.518
Nagelkerke pseudo-R^2	0.172			

[a]B, parameter estimate; SE, standard error of B; β, standardized estimate; Sig. = p-value; SVI scores based on Flanagan et al. (2011) and Centers for Disease Control Prevention (CDC) (2020).
[b]SVI-SES considers vulnerability based on socioeconomic status (below poverty, unemployed, income, no high school diploma).
[c]SVI-AgeComposition considers vulnerability based on household composition & disability (age 65 or older, aged 17 or younger, civilian with a disability, single-parent households).
[d]SVI-Race considers vulnerability based on minority status by race and ethnicity & language (minority, speaks English "less than well").
[e]Number of parks refers the total number of parks located within a census tract.
[f]Park ratio refers to the total proportion of land area within a census tract designated as park land.
Model includes a random effect for different urban areas in the state.

number of parks and park ratio were positively associated with park visits (**Table 4**). We observed similar patterns during the pandemic, as *socioeconomic status* remained inversely related to park visits (lower SES = fewer park visits), and the number of parks and ratio of parkland in a census tract were positively linked to visits. However, during the pandemic, higher SVI scores based on *race/ethnicity* were also negative correlates of park visitation (**Table 4**). In our logistic regression model where change in park visits was the binary dependent variable, we found
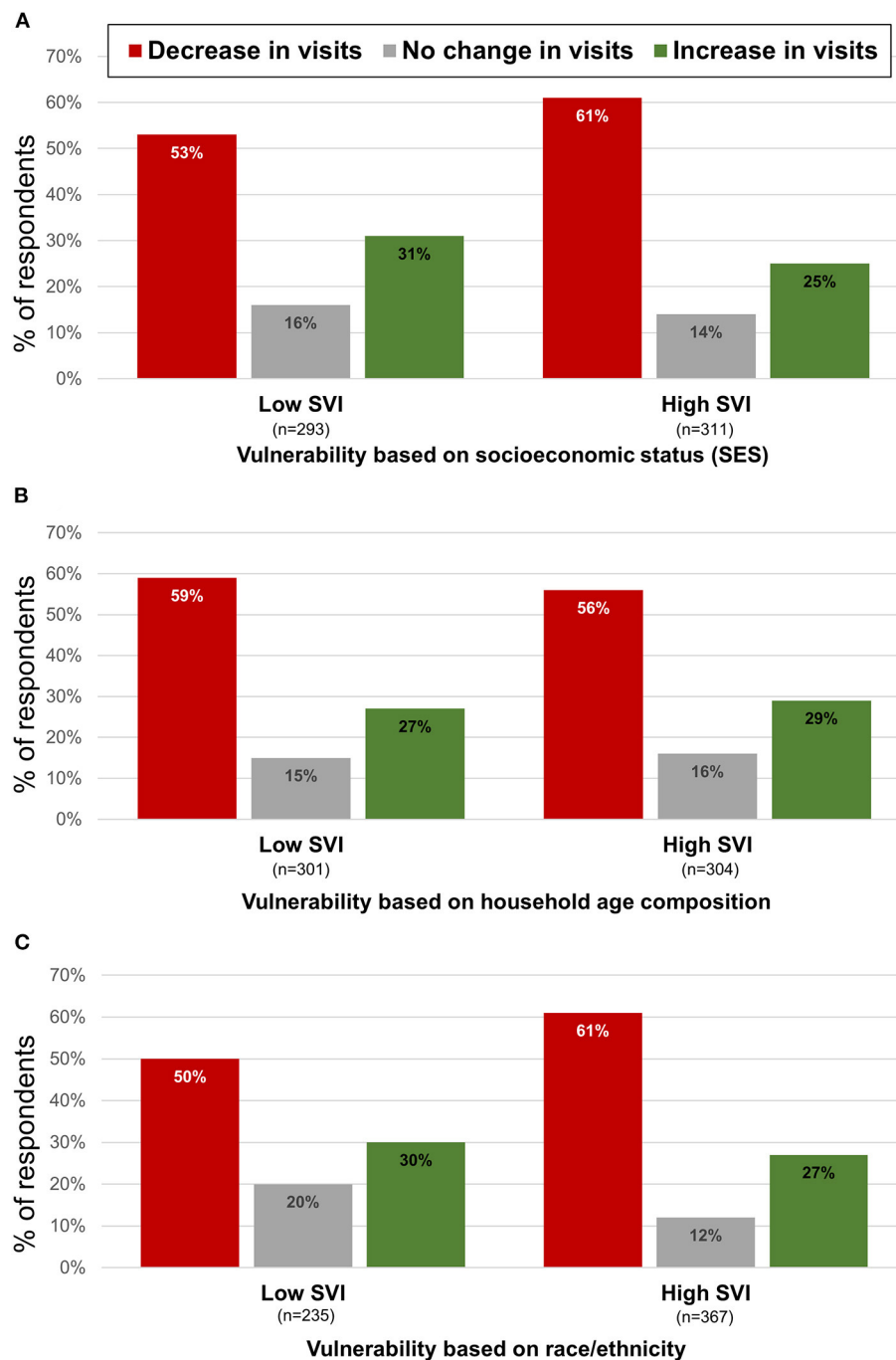
FIGURE 4 | Changes in geo-tracked park visits before (July 2019) and during (July 2020) the COVID-19 pandemic in urban census tracts across the state of North Carolina (NC), USA, based on social vulnerability of communities. Social vulnerability index SVI scores (Flanagan et al., 2011) were coded as low or high based with the midpoint of each index as the cutoff point (e.g., $\geq 2.0 =$ high vulnerability, $< 2.0 =$ low vulnerability). Park visit changes were grouped into three categories: more than 10% decrease in visits during COVID-19, no change in visits (visits remained within 10% of pre-pandemic levels), and more than 10% increase in visits during COVID-19. Differences are depicted by **(A)** SVI-SES ($X^2(2) = 3.9$, $p = 0.140$), **(B)** SVI-AgeComposition ($X^2(2) = 0.64$, $p = 0.728$), and **(C)** SVI-Race ($X^2(2) = 8.1$, $p = 0.018$). Park visit data are derived from cell phone locations within 605 socio-economically diverse urban census tracts across NC.

that social vulnerability based on *race/ethnicity* was a significant predictor: census tracts with large BIPOC populations were more likely to experience declines in park visitation (**Table 5**). We observed a similar, but not significant, trend based on

socioeconomic status. We also found that the number of parks in a census tract was negatively associated with park visit changes, such that more parks in a neighborhood resulted in a higher likelihood of park visits declining during COVID-19 (**Table 5**).

Bar charts comparing park use changes across census tracts with high and low levels of social vulnerability support these patterns, showing that park visits were more likely to decrease when SVI scores were high for race/ethnicity and SES (**Figure 4**).

DISCUSSION

Our study of cities across North Carolina (NC), USA, yielded two main findings regarding urban park use patterns during the COVID-19 pandemic. First, we discovered significant declines in urban park visitation since the start of COVID-19. This pattern was consistent across different data collection methods, including self-reported survey responses and geo-tracking data from cell phones. Second, declines in park visitation during the pandemic were more pronounced in socially vulnerable communities. This is alarming because these same communities, defined by residents who are BIPOC and/or low socioeconomic status, also reported lower levels of park use before the pandemic. Therefore, the COVID-19 pandemic appeared to exacerbate pre-existing disparities in park use, raising significant environmental justice concerns that might compound the COVID-related health crisis facing marginalized populations (Uchiyama and Kohsaka, 2020; Burnett et al., 2021; Dushkova et al., 2021).

Our results showing a drop in urban park visitation during the pandemic mirror some studies documenting declines in urban park use over the same time period (Jay et al., 2021), but they appear to contradict other reports indicating a rise in park visits during COVID-19 (Day, 2020; Pregitzer et al., 2020; Venter et al., 2020). Such discrepancies might be explained in several ways. Studies at different spatial scales have revealed variable patterns of outdoor recreation and park use since the start of the COVID-19 pandemic, ranging from unprecedented surges to dramatic declines (Geng et al., 2021). Shifts in park visitation have been linked to government policies during the pandemic, with stringent regulations and public health messaging deterring outdoor recreation in some places while encouraging it in others (Slater et al., 2020). In NC, most urban parks closed in the early stages of the pandemic. However, by July and August of 2020, most outdoor park spaces in cities were open with physical distancing guidelines in place. Parks in NC were therefore accessible during the time of data collection, although some degree of skepticism and concern regarding virus transmission in public spaces likely persisted, potentially curtailing visits (Weed and Foad, 2020).

Our data revealed another possible explanation for the rise in urban park visits seen in some cities around the world: more frequent visitation from past park visitors. We found that people who used parks frequently (i.e., on at least a weekly basis) were 23 times as likely to increase their park use during the pandemic than people who never used parks before COVID-19. Sporadic park users before the pandemic were nearly nine times as likely to increase park use during COVID-19. Perhaps these past users recognized the variety of benefits that parks can provide, and viewed parks as a critical health resource in these challenging times (Xie et al., 2020; Poortinga et al., 2021; Pouso et al., 2021). Or perhaps additional leisure time associated with workplace and school closures created more opportunities for higher-income outdoor recreation enthusiasts, already likely to visit parks before the pandemic, to pursue the activities they enjoy (Venter et al., 2020). Meanwhile, recreation and leisure opporunities for lower-income people, who were less likely to visit parks before COVID-19 and more likely to experience pandemic-related pressures, likely remained elusive (Yerkes et al., 2020). In any case, it appears that circumstances surrounding the COVID-19 pandemic did not attract many new users to urban parks in NC. In fact, only 1% of statewide survey respondents who did not visit parks previously started using them during COVID-19. These findings cast doubt on claims the pandemic has expanded the appeal of public parks across the general population (Grima et al., 2020; The Trust for Public Land, 2020a; Venter et al., 2020), and they underscore the need for more effective communication to reach underserved audiences in and around parks (Lee et al., 2020). While the health benefits of parks may be more evident due to COVID-19 (Razani et al., 2020; Slater et al., 2020), it does not appear that all segments of the American public are realizing those benefits.

Both survey and geo-tracking data indicated post-pandemic declines in park use were most significant in socially vulnerable communities, highlighting environmental injustices. BIPOC (particularly African American) and low-SES neighborhoods entered the pandemic with lower levels of park use, and it was these same individuals (and communities) that were more likely to experience decreasing park visitation during the pandemic. Among BIPOC respondents, only Hispanic/Latinx respondents maintained visitation levels comparable to white respondents during the pandemic, highlighting the particularly critical role of public parks as recreation destinations with the Hispanic community (Flores and Sanchez, 2020). Our findings mirror previous studies in the United States exposing race and income-related inequities related to greenspace access (Sister et al., 2010; Nesbitt et al., 2019) and park quality (Rigolon et al., 2018) in both urban and non-urban settings (Winter et al., 2020). Results also reflect disparities in park use and access to greenspace that have been observed in other countries during the pandemic (Burnett et al., 2021; Dushkova et al., 2021). In US-based studies, researchers found park visits during the pandemic decreased the most in areas where park availability was low (Curtis et al., 2021) and more residents were BIPOC (Jay et al., 2021). In places where park distribution and access is inequitable (i.e., socially vulnerable neighborhoods), alternative pathways to nature and outdoor recreation may be critical. Contact with any form of greenery, from views of vegetation to community gardens, can produce positive health outcomes during the pandemic (Dzhambov et al., 2021; Robinson et al., 2021; Soga et al., 2021). These nature-based experiences are especially strong correlates of well-being within BIPOC populations (Tomasso et al., 2021). To create new types of public outdoor recreation space, some cities have started open and shared street initiatives during the pandemic (Hanzl, 2020; Scott, 2021). Similar innovations may be needed in marginalized communities to foster healthy and active lifestyles when other park-based options are limited. Research has shown that historically marginalized and socially vulnerable populations are more likely to experience the physical

and mental health impacts of COVID-19 (Fortuna et al., 2020; Kim and Bostwick, 2020). Our evidence supports assertions that, within these communities, limited and diminishing use of park spaces during the pandemic could potentially widen health these disparities (Honey-Rosés et al., 2020; Taylor et al., 2021).

Limitations and Future Research

Several limitations should be acknowledged when interpreting the results of our study. Although our analysis synthesized results based on multiple methods of data collection, it only examined park use in urban areas of one US state. Other research has shown substantial variation in park use patterns across diverse geographic areas during COVID-19 (Geng et al., 2021), and our inferences should be extrapolated with caution. Furthermore, our study did not explore mechanisms behind observed imbalances in park use across demographic groups. Contextual factors that might impact park use in minority communities include park quality (Cohen et al., 2019), the built environment surrounding parks (Cutts et al., 2009), crime (Marquet et al., 2019), and other lifestyle factors (e.g., illness, income loss, childcare changes) that shifted in the wake of the pandemic—especially within socially vulnerable communities suffering disproportionate physical and psychological impacts from COVID-19 (Ruprecht et al., 2021). Although we controlled for differences across urban areas, we did not directly explore how different public health regulations in the wake of COVID-19 might have influenced park use (Geng et al., 2021). And we did not account for other concurrent events, such as the social justice movement in the US, that might have impacted the way different populations—especially BIPOC communities—utilize public spaces (Hoover and Lim, 2021). Future research could explore all of these relationships.

Several limitations associated with our distinct methodological approaches should also be noted. The term "park" was not defined for respondents on the self-reported surveys, and was therefore subject to different interpretations. Studies have shown that many members of the general public know very little about parks, and often conflate them with—or exclude them from—other types of recreation facilities (Spotts and Stynes, 1984). However, we specifically asked about use of five different types of park facilities in our survey, which should have minimized confusion. The one type of park facility emphasized in this analysis (i.e., open space and trails) was the only one that remained open in NC throughout most of the pandemic, but future studies could explore use of other types of park facilities as they reopen. Recall bias might have impacted self-reported park use frequency before the pandemic. However, researchers are increasingly using retrospective pre-post designs like the one we employed to effectively measure changes in outcomes over time when a baseline measure does not exist (Geldhof et al., 2018). Additionally, it is possible that Qualtrics online survey takers did not accurately reflect the general population in NC, but other studies have shown Qualtrics panelists effectively served as representative samples at the state and national levels (Boas et al., 2020).

With respect to cell phone data, all of the typical limitations of geo-tracking apply, with certain groups such as older residents less likely to be represented (Coston et al., 2021). Overall, although only 10% of urban residents are represented in SafeGraph data, the company's sampling is highly correlated with true census populations (Kang et al., 2020; SafeGraph, 2021b). Our filtering process only focused on POIs with "park" in the title, which might have inadvertently excluded certain types of public recreation resources, such as greenways. Thus, some forms of park use might have been overlooked due to SafeGraphs's imperfect classification system (Jay et al., 2021). Because we used the number of visits, there could be repeated data representing multiple visits a day from the same user at a park POI. We were not able to discern if the park user traveled from outside the local census tract to visit the park. If this was the case, then a park visitor may not necessarily reflect the demographic characteristics of the neighborhood in which a park is located. However, studies have shown that most urban park users live within close proximity to the parks they visit (Kaczynski et al., 2014; Moran et al., 2020). Cell phone location data may be less readily available in socially vulnerable communities, leading to underestimates of park visitation in these neighborhoods using Safegraph data. Even if this were true, however, the relative change in park use before and during COVID-19 should not have been significantly impacted. Finally, future research could dissect the somewhat unexpected finding that more parks in an urban census tract resulted in a greater likelihood of declining park visits during the pandemic. This could mean that quality is more important than quantity when predicting park use (Rigolon, 2016), or that numerous smaller parks may be viewed as more risky and less appealing during COVID-19 when compared to larger parks where physical distancing is easier to achieve (Mateer et al., 2021).

CONCLUSION

Despite many reports indicating urban park use increased during the COVID-19 pandemic, our survey and geo-tracking of the general public in cities across NC, USA, suggest this was not the case. Not only did urban park use in NC decline during the pandemic, but it became more homogenous. The same individuals and communities more likely to visit parks before COVID-19, white and high-income residents, were even more likely to use parks during the pandemic. Results expose broad concerns about urban park use (and subsequent health impacts) during the COVID-19 pandemic and raise additional questions about how those negative impacts might be inequitably distributed across diverse communities. Our findings underscore the need for more research on urban park use and associated benefits during the pandemic, and they highlight the importance of planning, managing, marketing, and investing in public park spaces that serve all segments of society.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board of North Carolina State University (IRB 21141). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

LL and JB are the principal investigators of the study and oversaw conceptualization of the study, funding acquisition, and survey instrument design. KJL, JC, KS, JAH, LM, MC, and MW helped develop the study protocols. ZZ, JO, and WB led the analysis of primary and secondary data, with input from LL and SO. LL and ZZ led the writing of the original manuscript draft, and including data visualizations. All authors contributed to the final draft of the article and approved the submitted version.

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Mechanisms of Intergenerational Environmental Stewardship Activated by COVID-19: Gratitude, Fairness, and Legacy Motives

Stylianos Syropoulos[1]* and Ezra M. Markowitz[2]

[1] Department of Psychological and Brain Sciences, University of Massachusetts Amherst, Amherst, MA, United States,
[2] Department of Environmental Conservation, University of Massachusetts Amherst, Amherst, MA, United States

The COVID-19 pandemic has caused an immense loss of human life, increased economic uncertainty, and negatively impacted individuals' mental health and close relationships. At the same time, experts have noted a concurrent improvement in many environmental quality indicators, including significant decreases in both localized air pollution and global greenhouse gas emissions. These positive trends are due to changes in human behavior necessitated by social distancing and self-quarantining measures (e.g., reduced car and air travel). However, there is already evidence that these improvements in environmental quality are only temporary. This suggests that more intentional efforts will be necessary in order to maintain positive environmental benefits and address major environmental issues as the world gets back to some version of pre-pandemic economic and social activity. Still, our collective experience over the course of the pandemic provides clear evidence that such change is possible and on a rapid timetable. Our individual and collective responses to COVID-19 reveal that we do indeed have the ability to respond to novel societal threats in highly coordinated and effective ways, suggesting that confronting the existential threat of climate change may in fact be feasible. Here, we theorize that the COVID-19 pandemic has potentially activated and made more salient some key psychological mechanisms—including norms of fairness and reciprocity, feelings of gratitude, and consideration of personal legacies—that previous empirical work suggests can be harnessed to promote beneficent intergenerational decision-making aimed at solving the environmental challenges we and our descendants will face in the twenty-first century.

Keywords: COVID-19, climate change, gratitude, legacy, fairness

INTRODUCTION

Near the end of 2019, a new coronavirus spread rapidly around the globe, causing an epidemic of acute respiratory syndrome (COVID-19). Within a few months (i.e., by March 11, 2020) the World Health Organization (WHO) declared the spread of the virus a global pandemic (World Health Organization, 2020). At the time of this writing (May 2021), a year after the declaration of the pandemic, COVID-19 has infected more than 200 million people globally, resulting in

more than 4 million deaths (Johns Hopkins University, 2021). The COVID-19 pandemic has also generated unprecedented uncertainty in the global economy by disrupting supply chains, decreasing consumer demand for many goods and services, and increasing unemployment across the globe (Wagner, 2020). The pandemic has also negatively influenced mental health at a massive scale, increasing depression and stress worldwide (Talevi et al., 2020). Personal relationships have also been subjected to increased stressors (Goodwin et al., 2020; Pieh et al., 2020; Pietromonaco and Overall, 2020).

At the same time, experts have noted a concurrent improvement in many environmental quality indicators over the past year, including significant decreases in both localized air pollution and global greenhouse gas emissions. These positive changes can be traced directly to the economic and social impacts COVID has had on society, largely due to changes in human behavior necessitated by social distancing and self-quarantining measures (e.g., reduced car and air travel). Thus, at the same time that COVID has imposed a massive new threat and stressor on humanity it has also revealed that large-scale, bottom-up and top-down changes in the structure and functioning of society can occur extremely rapidly under certain conditions. This insight holds critical implications in the fight against anthropogenic climate change.

CLIMATE CHANGE AND COVID-19

A recent perspective elucidates the connection between climate change and the COVID-19 pandemic (Barouki et al., 2020). In it, the authors discuss that ever-increasing populations, rapid urbanization, large-scale destruction of natural habitat, and growing consumption all combine to increase societal risk for the spread of zoonotic pathogens (Plowright et al., 2017; Gibb et al., 2020; OECD, 2020). Extant research has highlighted that climate change can contribute to the spread of epidemics, as it can impair biodiversity and damage natural habitats (Boissier et al., 2016; Bartlow et al., 2019; Caminade et al., 2019; Ryan et al., 2019). Climate change can also increase air pollution, another factor contributing to pathogen emergence (Karan et al., 2020; Woodby et al., 2020). In fact, some researchers have found evidence for a positive association between air pollution and increased transmission rates of COVID-19 (Ali and Islam, 2020). Further, scholars have pointed out several compounding environmental factors that could increase the spread of the pandemic (Phillips et al., 2020).

It is clear, then, that climate change and the destruction of natural environments are intertwined with the COVID-19 pandemic. It is almost ironic, then, that the spread of the pandemic has actually led to some unexpected positive outcomes for the environment. Researchers have noted a significant, if likely short-lived, reduction in daily global CO_2 emissions over the course of the pandemic, a result in part of social distancing and self-quarantining measures that restrict movement (e.g., Forster et al., 2020; Le Quéré et al., 2020). However, these changes are likely temporary if a post-pandemic world is not carefully planned for in advance; for durable, meaningful change

to occur a more systematic and consistent effort is required (Forster et al., 2020). Below we discuss how three psychological factors likely made more salient and powerful by the pandemic—fairness, gratitude, and legacy motives—could be harnessed to help promote that durable and much need change to confront long time-horizon environmental challenges like climate change.

PSYCHOLOGICAL IMPACTS OF COVID-19

Starting in early 2020, the COVID-19 pandemic upended people's lives across the globe. Since then, it has become increasingly clear that in addition to changing our patterns of consumption, travel, and interpersonal interaction, the pandemic has also had a massive, multifaceted, and complex impact on mental health and psychological functioning more broadly. In addition to the direct stress imposed by both actual illness and the sustained threat of potential illness (and death), the experience of living through the pandemic has also had subtler effects on a wide diversity of psychological dimensions and forces that, in turn, shape our understanding of the world and daily decision-making. For example, past work on mortality salience suggests that being bombarded with constant reminders of one's own mortality—a common experience over the course of the pandemic for most individuals—likely activates a slew of psychological mechanisms that have evolved to protect our mental well-being in the face of mortal threat (Pyszczynski et al., 2021).

Of particular interest here is the potential effect of the pandemic on activating and making particularly salient three core psychological mechanisms that have previously been shown to promote both prosocial behavior between contemporaries as well as intergenerational prosociality: (1) norms of fairness and reciprocity (e.g., Wade-Benzoni, 2002; Wade-Benzoni et al., 2008); (2) feelings of gratitude toward others (e.g., Ma et al., 2017; Watkins and Goodwin, 2020); (3) and endorsement of a personal legacy motive (e.g., Zaval et al., 2015; Syropoulos and Markowitz, 2021). All three of these mechanisms have been linked with willingness to engage in prosocial and pro-environmental behavior, largely through their positive effects on generating a durable (and intertemporal) sense of responsibility toward others (Wade-Benzoni, 2002; Wade-Benzoni and Plunkett-Tost, 2009). In the sections that follow, we first highlight how each psychological factor has been activated by the pandemic. We then elucidate the important role that each factor plays in promoting intergenerational environmental stewardship. Finally, we conclude by discussing potential avenues for future scholarship and practice focused on promoting intergenerational environmental stewardship including some interventions that could be employed utilizing these psychological mechanisms.

FAIRNESS

The COVID-19 pandemic has laid bare the vast inequalities that exist in contemporary society. Although everyone is vulnerable to the disease itself, it is clear that the impacts of COVID-19 have been distributed in highly inequitable ways as a function of geography, class, race, and other sociodemographic factors. For

example, whereas job and income losses have mostly accrued to lower-class workers (Bottan et al., 2020), billionaires have seen their wealth rapidly increase during the pandemic. In fact, the International Labour Organization (ILO) suggests that while the rich got richer, workers' income fell by $3.7 trillion (International Labour Organization, 2021). Aside from economic losses, lower socioeconomic status has also been linked with increased contraction of the virus as well as higher morbidity rates due to COVID-19 (Karmakar et al., 2021). Research also highlights racial disparities that have been highlighted by COVID-19 (e.g., people of color dying and being infected at a disproportional rate; Centers for Disease Control Preventions, 2020). COVID-19 did not create new inequalities out of whole cloth; rather, it revealed existing, structural, and massive inequalities that already existed pre-pandemic. One result is that the pandemic has likely elevated concerns about *fairness*, given the tight linkages between conceptions of fairness and inequality (Graham et al., 2009; Low and Wui, 2015).

Fairness is a moral foundation which pertains to altruism and reciprocity (Graham et al., 2009) and promotes prosociality even at the expense of the individual actor (Van den Bergh et al., 2006; Crone and Laham, 2015). Scholars posit that fairness is universal, and that moral evaluations of others rely on whether they are fair/unfair in their treatment of others (Haidt and Joseph, 2004). Fairness is particularly important in the context of intergenerational decision making, that is, situations in which present decision-makers make choices that affect future generations. Fairness and concerns about reciprocity within intergenerational dilemmas can be driven by egotistical motivations, which can bring about a breakdown in intergenerational stewardship (Wade-Benzoni et al., 1996, 2008). Importantly, fairness also drives intergenerational reciprocity (i.e., when present generations act toward the future based on how they perceive past generations treated them), which can lead to either beneficial or deleterious outcomes for future generations (Wade-Benzoni et al., 2008). In this manner, fairness in intergenerational decision-making processes can instill norms about fairness and reciprocity in future generations that will continue or at least maintain intergenerational stewardship.

Harnessing the newfound attention COVID-19 has placed on our considerations of fairness could prove influential for promoting concern for issues that rely on norms surrounding fairness and reciprocity, including climate change. Like COVID-19, climate change involves deep inequalities, especially across time (i.e., intergenerational inequality) because its most severe consequences will be experienced by future generations. Yet, like other issues that unfold over long time horizons, societal action on climate change is characterized by high levels intertemporal discounting, i.e., the tendency for individuals to discount the future value of harms and benefits relative to those experienced today solely based on the fact that they accrue at a future point in time (Frederick et al., 2002).

Research on efforts to combat temporal discounting has suggested that norms of reciprocity—which are tightly linked with perceptions and values of fairness—are crucial in this context (e.g., Wade-Benzoni and Plunkett-Tost, 2009). Wade-Benzoni (2002), for example, has emphasized that a

sense of fairness is a key motivator responsible for promoting reciprocity. Empirically, research has highlighted that being concerned about fairness directly translates to being altruistic in decision-making settings that involve exchange and/or helping (e.g., Graham et al., 2011; Nilsson et al., 2020).

We suggest that the powerful ways in which the COVID-19 crisis has made considerations of fairness and inequality particularly and widely salient reveals a possible opportunity to leverage this core prosocial motivation in the context of other fairness-involving issues such as climate change. The COVID-19 pandemic has made it clear that economic inequality and systemic racism are prominent in our societies, and that collective efforts are needed to address these issues. In a similar vein, equitable climate change action must be rooted in a collective conceptualization of fairness, particularly in an intergenerational fashion. Our actions today and in the near future directly affect future generations' exposure to climate-related risks (e.g., threats of extreme weather events, water and food shortages). Moreover, because future generations are not "at the table" in present-day negotiations over climate change, it is up to present generations to effectively advocate on behalf of future others. Promoting a sense of fairness may go a long way toward engaging individuals in collective efforts to preserve nature, understand the needs of the natural world, and engage in constructive intergenerational environmental stewardship.

The pandemic has demonstrated in a powerful way that humans are indeed capable of acting in a manner that emphasizes altruism and reciprocity (made evident by collective efforts to prevent the spread of the pandemic; e.g., Chan, 2021; Syropoulos and Markowitz, 2021). Building upon such collective efforts to prevent the spread of COVID-19 as well as the collective acknowledgment of the inequalities that have been emphasized as a result of the pandemic as a stepping stone for future endeavors could prove beneficial in promoting collective action efforts to mitigate the impact of climate change. This theorizing is in line with extant research which finds that of the five major moral foundations that influence decision making processes and moral judgement, concerns about compassion and fairness are the two most robust predictors of willingness to act to prevent climate change (Dickinson et al., 2016). Research on policy acceptance also supports this claim. In an experiment in which participants evaluated the acceptability of pro-environmental policies, ratings of how acceptable a policy was correlated positively with how fair each policy was perceived to be (Clayton, 2018). Another study utilizing data from a large-scale experimental survey found that in Germany, the U.S., the U.K. and France, public support for global climate change agreements was dependent on how prominently principles of fairness were featured (Bechtel and Scheve, 2013). In fact, a recent review of the literature also supports this theorizing, concluding that morality and notions of justice can promote cooperation within the context of climate change (Pearson et al., 2021).

Given these findings, behavioral interventions should strive to maintain an emphasis on fairness, while also ensuring that individuals have an accurate perception of whether their own decisions are fair (from a variety of perspectives, including intergeneratioanlly). From our childhood we rely on fairness

norms to inform our distribution of resources to others (for a review see Ruthland and Killen, 2016). Ensuring that these norms are upheld at later stages of life could thus prove beneficial. One potential avenue that could reinforce norms of fairness is the use of historical examples of fair and unfair treatment of (out)groups by the ingroup, with an emphasis on the consequences of these interactions. Such an example could instill a predisposition for fairness in future interactions by highlighting the benefits of engaging in fair treatment of a group as well as past injustices caused by the ingroup. Another intervention could focus on just/fair moral exemplars. This approach would focus on the use of individuals who throughout history were champions of justice, equality and fairness as examples that should be followed. Research on moral exemplars has shown that they are capable of influencing attitudes. For example, research in the field of intergroup relations has highlighted that the use of moral exemplars can promote intergroup reconciliation (for a review see Cehajić-Clancy and Bilewicz, 2020). Similarly, in the sphere of intergenerational decision making, utilizing examples of people who were fair in their distribution of resources could reinforce fairness norms, leading to a more equitable distribution of resources to future generations. As long as the historical examples and exemplars are utilized in ways that are not indoctrinating, such approaches could instill or maintain norms of fairness that are key in promoting fairness in intergenerational decision making.

GRATITUDE AND RESPONSIBILITY TO OTHERS

As with the spotlight that COVID-19 has shined on considerations of fairness, so too has it provided countless opportunities for people to experience gratitude, in ways both small and profound. Strangers and neighbors alike acting to help others in need, stories and images of everyday heroes working to save people's lives under terrible circumstances, recognition of the risks grocery store and other essential workers have taken every day in order to keep society fed and operating—all of these instances and more have helped many people feel a deep sense of gratitude throughout the course of the pandemic, despite all of the challenges it has presented. What's more, there is evidence that these feelings of gratitude help predict greater prosocial behavioral tendencies aimed at reducing the spread of COVID-19 (Syropoulos and Markowitz, 2021).

Gratitude is often described as "appreciation felt after one has been the beneficiary of an altruistic act" (Emmons and Crumpler, 2000, p. 56–57). From a theoretical perspective, researchers posit that gratitude seems to have evolved as a mechanism that promotes cooperation within and between groups (Trivers, 1971; Stellar et al., 2017). Gratitude often promotes altruism and helping behaviors, even at high personal cost to the actor (Bartlett and DeSteno, 2006). Increased gratitude, both as a disposition (i.e., trait) and as a transient, experienced emotion (i.e., state), predicts greater prosociality (Moss and Page, 1972; Buck, 2004; Harpham, 2004; Komter, 2004; Bartlett and DeSteno, 2006; DeSteno et al., 2010; Grant and Gino, 2010; Ma et al., 2017).

Further, research also highlights that gratitude also promotes reciprocity in helping behaviors (Froh et al., 2010; Emmons and Mishra, 2011).

Recently, researchers have found that gratitude is a key motivator of intergenerational stewardship (Barnett et al., 2019; Syropoulos et al., 2020). To the extent that people's experiences with COVID-19 may have increased trait-level gratitude and/or the salience of gratitude across a wide swath of the general public (see Fishman, 2020, for recommendations on how to harness gratitude during COVID-19), the extant research on gratitude as a motivator of intergenerational environmental stewardship (e.g., Syropoulos et al., 2020; Watkins and Goodwin, 2020) suggests there may be a new opportunity emerging to leverage these shifts to promote greater engagement and action on issues like climate change. The aforementioned instances of reciprocity and prosocial behaviors observed during the COVID-19 pandemic serve as instances during which gratitude toward the actors behind these actions is felt. Harnessing this gratitude as a tool for increasing prosociality, either through public campaigns or through individual practices, could prove effective in promoting intergenerational stewardship.

As alluded to earlier, climate change and COVID-19 are intertwined crises (at least to some degree). Thus, one could argue that to prevent such a pandemic in the future, and to ensure that we live up to the sacrifices that others have made for us already, it is our responsibility to protect the environment for the sake of future others. In fact, the primary psychological mechanism capable of increasing environmental stewardship that gratitude activates is its capacity to strengthen perceived responsibility toward future generations (Syropoulos et al., 2020; Watkins and Goodwin, 2020; Syropoulos and Markowitz, 2021). Given these connections, a potential avenue worth exploring is how the current generation is acting in a way that is grateful to its predecessors. Reinforcing such norms (i.e., valuing gratitude), or targeting people's felt gratitude toward those who have sacrificed to help others during the pandemic, may help promote concern for the environment by strengthening feelings of generativity and thankfulness which can help combat temporal discounting, a major obstacle to action on climate change and other long-term societal problems (Wade-Benzoni and Plunkett-Tost, 2009).

As noted above, much research has charted the prosocial effects of gratitude, with evidence also highlighting its ability to increase pro-environmental behaviors and attitudes (e.g., Syropoulos et al., 2020). Future interventions could thus utilize this psychological mechanism to reinforce altruistic intergenerational decision making. One avenue is elevating people's grateful disposition. Encouraging reflection for the people and things in one's life that an individual is grateful for could be prove to be impactful in this respect. Alternatively, another proposed mechanism is that of gratitude meditations (e.g., O'Leary and Dockray, 2015). By elevating people's grateful disposition, we would expect improved levels of mental health, prosociality, and, to an extent, charitable and pro-environmental behaviors. Alternatively, interventions with an educational focus could instead emphasize gratitude as a norm in our society. Feeling grateful toward the effort that past generations have exerted to ensure our well-being

could in turn promote our sense of responsibility toward future generations, an established predictor of intergenerational reciprocity (Wade-Benzoni and Plunkett-Tost, 2009) and of a host of pro-environmental attitudes (e.g., Syropoulos and Markowitz, 2020).

LEGACY MOTIVES

Perhaps most obvious of all is the impact COVID-19 has had on increasing the salience of our own mortality. Because the pandemic has led to an unprecedented loss of life, death has become salient to people, regardless of whether they believe that the impact of the virus has been exacerbated. In a recent article published by Pyszczynski et al. (2021), the authors highlight the psychological mechanism of terror management in response to the COVID-19 pandemic. The authors state that "the salience of death brought on by COVID-19 plays a central role in driving the attitudes and behavior of even those who believe that the dangers of the virus have been vastly exaggerated" (Pyszczynski et al., 2021). Research highlights that when faced with credible threats to one's own survival, some people react by denigrating messengers and denying the threat whereas others become more focused on living a good life with the time they have remaining (Zaleskiewicz et al., 2013). Further, researchers have found that one way in which individuals engage productively with their own mortality is to think about the positive legacies they can leave behind (Wade-Benzoni, 2019).

Broadly speaking, legacies are defined as "an enduring meaning attached to one's identity" (Wade-Benzoni and Plunkett-Tost, 2009, p. 183). A legacy motive, therefore, is the motivation to build a legacy that will last the test of time. Legacy motives have been revealed to be a powerful mechanism capable of reducing intertemporal discounting and promoting (intergenerational) environmental stewardship (e.g., Fox et al., 2010; Tost and Wade-Benzoni, 2013; Zaval et al., 2015).

Empirically, research has shown that concern for one's legacy is a robust predictor of proenvironmental attitudes. One study found that experimentally priming individuals to think about their legacy increased donations to environmental charities as well as strengthened their belief that climate change is a real phenomenon (Zaval et al., 2015). Another study found that regardless of the method employed to prime concerns about one's legacy, individuals who were primed to think about their legacy reported greater cooperation with future generations (i.e., reported less temporal discounting, a key obstacle of efforts to address climate change; Hurlstone et al., 2020). Further, there is evidence suggesting that legacy motives are independent (i.e., uncorrelated) of key antecedents of climate change skepticism, such as political ideology (Syropoulos et al., 2021).

One potential avenue that people can utilize to cope with the hyper salience of death brought about by the pandemic (i.e., mortality salience) is to focus on their legacies. Researchers have posited that "when people are primed with thoughts of death, their inherent desires to generate a positive legacy can transform the expected barriers to intergenerational beneficence (i.e., social and temporal distance) into conditions that promote beneficent allocations to other people in the future." (Wade-Benzoni et al., 2012, p. 704). By actively working toward establishing a positive legacy, individuals can first and foremost think about their mortality in constructive way. Further, they can honor the sacrifices of those dear to them (supported by recent evidence highlighting a positive association between gratitude and heightened legacy motives; Syropoulos and Markowitz, 2021). In addition, they can strive to act in a way that promotes intergenerational stewardship, ensuring that future generations do not have to face the same adversity that they have (Wade-Benzoni et al., 2012).

Climate change has been a persistent threat that has been met with inaction as present generations are not facing the worst of its consequences. However, because of the COVID-19 pandemic, we now have a clear example of how not rising up to the challenge of a collective threat as soon as possible, can impact our society as a whole. We have seen that humanity can stand together and unite against major threats to our existence. Being concerned with one's legacy, and actively working toward establishing a positive legacy, can aid a great deal in these efforts. Those who are concerned about their legacy engage in more conservation behaviors in their daily life, are more accepting of and concerned about climate change, and engage in greater environmental movement activism (Syropoulos et al., 2021). Crucially, those primed to think about their legacies expend more personal resources toward climate change for the sake of future generations (Zaval et al., 2015; Hurlstone et al., 2020; Shrum, 2021). Thus, by promoting legacy motivation as an avenue of dealing with one's own perceived mortality, we could engage people in the issue of climate change and increase our efforts toward reducing our contributions to its impacts on our planet.

Experimental research on legacy motives has found that asking individuals to reflect on their personal legacy in different ways (e.g., Zaval et al., 2015; Bang et al., 2017; Hurlstone et al., 2020; Shrum, 2021) activates a domain-general legacy motivation, thus increasing how much individuals think about future generations. In fact, evidence by Bang et al. (2017) suggests that this legacy induction is even capable of overcoming the tendency to act selfishly in an intergenerational decision making context, even when past generations acted selfishly. However, it is also important to note that these manipulations induce a general legacy domain but not more fine-grained and specific legacy motives such as motives focusing on the impact of an individual or efforts to establish a good reputation (Syropoulos et al., 2021).

We recommend two avenues for interventions focusing on legacy motives. One is the use of a legacy diary or the creation of a letter to one's future self (e.g., Shrum, 2021). In the case of the legacy diary, asking individuals to reflect daily or weekly on their efforts to establish a prosocial legacy, as well as on their success in meeting this goal, could potentially prolong the effects observed in the aforementioned studies which induced legacy motives by means of reflecting on one's legacy. The latter attempt (i.e., letter to one's future self) would act in a similar way and is in line with past literature on the positive effects of goal-setting on behavior change. Individuals could write monthly or yearly letters to their future selves, setting reasonable and attainable environmental goals (e.g., recycling more; reducing the use of

electricity), and read those letters in the future to re-activate their legacy-building motives. Alternatively, the use of advertisements that aim to increase support for proenvironmental policies or movements should attempt to leverage existing legacy motives that most people hold. Framing such a policy or movement as a means to create a lasting legacy could increase support toward the set goal. Individuals who are concerned about their legacy would potentially be inclined to lend their support. In turn, these individuals could serve as moral exemplars for other people, creating a cycle of public support for proenvironmental causes (e.g., Han et al., 2017).

CONCLUSION

The coronavirus pandemic has been, without a doubt, a universal crisis of unprecedented proportions. Despite all of the aforementioned destructive consequences that the spread of the coronavirus has resulted in, hope emerges from two positive outcomes. First, humanity has largely come together as a whole and responded to the virus effectively, both at the micro and local scales and more broadly. Nearly all countries have passed legislation to help their citizens confront the fallout of the pandemic, people have volunteered huge amounts of time, money and other resources to help those in need, inspiring stories have emerged around the world about people's selfless efforts to help one another, and scientists have produced several highly-effective vaccines within the span of just 1 year to help bring the pandemic under control. These and so many other efforts over the past year make evident that as a global community we are capable of acting in unison for the collective good when faced with a global threat. And second, because of our virus-imposed confinement and reduction in travel, there have been significant, if likely short-lived, improvements in global sustainability indicators, particularly those tied to air quality and greenhouse gas emissions (Forster et al., 2020; Le Quéré et al., 2020).

At the same time, the COVID-19 pandemic has also, we argue here, activated and made more salient three key psychological mechanisms in individuals that hold important implications for addressing other pressing societal challenges, including climate change. By highlighting the inherent inequalities that reside in societies, norms focusing on fairness were reinforced. Through their personal actions, the sacrifices of moral exemplars, and the inherent moral emotions that individuals exhibited during the pandemic, the emotion of gratitude as well as our sense of responsibility toward others may have been made more salient and concrete. And as death has become a collective, vivid experience for so many, attention has been drawn to our own mortality and the legacies we want to establish.

Climate change is an existential and realistic threat that we are facing as a species. The increased number of droughts, heat waves, and hurricanes will continue to deteriorate our natural habitat, cause the loss of human and animal life, and damage economies worldwide. Similar effects from flooding are expected due to the rise in sea levels, increased melting of large ice masses around the globe, and changes in precipitation patterns. Even

though concern about climate change has increased globally, with roughly 70% of people perceiving climate change as a major threat (Fagan and Huang, 2019), another 30% still considers climate change a minor threat or no threat at all. Increasing recognition of climate change as a clear and present danger may not be sufficient to promote proactive action, but it can support positive engagement moving forward.

The window to spur into action is closing, and in the near future the negative consequences of climate change may be rendered largely irreversible (United Nations General Assembly, 2019). Changes are needed both at the micro (i.e., individual) and macro (i.e., collective) levels. Moreover, when engaging in efforts to enact such change, regardless of whether such efforts are targeting individuals, organizations, or entire systems, it is important to consider that climate change is an issue that is deeply interconnected with essentially all other major social issues of our time (Islam and Winkel, 2017), including inequality, justice, health and prosperity. As such, there are many paths that can and will need to be taken in order to address the complex web of threats posed by climate change, only some of which need to directly target "climate change" itself; many other approaches will indirectly support the conditions necessary to bring climate change under control through their targeting of other major societal challenges we face. For example, addressing major educational inequalities and focusing on efforts to promote social justice and economic equality can ensure that more people are in a position to advocate on behalf of themselves and future others in the context of climate change, and are financially capable to engage pro-environmental and conservation behaviors that could reduce their carbon footprint. Given the scope of the challenge we collectively face, we must search for and embrace these indirect paths at least as strongly as we do more direct approaches to confronting climate change.

We believe that the three psychological mechanisms we have highlighted are crucial for efforts aimed at increasing individuals' and society's willingness to confront other looming, global threats to humanity (and other species), including the existential threat of climate change. Amid the terrible death and destruction caused by COVID-19, we see a glimmer of hope that these powerful motivators of prosocial behavior—fairness, gratitude and legacy making—might be newly renewed in their salience, personal relevance, and power to promote collective action to confront the threat of climate change that humanity faces in the coming decades.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

SS conceived the theoretical framework of the perspective and wrote the manuscript. EM offered feedback and revisions to the manuscript. Both authors contributed to the article and approved the submitted version.

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Building Adaptive Capacity Through Civic Environmental Stewardship: Responding to COVID-19 Alongside Compounding and Concurrent Crises

Laura F. Landau[1]*, Lindsay K. Campbell[2], Erika S. Svendsen[2] and Michelle L. Johnson[2]

[1] Department of Geography, Rutgers University, New Brunswick, NJ, United States, [2] USDA Forest Service Northern Research Station—New York City Urban Field Station, New York, NY, United States

A growing body of community resilience literature emphasizes the importance of social resources in preparing for and responding to disturbances. In particular, scholars have noted that community based organizations and strong social networks positively contribute to adaptive capacity, or the ability to adjust and respond to change while enhancing the conditions necessary to withstand future events. While it is well established that strong civic engagement and social networks contribute to enhanced adaptive capacity in times of change, there is more to learn about how adaptive capacity at the civic group and network level is impacted temporally by multiple and compounding crises. Research has shown that the ability for communities to adapt and respond to crisis is closely tied to longer term recovery. In the midst of the COVID-19 pandemic, which has overlapped and intersected with multiple additional climate crises as well as a reigniting of the ongoing American reckoning with racial injustice, the ability for communities to adapt and respond to compounding crises seems more crucial than ever. This paper uses qualitative data from semi-structured interviews with 34 civic environmental stewardship groups in New York City to explore their role in building adaptive capacity. In order to better understand how past crises have impacted stewardship groups' response to COVID-19, we focus on how groups have demonstrated flexibility and learning at an organizational scale. We look at two other crises, both acute (Superstorm Sandy, which hit the East Coast in 2012) and chronic (systemic racism) to identify instances of learning that lead to organizational transformation. We further aim to understand how group professionalization, measured by budget and staff size, and network connectivity impact their actions. By comparing the groups' experiences and responses to each event, we uncover strategies learned from past events (e.g., sharing contact lists, holding internal dialogues, leveraging new funding sources) that enable stewardship groups to respond to disaster in a way that builds their organizational adaptive capacity as well as contributes to the long-term resilience of their communities.

Keywords: adaptive capacity, environmental stewardship, crisis, systemic racism, community resilience

INTRODUCTION

Stewardship groups play a key role in the ongoing care of the urban environment. In addition to providing care and everyday maintenance of green and blue spaces, stewards participate in managing, monitoring, conserving, transforming, educating on and advocating for their local environments, becoming essential actors in resilience planning and climate adaptation (Landau et al., 2019; Campbell et al., 2021). This paper focuses on the general adaptive capacity of civic environmental stewardship groups, taking into account the local context and the varied resources available to New York City's communities. The term adaptive capacity has been widely used in the understanding of natural resource management and group level response to disturbance. As social-ecological actors in the city, stewardship groups span these contexts and play a unique role in building adaptive capacity. By looking at how these groups respond to disaster, we hope to identify examples of how adaptive capacity is created and fostered at the civic scale.

We use New York City as a study area to examine stewardship groups in the context of compounding crises. By Spring of 2020, New York City was seen as the epicenter of the COVID-19 pandemic in the US (Thompson, 2020). Though the pandemic spanned geographic boundaries, and in fact later hit the rest of the United States just as hard, for a moment in time it was acutely felt as a New York City crisis. The high case numbers and death rate, combined with the density of city life, led many New Yorkers to flee the city to summer homes and rentals in surrounding suburban and rural areas (Krauth, 2020). Others reflected on past disasters in New York City as evidence for the importance of staying put and contributing to the city's response and recovery (Paybarah et al., 2020). At the same time, this crisis did not occur in a vacuum—it operated in a societal and historical context that includes other concurrent disasters as well as prior disturbances. For New York City residents and stewards, the memory of Sandy still looms large. Superstorm Sandy hit the East Coast of the US on October 29th, 2012, killing over a hundred American residents and leaving nearly $70 billion dollars in damage (FEMA, 2013). New York City was among the hardest hit places, with millions losing power and access to communication and transportation systems. Following the storm, federal aid poured in from FEMA and HUD, leading municipal leaders to name new offices and departments to handle funding allocation and recovery projects, including the New York Governor's Office for Storm Recovery and the New York City Mayor's Office of Resiliency. Since Sandy, discourse around community resilience, multi-sector governance, and co-production have emerged even stronger in disaster literature and in government agencies, especially with regard to the growing threat of climate change (Grove, 2018).

The impact of climate change, evident in the neighborhoods hit hardest by Superstorm Sandy, disproportionately falls on low-income communities of color (Wilson et al., 2020). Similarly, COVID-19 is shaped by the racial inequities inherent in our society. It is no coincidence that as of March 2021, Black, Indigenous, Hispanic and Latino, and Pacific Islander Americans have suffered the highest COVID related death rates (CDC, 2020;

APM Research Lab, 2021). The systemic racism that undergirds our society represents its own crisis. The police murder of George Floyd and the subsequent protests of 2020 highlighted this racial injustice and forced many, including environmental stewardship groups in New York City, to respond (Osaka, 2020). Rather than treat climate change, COVID-19, and racial injustice as separate phenomena with distinct patterns of response and recovery, we view them as interconnected, compounding, and cascading crises (Felsenstein et al., 2020; Hoover and Lim, 2020; Liebman et al., 2020), all with roots in environmental injustice (Wilson et al., 2020). We aim to better understand how environmental groups learn and adapt in the context of multiple intersecting crises.

While civic groups are well established as key actors within environmental governance networks (Connolly et al., 2013), less is known about how they are impacted by compounded events or how these organizations and networks evolve temporally. Felsenstein et al. (2020) write about COVID-19 in the context of cascading disasters, which contribute to a domino effect of natural and human impacts and require new research approaches. COVID-19 complicates the recovery from concurrent social and environmental disturbances (Quigley, 2020), requiring innovative and emergent responses. Yet much of the hazards literature fails to meaningfully engage with the root causes of the uneven impacts of disaster (Wisner, 2019). This paper attempts to fill this gap by evaluating the literature on adaptive capacity in the context of natural resource management and environmental stewardship, and examining a network of environmental stewards over time and identifying how responses to multiple crises (both acute and chronic) impact adaptive capacity. We find that civic environmental groups contribute to adaptive capacity following disturbance through examples of learning and flexibility.

Adaptive Capacity and Natural Resource Management

In order to understand the potential role of stewardship groups in response to crises, we first provide a brief overview of the literature on resilience, vulnerability, and adaptive capacity as it relates to natural resource management. Researchers studying the impact of disasters on human populations often use the term resilience to capture the ways in which—and the degree to which—communities adequately prepare for, respond to, and adjust to disturbances (Cutter et al., 2008; Aldrich and Meyer, 2015). Vulnerability is one key factor that is fundamental in determining how communities are impacted by disaster. There are many definitions of vulnerability in the field of disaster research, but most explanations share the understanding that vulnerability involves the susceptibility of a community to disaster (Adger, 2006; Zakour and Gillespie, 2013; Kelman et al., 2016). Blaikie (1994) define vulnerability as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard." (p. 9). This concept helps bridge the natural with the social, as "Vulnerability ties general political economic conditions to very particular environmental forces to understand how basic

conditions such as poverty or racism produce susceptibilities to very specific environmental hazards" (Oliver-Smith, 2009, p. 14).

Adaptive capacity is a more specific way to consider the ability of a system to cope with change (Smit and Wandel, 2006). The term adaptive capacity is closely tied to resilience, though there is not a universal understanding of the relationship between the two. Some scholars frame adaptive capacity as an indicator of vulnerability, where vulnerability is a function of exposure to a threat and the sensitivity to that threat, offset by the adaptive capacity of a system (Gupta et al., 2010). Other definitions of adaptive capacity are nearly interchangeable with common definitions of resilience. For example, Cutter et al. (2008) define resilience as including "those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social system to re-organize, change, and learn in response to a threat" (p. 599). The authors similarly define adaptive capacity as including the ability to adjust and cope with change (p. 600). Still others place adaptive capacity within their definitions of resilience. Meerow (2016) define urban resilience as including the ability to "quickly transform systems that limit current or future adaptive capacity" (p. 39). In the same piece, they propose that in a constantly changing environment where nothing is ever static, definitions of urban resilience should prioritize the ability to continually evolve: "...building resilience hinges on general flexibility and adaptability (denoted by "adaptive capacity" in the definition), rather than becoming highly adapted to specific threats" (Meerow, 2016, p. 46). Considering the context of compounding crises, we adopt this definition in which adaptive capacity is highlighted as the innate ability to handle any number of threats and changes. This trait is both reactive and proactive— reactive in that adaptive capacity allows a system to respond to change, and proactive in that a system can learn to better adapt to its environment in order to cope with future uncertainty (Dressel et al., 2020).

Scholars studying natural resource management have increasingly adopted a social-ecological systems approach that integrates the human dimension of climate adaptation described above into the on-the-ground management of environmental resources. In this perspective, community-based natural resource management (CBNRM) is widely acknowledged as a best practice (Ostrom, 1990; Armitage, 2005). CBNRM encourages a shared model of decision making that involves all resource users, including local stakeholders and community-based groups. Ideally, a CBNRM model addresses both environmental and socio-economic goals, shifts at least some decision-making power to the community, addresses issues of access to and control of the resource in question, and balances the concerns of multiple actors that may not always have common goals, such as equity and conservation (Armitage, 2005). Commons theorists, most notably Eleanor Ostrom, suggest that common pool resources are best managed in a polycentric governance system, and require the inclusion of local decision makers supported by, and working in cooperation with, larger government entities (Ostrom, 1990, 2010). Polycentric governance structures that include local representation are viewed as more equitable as well as more nimble (Morrison et al., 2019), but more information

on how these local groups function is needed in order to better understand how they contribute to the governance system in times of disturbance.

Despite the many benefits of polycentric governance, it remains unclear why some CBNRM models are more successful than others. In his 2005 paper, Armitage looks at adaptive capacity as a possible answer to this question. He defines adaptive capacity as the "ability to experiment and foster innovative solutions in complex social and ecological circumstances" (Armitage, 2005, p. 704). He builds off of Folke et al.'s (2005) paper highlighting four key processes that build resilience and adaptive capacity in social-ecological systems: learning to live with change and uncertainty, nurturing diversity for reorganization and renewal, combining different types of knowledge for learning, and creating opportunity for self-organization (p. 355, Table 14.1).

Dressel et al. (2020) echo the trend toward co-management in building adaptive capacity, but question the best model of governance within a community-based management context. The authors use a case study of a community-based moose management effort in Sweden to look at the perceived adaptive capacity across scales of governance. They argue that while different levels of governance can impact one another, adaptive capacity should be present at all levels, and both vertical and horizontal linkages can help create cohesion across the system. This finding highlights the need to analyze the stewardship system as a whole, from the small informal block associations to the larger private-public partnerships that help link community needs to government entities (see also Svendsen and Campbell, 2008).

Social Capital and Organizational Capacity

The emphasis on *people* in definitions of adaptive capacity is found across the literature, often described as a social concept that depends on the ability of people to work together, mediate challenges, and invent new solutions (Armitage, 2005). Cinner et al. (2018) define adaptive capacity as "the conditions that enable people to anticipate and respond to change, to minimize the consequences, to recover, and take advantage of new opportunities" (p. 117). Adger (2003) writes that understanding the human response to climate change requires examining more than just the cost and benefits of specific adaptations, but "the social acceptability of adaptation options, the institutional constraints on adaptation and the place of adaptation in the wider landscape of economic development and social evolution of societies into the future" (p. 30). This acknowledgement of the human dimension of climate adaptation draws from literature on social vulnerability and social-ecological systems (SES). An SES approach to resilience honors the role of the human, both in contributing to anthropogenic climate change and in managing the resulting crises. Adaptation is key in this process, as Folke et al. (2005) note: "In a social-ecological system with high adaptability, the actors have the capacity to reorganize the system within desired states in response to changing conditions and disturbance events" (p. 444).

Indicators for adaptive capacity in the social context include social capital and collaboration (Adger, 2003). Social capital,

broadly understood as the beneficial outcomes of social relationships, can be further broken down into three categories: *bonding social capital*, or the ties between kin that are often based on a shared identity or locality; *bridging social capital*, the loose relationships and networks that connect people across race and class lines; and *linking social capital*, the connections between local community members and those with political power (Aldrich and Meyer, 2015). Each of these can contribute to adaptive capacity, but they should be somewhat balanced for the optimal impact. Too much bonding social capital, for instance, can create the feeling of exclusivity, and a lack of linking social capital can place a burden on a local community while alleviating government responsibility. Dressel et al. (2020) find that "linking social capital towards decision-making levels will heavily influence actors' risk perception and adaptive behavior" (p. 95). Adger (2003) recommends a model of context-specific "synergistic social capital" (p. 43), where the government works with local community members to enhance adaptive capacity and manage risk. Cinner et al. (2018) note that tactics to enhance social capital at the organizational level include building and strengthening networks, incentives for community volunteering/participation, and co-management tactics like community meetings. Community organizations such as stewardship groups have the ability to enhance bridging social capital by fostering the kind of reciprocal loose ties that build local trust, as well as form relationships with those in power (Aldrich and Meyer, 2015; Campbell et al., 2021).

Adaptive capacity has also been studied at the institutional and group scale. Here, we use Gupta et al.'s (2010) definition of institutions as not only organizations themselves but "the social rules that both constrain and empower social actors" (p. 468). Adger (2003) cautions that while institutions can help to build trust and social capital, two key social indicators of adaptive capacity, they can also be harmful and make vulnerable groups more vulnerable if they exist within systems of oppression. In fact, many of the major organizations that are tasked with post-disaster recovery work, such as FEMA and the Red Cross, have fixed regulations about which groups of people they serve that exclude the most marginalized (Dawson, 2017). In this way, institutions, according to Gupta et al. (2010), are inherently both conservative and reactive. The authors define the adaptive capacity of institutions as including both the characteristics that allow society to cope with climate change, and the ability for the institution itself to change in order to become better equipped to cope.

It is well established in the literature that civic groups and social networks play a key role in climate adaptation and resilience. The role of social capital, particularly linking social capital in natural resource co-management networks, has been shown to support desirable outcomes in post-disaster scenarios (Marín et al., 2015). Graham et al. (2016) found that following Superstorm Sandy, the civic infrastructure laid by community based organizations (CBOs) on the Lower East Side of Manhattan made the community better able to mobilize and respond to disaster needs than a demographically similar neighborhood lacking the same civic organizing. Stewardship groups are also a key part of this civic infrastructure. Some stewardship groups

are CBOs, but they also exist at multiple scales in the governance system, from small groups of local actors, to mid-size non-profit organizations, to full on institutions that function alongside city agencies as quasi-governmental actors (Fisher et al., 2012; Fisher and Svendsen, 2014). McMillen et al. (2016) identified five indicators of social resilience operationalized by urban environmental stewardship, including social cohesion, social networks, and knowledge exchange—each of which shows up in the adaptive capacity literature as well. These indicators support the argument that stewardship groups are uniquely positioned to respond to disturbance.

Indicators for Adaptive Capacity: Learning and Flexibility

The adaptive capacity literature centers a few prominent indicators, including trust, access to financial and human resources, institutional diversity, ability to improvise, and collaboration (Adger, 2003; Folke et al., 2003; Armitage, 2005). In addition to a focus on the material and social resources that prove important to a group's general capacity and ability to function, learning and flexibility are key concepts that capture the processes that enable groups to best adapt to shifting circumstances. Learning shows up in the literature in a number of ways. Armitage argues that in a CBNRM context, there are a number of prerequisites that enhance a system's ability to adapt, including "…learning through uncertainty and crises, learning from mistakes in practice, maintaining a collective memory of experiences with resource management, linking different knowledge systems to support learning and adaptation, and collaborating and power sharing in order to promote tight feedback loops and maintain institutional and organizational diversity and redundancy" (p. 707). Learning here happens in the context of prior experiences. Some scholars further break down learning into single-loop and double-loop learning. Plummer and Armitage (2010) describe single-loop learning as simply modifying practices, while double-loop learning addresses the core beliefs and assumptions behind the practices, and leads to more holistic transformation. Fostering double-loop learning requires diverse types of knowledge and drawing on networks of trust and reciprocity (p. 13). Both types of learning are important, particularly following a crisis. According to Cinner et al. (2018), "Instrumental single-loop learning only informs and changes the most immediate technical operations (for example, turning on the air conditioner in a heat-wave), while deeper double-loop learning may change governance procedures at the organizational level (for example, local green infrastructure planning), and even overarching values and norms at the policy and paradigmatic levels (for example, reduction of carbon emissions at a societal level)" (p. 120). Double-loop learning occurs over longer time spans, making it an important indicator when looking at how groups continue to learn from and respond to past events.

Flexibility is similarly key in understanding how environmental groups adapt to change (Carpenter and Brock, 2008). Unlike some of the other indicators in the literature, flexibility is sometimes used as a parallel concept to adaptive

capacity (Smit and Wandel, 2006), where flexibility encompasses the many traits and characteristics that allow a system to evolve. It also shows up in the literature as room for change (Cinner et al., 2018) and improvisation (Gupta et al., 2010). Returning to Meerow's (2016) definition of resilience, we see that general flexibility is used as a stand-in for adaptive capacity, and is considered key in being able to respond to multiple threats. Highly flexible groups are better able to respond to climate change (Cinner et al., 2018), and flexibility is considered an important trait in ecosystem management when dealing with uncertainty (Folke et al., 2005). Folke et al. (2005) also show that flexibility is closely tied to the literature on social capital, and is supported by informal social networks. In defining adaptive co-management, they write that "The flexible structure allows for learning and ways to respond to and shape change" (p. 448). In this way, learning and flexibility are strongly linked in the literature. At the group or organizational level, Gupta et al. (2010) argue that "institutions should allow actors to learn from new insights and experiences in order to flexibly and creatively "manage" the expected and the unexpected, while maintaining a degree of identity" (p. 461). Hutton et al. (2017) build on Hatano and Ignaki's definition of an "adaptive expert" as someone who can not only adapt but explain the reasoning behind an adaptation, suggesting that a degree of knowledge and learning contributes to flexibility. Using these definitions, we see that learning and flexibility are part of the same cycle: flexible conditions can allow for learning, and learning from past experiences can lead to flexibility in social-ecological systems. In this paper, we aim to understand how this cycle of learning and flexibility occurs in the context of past and concurrent crises. We focus on both of these key indicators, aiming to identify examples of each in order to illustrate how civic stewardship groups contribute to adaptive capacity over time.

MATERIALS AND METHODS

This study builds on the 2017 New York City Stewardship Mapping and Assessment Project (STEW-MAP) (Landau et al., 2019). STEW-MAP is a research methodology and set of tools to understand civic environmental stewardship groups. Data for STEW-MAP are collected through an organizational survey that includes questions about group history, mission, stewardship actions, organizational networks, and geographic territory. STEW-MAP defines a stewardship group as two or more people with a group name working toward a shared mission of managing, monitoring, conserving, transforming, educating on, or advocating for the local environment (Campbell et al., 2019). Although many stewardship groups are registered 501(c)(3) non-profit organizations, others are groups of neighbors working with no budget and supported entirely by volunteers. In order to understand the differences between these types of groups, we classify them through budget and staff size to create a professionalization index between 1 (0–1 paid staff and small budget) and 5 (more than 11 paid staff members and budgets of $1 million or more) (Fisher et al., 2012). While there are multiple

TABLE 1 | Characteristics of stewardship groups interviewed.

Category	Distribution of groups interviewed (n = 34)
Stewardship network connectivity	• 14 highly connected groups • 11 named by other groups • 9 not named by other groups
Geographic territory size	• 9 citywide • 13 borough to neighborhood • 12 smaller than neighborhood
Territory inundated during Superstorm Sandy	• 27 yes • 7 no
Level of professionalization (see Fisher et al., 2012)	• 17 high • 9 medium • 8 low
Sampling strategy	• 21 in 2017 STEW-MAP dataset • 13 snowball groups

forms of civic capacity, measured through indicators from voting to volunteerism (Dewey, 1927; Krinsky and Simonet, 2017), we aim to focus on the group scale in order to understand how stewardship groups differ from one another in their ability to adapt and sustain their organizational mission. For the purpose of this paper, the terms "stewardship group" and "stewardship organization" are used interchangeably.

In 2019, in depth, semi-structured interviews were conducted with 26 STEW-MAP respondent groups (Robinson, 2014). Interview subjects were randomly chosen through a sampling design that looked at size of geographic turf (small, neighborhood, citywide and larger) and the degree of network connectivity (not named within the network, moderately connected, and highly named/brokers) (see Connolly et al., 2013). Nine categories were created through this typology, and three groups were randomly selected within each category. Within the category of large turf size and moderate connectivity, only two groups were able to be reached for interviews, resulting in a total of 26 interviews (Campbell et al., 2021). In the summer of 2020, follow-up interviews were conducted with the original 2019 respondents. This time, interview questions focused on the ways in which stewardship groups had been impacted by and responded to the COVID-19 crisis and the uprising against racial injustice following the murder of George Floyd. Of the original 26 groups, 21 were able to participate in the 2020 interviews. An additional 13 groups were identified through snowball sampling (see **Table 1**). Together, this sample represents a broad spectrum of stewardship groups in NYC in terms of geographic reach and partnership connections and also includes a number of groups known to be responding to COVID-19 through snowball sampling. Overall, groups identified by snowball sampling covered all categories, but were more likely to be small (n = 5) or neighborhood (n = 6) and moderately connected (n = 6) or highly named/brokers (n = 6) than citywide and larger or not named groups. Twelve of the 13 snowball groups worked in areas affected by Sandy.

The 2020 STEW-MAP interview protocol invited respondents to reflect on their response to COVID-19 as well as both the acute crisis Superstorm Sandy and the ongoing crisis of racial injustice. For the purpose of this paper, we concentrated on the interview responses to the following questions:

1. What was your group's experience following Hurricane Sandy? Did those experiences or lessons inform your work and partners in the time of COVID-19?
2. COVID-19 is occurring entwined with the rise of protest over racial injustice, how has your group been affected by or responded to these twinned crises?
3. How are you collaborating with other groups to adapt and respond to COVID-19? Please name your most important collaborative partners. Has that been a significant shift since pre-COVID?

These interviews were confidential and anonymous (IRB: Pro2020001281). Interviews were recorded with permissions, transcribed, and coded using NVivo 11. Two interviews did not have audio recordings, so detailed field notes were coded in the place of the transcriptions. We used a mix of inductive and deductive coding, drawing on grounded theory (Strauss and Corbin, 1994) to develop a coding scheme based on the most common indicators in the adaptive capacity literature. Using NVivo, we allowed a single fragment of text to be assigned one or more of these codes, if the text aligned with the definition of a particular code. We identified emergent sub-codes through team debriefs and used member checks to validate the coding scheme (Seale, 1999). Examples of flexibility were further broken down into (a) change in organization, (b) diversity, equity, and inclusion actions, (c) programming and messaging changes, and (d) workplace and fieldwork adaptations. Learning included both single and double-loop learning and was broken down into (a) individual learning, reflection, and visioning, and (b) institutional memory or group learning. Once the coding scheme was developed by the full team, a single team member (LL) completed coding for all transcripts, which allowed for additional interpretative inquiry (Morse, 2020).

RESULTS

Our interviews showed that stewardship groups across the board were impacted by COVID-19. We interviewed groups that lost significant funding, paused or cancelled programming, created new online tools, and even shifted their efforts to respond to the pandemic. When asked about prior events and parallel crises, flexibility and learning emerged as the most prominent indicators of adaptive capacity. Understanding a group's social capital, assets, and leadership is crucial context, but when asked to compare their experiences with other events groups responded by sharing examples of changes in practice, however small (flexibility), and reflected on their vision and desire to change (learning). We present results in two sections based on the two crises we highlighted in the research questions: first, we examine group response to Superstorm Sandy, and then we look at the ongoing crisis of racial injustice. In each of these

TABLE 2 | Learning and flexibility characteristics of stewardship groups by disturbance.

Crisis	Results: learning	Results: flexibility
Superstorm Sandy (past, acute disturbance)	• Recognition of racial disparities following Sandy impact • New understanding of place meaning/ importance of green space • Lessons about stewardship and activation of space • Lessons on organizational response to disaster	• Group formation in response to Sandy • Leveraging of post-Sandy funding • Implementing long-term stewardship and restoration projects
Systemic racial injustice (chronic, co-occurring crisis)	• Examining issues of representation at the group level • Implementing trainings and holding group conversations • Learning about Black Lives Matter and writing statements in support of the movement	• Changing organizational policies • Providing support to women of color • Addressing systemic power imbalances

cases, we look for examples of how these lessons and experiences have impacted their ability to respond to COVID-19. **Table 2** introduces a summary of the results from each category, and the narratives below offer evidence and examples of these findings. Finally, we look at professionalization and network connectivity in order to understand the group characteristics which hindered or supported their ability to respond to change.

Sandy: Ongoing Recovery Timelines

When Superstorm Sandy hit New York City in October 2012, the impact varied greatly by neighborhood. Interview respondents in neighborhoods with higher elevations, such as Brooklyn Heights and the Upper West Side of Manhattan, reflected on the relatively minor and short-term damage they faced, sharing that within a few days their work was more or less back to normal. For other stewardship groups, Superstorm Sandy remains a defining moment in their ongoing work. Within the STEW-MAP dataset, respondent groups with lower elevations and higher social vulnerability in the neighborhoods of Red Hook, Coney Island, Jamaica Bay, and the Lower East Side were particularly impacted. In addition, some larger multi-neighborhood and city-wide groups navigated changes in their stewardship work in response to Sandy. Aside from the varied geographic impact, Sandy differed from COVID-19 in that despite its ongoing impact in certain neighborhoods, it was an acute event with a clear timeline of before, during, and after. One steward reflected on the differences between Sandy and COVID-19, describing

how in many ways, COVID-19 is a more challenging crisis for organizations to face:

> "I would say that the one thing I've learned from managing through crises, then and what's different now is that Sandy was like a moment in time that occurred. It was awful. And we figured out how to get around it and plan and dig ourselves out of the mess...the difference now is that nobody is coordinated at the leadership level and there's no end in sight to this crisis." (Respondent 1, hereinafter R1)

Flexibility

Groups in areas hit hard by Sandy reflected on the many similarities between the two events. These groups often needed to respond quickly to on the ground damage from Sandy. First, a number of groups had founding stories that were directly linked to Superstorm Sandy. In one case, a neighborhood group in Coney Island was founded immediately following Sandy to address the physical and environmental devastation by planting flowers to beautify their neighborhood and bring together members of the community around a common goal. Another citywide stewardship group that was founded just before Superstorm Sandy received a large grant following Sandy that helped them focus their efforts on recovery and resilience. For other groups, Sandy inspired specific stewardship projects that are still ongoing, such as the living shoreline project in Jamaica Bay. One steward reflected on the project and shared how COVID-19 felt to a community that was still grappling with the impact from Sandy, saying, "it's something that the community references all the time. And I think COVID, this feels like Sandy and a lot of ways for people, especially in the month of March, April and May when everything was so shut down. It felt very similar to Sandy" (R2).

Still others shared specific ways that their response to Sandy directly prepared them to respond to COVID-19. Often, these examples took the form of contact lists and social networks that were compiled after Sandy and became key tools in their COVID response. As one steward said, "I think by the time we got to COVID we had already built a lot of important relationships that we maybe didn't quite have in Sandy" (R3). A Red Hook organization that opened their doors to use their physical space as a community center following Sandy, had to re-think the best way to serve the community in the COVID-19 context where physical gathering was no longer a safe solution. In the interview, they spoke about the challenge of not being able to serve their community the way they knew how, coming to the realization that "We can't be what we were for Sandy" (R4). However, the group managed to find other ways to be responsive by relying on community connections and digitizing tools they had built in the aftermath of Sandy, like their neighborhood bulletin called the "hub":

> "So they didn't open the doors, but they open the lists and the database and they knew all the people to call and check in and ask which questions and who to connect them to. And who's the medical team who's the social, emotional team who's the high school team who's the food team. How are we getting connecting

people to resources. And just shifting that all to phone calls in an online using something called the hub." (R4)

Learning

In the time since addressing the most immediate needs post-Sandy, many groups have had the chance to reflect on their experiences and distill specific lessons learned. Within these responses, four distinct categories of takeaways or lessons learned emerged. The first, expressed by groups both within and outside the Sandy storm surge area, were lessons about inequality. For many stewards, witnessing the uneven impact of Sandy across class and race lines opened their eyes to the reality of environmental racism. An artist who explores our relationship with the waterfront said that once she understood the way low income communities of color were disproportionately impacted during Sandy, she started seeing systemic racism everywhere. For the many stewardship groups located in low-income areas and led by people of color, environmental justice has always been central to their mission. The most extreme impacts of COVID-19 have also disproportionately fallen on the Black community and other communities of color in New York City, many which also shouldered the burden of destruction from Superstorm Sandy. One steward in Coney Island reflected on this pattern, saying, "it's like it's happening all over again....you know, the most vulnerable are most affected and here the people in this community are making this huge sacrifice and a lot of them have sacrificed their life. And that's something that we take a look at and it shouldn't be that way." (R5)

In addition to lessons learned about inequality, Sandy influenced place meaning and stewardship for many stewards, who spoke about both Sandy and COVID-19 as events that enhanced the importance of open space. One group, located on the Lower East Side of Manhattan, reflected on the importance of green space both as a tool to increase coastal resilience following Sandy, and as a safe place to gather in a socially distant way. Yet while both Sandy and COVID-19 have emphasized the need for public green space, specific responses have at times been at odds with one another. As part of the city's response to Sandy, the East River Park in Manhattan is set to undergo construction to develop a raised storm barrier, which would require parts of the park to be closed during a time when open space is extra important, as one Lower East Side steward explained:

> "So, the community has kind of been like a you're really going to close this park in a community that already faces low access to open space? And so that's been like a push point in the community with regard to COVID related access to outdoor space. And I mean the project, when complete, will provide some flood protection, but do you address the immediate need for this public health crisis or do you just move on forward with a large-scale future resiliency?" (R6)

Some interviewees spoke about more specific lessons on stewardship that they learned following Sandy. One group, a civic manager of a public city park, reflected on how they learned a valuable lesson following Sandy about how the public interacts with their space.

"[steward name] and his team created [site name] natural play space using trees from Sandy and created a really wonderful location that is highly used by kind of preschool age children, for the most part. So I think it's that there's lessons Learned about, you know, land management, but also how to then connect to the community about the needs of the park and you know how to… be creative in a space that was underutilized at the time. I think it's kind of related to now during this time period. It's really a great opportunity to introduce visitors to areas of the park that they have never visited." (R7)

Finally, a few stewardship groups examined their response to Sandy and discussed how the aftermath taught them larger lessons about organizational response. One steward, also based on the Lower East Side, posited that Sandy had the "advantage" of striking New York City on the heels of the Occupy Wall Street movement (R8). The organizers who had been involved with Occupy Wall Street were able to build on their existing networks to create Occupy Sandy, which provided aid to many neighborhoods before official funding streams came through. This taught the lesson that active social networks are necessary following a crisis. Another steward, based at the New York City branch of a global environmental non-profit, shared that their biggest takeaway from Sandy was also the importance of working across networks. They said that the "tangible" and "piecemeal" stewardship actions they took on were important, but not sufficient (R9). In the aftermath of Sandy, they were able to make the argument that they can become more nimble and have greater impact if they work in partnership with other organizations.

Racial Injustice: Getting to Organizational Change

On May 25th, 2020, George Floyd was brutally and publicly murdered by the Minneapolis police. Police murder of Black people is not a new story in the US, but George Floyd's death, as well as the previous murders of Ahmaud Arbery, Breonna Taylor, Elijah McClain, and others, sparked "the biggest collective demonstration of civil unrest around state violence in our generation's memory" (Wortham, 2020, para. 5). Activists and writers have proposed that the combination of video documentation, pandemic anxiety, and exhaustion over social distancing all contributed to the surge in Black Lives Matter protests in 2020 (Wortham, 2020). Racial injustice, particularly against the Black community, has also been highlighted by the disproportionate death rate of Black Americans due to COVID-19. Yet the crisis of racial injustice and anti-Black racism is embedded into the history of this country and far outdates the pandemic. As one stewardship group noted, for Black people in America, "This is not new for us." They named "the two pandemics, COVID-19 and COVID-1619," (R10) a term coined by Raphael Warnock referencing the year that Africans were first brought to America as enslaved people (Galloway and Journal-Constitution, 2020). COVID-19 and racial injustice are not equivalent crises, but by understanding how stewardship groups address systemic racism we can begin to identify the properties and processes that support them in responding to the inequities inherent in all forms of disaster.

Learning

Because of the perennial nature of racial injustice, stewardship groups often spoke about the learning and reflection they underwent prior to taking action or making tangible organizational changes. Individual stewards approached the conversation about racial inequality from a wide range of perspectives—some drawing upon their personal lived experiences as stewards of color, and others confronting their racial privilege for the first time. One steward, the volunteer president of a rooftop community garden in a predominantly white neighborhood, shared that there had been some uncertainty within the group of how to express their support for the Black Lives Matter movement. A community gardener had brought up the possibility of hanging a Black Lives Matter sign on the garden gate, but the president of the group wanted to pause and reflect before signing off. He explained, "In spite of my absolute support for the movement and visceral hope that something is really changing now in this country, I did not think it was a good idea. It smacked of lip service to me. It was like what so many corporations are doing and selling with it, though that's not our intent. I think we still need to find a more meaningful way to respond to it" (R11). Other stewardship groups were similarly concerned with how to have a conversation at the organizational level in order to determine next steps. One expressed frustration at the lack of action taken by their organization, saying "the organization as a whole didn't even explicitly say anything about support or anything of the Black Lives Matter movement. And was not really able to vocalize a response to that at all. And that was something a few of us on staff were really upset about and really felt that the organization needed to step up and say something" (R12).

Other groups were able to move past individual reflection and hold conversations about racism and representation at the staff or board level. One mid-sized organization noted that the work to dismantle racism has to begin with the recognition of how white supremacy is built into the structures we work within, stating that "one of the really helpful pieces of dialogue that has emerged more prominently in the last 2 months is around concepts of racism and white supremacy being cultural structures that that and we're all subject to and influenced by and that our organization, like every organization, is one that functions with white supremacy" (R13). Understanding these structures served as a starting point for holding inter-staff discussions where multiple action items were identified, including holding training sessions for staff that would be led by paid professionals with expertise on racial justice, and putting out a public statement in support of the Black Lives Matter movement. They worried that the statement would fall flat or be seen as an empty promise, but soon after publicizing the statement they heard that at least one partner organization used their statement to kick off their own internal conversation about anti-racism efforts. This served as an important reminder of the potential for leading by example and creating a ripple effect of change throughout a professional network.

Many STEW-MAP respondent groups also reflected on the reality of working in predominantly white-led organizations. One group, a small organization with only two full-time staff (both

white) spoke about exploring ways to diversify their board in order to better represent the communities in the full extent of the neighborhoods they serve.

"We are not diverse in our staff, either. I think it's something that we do need to look at and be very aware of in terms of the board….We certainly know the elected officials and we have spoken for many years with the elected officials for any sort of introductions or suggestions for board members because you don't want all your board members to be located between you know 20 blocks or 30 blocks. They should represent all of the neighborhoods that we serve. We've also been looking at some board matching organizations." (R14)

Other stewards reflected on the structural challenge of getting traditional white male leadership to respond to the need for more diverse voices, or the difficulty they have had in trying to identify stewards of color to partner with in specific white dominated sub-fields, such as energy efficiency. Even groups with more diverse staff shared challenges of implementing change. One stewardship group, an environmental justice organization located in a low-income community of color, took an active approach to addressing racial injustice and the events of summer 2020. They organized a racial justice committee, held a staff-wide discussion following a viewing of a James Baldwin documentary, and administered a staff survey to better understand where their employees were coming from. The results of the survey highlighted the fact that not all staff felt included in these events and processes. In particular, there was a perceived barrier between office staff and the more racially diverse field staff, who may not be able to check email as frequently and as a result sometimes felt out of the loop or ill-informed of leadership decisions. These examples serve as reminders that staff training and personal reflection on dynamics of race and power are only the first steps towards addressing systemic racism.

Flexibility

Certain stewardship groups were able to take their lessons learned and implement action items in the hope of supporting racial justice work and shifting organizational culture. One group that stewards a small park under the management of a larger environmental non-profit saw a shift from how the leadership responded to protests over police brutality in the early summer to late summer. The steward explained, "I know that yesterday in response to the Jacob Blake outcry, we received an email saying that if anyone needed to go protest that their time would be covered, that somebody could cover for them if they had work that needed to be done. At the beginning of the summer, that was not an email that was sent. So that's cool. That's a step, you know" (R15). Another organization decided to make Juneteenth, the commemoration of the date that the last enslaved people in Texas received notice of the Emancipation Proclamation, a paid holiday for all staff.

A smaller subset of groups shared examples of how they were able to begin to address some of the root causes of racism, such as systemic power imbalance and lack of resources and autonomy in historically Black communities. One group led by women of color shared that the events of summer 2020 only reinforced

the need for the work that they do, which focuses on Black and Brown women specifically. They reflected on the need for a "framework for healing" that they addressed by holding virtual processing circles and sharing tools to promote both physical and mental health for their members. Creating that space for wellness, especially in a culture where the wellness industry centers white women, helps situate their work as resistance to white supremacy. In addition to their wellness work, they are also beginning to look into the possibility of opening a food co-op. They discussed the importance of community ownership in economic empowerment, explaining, "if we control the food chain, we really have the means to impact people's health" (R10). Another woman of color-led organization is similarly interested in food sovereignty as a tool for building long term equity. They have been providing food boxes to neighbors in need since the beginning of the pandemic, but dream of being able to move away from this charity model and towards a more sustainable and long-term solution to food insecurity. This is not easy work, however, as one steward noted:

"And I think that it's easier to fund an emergency food program than it is a food sovereignty program. Because a food sovereignty program is dismantling as it is building and it requires time. It requires opening up decision making, who's at the table. And so that doesn't have the same kind of outputs and outcomes that you put in a grant report that's clean, like "we're going to do this many pounds and this many boxes and this many people." So I think it's easier to fund a traditional food access model." (R4)

Another way stewardship groups can make an impact on procedural justice is by using their privilege to promote equity. For one organization, a conservancy for a park that was a popular protest site, this meant stepping up to support Black Lives Matter protesters.

"We started sort of slowly listening and finding out what's going on with some of the following protests that week and then we started a conversation with the organizers, and we did two things. One, we shared it out that we wanted to coordinate with any protesters to keep the visitor center open. We will keep it open late, we are advertising cold water and advertising PPE like just saying, you know, come on. This is a place we want you to protest…it's just a place where civic action should happen. So after that, we started talking with the organizers of the demonstration and we, to this day, are still coordinating with them." (R16)

In addition to promoting the use of their space for protest, stewards stepped up to serve as a mediator between the protest organizers and the New York City Police Department. They explained, "So our role there has been to support them by giving them what they call sort of back end cover with NYPD, meaning they don't have to coordinate with them. We coordinate with them and we say, Please don't bring more vans into the park…this is a peaceful protest, we're supporting it. There's no need for that" (R16). Considering the police brutality many protesters in New York City faced, this seemingly simple action had the potential to protect community members and even save lives.

Adaptive Capacity and Group Characteristics

While all stewardship groups responded to the COVID-19 crisis in some way, the extent of their adaptive measures varied group to group. We sought to understand how group characteristics impacted their responses. Some smaller, single-issue organizations such as community gardens or street tree stewardship groups simply cancelled scheduled programming or used PPE and social distancing to minimize risk. Other groups dramatically shifted their priorities in order to respond to new and pressing needs created by COVID-19, such as heightened food insecurity, cancelled municipal compost collection, and growing economic inequality. As the adaptive capacity literature suggests, groups that demonstrated learning and flexibility in response to the crises of Superstorm Sandy and racial injustice were able to draw on those experiences to build their organizational adaptive capacity, placing them at an advantage when responding to unexpected challenges such as COVID-19. Other factors, such as an organization's size, degree of professionalization, and mission also contributed to their ability to begin new initiatives or make changes to existing programs. Here we look at how learning and flexibility varied by groups' *level of professionalization* and position within the stewardship *network*.

Professionalization, Learning, and Flexibility

Our analysis found that highly professionalized groups showed the most examples of both flexibility (fieldwork/workplace adaptation and programming changes) and learning. These groups have the highest budgets and largest staff size, which may put them at an advantage in moments of crisis. However, groups with a professionalization score of 3, corresponding to mid- or semi-professionalized groups, had more examples of organizational change, where a shift was made more permanent in the organization's structure. There are a number of possible reasons why groups at the highest level of professionalization struggled to implement these organizational changes. Some stewards of large and highly professionalized groups that care for New York City parks through a public-private partnership with the Department of Parks and Recreation shared that it was challenging for them to continue their volunteer stewardship efforts in the beginning of the shutdown because of regulations from the Parks Department that prohibited any volunteer stewardship efforts, even small groups working in a socially distanced manner. Eventually these restrictions eased, but in the meantime smaller grassroots efforts were at an advantage because they could organize without oversight. One steward reflected:

> "So you know the Parks Department has a process through which you have to go through to do anything in parks and so right now, they had also sort of put a stop on all of that, you weren't allowed to volunteer. You weren't allowed to do events. And at a certain point, the people, you know, the park users were saying, you know what, we're just, we're just going to do it. So you just had crowds of people...taking up trash bags and they're going out there and they're actually organizing and being more effective than we have been or any of our institutional partners have been because [as an]

institutional partner there's just more bureaucracy that you have to go through an organization." (R17)

Another steward at a large and highly professionalized organization spoke about how large institutions can struggle to adapt to new norms, speaking about the diversity, equity, and inclusion initiatives that have not reached the level of effective organizational change:

> "And so whenever I think about [organization name] in relation to race issues I have to put it in the context that big NGOs are failing every day. Like, I'm not saying it's for lack of trying. But failing miserably....there are structural norms that we were unwilling to break down so I think that [organization name], like a lot of organizations, is issuing public statements and is trying to double down on our diversity, equity inclusion efforts but has not cracked the nut." (R9)

These examples show that professionalization is only one variable in understanding organizational adaptive capacity. The interview results also indicated that groups are often more fluid than their budget and staff size may imply. Some groups are headed by a single leader with no paid staff, but nonetheless become formalized 501(c)(3)'s. Other stewards work for large organizations but are able to take initiative and bring in new partnerships or ideas, like one gardener who used the organization's outdoor space for food storage and distribution in partnership with the local mutual aid group. These networks, both personal and professional—or what one steward described as their "mycelial network" (R15) of contacts, allows stewards to adapt.

Network Connectivity, Flexibility, and Learning

Network connectivity had some bearing on the number of adaptations a group mentioned in their interview. Civic brokers—the most highly connected groups in the stewardship network—had the highest number of examples of fieldwork/workplace adaptations and programming changes. This suggests that working across a network is an important indicator of adaptive capacity that is underexplored in the context of stewardship groups experiencing multiple disturbances. Yet stewards from every level of network connectivity reflected on the importance of collaboration across groups. One shared that she wanted to build a larger network and work more with environmental justice organizations in order to integrate conversations about race and coastal resiliency and come up with more innovative and equitable solutions. She said, "well, maybe it's more important now than ever to kind of strengthen these community networks and really build up the voices of people that have been historically left out of the conversations" (R18). Another steward working in a non-profit shared a story of how she was able to work with an informal network to relocate a 2–3 acre milk crate farm from JFK airport to various sites around the city to combat the food insecurity that peaked as a result of COVID-19. The farm was launched by Jet Blue in 2015 to grow potatoes and other vegetables in order to stock the airport restaurants with local produce (Baskas, 2015). After the airport decided they were not able to maintain the urban farm, they

reached out to a large stewardship group who did not have the capacity to take on the project. This group instead contacted a small number of individuals with expertise as urban farmers, food justice advocates, and artists, including the steward we interviewed. She explained:

"[The contact at the large stewardship group] put us on an email together and I immediately was like, Oh my God, yes, because for the weeks prior my phone has been blowing up with friends, wanting to know where they could get clean soil and seeds and things and so it just felt like I didn't want to see that resource go to waste. So we kind of got together a small group of people. There were six of us that were the primary coalition members…so the six of us in the span of about a month, figured out how to relocate 3000 milk crates... Some of that was through individuals who just signed up through a Google form and some of it was through outreach that different members of the coalition had you know, like the [another large stewardship group name]." (R15)

This example powerfully illustrates the ability for a small group of people to come together around a common goal and, using their personal networks, scale up the impact of a project.

In addition to these personal networks, organizational networks emerged as an important theme throughout the interviews. One in particular, a network of mid-sized and large organizations that work in New York City's open spaces, formed specifically as a response to COVID-19. One of the founders came from the arts and cultural non-profit world and described her experience following September 11, 2001 as a moment where organizations came together to apply for joint grants and share resources. After shifting to the parks and open space sector, she was surprised that there was not a similar network with which to work in response to COVID-19. Many of these stewardship groups were facing extreme budget cuts and she thought they could benefit by meeting weekly with one another to share ideas and support. The coalition that emerged became a space for groups to talk about new funding opportunities, volunteering and visitorship, and even racial justice. Together, they penned a letter in response to George Floyd's murder and in support of the Black Lives Matter movement. In order to address structural racism within their organizations, they collectively applied for a grant that would bring in trained facilitators to conduct anti-racism workshops and "support a "train the trainer" curriculum so that we can sustain this going forward" (R19). This joint grant would ensure that even organizations within the network that don't have the funds to pay for a staff training will still have access to these resources. Efforts like this point to a recognition that working across a network enhances a group's ability to adapt.

DISCUSSION AND CONCLUSION

The realm of disaster response and recovery work is dominated by the role of government and large-scale response organizations. In this study, we have uncovered the important role that local environmental groups play in the context of compound crises. The civic groups we spoke to contributed to the adaptive capacity of the neighborhoods they serve through learning and their unique ability to flex in response to change. Our interviews also

showed that prior experiences with crises played an important role in shaping the ability of stewardship groups to adapt and respond to COVID-19. Almost all groups demonstrated single-loop learning in figuring out how to quickly change their practices when COVID-19 hit. We also saw examples of double-loop learning—ways that stewards used lessons learned from past events to reprioritize their work and transform their organizations, making them better able to respond to COVID-19. One way that stewardship groups demonstrated double-loop learning was by reflecting on Sandy, racism, and COVID-19 and acknowledging the intersections of climate, race, and public health. Even those who did not label these as environmental justice issues were able to point out the ways that marginalized people, and especially Black Americans, continually face the brunt of the harm from disturbances. We found that groups looked inward—with the Black Lives Matter movement serving as a catalyst for organizational changes—and looked outward to the rest of the communities they serve to explore how they can reach people and share their resources more equitably. Stewardship groups also synthesize learning across scales and sectors, blurring lines between civil society and government by brokering and sharing roles.

Stewardship groups across the board also demonstrated flexibility in their response to COVID-19. Following disturbance, stewardship groups navigate large scale changes such as gaps in funding and collaborative campaigns. While the access to funding and resources that comes with larger non-profits and institutions can certainly support larger-scale efforts to respond to disaster, the same assets can constrict or slow organizational change through red tape or static organizational culture. On the other hand, emergent groups that operate outside the structure of a non-profit or government agency can use their nimbleness to respond to crises more quickly, but they may lack the support to continue long-term. We found that stewardship groups responded to these challenges by reflecting on where they fit within the governance structure and then using their resources and local knowledge to fill the gaps that the government and the private sector are unable or unwilling to address. The innovation of civic stewardship groups is crucial in meeting the immediate needs of communities facing crisis, and in dismantling the systems that lead to injustice.

One way that stewards work to counter these limitations— whether within an organization or as an independent actor— is through collaboration across a network. We found that stewards are not bound by the size and professionalization of the groups within which they work. Further, we found that stewards sometimes work outside the bounds of their organizations completely, leveraging contacts from both their professional and personal lives to address concerns that don't fit within their group budget or mission. Network partners enable a level of learning and knowledge exchange that is not possible within a single group, as the literature on adaptive capacity suggests. Crucially, we found that many of these network relationships were formed in the context of a prior or parallel crisis, and maintained through everyday efforts. In response to COVID-19, many stewardship groups reached out to partner organizations to share their concerns about loss of funding, the changing role of public space,

and inequity in the workplace. Through regular conversations, they were able to deepen their individual understandings of their roles as stewards. Personal networks were often blended with professional networks and were similarly important to flexibility in the COVID-19 response, allowing stewards to quickly connect with those in need and amplify their efforts.

Stewardship groups in New York City are well positioned to respond to a wide range of crises because they are keepers of place-based knowledge and social trust, and operate within a frame of networked governance. The findings from our interviews illustrate the ability of these groups to learn from past experiences and adjust their practices to address changing needs, both within their organizations and in their wider communities. We note that our interview sample is limited to New York City; stewardship groups in other locations may respond differently. Additionally, our interview sample covers a wide variety of geographic scope and density of partnerships, but other group factors may affect whether and how groups responded to the COVID-19 crisis. More research is needed to understand the internal and external factors and characteristics that allow some groups to transform more quickly and fully than others. In addition, future studies could focus on the varied outcomes of these transformations, in order to better understand how learning and flexibility impact a group's overall effectiveness. As we grapple with systemic racism and exclusionary practices of all kinds, all in the context of a still present global pandemic and with the threat of climate change looming, we have to keep in mind the outsized impact disasters will continue to have on our most vulnerable people and places. Further research on the root causes of these inequities in the context of compounded disasters, including through the lens of racial capitalism (Liebman et al., 2020), could help link existing literature on hazards and disaster with political ecology and critical scholarship and activism. In the meantime, learning from and supporting the groups that have demonstrated truly novel approaches and sharing these practices across a network can expand the toolkit of stewardship practices to support populations in crisis. How can we best leverage the capacity of these stewardship groups as we grapple with our country's racist history and face increasingly compounded disasters in the future?

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation. Data shared will contain no identifiers associated with interviewed individuals or organizations.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Rutgers University IRB. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

LL recruited and conducted interviews, coded interview transcripts, analyzed data, and led the writing. LC, ES, and MJ developed the conceptual framework, contributed to the coding scheme, assisted with interviews and analysis, and contributed to writing. All authors contributed to the article and approved the submitted version.

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Open for All: How Are Federal and Municipal Land Management Agencies Adapting to the COVID-19 Pandemic Alongside Increased Societal Recognition of Racial Injustice

Erika S. Svendsen[1]*, Lindsay K. Campbell[1], Sophie Plitt[2] and Michelle L. Johnson[1]

[1] USDA Forest Service Northern Research Station – NYC Urban Field Station, New York, NY, United States, [2] Natural Areas Conservancy, New York, NY, United States

In addition to impacts on human health and the economy, COVID-19 is changing the way humans interact with open space. Across urban to rural settings, public lands–including forests and parks – experienced increases and shifts in recreational use. At the same time, certain public lands have become protest spaces as part of the public uprisings around racial injustice throughout the country. Land managers are adapting in real-time to compound disturbances. In this study, we explore the role of the public land manager during this time across municipal and federal lands and an urban-rural gradient. We ask: How adaptable are public land managers and agencies in their recreation management, collaborative partnerships, and public engagement to social disturbances such as COVID-19 and the co-occurring crisis of systemic racial injustice brought to light by the BLM uprisings and protests? This paper applies qualitative data drawn from a sample of land managers across the northeastern United States. We explore management in terms of partnership arrangements, recreational and educational programs, and stakeholder engagement practices and refine an existing model of organizational resilience. The study finds abiding: reports of increased public lands usership; calls for investment in maintenance; and need for diversity, equity, and inclusion in both organizational settings and landscapes themselves; and the need for workforce capacity. We discover effective ways to respond to compound disturbances that include open and reflective communication, transforming organizational cultures, and transboundary partnerships that are valued as critical assets.

Keywords: COVID-19, racial justice, public lands, recreation, forest management, partnerships, organizational resilience

INTRODUCTION

In addition to the devastating impacts on human health and the global economy, COVID-19 has changed the way humans interact with open space, natural resources, and public lands (Soga et al., 2021). Under anything but the most extreme situations, outdoor walks and exercise at safe distances were not only allowed, but encouraged for sustaining physical, mental, and emotional health and well-being (Samuelsson et al., 2020; Slater et al., 2020). While research on overarching patterns of open space use during the pandemic is still emerging—the use of some natural areas, parks, forests, trails, and bike paths increased (Grima et al., 2020; Venter et al., 2020; Outdoor Industry Association and Naxion Research Consulting, 2021; Plitt et al., 2021 this issue), but this increase was moderated by park closings and occurred more often in white majority neighborhoods in cities (Jay et al., 2021). Certain spaces became overcrowded, and some were closed to public use during the peak of the pandemic. At the same time, many land managers were often deemed "essential", operating under new protocols to ensure that these resources remained open to the public. Public land managers in both rural and urban settings had to adapt old practices in real-time to a new and changing reality (Jacobs et al., 2020; McGinlay et al., 2020; Miller-Rushing et al., 2021; Sainz-Santamaría and Martinez-Cruz, 2021). Updating fieldwork protocols, adjusting workforces, canceling or changing public events, and providing educational content online are just a few of the adaptations. As the crisis deepened and spread, the impacts on how public land managers steward natural resources and support recreation and public engagement opportunities continued to unfold.

The COVID-19 pandemic is entwined with the concurrent crisis of systemic racial injustice. While structural inequality and systemic racism have long been part of our society, this injustice was brought to broader public attention following the murder of George Floyd and the uprisings and protests as part of the Black Lives Matter (BLM) movement during summer 2020. In addition to the focal attention on police violence, this movement amplified conversations about disproportionate impacts of the pandemic on people of color, as well as foregrounding issues of diversity, equity, and inclusion (DEI) in all aspects of society (Lipp, 2015; Rodriguez, 2020). For public land managers and urban park professionals, this centered on who feels safe, welcome, and served in green spaces (Hoover and Lim, 2021; Klein et al., 2021), which has been a critical question of recreation research and management particularly in light of changing demographics and values around outdoor experiences (see, e.g., Blahna Dale et al., 2020). During COVID-19 as well as before, many residents could not access larger public lands and natural areas for reasons that include inequitable distribution of open space, physical limitations, reduced transit options, time constraints, or lack of familiarity (Jennings et al., 2012; Jacobs et al., 2020; Lopez et al., 2020; Spotswood et al., 2021). These twinned crises revealed underlying inequities and vulnerabilities that cause people to experience risk and interact with the public realm in different ways (see, e.g. Bassett et al., 2020; McPhearson et al., 2020).

Disturbances do not happen in isolation; they often co-occur or compound upon each other spatially and temporally,

creating intersecting impacts and influencing adaptation, and they are situated in longer historical arcs of prior disturbance cycles and underlying social vulnerabilities (Steinberg, 2006). Quigley et al. (2020) define "concurrent hazards" as hazardous events of biophysical origin (e.g., earthquake, cyclone) that overlap in space and time, whereas "compound events" can be hazardous events of any origin that co-occur (e.g., COVID-19 and a hurricane). New research has begun to examine the compound crises of how COVID-19 intersects with other forms of disturbance, including wildfire and systemic racism (see, e.g., Goldstein, 2021; Landau et al., 2021 this issue). Rodriguez (2020) frames COVID-19 as an "interlocking health crisis" that is fundamentally connected with systems of oppression and examines the ways in which both NYC residents in general and social workers in particular work to dismantle these systems (see also Lipp, 2015; Reynolds, 2020). Examining wildfires in Arizona, Edgeley and Burnett (2020) found that current challenges around collective action to address wildfire risk may be further exacerbated due to COVID-19 and the pandemic has potentially widened existing disparities in household capacity to conduct wildfire risk mitigation activities in the wildland–urban interface. COVID-19 must be considered as a disturbance that intersects with structural forces, including pre-existing social inequities and vulnerabilities, leading to "cascading disasters" and inequitable outcomes (Thomas et al., 2020). Response to disturbances–compound or otherwise–is dependent upon processes, practices, and socio-cultural norms in place prior to the event (Harrison and Williams, 2016).

In a land management context, disturbances are often examined for their impact on the landscape and biophysical components of the ecological system (Dolan et al., 2017); leaving a need to examine social disturbances such as racial injustice and pandemics. Particular attention has focused on weather-based and insect-based disturbances, such as wildland fire, bark beetle, pine beetles, and hurricanes (Cannon et al., 2017; Hislop et al., 2018; Van Beusekom et al., 2018 Morris et al., 2018; Bowd et al., 2019; Negrón and Cain, 2019; Vogeler et al., 2020). Disturbances, acting as "focusing events," and their subsequent "policy windows" also enable organizational learning and adaptation (Michaels et al., 2006). The Forest Service has been shown to learn from responding to both fire (Petersen and Wellstead, 2014) and insect infestation (Steen-Adams et al., 2020; Abrams et al., 2021). At the same time, scholars also point to the presence of "rigidity traps" in fire management approaches that limit the ability for institutional innovation by the agency and its collaborative partners (Butler and Goldstein, 2010). Based on a survey of local governments, Dzigbede et al. (2020) found that preparedness for weather-related natural disasters informs responses to the current crises, yet not all disasters lead to permanent changes in rules and regulations, and this holds in the case of local governments post-fire (Mockrin et al., 2018). In examining pathways of transformation, Newig et al. (2019) highlight the role of failure in organizational learning, noting that "institutional improvement through learning and adaptation resulting from crisis experience happens in a rather *ad hoc* manner" (p 5). Finally, researchers are re-conceptualizing focusing events and their potential effects

on windows of opportunity as a result of the long-term nature of COVID-19 and other pulse events (DeLeo et al., 2021).
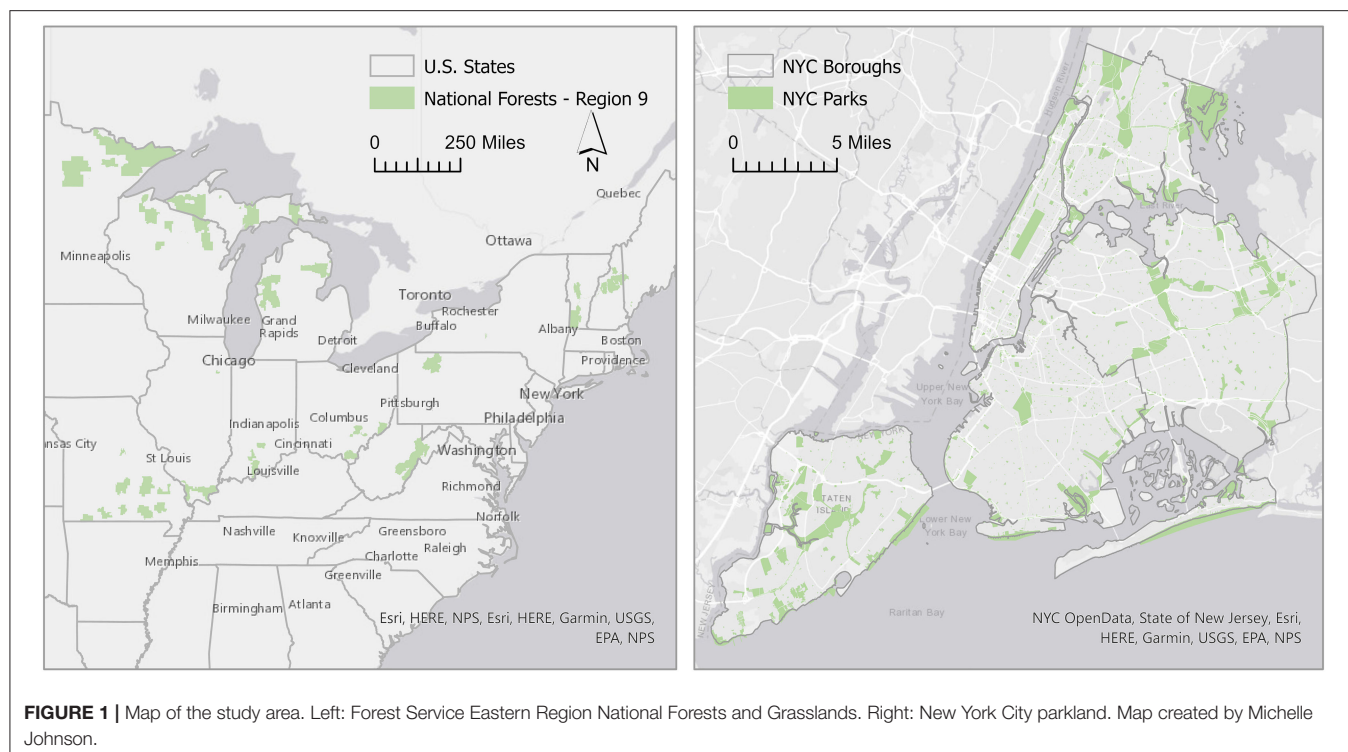
Organizational cultures of public land management agencies at multiple organizational levels have long been a subject of scholarship. Kaufman (1960) sought to understand how the Forest Service maintained organizational coherence at such a broad and dispersed geographic scale. Fleischman (2017) revisited Kaufman's findings and examined the contemporary Forest Service, finding that Kaufman's analysis under-explored the importance of political context–as opposed to internal organizational dynamics alone–in shaping outcomes. Further, it is important to acknowledge that large federal agencies are not monolithic. "Street level bureaucrats" working on national forests have some room to maneuver and innovate, but also they are nested within a larger bureaucratic and institutional structure (Lipsky, 1980; Trusty and Cerveny, 2012; Moseley and Charnley, 2014). Recent scholarship continues to emerge about the culture and capacity of land management agencies operating in urban areas or at the municipal level, including from the lenses of: public lands management (Zamanifarda et al., 2016), parks and recreation management (Farland, 2010), urban forestry management (Wirtz et al., 2021), tree planting initiatives (Eisenman et al., 2021), and green infrastructure governance (Hsu et al., 2020). Though various factors are identified and discussed, these studies point to the importance of financial resources from both public and private sectors, leadership, collaborative management approaches with multiple stakeholders, and data-driven decision-making as key components in successful outcomes. Homing in on the culture of urban parks and recreation organizations, Farland (2010) found that these agencies have an "achievement" orientation as their dominant culture, as well as an increasing emphasis on professionalization and accreditation in the field.

To understand whether, where, and how organizational adaptation and transformation happens in response to disturbance, it is necessary to interrogate pre-existing organizational cultures, capacities, and capabilities. The study of contemporary organizational culture and learning developed initially to examine private firms, but also has been applied to the government sector (Edginton, 1987; Schein, 1992; Coleman and Thomas, 2017) and draws attention to the role of bureaucratic structures and their influence on learning (Cuffa and Steil, 2019). A review by Gilson et al. (2009) identifies knowledge management and organizational learning (and "unlearning") as key components of government sector organizational culture involved in adapting to crises. Abrams et al. (2017), focusing on land management agencies, point to the enduring importance of bureaucratic institutions and how "institutional persistence and path dependence in limiting the latitude of adaptation to social and environmental shocks" (p.1). Other scholars have called for a focus on not only moments of crisis and disaster management, but also "slow variables" that create mounting pressure on SES (Duit, 2016). Wyborn et al. (2015), examining the adaptive capacity of land management agencies, identify multiple potential "adaptation pathways" that are also constrained by structural "envelopes" that shape potential action. Organizational resilience has also been conceptualized through a capability-based framework. Duchek (2020) identifies proactive, concurrent, and reactive actions that organizations take in response to a disturbance, which occur through processes of anticipation, coping, and adaptation, respectively, which are enabled or constrained by resource availability, social resources, power and responsibility (see **Figure 1**, p. 224). Duchek also notes two types of actions: cognitive and behavioral occurring within these processes and identifies strong and weak feedback loops. Their study investigates partnerships as an adaptive pathway that enables land management agencies to respond to large scale and concurrent disturbances.

Federal and other government land management agencies do not manage natural resources or respond to disturbance alone–they work in collaborative arrangements with a wide range of stakeholders, partners, and cooperators in a governance network that spans sectors and scales. These arrangements among land management actors have variously been explored as co-management (Wondolleck and Yaffee, 2000; Tompkins and Adger, 2004; Koontz and Thomas, 2006; Armitage et al., 2007) and multi-level or networked governance (Bodin and Crona, 2009; Davis and Reed, 2013; Scarlett and McKinney, 2016; Abrams et al., 2017; Abrams, 2019). Focusing on recreation management, partnerships and collaboration are seen to be critical to adding capacity and implementing sustainable practices (Charnley et al., 2014; Selin et al., 2020). Steen-Adams et al. (2020) analyzed the emergence of network governance approaches within the Forest Service in the context of an invasive pest outbreak. The authors found that these network approaches offered added capacity and local legitimacy, but the emergence of networks is driven by preexisting top-down and bottom-up factors–including existing capacity and prior engagement in network approaches (i.e. "network history").

Urban forest and green space management occurs in a context of a patchwork landscape of multiple landowners and a networked or "mosaic" governance arena (Jansson and Lindgren, 2012; Buijs et al., 2019). In examining and analyzing urban forestry and public lands management, it is important to consider the power dynamics and politics that underlie and shape the planning, programming, and implementation of collaborative partnerships and network governance arrangements (Campbell and Gabriel, 2016; Hsu et al., 2020). Municipal government often plays a lead role in the management of urban tree canopy on streets, in parks, and in "natural area" forested parks (Campbell, 2014, 2017). An array of public-private partnerships and private contracting arrangements exist in the financing and management of urban green spaces, which have variously been celebrated as adding capacity and nimbleness or critiqued as the roll-back of the state under neoliberal approaches that emphasize market efficiencies (de Magalhães and Carmona, 2009; Lindholst, 2017). Civil society–including non-governmental organizations and civic groups– also provide capacity for environmental stewardship (Svendsen and Campbell, 2008), engage in programming and planning that axctivate open space to function as social infrastructure (Campbell et al., 2021), and participate as key brokers in environmental governance networks (Connolly et al., 2013, 2014), but they are uneven across the landscape (Johnson et al., 2019).

FIGURE 1 | Map of the study area. Left: Forest Service Eastern Region National Forests and Grasslands. Right: New York City parkland. Map created by Michelle Johnson.

Given this context and background, we posed the overarching research question: How adaptable are public land managers and agencies in their recreation management, collaborative partnerships, and public engagement to large scale social disturbances such as COVID-19 and the co-occurring crisis of systemic racial injustice brought to light by the BLM uprisings and protests? We conducted semi-structured interviews with representatives of two public land management agencies operating under different authorities and geographic contexts: urban forested parks in New York City (NYC) operated by the City of New York Department of Parks and Recreation (NYC Parks) and National Forests within the Eastern Region (Region 9, or R9) of the USDA Forest Service National Forest System (Forest Service). Our study area focuses in the northeast United States because it contains public lands and communities that allow for comparison between two different organizational settings working across an urban to rural gradient. We draw upon and test Duchek's (2020) process-based conceptual model of organizational resilience through stages of the prior knowledge base, anticipation, coping, and adaptation (see Duchek, 2020, **Figure 1**, p. 224) with our public land manager cases, examining how the nature of these concurrent crises affect public agencies as they adapt and potentially transform in response to these inherently social disturbances and underlying inequities. Considering Lipsky (1980) as well, we look for differences in hierarchy and degree of trust as both are important in shaping organizational culture and subcultures. In doing so, we apply organizational resilience literature to public agencies experiencing disturbances at present less examined by this literature: press disturbances requiring immediate responses.

Our work also contributes empirical knowledge about municipal land managers, an understudied subject, in conversation with a more well-studied subject, federal public land managers.

MATERIALS AND METHODS

We conducted a total of 36 semi-structured interviews with public land managers in the northeastern United States from July to November 2020, a period that encompasses the initial wide spread of the COVID-19 pandemic in the United States before the development of a vaccine–including an early concentration in New York City. Through our study design, we sought to understand the patterns and processes associated with collaboratively managing public lands for recreation and public use on national forests and on urban parkland. In setting the comparative frame, we chose two agencies that were generally aligned in mission and structure, but that vary in terms of geographic context. We interviewed state land managers as well but were unable to reach saturation due to challenges with recruitment and time and resource constraints–as such we excluded those from these analyses. The Forest Service Eastern Region consists of more than 12 million acres spread across 17 National Forests and one National Tallgrass Prairie. Over 40% of the population of the United States lives within the footprint of the Eastern Region–which extends across the Northeast and Midwestern United States. The Eastern Region is distinct with many forests adjacent to urban or urbanizing areas. Still, there are forests within this region that fall within the wildland-urban interface and surrounded by rural counties. NYC is home to

approximately 8.8 million people and NYC Parks is the largest public land management agency in the city. NYC Parks is responsible for the care of 30,000 acres–of which approximately one third are forested "natural areas"–across more than 5,000 individual parks (See **Figure 1**). While national forest lands may be larger in terms of number of acres managed, city parklands are situated within a much greater population density and have extremely high rates of usership. During times of crisis, with such differences in density and geographic context, partnerships and stakeholder engagement in the management of public lands differ and should be examined.

Despite what appears to be stark differences, the two agencies share similar objectives at the broadest scale: to manage public land for the health and vitality of people, plants, and wildlife. Both NYC Parks and the Forest Service engage in the type of land management that includes tending to a wide range of conservation practices while assuring that these lands remain open and accessible to the public for sanctioned use. This study focuses on recreation-based partnerships designed to engage the public. Both agencies operate within regulatory frameworks that guide management and community engagement. The agencies have similar scaled staffing structures that include national or city-wide leadership, forest or park administrators (or park districts), and common field positions (e.g., foresters, rangers, enforcement officers, seasonal workforce, public affairs officers, educators, and scientists). During peak periods of quarantine, both NYC Parks and National Forests were staffed primarily by maintenance workers that were given only the most essential tasks related to trash and signage.

For NYC interview recruitment we included municipal land managers working at NYC Parks (n=9), including seven park administrators who manage large parks and forested areas spread across the five boroughs and two employees who manage partnerships and volunteers citywide. For the Forest Service, we reached out to partnership and volunteer coordinators working on Region 9 National Forests, interviewing 1–2 representatives at each of the National Forests (but not including the National Tallgrass Prairie in the Region) ($n = 16$), and an additional "spot check" interviews with key leaders at the national level ($n = 11$). Interviews covered a wide range of topics, including emergence of new strategies, learning, adaptation, and transformation of existing practices, ways in which partnerships are created, how the state-society boundary is navigated, and visions for the future. Interviews took place during the peak outdoor recreation season from June through early fall in 2020. The murder of George Floyd occurred on May 25, 2020 and ensuing protests were underway in many parts of the country. During this period, many states were under strict stay-at-home orders, dependent upon the number of COVID-19 cases.

Interviews were voluntary and confidential in nature (Rutgers University IRB Pro2020001281), lasted approximately 1 h, and were conducted entirely via Zoom video conference. Following the receipt of informed consent, interviews were recorded as audio transcripts, which were auto transcribed and then corrected for accuracy. Each interview was conducted by two researchers from among the team, and immediately following each interview, debrief notes about the core themes and findings

were discussed. A total of 154 pages of debrief notes and 478 pages of interview transcripts were generated in this process. Following a process informed by grounded theory (Strauss and Corbin, 1998), at several points throughout the project, full team debriefs were discussed to identify emerging themes and patterns. These emerging themes were then developed into preliminary findings presentations, which were shared with communities of practice at both the municipal and federal levels as a "member check" and a way of validating and ground-truthing preliminary results (Lincoln and Guba, 1985). We then compared these cases and their emergent themes against an existing model of organizational resilience (Duchek, 2020) to empirically examine and refine this model for public land managers and long-term disturbance contexts.

RESULTS

New York City Department of Parks and Recreation (NYC Parks)

COVID-19 Impacts on NYC Parks

NYC Parks managers reported record-breaking rates of visitation throughout the spring and summer of 2020. During the height of NYC's quarantine period, small neighborhood parks and playgrounds were closed to the public while the larger parks remained open to the public. By late spring, it was clear that outdoor public space and specifically parks became the only places that people could gather in small groups and seek respite from their homes during stay-at-home orders. One administrator said, "People are really seeking a natural experience and trying to find solitude, which I think is obviously becoming increasingly difficult with all the people" (NYC Parks, R1). As most other businesses, offices, and schools were closed, people turned to public lands not only to recreate, but also to adapt other activities that now were only safer outdoors. Land managers observed parks being used for classrooms and summer camps, sites for exercise classes, outdoor workplaces, and even field hospital sites.

Park managers felt overwhelmed by the new maintenance that needed to be performed and struggled to keep parks clean and safe for new and returning users. At the same time, administrators were heartened by the new surge of use and appreciation for parks and forested areas, and the ability to provide a vital space for New Yorkers during the early days of the pandemic. As one park administrator described:

> "It felt like every day was a weekend... people were using the park to do their job, working remotely, for their spiritual well-being, for physical activity, you name it. It was all happening in the parks. The level of trash that was generated was unprecedented so, in the parks we're teeming with activity, which was wonderful. But then there was that side effect." (NYC Parks, R4)

The impacts of these intensified maintenance demands were felt doubly as many parks lost significant staff due to city budget cuts in response to the pandemic. A city-wide hiring freeze eliminated crucial seasonal maintenance positions. One park administrator described the situation as having "twice as many people (in the parks) and half the staff" (NYC Parks, R9). Additionally,

social distancing rules prevented the gathering of large groups of volunteers, which for many land managers was a huge loss of maintenance labor on which they had come to depend.

Impacts of Racial Injustice Uprisings on NYC Parks

The murder of George Floyd and the subsequent uprisings against racial injustice had an impact on both how parks were used across NYC and the internal culture of NYC Parks. As public outrage grew, NYC Parks granted permits and allowed protesters to gather in publicly visible areas in parks such as sport fields and landscaped parkland, at times even working with local police forces to discuss the events before-hand and help to ensure the safety of the protesters.

> "Our parks are seen as a safe haven and when we did have protests and vigils for the most part, they were very constructive…. I found it very encouraging that the park was a neutral ground where people could come together in a very diverse neighborhood and things remained respectful." (NYC Parks, R4)

In addition to anti-police and BLM protests and vigils, NYC Parks staff also mentioned that there were other counter protests happening in parks, such as pro-police protests and, in one case, an anti-lockdown protest. There were some cases in which park administrators mentioned conflicts between BLM protesters and pro-police protesters which turned "violent" or "ugly." Another racially charged incident occurred in Central Park in May 2020 in which a white woman called 911 to report a Black birdwatcher after he asked her to leash her dog. This incident ignited further discussion on access, safety, and inclusion in parks.

Beyond protests and other actions happening in parks, this moment of national reckoning also stimulated discussion and reflection within the workplace. The NYC Parks Commissioner and senior staff sent emails reflecting on the moment in time. Additionally, the agency, starting first with people of color in a Black-only affinity space, planned and hosted listening sessions in which staff were able to share their feelings, not only about the current moment, but on the staff experiences with racism and agency culture as a whole. Many park administrators spoke of these communications and programs coming from the Commissioner favorably and mentioned that they had been examining their own prejudices and practices as a result of the cultural climate and resulting conversations and programs internal at NYC Parks. However, one NYC Parks employee was more critical of the conversations, appreciating their focus but wondering if they would lead to any lasting change in the agency: "From my perspective I think as a woman, as a person of color, as a New Yorker, as someone who works in a predominantly white division as a public servant in the city, it can be, incredibly challenging, but I do my best" (NYC Parks, R7). Many in the agency used this time of increased focus on racial injustice as a moment to reflect on the relationship between public land management and structural racism, beginning conversations and new programming that some saw as long overdue.

Learning and Adaptation: Relaxed Enforcement, New Programming and Messaging, and New Meaning of Public Space and Partnerships

We found that NYC Parks adapted the way park rules were communicated and enforced in response to COVID-19 and BLM protests. Respondents mentioned relaxing rules and allowing New Yorkers to use parks a bit more freely during the pandemic, as it was the only space people had to get out of their houses during the lockdown. Park supervisors were looking the "other way" as small groups gathered without permits. For example, personal trainers used the park for fitness instruction, dog walkers created play spaces for canines, and sports clubs met for practice in small groups. Additionally, in response to the BLM uprisings, NYC Parks staff made efforts to maintain a safe space for protesters. As one park administrator described: "We had protests and sit-ins in the park and we obviously, we weren't accepting permits at the time, but we knew that this was going to happen and we let it happen" (NYC Parks, R9). Some of this relaxed enforcement was clearly intentional, in other cases, enforcement in parks was reduced because of staff cuts which lead to fewer NYC Parks Enforcement Patrol officers in parks. What did not come up in interviews but was reported on extensively in the media (Noor, 2020; Schweber et al., 2020) around this time was increased enforcement of social distancing rules that targeted people of color in public spaces, causing the mayor to publicly reverse orders for police enforcement of social distancing.

In response to both budget cuts and the surge in visitation, the NYC government allocated funding for the hiring of social distancing ambassadors. These positions were created and exempt from the city-wide hiring freeze to help keep New Yorkers safe in parks. In many cases these new staff were also able to help with the increased maintenance burden and take on some of the tasks of the seasonal employees who were not hired. Parks staff also shifted their regular means of reaching out to the public in this unprecedented time. NYC Parks educators and rangers shifted their usual in-park programming to virtual, developing videos and online programming, often targeted to children doing virtual school at home. Park administrators that rely on volunteer maintenance were also able to pivot and create opportunities that allowed for social distancing, such as creating distanced zones and pre-described tasks that volunteers could spread out and complete on their own in the park.

In reflecting on COVID-19 and the BLM uprisings, many NYC Parks administrators looked upon the resources they manage and their role as public servants with a newfound appreciation. The term "essential worker" became part of the public vocabulary during COVID-19, often referring to healthcare and other frontline crisis workers. In this moment, parks workers began to receive recognition as essential workers as they kept the vital green spaces open and available to the public throughout the crisis. In one case, the Empire State Building and other prominent landmarks and buildings were lit green for the night in honor of Parks workers as part of the public recognition campaign #GoingGreenForParkies There was an overall sense of pride in the ability for parks to provide a place of respite as well as a place to protest, grieve, and mourn in the wake of these twinned

crises. Some expressed a hope that the intense visitation of and attention on city parks would result in a lasting change in the way New Yorkers support green space and parks.

> "I really hope that when the dust settles there will be increased interest in stewardship and advocacy. If people have spent more time in parks…. maybe this is an opportunity…for a new influx of people who have a real interest in the parks and how they are maintained and taking care of them and getting involved. So, I am optimistic that that is how that will change…in the next year and beyond." (NYC Parks, R5)

Our summer interviews coincided with this time or reflection and dialogue for the agency. Ongoing programmatic change in response to calls for racial justice and inclusion have continued. For NYC Parks this has included programming annual Juneteenth commemorations as well as going through a citywide process of park namings and re-namings as part of a larger effort to revisit whose stories are commemorated in our public lands. Many of these efforts to address racial injustice had long been discussed and debated with partnership groups and local residents but these matters took on a new urgency, momentum, and personal meaning among NYC Parks staff as a result of the stark revelations brought about by COVID-19 and the BLM movement.

Nearly all park administrators echoed a hope to expand and deepen their partnerships. It is important to note that NYC Parks has always relied heavily on public-private partners and, since the fiscal crisis of the 1970s, park conservancies have taken hold in many of the city's largest and most prominent parks. In some cases, park managers serve hybrid roles of being both a park administrator and the executive director of a conservancy group. Partnerships for Parks, as an outreach program incubated within NYC Parks, has long worked to foster collaboration and, as appropriate, create formal agreements with communities to care for parks or different types of public parkland. These stewardship groups have proven themselves to be part of the governance network of the city's public lands (see also Connolly et al., 2013).

NYC Park's network of civic partners' have shown their ability to respond to the needs of the public quickly and agilely during this time of crisis (see, Landau et al., 2021 this issue). In response to the loss of funding and staff and increased use of public space, several parks advocacy groups formed a coalition, the Parks and Open Space Partners–NYC (POSP). The group, made up of 20 organizations, worked quickly and nimbly to summarize the financial impacts of COVID-19 on NYC's public space (Parks Open Space Partners-NYC, 2020) and mount an advocacy campaign to bring private money to hard-hit parks. In response to these organizing efforts, a coalition of national, family, and community foundations launched the *NYC Green Relief & Recovery Fund* and distributed $3.6 million in grants to support stewardship organizations that care for NYC's parks and open spaces. The power of civic partners to organize support for public space was also evidenced in a number of virtual public forums and hearings. An October 2020 NYC city council hearing on parks and equity and a March 2021 hearing on the NYC Parks budget were attended by a number of civic partners and

city officials who provided testimony urging a reversal of the budget cuts to NYC parks and support for civic partners in their work of maintaining parks and making them more accessible and equitable to all. Some of the hearings, testimony, and interviews reflected on moments of learning in past budget crisis:

> "Quite frankly, we still have impacts following Sandy, but for the most part, we recovered. It took some time and it was frustrating but like New Yorkers, we came together. We had wonderful volunteers who helped us rebuild and so I think it was a good exercise, the muscles of knowing this too shall pass, like as frustrating as it is and we might have to redo and do over, but we will get through this and we have such a strong community of helpers." (NYC Parks, R4)

In this case, NYC Parks and partners were ready to adapt to the pulse of COVID-19 and felt the call to address the press of systemic racism. All respondents tended to agree that there is more work to do in addressing both crises but, for the moment, there seems to be a true awakening to the power of partnership networks, open dialogue, and shared messaging.

USDA Forest Service Eastern Region
Response: COVID-19

The Forest Service Eastern region can be characterized as a complex landscape of regulatory frameworks and prevailing socio-cultural norms. COVID-19 created another layer of variation as land managers worked to abide by federal and state directives and adapt to local conditions. In general, land managers felt that adaptation to COVID-19 had been swift. For some, this meant adapting to decisions made at the Governor's office, revisiting work for seasonal maintenance, or shifting plans for volunteer engagement. In certain cases, COVID-19 increased the level of planning and collaboration with partners.

> "In a typical year, we would meet quarterly. With COVID going on, we actually were on calls pretty much weekly every Friday. We're still coordinating and asking each other: How are you guys doing? Have you started doing this or that yet?" (Forest Service, R22)

Many managers recognized the need to immediately engage their partners and peers to ensure that they were being consistent in managing public lands across varied jurisdictions and sociocultural norms. Forest Service staff echoed pride in being able to provide free, open, and safe access to the national forests. At the same time, staff were cognizant that national forests are adjacent to other state, federal, and private lands with different jurisdictional and regulatory frameworks. Familiar with this patchwork configuration, many anticipated the need to create a more uniform approach to public access and recreational opportunities during COVID-19.

> "We have great communications with a lot of our neighbors. When we met, we included all of our partners from trails, recreation and the private sector and nonprofit sector, all were represented. We really tried to be consistent wherever we could." (Forest Service, R13)

Across all forests, staff responded to a sometimes-extreme uptick in visitation. Concern over comfort stations and trash was universal. Field workers needed to be deployed quickly but safely and only mission critical workers attending to issues of public safety were working in the office or in the field instead of teleworking from home. As visitation increased, many reflected on the challenge of thinking through a complex web of new protocols in real time, including the need for separate vehicles, field quarters, and actions that could be accomplished at a distance. As one respondent shared, "It's not so easy to shut down a national forest." Others anxiously expressed that novice visitors to remote forest areas might put themselves and others at risk, requiring additional work for a field staff that was already feeling the strain of COVID-19 conditions. Some respondents relied on partners to send "reports back" from places that were hard to reach, overcrowded, or where trail or other maintenance was becoming an issue.

In meeting this new challenge, Forest Service employees drew upon lessons from prior disturbances including floods, fire, and storms. While the agency's well-known "Incident Command System" was not officially deployed for COVID-19, the imprint of it was present in the agency's response to this novel disturbance. At the forest level, managers reported drawing upon well-established agency procedures for assessing and managing risk, such as performing Job Hazard Analysis (JHAs) to shape workplace and field protocols. At the leadership level, the Washington Office created Operation Care and Recovery as a "one stop shop" to provide internal resources for responding to the pandemic and the 2020 wildfire season. Still, many remarked that COVID-19 was different, as this crisis was not contained to discrete areas and outbreaks continued to shift across space and time. Instead, as the season progressed, so did the steady stream of visitors who spread out across the forest terrain, clustered in popular zones. Managers observed that if visitors were able to access a steady data signal, they would often make the forest their new office or school classroom for weeks.

> "We've experienced more families coming out. And younger individuals coming to the Forest, simply because they're able to. Either they lost a job or were laid off or they were able to do their work remotely as long as they could grab internet access or a phone." (Forest Service, R19)

Not unlike their urban counterparts in NYC, Forest Service staff were, overall, excited over this influx of visitors seeking to recreate in the woods. With so many more visitors engaging in recreational activities of all kinds, staff began to speculate where there might be a rise in revenue from permit fees (e.g., fishing, hunting). One manager remarked, "Because of COVID, we [recreation] have finally been validated within the agency. In the past, it's been all about timber and fire. That's who was getting the support and now I feel that people have realized that the public is really utilizing this land and recreation is an important part of the game." (Forest Service, R25) As one manager quipped, "You can never fully prepare for this stuff. My joke this whole time has been that two years ago we were worried about our relevancy and whether or not we were still relevant to the American public. Now I'm like, hey, we are *over* relevant now!" (Forest Service, R17)

With relevancy came responsibility and initially there were constant struggles with maintaining trails, toilets, and shelters. Visitor centers were often closed, and concessionaires were slow to open as they adjusted to COVID-19 protocols. The status of Youth Conservation Corps and seasonal volunteers at campgrounds and shelters, on which each forest depends, were in flux or canceled. Overall, there was an unmistakable pride in service that the agency was able to provide the public with this resource during a time of great tragedy and loss. Many were prepared to do whatever they could to extend the camping season and improve visitor experience as the forest had become a sanctuary for so many. These expressions were not devoid of concern for the cost of forest stewardship. Yet, nearly all respondents were hopeful that the Great American Outdoors Act would provide much-needed attention to the deferred maintenance of the nation's forests and grasslands.

Reflect and Connect: New Dimensions to Response and Recovery

In its long history responding to and recovering from wildland fire, the Forest Service has experienced workplace fatalities and has worked steadily to make safety part of its organizational culture. In recent years, the agency has addressed cases of gender discrimination; a series of very public sexual harassment and assault allegations were documented in a PBS news show in 2018 that news outlets reported may have contributed to the resignation of a former Chief (Baumgaertner, 2018). The Forest Service has expanded this commitment to safety to protect the public and its employees across all locations and categories of work. There is an informal motto that prevails among all levels of leadership: "safety first". Many respondents commented on this fact and that during COVID-19, being "safe" took on new meanings in relationship to co-workers and partners. Attending to emotional needs and related support appeared to draw colleagues closer to each other.

Many approached their external partners in this way, noting that there was no "official rulebook" on how to connect at this time. As one partnership professional shared, perhaps we rely "too much on tools" and what is really needed is to find ways to adapt, improvise, and connect with each other. Often the conversation would turn toward a respondent's concern for an individual–a loyal campground host who was elderly or a dedicated local volunteer who still wanted to "get out there" and help. Managers found that "sparks of innovation" would emerge, albeit small and measured, by simply checking in with partners. These innovations might include a new way to conduct training on-line, to crowdsource ideas, or to monitor distant areas of the forest. As one manager reflected, "I think we've all learned a lot more from each other and have gotten closer, trying to figure out our way through this together." (Forest Service, R24)

The ability to improvise in the social realm was not shared by all respondents. Many reported frustrations that much of their programming was "on pause" or their partners "went silent." As important as it was for land managers to share stories of adaptation, it was noted that not all staff, partners, or members

of the community held the same beliefs about COVID-19 or related sociopolitical issues. From those in the field, there were reports of dissent over everything from politics, to distancing protocols, to trail closures. Transboundary partnership groups became essential during the early days of COVID-19 precisely because they offered managers a trusted network of state and local partners. Many of these partnership groups were created to manage shared boundary waters or invasive pests–issues that transcend the forest boundary, but at this moment, groups were serving as a critical community response network. External partners served as a sounding board for tactics and strategies in adapting to COVID-19 and navigating the politics associated with the pandemic and racial unrest.

Responding to Racial Unrest: The Journey Continues

Nearly all land managers interviewed for this study perform roles that require them to engage with the public. Engagement might include serving as a liaison to a recreation club, coordinating corporate volunteers, shaping student field guides, or facilitating community meetings. Many of these respondents felt they had "lost the season" in terms of building social solidarity through shared field activities. Virtual meetings were an insufficient replacement for field work that might often start by "gathering around camp with a morning coffee" and setting intentions for the day. Many embraced virtual communication strategies out of a necessity to connect and expressed gratitude for technology as at least it offered them some a way to engage. For some managers, virtual technologies would help them adapt in the future.

> "When I came on board our social media was just there. It was, oh, this thing happened. And we took pictures of it. Posted it. Now we've really begun to get organized and plan for it. I'm really grateful for it. How else are we going to do this work across such a large area?" (Forest Service, R16)

However, coping and adaptation strategies were slower to form in response to racial unrest. When asked about how the murder of George Floyd and related uprisings might have had an impact on their work with partners, there was a significant pause in the interview conversations. Racial injustice of this magnitude was the disturbance for which there was no unified response or incident command protocol. For some, the summer's racial unrest seemed distant from both their job and their community. A few commented that they were concerned but uncertain on how to mediate the issue, so they did not engage. This was a particularly common response in places that managers described as "not very diverse" or "almost all white." One respondent remarked, "It really had no impact here." However, the vast majority of respondents expressed that the murder of George Floyd, BLM protests, and a summer of racial unrest had caused profound personal and professional reflection. Some took action to create dialogues among their staff or with close colleagues. Many reflected that over the years they had witnessed overt racism toward others while in their position. Others reflected on more recent incidents where they had directly experienced racism on the job.

> "Things really opened up when we had that conversation where we had multiple employees come forward and say, hey, this happened to me before. An incident happened to [a Native American Forest Service Employee] and she was coming out of a grocery store in town and somebody had made some comments and it's just very disheartening. It is so disheartening to feel that you're just not safe or welcomed, you know, for no apparent reason other than your appearance." (Forest Service, R14)

It was as if respondents were revisiting events and their communities of practice anew and seeing them in a new light.

> "I kept thinking about an incident on our forest and it was very unfortunate. We had a new [African American] deputy district ranger. He absolutely loved the [Local National Forest] employees and was very excited about his job. And this is the part that makes me sad because as I said, I was born and raised here. But he didn't feel comfortable in our community. He said that he was having some issues locally… People would say things to him, you know, holler things out of the car and stuff. After one incident, he ended up putting in for a transfer." (Forest Service, R14)

Several respondents were grateful for the federal laws that protect individuals' freedoms on public lands as they helped them navigate "spirited encounters" with those visitors who questioned social distancing and mask mandates to prevent the spread of COVID-19 or, those who wanted to express their political views on the forest. Forest Supervisors were helpful in providing guidance, but still many expressed being left to their own judgement when the "lines became blurred" in a certain moment.

In mediating issues, managers had to know and navigate the prevailing sociocultural norms that govern a particular place to be most effective. One respondent who had recently transferred to the forest was surprised at the difference in visitor behaviors when it came to public confrontations over identity politics. She described incidents during the summer where action was taken by Forest Service personnel to remove divisive flags, noting her co-workers' surprise over witnessing so many visitor conflicts this season. Another person shared that in any given year, local groups become agitated over the rights of Tribal members to hunt and fish within the forest, noting that this year was milder than the rest with regard to racially motivated incidents.

> "All that information is out there, but still a lot of people aren't aware that the Tribes actually restock this area, monitor it and help control things. Way before I got here, the National Guard had to get called in. But even this year, there was a shooting over this, and somebody was standing on shore, shooting over the heads of the guys [Tribal members] out spearing. Just trying to intimidate them and scare them off. Yeah, once a year or once every other year, we get these reports of someone shooting to intimidate and threaten." (Forest Service, R11)

The rights of Tribal Nations–including those which include tribal lands and heritage sites–were understood but not forefront in discussions around COVID-19, vulnerabilities, and racial unrest. Numerous interviewees mentioned that similar to the Forest Service campaign around safety, the agency had just begun

initiatives designed to address DEI issues prior to the COVID-19 pandemic. These initiatives include both an examination and affirmation of an inclusive agency culture (e.g., This is Who We Are; DEI trainings) as well as specific recruitment and hiring programs aimed at diversifying the composition of the Forest Service workforce (e.g., Resource Assistant Program; Generation Green; partnerships with Historically Black Colleges and Universities). The genesis of This Is Who We Are was, in part, a direct response to highly visible Forest Service incidents and misconduct involving gender issues, and it broadened over time to include other dimensions of discrimination, bias, and building an inclusive agency culture. While protesters were calling for social justice in many parts of the country, there was no pause in the message coming through the Forest Service's Work Environment Performance Office (WEPO); the Chief's Messages; and programs such as Operation Care and Recovery. A series of internal "listening sessions" were organized by WEPO, which is currently headed by a Black woman, and which centered stories of Black employees' lived experiences with discrimination and bias as a starting point for these discussions. In some cases, interviewees also noted that local sessions were also organized in the field and designed to create a space for employees to listen, share, and learn. There was clear appreciation for these efforts among respondents with many offering ideas to reshape partnerships and practice–by advocating for more inclusive hiring practices and engaging urban youth. Those who were adamant about systemic change were often near retirement, new to their position or had been assigned a role that valued diverse partnerships. While there appeared to be an overall desire for change, there was some skepticism shared by individuals or, as one respondent affirmed, by certain groups.

> "I was hearing this very loudly from even some of my supervisors. They were starting to feel ashamed. If you were white, you were starting to feel like you were the problem.... So, for now, we're focusing internally. And then the next year or two or three, we're really going to start going out with it to our partners and our stakeholders to say 'hey you know we're waving our Forest Service flag and we're proud of it. And we want you to be too." (Forest Service, R32)

The Forest Service, as an organization, is structured to know how, when, and to what degree to respond to the pulse of natural resource disturbance. Adapting to the press of systemic inequalities and achieving the changes needed to redress racism in any agency that covers such a large and expansive social geography will take time and perseverance.

DISCUSSION

From these two cases of municipal and federal land managers, we revisited Duchek (2020)'s model of organizational resilience, with an eye to adapting this conceptual model based on these public agencies and in the context of longer-term disturbances of COVID-19 and responses to racial injustice (**Figure 2**). We identify *organizational culture* and the specific consideration of *partnerships* as a component of social resources as key factors
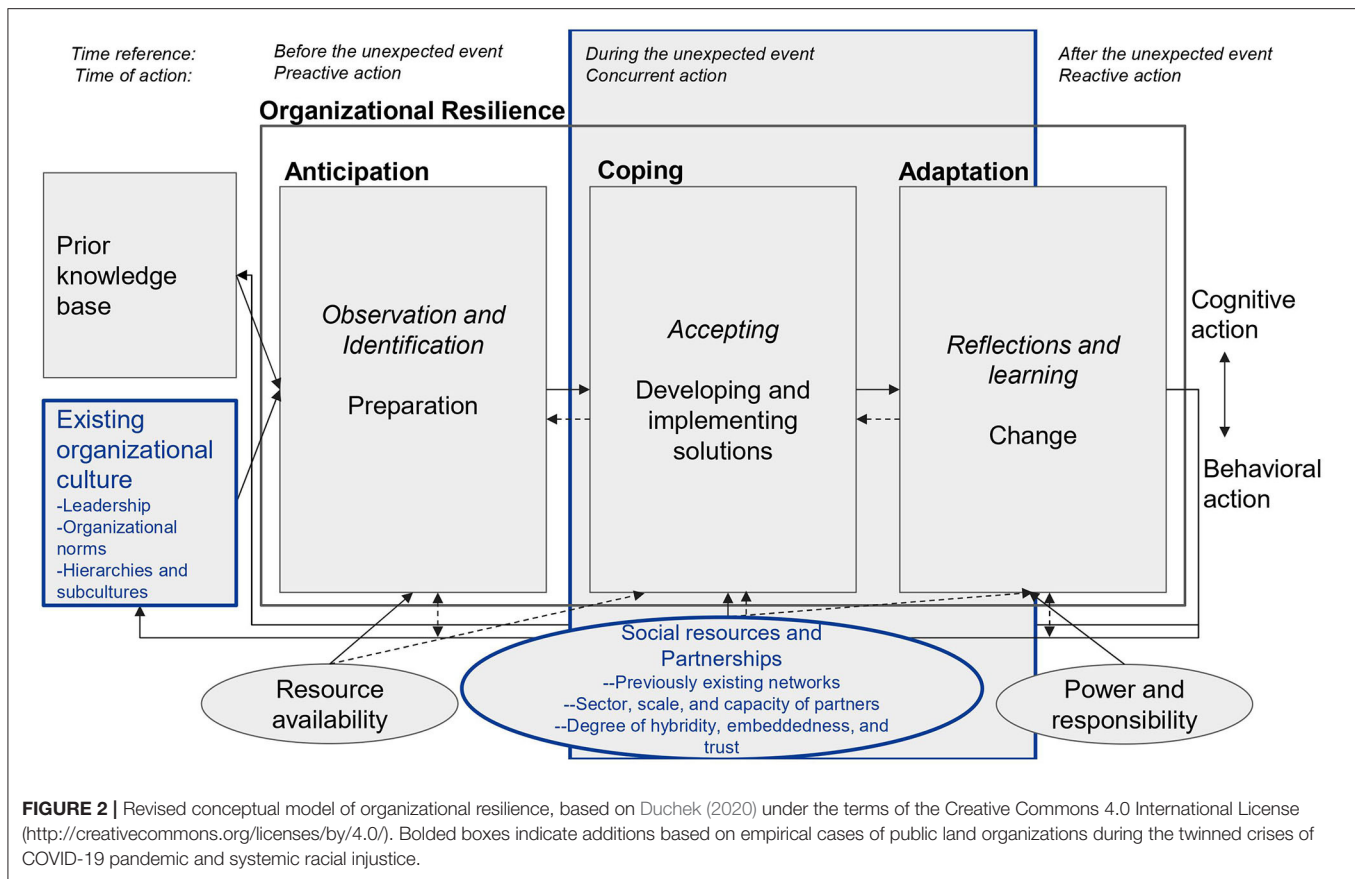
important to anticipation, coping, and adaptation processes. We also propose revisiting how "during" and "after" the event are conceptualized, as here we saw evidence of both coping and adaptation occurring over months of experiencing both crises. Across these two cases and two concurrent disturbances, we identified key themes that influenced coping and adaptation actions: *communications, partnerships,* and *organizational culture.* Communications are critical to organizational resilience, but we did not situate them in the conceptual model since they occur as both flows (e.g., the arrow between social resources and partnerships and coping) and as part of processes (e.g., accepting and reflecting). Following Duchek (2020)'s model and our updated model, our empirical work also highlighted arenas where cognitive actions such as accepting and behavioral actions such as measurable change inconsistently occurred, suggesting these actions may be happening at different scales within the organizations: individuals, field managers, and leadership.

Communications

Communication is key not only in the Forest Service, but also in many other complex organizations. The ways in which the public workforce share ideas and messages is critical to how organizational change occurs in large bureaucracies (Jones et al., 2004). Change must be mediated and discussed at all levels of the organization for effective organizational shifts and transitions (Lewis, 1999). Communication across a vast network is challenging when planned and anticipated, even more so in response to an unanticipated or unfamiliar disturbance.

Indeed, communication was an active area of engagement for land managers due to the need for both virtual connection during the pandemic and spaces for reflection and dialogue about DEI. NYC Parks placed a new emphasis on employee communications and reflections, encouraging staff to engage in listening to others' concerns. Many referenced internal sessions that inspired them to think differently about themselves, their work, and their community. There already had been a movement toward this type of reflective dialogue in the Forest Service to address issues of diversity and discrimination. The pandemic created space for external communications with partners and the broader community. It may be that the vulnerabilities brought to light by COVID-19 had prompted a shift in focus to a broader range of societal issues. This shift surfaced ideas for cross-boundary partnership networks with groups that focus on issues of diversity, vulnerability, and social change.

External communications by many public land agencies are primarily driven by a directive or the need to inform. The Forest Service provides life-saving information regarding conditions and public access. COVID-19 and BLM uprisings prompted the need for communication about complex, contentious, and unpredictable matters. Managers reported paying closer attention to social media to quell misinformation or unproductive dialogues. The pandemic marked a shift in the type of communication needed to be effective and responsive. Broadening the use of communications beyond signage to include active listening, exchange, and boundary spanning activities was the most common reflection shared by respondents in either public agency.

FIGURE 2 | Revised conceptual model of organizational resilience, based on Duchek (2020) under the terms of the Creative Commons 4.0 International License (http://creativecommons.org/licenses/by/4.0/). Bolded boxes indicate additions based on empirical cases of public land organizations during the twinned crises of COVID-19 pandemic and systemic racial injustice.

Shifting to virtual platforms had its discontents and virtues. Virtual communications gave managers a way to reach a broader public audience, but it was not always effectively used to make meaningful direct contact with partners. Many reasoned that it was the informal conversations about life and community that had built trust between groups. At the same time, the rise of virtual platforms–including the use of anonymous fora–for listening sessions, discussion, and training on sometimes sensitive topics related to DEI was cited as creating opportunities for "unfiltered," honest personal reflection and exchange that could lead to growth.

Social media also created a way to see how the public was using forests and parks during the pandemic. Many remarked that it was satisfying to know that public lands were appreciated by more people and were "on the radar" of the press and elected officials. Respondents noted that COVID-19 communications may have helped to expose a new generation of users to public lands. Public awareness raised hopes for new opportunities via grants, partnerships, donations, and legislative actions. The fact that public lands "belong to everyone" seemed especially cogent at this time. Land managers expressed pride in their work. Many shared examples of colleagues working in the field during the pandemic, noting the importance of their work every day and including during times of crisis.

Partnerships

Overall, networks, partnerships, and relationships have been theorized as key components of both adaptive capacity and social resilience at the organizational and community levels (see, e.g., Ceddia et al., 2017; Patel et al., 2017), including in particular for collaborative recreation management (Selin et al., 2020). Amid an unprecedented disturbance, we found land managers from both the Forest Service and NYC Parks were able to assess, adapt, and respond to a changing set of conditions that directly impacted the use and meaning of public lands, in part through their networks and partnerships working to amplify capacity (see, e.g., Bodin and Crona, 2009). Partnership activities were initially paused but, in nearly all cases, managers adapted and engaged with partners. In NYC, partnership networks were activated almost immediately with little or no prompting but drew upon existing networks rather than forming *ad hoc* ones as observed during other crises (per Weick et al., 1999). Private foundations quickly joined with civic stewardship groups in lending support through fundraising, social media, and hosting public forums in support of urban public land (see also Landau et al., 2021 this issue) Collaboration continued throughout the year including through the summer's protests over racial injustice prompted by the murder of George Floyd. NYC's park network was poised for action, as it engaged in both coping and adaptation processes.

Still, the partnership landscape of both agencies remains uneven with certain geographies having more civic capacity

than others. Perhaps because NYC was an initial focal point of the pandemic in the United States, its partnership network responded with the intensity of the crisis itself. Forest Service counterparts often described their network's response to the pandemic as watchful or unsure, reflecting the uncertainty of how or when the pandemic would impact their communities. Transboundary groups seemed to offer the type of support and collaboration that the Forest Service needed for wayfinding among partnership groups and a more expansive geographic terrain. Many of these partners were able to share how their local communities were impacted and adapted to COVID-19 so that agencies could adjust their actions to be more consistent across public lands.

Comparatively, there did not appear to be the same level of transformative change in Forest Service partnership networks other than to serve as a "check in" for COVID-19 protocols, field activities, and some emotional support. While the partnership network was functional, it did not adapt and respond with the same intensity of the urban partnership network. There was no mention of new partnerships emerging in response to the summer of racial unrest. There was no clear indication that the Forest Service staff sought out, leaned on, or activated its partners over issues related to environmental justice, diversity and inclusion, or vulnerable populations. While many did not specify recommendations for future action, there was a strongly expressed desire for change. These findings add to our understanding of the transformative potential of network governance in land management (Scarlett and McKinney, 2016; Steen-Adams et al., 2020).

The complexities of addressing systemic racism and vulnerable populations presented a greater long-term challenge than the rapid adaptations to COVID-19 for land managers in NYC and throughout the Eastern Region. The most significant difference between these two organizations was that not everyone in the Forest Service network agreed on the problem and/or how to address it through partnerships and collaboration (see coping processes, **Figure 2**). In both cases, there was a great deal of reflection on staff composition and agency responsibility, highlighting cognitive actions that could lead to adaptation. These reflections highlighted the need to attend to the particularities of place. At the same time, there was a desire to identify ideals that could transcend place and inspire shared aspirations across the region. Forest Service staff had limited ways to grow their partnership networks, expressing that staff capacity or local conditions, particularly in rural areas, were limited in terms of financial and human resources. This inertia was a clear counter to NYC Parks' partnership network that had become a persistent driving force of resources and adaptation.

Organizational Cultures

Kaufman (1960) identified the importance of both procedural and reporting techniques and line-level bureaucrats, such as the Forest Supervisor and District Ranger, in modeling and enacting organizational culture, as well as the role of details and lateral moves across geographies as pathways to promotion that create internal coherence by ensuring that staff remain connected to the central mission of the agency more than the particulars of any

place or community. Since the 1960s, American society has gone through numerous transformations, including the civil rights movement, the passage of key federal environmental legislation including the National Environmental Policy Act, and changes in technologies of communication – all of which have shaped the composition of the Forest Service as well as the way in which it manages land and interfaces with the public (Tipple and Wellman, 1991; Koontz, 2007; Burton, 2012). The cultural turn influenced by the rising environmental movement alongside the shift in the American economy toward post-industrialism, lead to the rise of an "ecosystem management paradigm" in the Forest Service (Kennedy and Quigley, 1998). Examining this shift to ecosystem management, Sabatier et al. (1995) point to the role of a shared agency ideology in creating similar behavior of local Forest Service officials in the 1980s. Considering a context of compound crisis such as COVID-19 and systemic racial injustice, organizational structures and cultures–including top-down leadership (Maak et al., 2021), readiness of employees as "change recipients" (Armenakis and Harris, 2009) and the role of public service motivation (Wright et al., 2013) are key to consider when examining the potential for transformation within hierarchical, public bureaucracies.

We found that while public land management is structured to respond to disturbances that are typically related to extreme weather, visitor safety, wildlife, and wildfire, responding to the impact of COVID-19 was different in several ways for the land management community and forming a shared ideology. COVID-19 had some degree of impact on all staff and visitors that required actions to take place within households, the workplace, and broader communities. Some staff were more vulnerable than others to the pandemic. Agency response protocols were tested and changed in real time and needed to be adjusted to the local context. Coping with this disturbance required different and new expertise, suggesting this disturbance acted as a focusing event for the agencies' learning and adaptation (see Michaels et al., 2006). Still, many of the skills needed were within the scope of public land management and outdoor recreation. It was the murder of George Floyd, as a pulse within the press of systemic racism, that may have triggered a closer examination of land management in terms of who it is designed to serve, employ, and how the land itself holds meaning for different societal groups. Only time will tell whether the vulnerabilities revealed by the pandemic and the BLM protests will rewrite the cultural code that shapes organizational knowledge and practice.

From their own locational vantage points, land managers relaxed the rules a bit during the 2020 peak recreation season as they tried to navigate the social context of the pandemic and societal unrest. More visitors were allowed to press onward into wilderness areas or to use campground sites for extended stays. In NYC, parks were occupied at all hours of the night and used repeatedly as sites of protest, with or without the permits to do so. Both agencies remained flexible and adaptive to public needs despite staffing challenges in either covering vast areas of a regional forest or densely populated urban areas. It was a time of critical coping for both organizations. Organizational leadership played a key role in the response variation to racial

uprisings cited by respondents in both agencies. Many reported being influenced by either their agency head, their park or forest supervisor, or a trusted colleague, supporting previous research around trust as crucial to effective management by Davenport et al. (2007). NYC Parks staff typically referred to the Parks Commissioner, a Black man, as a key influencer at this time. Staff noted the Commissioner's office offered clear direction to learn, listen, and engage with their co-workers, partners, and the community. Some Forest Service respondents pointed to the importance of having Black leaders within the agency speak up and lead, particularly in the context of the creation of the permanent WEPO office and the listening sessions it led. There was much more variation in the response by Forest Service staff. Some land managers drew inspiration and support from their Forest Supervisor and others, directly from their colleagues. Some mentioned that they felt "left in the moment" to determine a course of action for themselves as they became more aware of place-based cultural norms. From a DEI perspective, individual responses reflected a spectrum of values and beliefs that included those who might be typed as a proactive ally, a neutral agent, or a person holding counterproductive views. Several mentioned learning from prior bias incidents or participation in listening sessions as helpful to them at this time. Historically, the Forest Service has a shared ideology (see Kaufman, 1960) that typically shapes similar behavior of local Forest Service officials (Sabatier et al., 1995). However, like Lipsky's (1980) work, Sabatier et al. (1995) also points to differences within the hierarchy, with a preference to adjust directives from regional or national level offices, if they caused problems locally or conflicted with local professional judgment. Our findings signal this sort of small but substantial shift in organizational culture and affirmed the influential role of street level bureaucrats (Lipsky, 1980; Trusty and Cerveny, 2012; Moseley and Charnley, 2014) in shaping aspects of the organization from the field.

Within each agency there are different structural hierarchies and organizational subcultures within those hierarchies. Organizational hierarchies and subcultures are related to the institutional positions of each agency. NYC Parks as a city agency that directly reports to the Mayor of the City of New York who, during this time, called for direct engagement and attention to racial inequities. As an agency under the US Department of Agriculture, the Forest Service is located within the Executive Branch of the federal government. During this same period, the US President was signaling strong disinterest in such issues, eventually signing an Executive Order prohibiting the use of federal funds for DEI training addressing racial injustice and racial bias. Given this complex political landscape, the organizational trajectory that the Forest Service was moving ahead on prior to COVID-19 with regard to DEI awareness and engagements became particularly important in how to frame current actions, adaptations, and future work with staff, partners, and local communities.

In a large public bureaucracy, it can be challenging not only to "sing with one voice," but also to find one's voice. When individuals were asked about learning from both COVID-19 and BLM uprisings, there was a resounding hope for the future that was largely unspecified in nature. This lack of specificity does not indicate a lack of vision. It suggests an understanding that there are rules that dictate the behaviors of government employees while performing their duties as well as place-based sociocultural norms. It is within the space between organizational hierarchy, subcultures, and the street level bureaucracy that adaptive strategies are formed. Although visions for the future may still be forming in the minds of many land managers, there was consensus on the need for change and that positive change had happened before. How will change be mitigated as a result of COVID-19 and the call for racial justice? What role do new partnerships have in shaping that change and the future of public land management? Perhaps, as observed in other bureaucracies, changes will happen in an *ad hoc* manner, but also create improvements that endure (per Newig et al., 2019).

CONCLUSION

By documenting how public land managers across the northeastern United States responded to the first 9 months of the pandemic, this study builds understanding of how adaptation can strengthen resilience to future disturbances and expands Duchek's conceptual model of organizational resilience to include organizational culture and emphasize partnerships. Understanding such efforts has implications beyond public land management, as "the resilience of a public administration…raises questions about the extent to which societies are able to purposefully reform themselves based on lessons from the past" (Duit, 2016, pg. 376). Our work builds upon scholarship that has examined stewardship of nature and social resilience in the wake of acute, chronic, natural, and human-made disturbances including September 11th, 2001, hurricanes, floods, wildfires, and pest invasions (Campbell et al., 2019) and advances our understanding of the novel, compound crises of COVID-19 and systemic racial injustice. The stressors of COVID-19 caused land managers to assess, cope, and adapt to a shifting set of conditions. Responding to a pandemic affecting human populations arguably does not align easily with the mission of public land management. Yet, urban parks and national forests became critical resources for millions of people during the pandemic. In some locations, the impact of COVID-19 was not felt strongly enough at the time to directly impact partnerships or organizational culture and in others, it has been a driving force revealing the importance of recreation and use of public lands. This raises a question of how large bureaucratic organizations can structure adaptation and change, especially when the acceptance, interpretation, and impact of the disturbance may differ depending upon organizational subcultures and uneven access to personnel, partnerships, and related social resources. In caring for the land, it may be a useful precept for natural resource agencies to anticipate and attend to integrative socio-cultural aspects, at any scale, of any given disturbance.

Across both cases, we found abiding: reports of increased public lands usership; calls for investment in maintenance; need for diversity, equity, and inclusion in both organizational settings and landscapes themselves; and the potential for strengthening workforce capacity on public lands. First, communication

is key, particularly the need to foster two-way and lateral communication, including on virtual platforms. The most effective leadership has been that which has been open, honest, and reflective, while remaining focused on the core mission to support both land and people. Second, transboundary partners and polycentric environmental networks are critical for public lands management, as these relationships are useful in responding to both press and pulse disturbances. Last, COVID-19 and the BLM movement have revealed that organizations' cultures exist alongside subcultures within public land management. These subcultures are shaped by prior histories, social geographies, and leadership and have the potential to shape larger organizational culture and policies.

Understanding environmental governance during a time of cascading and compounding disturbances is challenging and we find ourselves at a crossroads. The institutional landscape will undoubtedly change as organizational culture shifts in response to greater awareness and reflection, including assessing the impact of policies and programs on issues such as social equity. In this way, actions by NYC Parks or the Forest Service in response to COVID-19 and the BLM uprisings should not be assessed as "better or worse, "but simply affirming that organizational culture is an active and important agent within these institutions. In both cases, we found processes and pathways unique to time and place but driven by organizational culture and partnership interests. For example, at the time of this research it was clear that NYC Parks responded to a dynamic and demanding social network of individuals, groups, and partners who were able to quickly establish a shared course of action in support of urban environmental governance. The reason for this successful transformation remains speculative but may suggest NYC's pre-existing density of partners, intensity of exposure to the virus in the spring of 2020, and the ensuing departmental budget cuts during a time of peak demand for public space resulted in transformative actions. Both agencies used internal adaptive mechanisms to respond to COVID-19 and the BLM uprisings while providing core services. Those who kept in virtual contact with external partners and relied on internal peer networks tended to think more reflectively about inherent social inequities regarding program and practice than those who engaged less often with new or existing partners. This observation opens the door for further inquiry into the role that partnerships and social networks play in flexibility and adaptation to compound disturbances, including complexities facing interstitial public lands along the wildland-urban interface. How can an organization become more flexible and responsive to underlying inequities and engage with new networks and coalitions, while staying on track with its abiding mission? How

and when do partnerships begin to shape the organizational culture of land management agencies? Continuing to observe public agencies as they adapt to these and future disturbances in an increasingly unstable world (Harrison and Williams, 2016) offers an opportunity to empirically understand and possibly anticipate future adaptation and response.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Rutgers University Institutional Review Board. The participants provided their informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

ES co-led the conceptualization of the research question and study design, co-led Forest Service interviews, participated in coding and analysis, and led the Forest Service case, discussion, and conclusion. LC co-led the conceptualization of the research question and study design, participated in interviews, co-led coding and analysis, and led the introduction and literature review. SP led NYC Parks and Forest Service interviews and participated in coding and analysis, and led the NYC Parks case. MJ participated in conceptualization of the research question and study design and participated in interviews, coding and analysis, and led the conceptual diagram revision and framing within the literature. All authors participated equally in writing.

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Understanding Multiple Dimensions of Perceived Greenspace Accessibility and Their Effect on Subjective Well-Being During a Global Pandemic

Megan Maurer [1,2*†], Elizabeth M. Cook [3†], Liv Yoon [1], Olivia Visnic [3], Ben Orlove [1], Patricia J. Culligan [4] and Brian J. Mailloux [3†]

[1] The Earth Institute, Columbia University, New York, NY, United States, [2] Department of Geosciences and Natural Resource Management, University of Copenhagen, Frederiksberg, Denmark, [3] Environmental Science Department, Barnard College, New York, NY, United States, [4] College of Engineering, University of Notre Dame, South Bend, IN, United States

The COVID-19 pandemic has demonstrated how the accessibility of greenspace can shift in response to social-ecological disturbance, and generated questions as to how changing dimensions of accessibility affect the ecosystem services of greenspace, such as improved subjective well-being. Amidst the growing consensus of the important role of greenspace in improving and maintaining well-being through times of duress, we examine how access to greenspace is affecting subjective well-being during the COVID-19 pandemic. Both the relationship of greenspace to subjective well-being and the barriers to greenspace access are well-established for normal conditions. Much remains to be known, however, about how barriers to access and the effect of greenspace on subjective well-being shift in response to periods of social duress, such as the current COVID-19 pandemic. Using data from surveys and interviews conducted with 1,200 university students in the United States during the spring of 2020, we assess the effect of going outdoors on subjective well-being, commonly experienced barriers to going outside, and how these barriers in turn affected subjective well-being. We find that time spent outside, particularly in greenspace, correlates with higher levels of subjective well-being, and that concern over COVID-19 risk and transmission negatively affects this relationship both in reducing time spent outdoors and the subjective well-being benefits. We also find that type of greenspace (public vs. private) does not have a significant effect on subjective well-being, that while those in areas with lower population density have significantly higher subjective well-being when outdoors, all participants experience a statistically equal benefit to subjective well-being by going outside. Our findings suggest how understanding the ways dimensions of accessibility shift in response to times of social duress can aid public health messaging, the design and management of greenspace, and environmental justice efforts to support the use of greenspace in improving and maintaining subjective well-being during future crisis events.

Keywords: subjective well-being, risk perception, COVID-19, greenspace accessibility, urban-rural differences, environmental justice (EJ), public greenspaces, cultural ecosystem services

INTRODUCTION

In the spring of 2020, life dramatically changed for millions as the COVID-19 pandemic spread across the globe. In order to protect the health and safety of residents, governments introduced a series of mandates to stay at home, wear masks, maintain six feet of distance ("social distancing"), and close schools, parks, and non-essential businesses (Courtemanche et al., 2020; Guy et al., 2021). These response measures, while necessary to stop the spread of COVID-19—the disease caused by severe acute respiratory syndrome coronavirus 2 (SARS COV-2)—also created a severe social disruption by curtailing activities outside the home, including time spent outdoors in parks and other greenspaces (Badr et al., 2020; Moreland et al., 2021). While access to greenspace will likely return to pre-COVID norms once this pandemic is over, it is unlikely that this current disruption will be the last time people around the world experience an event that limits access to, and perceived accessibility of, greenspace. For example, the ongoing climate crisis includes a number of potential social-ecological disturbances, including infectious disease outbreaks and increased heat waves (Smith et al., 2014; Depietri and McPhearson, 2018), which might also limit or prevent outdoor activities. Currently, however, little is known about how changes in greenspace accessibility during times of social disruption and crisis affect the health and well-being of individuals.

The COVID-19 pandemic has, and continues to, take the lives of millions around the world; it has also exacted a toll on the physical and mental health, economic security, and overall well-being of people everywhere. The threat to health and safety posed by the disease itself, in conjunction with the social and economic costs of measures necessary to stop its spread, are largely responsible for these negative health effects. However, there is also reason to believe that reduced time spent outside due to stay-at-home orders, and in particular reduced access to greenspace, might also have negatively affected the health and well-being of individuals and communities (Galea et al., 2020; Slater et al., 2020). In this paper greenspace is understood through definition and example based criteria (Taylor and Hochuli, 2017) as a spatial area with some degree of vegetation such as a park, tree-lined sidewalk, or yard. In order to understand how reduced access to greenspace impacts human health and well-being during conditions of crisis, it is important to develop a more nuanced understanding of greenspace access that accounts for the multiple dimensions of perceived accessibility, including perceptions of risk as affected by pandemics and other such disturbances. The goal of this paper is to advance such understanding by examining the effect of being outdoors on subjective well-being during the COVID-19 pandemic and how this relationship is affected by changes in perceived greenspace accessibility, including the perceived risk of going outside.

Subjective Well-Being and Greenspace Access

Improvements to subjective well-being are one of the many ecosystem services associated with greenspace (Herzog et al., 2003; Russell et al., 2013; Jennings et al., 2016;

van den Bosch and Sang, 2017). Following the existing literature, we define subjective well-being (SWB) as a composite of an individual's perception of satisfaction with their life as a whole, their happiness at the present or given moment, and their level of stress and/or anxiety (Diener and Suh, 1997; Manderscheid et al., 2010; Das et al., 2020). Previous research has identified direct relationships between greenspace and improved SWB. Important factors influencing SWB include the quantity of available greenspace (van Dillen et al., 2012; Houlden et al., 2018; Cleary et al., 2019), frequency of visits to greenspace (Fretwell and Greig, 2019; Grilli et al., 2020), biodiversity of the greenspace (Carrus et al., 2015; Cameron et al., 2020), perceived restorativeness of greenspace (Grahn and Stigsdotter, 2010; Lin Y.-H. et al., 2014; Subiza-Pérez et al., 2020), and feelings of connectedness to nature (Nisbet et al., 2011). Frequency of greenspace use has also been shown to be mediated by greenspace design, landscape attributes, and amenities—factors which also influence the perceived accessibility of greenspace (McCormack et al., 2010; Roberts et al., 2019; Grilli et al., 2020).

Perceived accessibility, which is conceived of including both the ability to physically access a space and the extent to which it is socially acceptable or desirable to do so, is in turn associated with changes in SWB (Deng et al., 2019; Wang et al., 2019). Perceived accessibility is thus influenced by greenspace access—understood here as the relative ability of an individual to have contact with a vegetated area—as well as individual, social, and cultural factors, all of which can interact in spatially and temporally specific ways. As such, perceived accessibility is subject to change with respect to social and environmental context, public norms, and individual perceptions; moreover, which factors most influence perceived accessibility are also subject to change in similar ways. Thus, rather than conceive of perceived accessibility as a two-dimensional continuum (from low to high), in this paper we present perceived accessibility as an attribute of greenspace that possesses multiple dimensions, which shift in importance with respect to time, space, and social position of greenspace users.

During the COVID-19 pandemic, stay-at-home orders and concerns about the risks of disease transmission have potentially decreased both the availability and perceived accessibility of greenspace. While emerging research documents changes to greenspace use (Ugolini et al., 2020) and the demographic profiles of park users (Derks et al., 2020; Rice and Pan, 2020; Uchiyama and Kohsaka, 2020), recent studies also document increases in the number of people going to greenspaces (Derks et al., 2020; Fisher and Grima, 2020; Rice and Pan, 2020; Venter et al., 2020; Geng et al., 2021). It remains to be seen whether changes to availability, perceived accessibility, and frequency of use in a time of stress translate into changes in the ecosystem services provided by greenspace, including individual SWB.

Moreover, the pandemic is also potentially affecting factors known to negatively influence the relationship between greenspace and SWB. Foremost among these previously identified factors are concerns with safety and perceived safety (Lai et al., 2020). Here, both vegetation and spatial arrangement of greenspace have been identified as influencing the degree of perceived safety (Jorgensen et al., 2002; Jansson et al., 2013; Sreetheran and Van Den Bosch, 2014; Lis et al., 2019;

Mouratidis, 2019). Greenspaces with lower levels of perceived safety, lack of physical access, and disamenities, such as poorly maintained facilities, litter, or unwelcome uses, are associated with lower measures of SWB and often result in lower rates of use (McCormack et al., 2010; Weiss et al., 2011; Wang et al., 2015; Zhang et al., 2015; Cheesbrough et al., 2019; Roberts et al., 2019; Groshong et al., 2020; Jarvis et al., 2020; Sonti et al., 2020). Moreover, physical access to greenspace in the US is disproportionately affected by race and socioeconomic status, with Black, Indigenous, and people of color (BIPOC) and those with incomes below the national median having lower access to greenspace than white, higher-than-median income individuals (Heynen et al., 2006; Wolch et al., 2014; Nesbitt et al., 2019). The COVID-19 pandemic has introduced additional barriers influencing greenspace access, such as crowding and park closures (Shoari et al., 2020; Ugolini et al., 2020), though these findings may not be conclusive (Rice and Pan, 2020). Overall, further information on the barriers to greenspace access, changes in perceived accessibility, and perceived risk is needed.

Population density and relative amount of greenspace can also impact SWB. While urbanites may have lower available greenspace area per capita than suburban or rural residents, population density itself has not been shown to be a factor influencing the relationship between greenspace and SWB (Maas et al., 2006; Dennis and James, 2017; Coldwell and Evans, 2018). For example, Tyrväinen et al. (2014) found both an urban park and a woodland outside the city had similar effects on psychological and physiological stress levels when compared to an unvegetated city center. This suggests general greenspace experiences, regardless of surrounding population density or built landscape, can have an important positive effect on a person's SWB (see also Van den Berg et al., 2014). Meanwhile, research on differences between public and private greenspace are mixed, with some studies suggesting public greenspaces provide well-being benefits—or "substitute"—where private greenspace is not available (Maat and de Vries, 2006), while other research indicates that users of private greenspace are also more likely to access public greenspace (Lin B. B. et al., 2014).

Due to stay-at-home orders and park closures during the COVID-19 pandemic individuals in less densely populated areas, and / or with access to private greenspace (such as a yard or rooftop garden), may have more available greenspace with a higher degree of perceived accessibility and safety than those with only access to publicly available greenspaces. Results from Poortinga et al. (2021) suggest that COVID-19 may be influencing the relationship of access to private greenspace—and thus the role of population density or degree of urbanicity—to SWB. It remains to be seen what greenspaces people are utilizing, the barriers to access, such as crowding or risk of disease transmission, they perceive, and the effect of both on SWB.

Understanding the role of perceived accessibility in people's subjective well-being during the COVID-19 pandemic is necessary for assessing the full impact of this event (McCunn, 2020; Samuelsson et al., 2020). Understanding how the provision of ecosystem services like SWB changes can in turn aid both continued response to this protracted pandemic (Salama, 2020), and responses to future social and ecological disturbance.

Thus, we ask if and how disruptions to perceived greenspace accessibility affect SWB. We specifically investigate three questions: (1) What effect does going outdoors, for the purpose of being outside, have on subjective well-being during the COVID-19 pandemic?; (2) how has the perceived accessibility of greenspace changed during this period of disruption, particularly with respect to changes in perceived risk of going outdoors? and; (3) do these changes influence the observed relationship between greenspace and SWB?
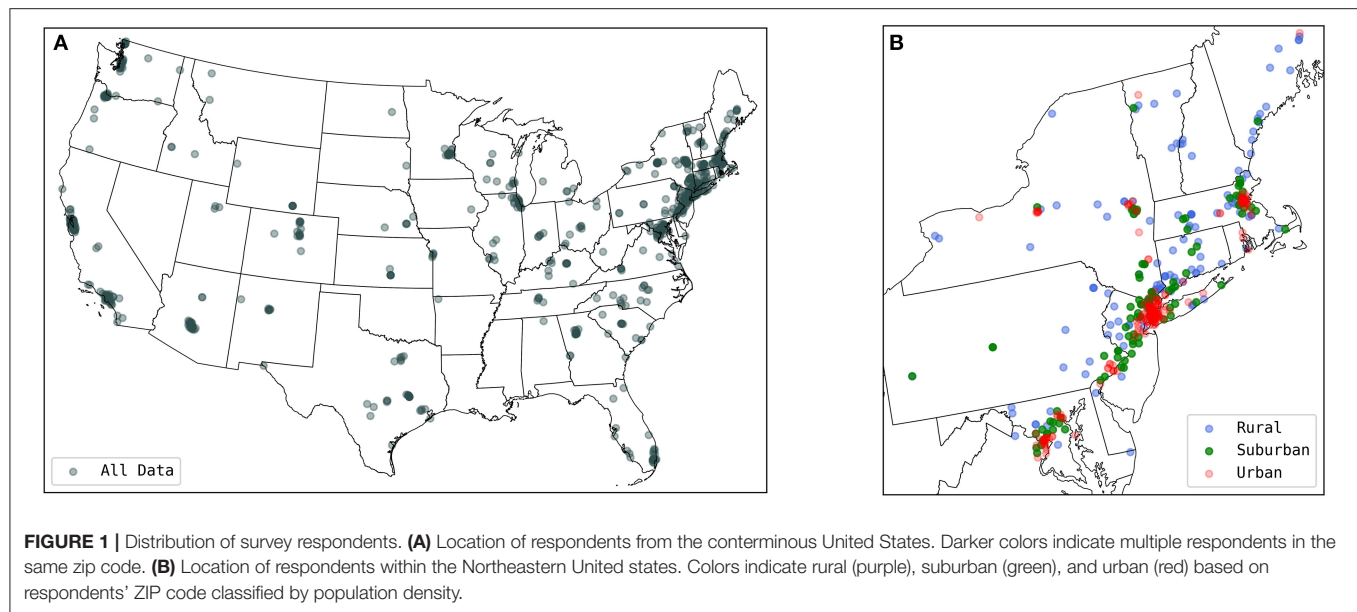
METHODS

To investigate our research questions, we conducted an online survey and semi-structured video interviews with undergraduate and graduate students across the US. As campuses closed across the country in spring 2020, most students either returned home or remained in off-campus housing, resulting in a respondent population living in a wide range of landscape contexts. Furthermore, this population experienced a shared form of disruption from the closure of campuses and the switch to remote learning. We analyzed the quantitative and qualitative data from surveys and interviews alongside 2018 American Community Survey (ACS) Census socio-demographic data. Research design and instruments were approved by the Barnard College IRB and informed consent was used for both surveys and interviews.

Survey

The survey instrument featured 40 questions divided into five main sections: (1) general background, including location and living situation; (2) self-reported SWB; (3) greenspace use and perceived accessibility; (4) risk perception regarding COVID-19 and outdoor activity; and (5) demographics (**Supplementary Material 1**). We asked participants to rate, on a 1–10 scale, their SWB based on overall life satisfaction (hereafter "well-being overall"), momentary SWB at the time of survey (hereafter "well-being now"), and SWB during the last trip outdoors (hereafter "well-being outdoors").

Surveys were distributed online and were designed to be completed in ∼ 15 mins. Participation was anonymous. The survey was distributed through convenience snowball sampling through personal contacts and colleagues at higher educational institutions across the country, which resulted in participants from 71 academic institutions (Table 1 in **Supplementary Material 2**). Surveys were distributed between April 12, 2020 and May 15, 2020, and survey responses were received through May 23, 2020. Of the 1,130 responses, 85% ($n = 964$) of the respondents completed 98% of the survey and 8.5% ($n = 93$) completed at least 40% of the questions.

Survey respondents reported the zip code in which they were currently residing at the time of the survey. Using the zip code, we joined US ACS Census demographic data (2018 five year average) to calculate population density within each zip code. Following US Census designations, we classified zip codes as high population density urban (>1,159 persons km^{-2}), medium population density suburban (386–1,159 persons km^{-2}), and low density rural (<386 persons km^{-2}; U. S. Census, 1994). Survey responses were analyzed in R (R version 4.0.2) and graphed in

FIGURE 1 | Distribution of survey respondents. **(A)** Location of respondents from the conterminous United States. Darker colors indicate multiple respondents in the same zip code. **(B)** Location of respondents within the Northeastern United states. Colors indicate rural (purple), suburban (green), and urban (red) based on respondents' ZIP code classified by population density.

Python (3.6.6). Analyses were conducted using parametric t-test and one-way analysis of variance (ANOVA) analyses.

Study Population

Participants in this study were drawn from the population of students (undergraduate and masters level) attending US post-secondary educational institutions. The study sample was 57% white and 26.5% people of color, including 6.7% East/Southeast Asian, 3.7% Latinx, 3.5% South Asian, 2.2% Black/African American and 9.5% who reported more than one race (Table 3 in **Supplementary Material 2**). When compared to the undergraduate student population in the US, our sample aligns with national demographics for white and Asian students (55.2 and 7.3% of US-wide student population, respectively), but under-represents Black (13.4%), Hispanic (19.5%), and Native American students (0.7%) (NCES, 2019). Respondents were approximately evenly distributed by class year (13.7% in first year of school, 14.8% second, 19.5% third, 22.9% fourth, and 13.8% post-graduate) and 42% ($n = 470$) of the sample reported receiving some form of financial aid (Tables 4, 5 in **Supplementary Material 2**). As a result of the large participation ($n = 343$, 30%) by Barnard College students (an all-women institution), 67% of respondents identified as women, 15% as men, 1% as non-binary, and 16% did not report their gender (Table 2 in **Supplementary Material 2**). Our sample was distributed across 45 states, including Alaska, and 788 US zip codes (**Figure 1**). To further understand the spatial distribution of our sample, we classified individuals as living in rural ($n = 288$, 25.5%), suburban ($n = 221$, 19.6%), or urban ($n = 580$, 51.3%) areas based on the population density of their ZIP code following the US Census urban-rural classification (U. S. Census, 1994).

Interview

Survey respondents indicated if they were willing to volunteer for a follow-up interview. Four hundred sixty-nine survey

participants (42.4%) answered yes and provided adequate contact information. To select interview participants, volunteers were sorted into six bins based on population density of reported ZIP code and self-reported risk associated with going outdoors. For the first round of interview requests, 20 individuals were contacted from each bin (120 individuals total). Individuals from each bin were selected based on the race and gender categories in order to best match the demographics of the US undergraduate population. Where the number of survey respondents was insufficient (e.g., number of men and BIPOC), additional individuals from other demographic categories (e.g., white and/or women) were sampled to achieve 20 individuals for that bin. First-round requests were distributed *via* email on May 12, 2020. The sampling process was repeated for two additional rounds, on May 17 and June 6. At this point interviews had reached saturation—that is, additional interviews were not generating novel responses or new themes. The total number of individuals contacted for interviews was 356 and the total number of completed interviews was 72.

Interviews were scheduled using the online service Calendly and conducted over Zoom. Consent forms were submitted *via* email. All interviews were recorded, but only the audio tracks of interviews were saved. All audio recordings were transcribed using the online service Rev. Interviews were semi-structured and consisted of 12 questions, covering topics of living situation, well-being, greenspace access, risk perception, and connection to nature (**Supplementary Material 1**). Interviews ranged in duration from 30 to 60 mins. Interviews were one-on-one, conducted by one of four research team members.

Interview transcripts were uploaded into the coding software Dedoose and a team of three researchers completed two rounds of content-based coding. The first round of coding used codes derived from the research questions and aligned with the survey questions. During this process emergent themes were identified and additional codes created. A second round of coding was
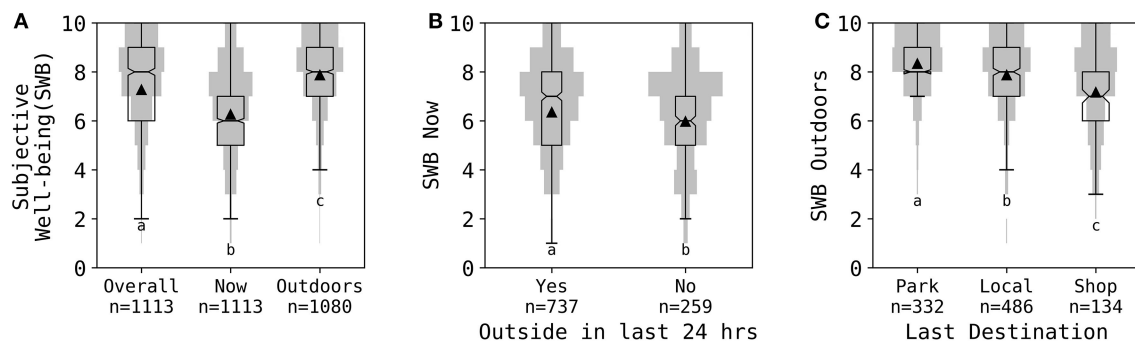
FIGURE 2 | Subjective well-being (SWB) given recent time outdoors and destination. **(A)** SWB ratings for overall life satisfaction (SWB overall), momentary happiness at time of survey (SWB now), and during their most recent trip outdoors (SWB outdoors); **(B)** SWB now as a function of being outdoors in the last 24 h; **(C)** SWB outdoors as a function of most recent destination (park or garden; local destination such as neighborhood walk or backyard; indoor shop). Lowercase letters indicate statistical significance between groups as determined using an ANOVA or *t*-test with a significance level of $p < 0.05$. Black triangles represent mean; boxplots indicate median (middle line) and first and third quartiles; gray shading highlights distribution of data.

completed in order to apply these inductively derived codes, as well as eliminate or combine deductive codes with little or no associated content.

Interview Respondent Population

While our interview population varied slightly with respect to the broader survey population, interviewee demographics remained skewed in similar ways with respect to race and gender (Tables 2, 3 in **Supplementary Material 3**). Our interview sample, however, included a higher proportion of graduate or professional students when compared to the survey population (Table 4 in **Supplementary Material 3**) and interviewees were also more likely to not receive financial aid (Table 5 in **Supplementary Material 3**).

RESULTS

Subjective Well-Being (SWB)

In the online survey, participants were asked (a) "On a scale of 1 to 10, rate your well-being right now (today)" (momentary happiness or "SWB now"); (b) "When you think about your life overall (not just today, but cumulatively), rate your well-being on a scale of 1 to 10" (life satisfaction or "SWB overall"); and (c) "On a scale of 1 to 10, rate your well-being during your most recent trip outdoors" ("SWB outdoors"). Average (±1SE) well-being at the time of survey was significantly lower (SWB now; 6.3 ± 0.05) than average SWB overall (7.3 ± 0.05) and average SWB outdoors (7.9 ± 0.05, $df = 2$, $p < 0.001$; **Figure 2A**).

Examining the demographic characteristics of survey respondents, we found women reported significantly lower SWB now ($p = 0.01$) and SWB overall ($p = 0.02$) than men; neither women nor men's SWB now or SWB overall were significantly different from gender non-binary respondents ($p > 0.05$). SWB outdoors did not differ by gender ($p = 0.3$). There were no significant differences in any reported SWB measure among different races and ethnicities, differences in financial aid, or in living situations at the time of survey (e.g., dorm, single, or multi-family unit; $p > 0.05$ for all). We found respondents who

moved since the beginning of the pandemic reported a lower SWB now (6.0 ± 0.09) than respondents who did not relocate during the pandemic (6.5 ± 0.09; $p < 0.01$); yet there were no significant differences for ratings of SWB overall or SWB outdoors ($p > 0.05$).

We observed effects on SWB based on respondents' most recent destinations and how recently they went outdoors (**Figure 2**). 23% of survey respondents reported not going outdoors in the past 24 h, 29% reported going outdoors one time and 36% reported more than one trip outdoors in the past 24 h. Those who had been outside at least once in the last 24 h had significantly higher SWB now (6.4 ± 0.07) than those who had not been outdoors in the previous 24 h (6.0 ± 0.1; $p = 0.005$; **Figure 2B**). We also found the same trend for SWB overall, in which those who had been outside at least once in the last 24 h had significantly higher overall SWB compared to those who had not been outdoors ($p < 0.005$, data not shown). Moreover, SWB outdoors was highest for respondents who reported their last destination as a park or other extensive greenspace (survey options for park, garden), compared to other local outdoor destinations (with highly variable degree of green elements; survey options neighborhood, yard, porch, roof) or a shop (survey options store or restaurant) ($p < 0.05$; **Figure 2C**).

Risk Perception and Accessibility

In addition to the influence of physical access and outdoor destinations on SWB, we find that risk perception and perceived accessibility affect the degree to which going outdoors improves SWB. The risk individuals associated with going outside influenced their reported SWB outdoors (**Figure 3**). The majority of respondents (68%) associated at least some degree of risk with going outside (**Figure 3A**). We observe that as risk associated with going outside increases, SWB outdoors decreases significantly ($p < 0.05$; **Figure 3A**). SWB outdoors was significantly higher for those who associated no risk (8.4 ± 0.1), or considered going outside only somewhat risky (8.0 ± 0.1) compared with those reported going outdoors as risky (7.5 ± 0.1) or very risky (6.6 ± 0.3). Those who perceived a greater risk in

going outside were less likely to have been outdoors in the past 24 h; as perceived risk decreased, the likelihood of going outdoors in the last 24 h increased (**Figure 3B**).

The perception of risk associated with going outside influenced the perceived accessibility of outdoor spaces. Fifty percent of respondents Strongly Agreed or Somewhat Agreed with the statement "I would like to spend more time outdoors for the purpose of being outside, but I find it too risky because of COVID-19." Those who strongly agreed with this statement reported the lowest SWB outdoors (7.4 ± 0.1; **Figure 3B**). Those who Somewhat Agreed were indistinguishable from Neutral, which along with Somewhat Disagree and Strongly Disagreed (8.5 ± 0.1) had the highest SWB Outdoors (**Figure 3C**).

Barriers to Access and COVID-19

Four hundred forty-two survey participants reported in an open-ended question the obstacles they faced to spending time outdoors, for the purpose of being outside (**Figure 4**). A content coding analysis indicated that 65.2% of respondents cited obstacles directly related to COVID-19, including crowding or inability to maintain 6 feet physical distancing (24.7% of total identified obstacles), facility closures (13.6%), and an explicit fear of contracting or spreading COVID-19 (12.7%; **Figure 4**). The most commonly cited barriers to going outdoors not directly related to COVID-19 were time constraints (14.9%) and lack of greenspace and/or physical access (13.6%; **Figure 4**).

Population Density and SWB

We also found SWB varied based on current living location and population density. SWB now did not significantly vary for respondents living in urban, suburban, and rural locations ($p = 0.2$; **Figure 5A**). However, respondents living in rural locations had significantly higher SWB overall ($p = 0.02$) and SWB outdoors ($p < 0.01$) than those living in more densely populated urban locations (**Figures 5B,C**, respectively). Suburban landscapes did not have a significant impact on SWB (**Figure 6**). When examining the impacts of being outdoors through differences in SWB now compared to SWB outdoors (**Figure 6A**) and SWB overall compared to SWB outdoors (**Figure 6B**), we found no significant differences among locations of different population density ($p > 0.05$). In other words, this suggests that the difference to SWB resulting from going outside does not significantly vary with respect to location.

Type of Greenspace: Public vs. Private

Nine hundred sixty-eight survey respondents indicated the types of greenspace to which they felt they had access, including public benches (21%), porch or stoops (62%), private yards or gardens (69%), public parks (59%), plazas, playgrounds, or courtyards (21%), and public sidewalks (74%). Respondents living in urban areas reported lower access to greenspace, generally (69% with no access) and higher access to public parks (74% with access to public greenspace) when compared to suburban and rural respondents (**Figure 7A**). 53% of those with no reported access to greenspace considered going outside to be Risky or Very Risky, as compared to 34% of those with reported access to public
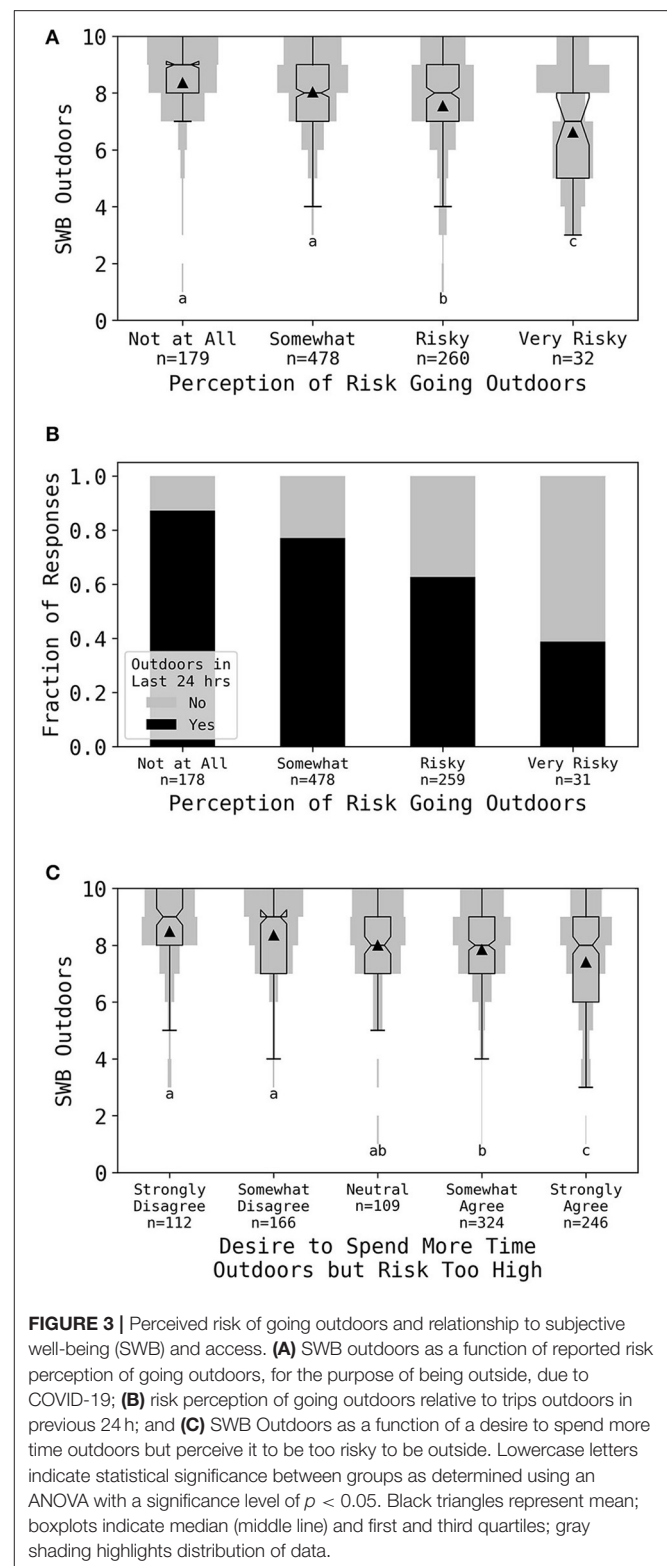
FIGURE 3 | Perceived risk of going outdoors and relationship to subjective well-being (SWB) and access. **(A)** SWB outdoors as a function of reported risk perception of going outdoors, for the purpose of being outside, due to COVID-19; **(B)** risk perception of going outdoors relative to trips outdoors in previous 24 h; and **(C)** SWB Outdoors as a function of a desire to spend more time outdoors but perceive it to be too risky to be outside. Lowercase letters indicate statistical significance between groups as determined using an ANOVA with a significance level of $p < 0.05$. Black triangles represent mean; boxplots indicate median (middle line) and first and third quartiles; gray shading highlights distribution of data.

greenspace only, 35% with private greenspace only, and 18% of those with access to both (**Figure 7B**).

Neither SWB today nor SWB outdoors varied significantly based on type of accessible greenspace; SWB did not differ by

FIGURE 4 | Obstacles to spending time outdoors. Survey respondents self-reported obstacles to spending time outdoors, for the purpose of being outside ($n = 442$). Obstacles in red are directly related to COVID-19, including crowding, closed facilities, and fear of contracting COVID-19. Obstacles in blue indicate other obstacles to going outdoors, including physical access (e.g., lack of sidewalks) and time constraints (e.g., too much schoolwork) not related to COVID-19.

FIGURE 5 | Subjective well-being (SWB) based on population density. Population density was divided into three categories: rural (<386 persons km^{-2}), suburban (386–1,159 persons km^{-2}), and urban (>1,159 persons km^{-2}) based on census data and zip code (**Figure 1**). **(A)** SWB now as a function of population density. **(B)** SWB overall as a function of population density. **(C)** SWB outdoors vs. as a function of population density. Lowercase letters indicate statistical significance between groups as determined using an ANOVA with a significance level of $p < 0.05$. Black triangles represent mean; boxplots indicate median (middle line) and first and third quartiles; gray shading highlights distribution of data.

whether respondents reported access to only public greenspace (i.e., respondent did not selected "private yard or garden" but did select "public benches," "porch or stoop," "public park or garden," "plaza, playground or courtyard," and/or "public sidewalks"), only private (i.e., respondent selected "private yard or garden"), or both types of greenspace ($p > 0.05$; **Figures 7C,D**). However, respondents with no reported access to greenspace—public or private—had significantly lower SWB now and SWB outdoors when compared to those with access to some kind of greenspace ($p < 0.05$; **Figures 7C,D**).
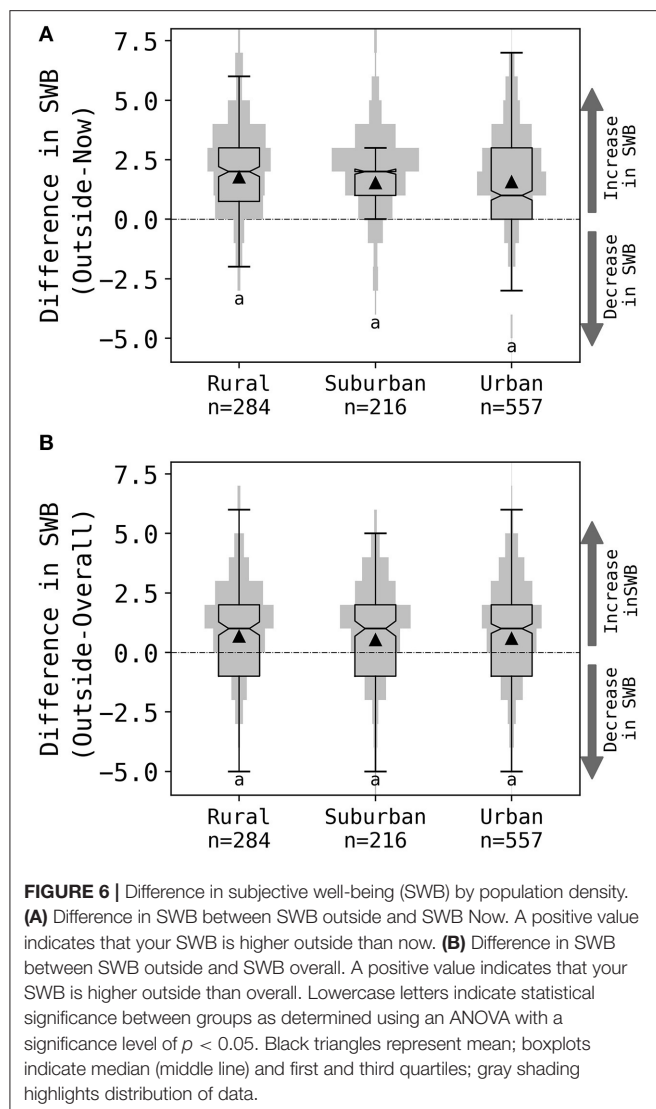
Interview Results

Analysis of interview data identified five key findings relating to perceived greenspace accessibility, SWB, and risk perception. First, going outdoors was reported to improve SWB by providing a chance to get out, an opportunity to have contact with nature, and offering a sense of variety, comfort, and/or normalcy. Second, interviewees reported decreases in the perceived accessibility of greenspace due to risk perception associated with

COVID-19, in particular lack of available space and crowding. Just over one-third (37%, $n = 29$) of interviewees reported going outside less. Third, we found that issues of limited physical access and sociocultural barriers persisted. For example, interviewees in low-income, majority-BIPOC neighborhoods continued to have few greenspaces available to them. Relatedly, racial identity itself emerged from our interview data as a barrier to access. Interviewees who identified as Asian-American also reported that their perceived accessibility of greenspace (and public space generally) had declined in response to incidents of racial harassment and violence. Fifth and finally, interviewees reported accessing multiple types of greenspace, both public and private, and valuing this variety.

DISCUSSION

Our results suggest that limitations to greenspace accessibility associated with social-ecological disturbances have an effect on subjective well-being (SWB). We find that spending time outside

FIGURE 6 | Difference in subjective well-being (SWB) by population density. **(A)** Difference in SWB between SWB outside and SWB Now. A positive value indicates that your SWB is higher outside than now. **(B)** Difference in SWB between SWB outside and SWB overall. A positive value indicates that your SWB is higher outside than overall. Lowercase letters indicate statistical significance between groups as determined using an ANOVA with a significance level of $p < 0.05$. Black triangles represent mean; boxplots indicate median (middle line) and first and third quartiles; gray shading highlights distribution of data.

is associated with higher levels of SWB for individuals during the COVID-19 pandemic. In particular, we find the highest levels of SWB among those who spent time in an outdoor greenspace, and those who had been outdoors in the previous 24 h. While going outdoors is associated with higher SWB, the majority of people associated some degree of risk with going outdoors and cited obstacles to spending time outside directly related to COVID-19. Moreover, those who associated greater risk with going outside had lower SWB while outdoors than those who perceived very little risk. We do not find demographic variables or type of greenspace access (public or private) to affect SWB while outdoors. Finally, while those living in high density urban areas had lower SWB outdoors than those living in more rural locations, we find respondents experienced the same degree of benefit to SWB in going outdoors regardless of where they lived. We conclude that strategies for creating and maintaining safe access to outdoor greenspaces are a much-needed component
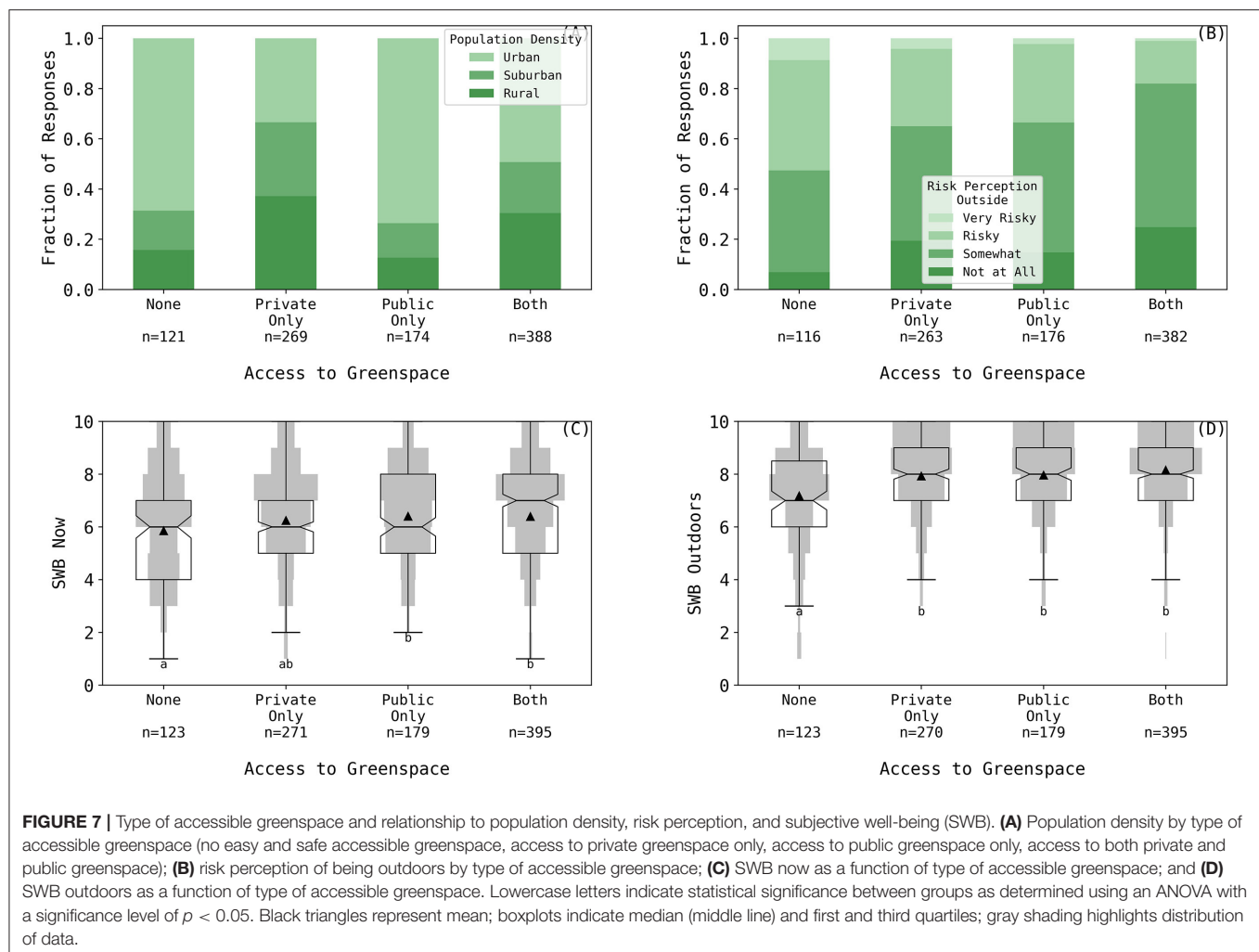
of institutional responses to both the COVID-19 pandemic and future social-ecological disturbance.

Previous research has established that improvements to SWB are a key ecosystem service provided by greenspace (Russell et al., 2013; Jennings et al., 2016; Houlden et al., 2018), and indicates that contact with greenspace can lead to reductions in stress and anxiety and increases in happiness (Herzog et al., 2003; van den Bosch and Sang, 2017). While these studies were conducted under normal (i.e., non-pandemic) conditions, our results suggest that the relationship between greenspace and SWB holds during the COVID-19 pandemic. We found levels of SWB during respondents' most recent trip outdoors to be higher than both SWB overall (life satisfaction) and SWB now (at time of survey; momentary happiness). We also found that those who had been outdoors within the past 24 h reported higher levels of SWB now than those who had not. Data from follow-up interviews provide some further insight into these results. For many, the benefit of going outside was simply a chance to get out: "extremely good to get outta the house" (A76, white woman in rural area, 5/29/2020). For others, it was the presence of nature: "I love seeing all the different shades of green. That gives me a happiness-base everyday" (A68, demographics not reported, 6/11/2020). Finally, there were those for whom going outside to a greenspace provided a sense of variety, comfort, and even normalcy.

It's really comforting, I've been finding, to be able to go outside and see trees and see people biking and going on walks and walking their dogs. Like, even though to my knowledge everyone's practicing the proper precautions and they have masks on and they're keeping space, there's something just really nice about being in a space with other human beings and being outside, and I think that that's really done wonders for my mental health and has made me just feel, like, you can carve out a simulation of normalcy even in these circumstances and it can still be safe. (A27, white woman in urban area, 5/28/2020)

Together, these results suggest that greenspace continues to play an important role in maintaining and improving SWB, even during the COVID-19 pandemic. This conclusion is supported by findings in recent studies that suggest individuals are identifying well-being benefits to going outdoors in the context of COVID-19 (Fisher and Grima, 2020; Lopez et al., 2021; Poortinga et al., 2021), as well as studies of the important role of nature for well-being during previous crisis events (Van den Berg et al., 2010; Campbell et al., 2016; McMillen et al., 2016).

While barriers to accessing greenspace—such as perceived (non-COVID related) safety (Cheesbrough et al., 2019; Lai et al., 2020) and lack of physical access (Wolch et al., 2014; Zhang et al., 2015)—are present in our study, we do not find that these represent the primary barriers to access identified during the COVID-19 pandemic. Rather we find that the perceived risk of going outdoors, specifically due to COVID-19, is decreasing perceived accessibility. Participants indicated that the perceived risk of going outdoors resulted in less than the desired amount of time outside, and the most frequently cited barriers to access were directly related to COVID-19. For many, these obstacles

FIGURE 7 | Type of accessible greenspace and relationship to population density, risk perception, and subjective well-being (SWB). **(A)** Population density by type of accessible greenspace (no easy and safe accessible greenspace, access to private greenspace only, access to public greenspace only, access to both private and public greenspace); **(B)** risk perception of being outdoors by type of accessible greenspace; **(C)** SWB now as a function of type of accessible greenspace; and **(D)** SWB outdoors as a function of type of accessible greenspace. Lowercase letters indicate statistical significance between groups as determined using an ANOVA with a significance level of $p < 0.05$. Black triangles represent mean; boxplots indicate median (middle line) and first and third quartiles; gray shading highlights distribution of data.

centered on the amount of available space and included crowding or inability to maintain six feet distance, as well as others not wearing masks. As one interviewee explained their concern for going outside:

> Mostly just fear of coming across people and, like, tight trails and [people] who aren't wearing masks, cause people here are not wearing masks. It is hard because I wanna be spending all this time in green space for, like, my mental health, but I am trying really hard to social distance to protect my older family members. There is always an anxiety and a fear there. And it has kept me, several times, from going out on, like, the nicest days, because I know it's gonna be more populated, with people that I probably can't avoid. (A65, white suburban woman, 6/8/2020)

Park closures were also a COVID-19 induced barrier to spending time outdoors mentioned by both survey respondents and interviewees. For example, when one interviewee (A32, white suburban man, 6/12/2020) was asked if he was going to any greenspaces, he replied: "It depends on the timeline." He noted he had no access to greenspace for roughly three months while

parks were closed, except for a few times he snuck into a park to go bird-watching.

While time spent outdoors, particularly in greenspace, is an important contributor to SWB during the COVID-19 pandemic, risk perception associated with the pandemic is a moderating variable. This point was driven home by interviewees who reported on the negative effects of observing strict quarantines, or the inability to sustain long periods of indoor isolation. For example, one interviewee (A61, white non-binary individual in suburban area, 6/15/2020) described their family living in a tiny apartment observing a strict cycle of 2-week quarantine periods. They had been easing up on this regime, and when asked why, they explained: "It [COVID-19] didn't totally blow up [here]. And the other thing is just I think at a certain point of being stuck in a tiny little space for a really long time, you just kind of hit your limit...I'm willing to accept a little more risk." Other studies offer some support for these findings, observing concerns about crowding, decreased time outdoors and reduced accessibility of greenspace as responses to COVID-19 that also represent additional stressors to health and well-being (Galea et al., 2020; Slater et al., 2020; Ugolini et al., 2020).

Our findings support a multi-dimensional understanding of perceived accessibility, which is subject to change with respect to social and environmental context, public norms, and individual perceptions. Moreover, these findings indicate that access is intersectional (Powers et al., 2020), and that issues of physical or sociocultural access persisted. Those who lived in neighborhoods with little available greenspace continued to struggle with physical access: "I'm in like South East Bronx. So there's not a lot of green space. It's just mainly residential housing. In order to get to any green space we have to drive. Or take the train, or just walk a really long time" (A71, Latina woman in urban area, 6/9/2020). This lack of access had very real consequences for SWB, as those who reported no access to greenspace had significantly lower levels of SWB today and SWB outdoors than those who did have access to public or private greenspace.

Physical access was also limited by inadequate infrastructure in both rural and urban areas:

The closest park is I think like two miles but because I don't have a car I can't really get there easily and in this area, it's kinda dangerous even just to walk because we don't really have sidewalks. I've heard stories of people getting hit by cars, their pets being hit by cars in broad daylight. (A30, biracial woman in rural area, 6/1/2020)

Finally, general safety was a persistent sociocultural barrier. "Being a woman it's just not safe to run through those parks at those times [early morning and late evening]" (A16, Latina urban woman, 5/31/2020). This quote gestures to the important intersection of gender identity and safety (Jorgensen et al., 2002; Campbell et al., 2016). It is important to note that in our study, while we find that women reported lower overall SWB and SWB now when compared to men—a finding consistent with previous research (Batz and Tay, 2018)—these differences disappear when assessing SWB outdoors. This suggests that going outside ameliorates gender-based differences in SWB. In total, non-COVID specific barriers associated with physical access and safety represented 19.9% of those mentioned by survey respondents.

Race/ethnicity did not affect SWB in our survey responses, however interviewees did reflect on persistent macro-sociocultural issues and barriers. For example, several Asian-American individuals reported experiencing or observing incidences of racism and expressed increased reluctance or anxiety associated with going outdoors. After being harassed on public transit and witnessing a friend being assaulted, one interviewee stated she was increasingly afraid of going outside (A56, East Asian woman in urban area, 6/2/2020). Another stated that after enduring several incidents of people being "physically aggressive in my space" she was glad she had started carrying pepper spray and a knife (A44, East Asian woman in urban area, 5/25/2020). As demonstrated in these excerpts, racism persisted as a barrier to greenspace access for many, highlighting that not all bodies were considered 'neutral' presences in public space—a reality echoed and witnessed in the continued harassment and murder of BIPOC during our study (Cohen, 2020; Ho, 2021).

The persistence of barriers, such as racism, to greenspace access is not necessarily independent of COVID-19—in the case of anti-Asian racism, it is intimately tied to it. The relationship of new challenges presented by COVID-19 to persistent barriers to access, however, requires careful presentation. Our surveys and interviews indicate that COVID-19 revealed new dimensions to perceived accessibility and introduced new barriers to access. While barriers created by racism (among other sociocultural and physical barriers) continued to be a influential component of access and perceived accessibility, during the COVID-19 pandemic issues of risk perception and disease-related safety became primary. In other words, those with racialized bodies, and/or living in majority-BIPOC or lower-than-median-income neighborhoods experienced further declines in greenspace accessibility, compounding the already unequal toll of the COVID-19 pandemic and structural racism in the USA (McPhearson et al., 2021).

Though prior research suggests that population density does not have an effect on the relationship between greenspace and SWB (Maas et al., 2006; Dennis and James, 2017; Coldwell and Evans, 2018), these studies were undertaken during normal (i.e., non-pandemic) conditions. Given contemporaneous research on greenspace accessibility and usage (Derks et al., 2020; Fisher and Grima, 2020; Rice and Pan, 2020; Ugolini et al., 2020; Venter et al., 2020; Geng et al., 2021), and anecdotal accounts of park closures and crowding in cities across the country, we expected to find residents of higher density areas and those without access to private greenspace to have higher perceived risk of going outdoors and lower SWB, particularly while outside. Likewise, while previous research on the effects of public vs. private greenspace are mixed (Maat and de Vries, 2006; Lin B. B. et al., 2014), during the COVID-19 pandemic, private greenspace seems to play an important role in compensating for decreased accessibility of public greenspace and maintaining individuals' SWB (Poortinga et al., 2021). We find that access to a private greenspace is associated with lower risk perception and higher likelihood of having gone outside in the last 24 h. These differences in access to public vs. private greenspaces did not translate into a significant effect on SWB while outside; access to any form of greenspace, public or private, had a statistically similar effect on SWB outdoors. Overall, going outdoors, regardless of the type of greenspace, was associated with positive differences in SWB. This finding supports Poortinga et al.'s (2021) conclusion that private gardens increase perceived accessibility of greenspace, but indicates that this perception does not translate into significant differences in SWB when actually going outdoors. Likewise, while residents in rural ZIP codes had higher access to greenspace, lower perceptions of risk associated with going outside, and higher levels of overall SWB and SWB while outdoors, differences based on population density disappeared when considering differences in SWB between SWB outdoors and SWB overall and today. The degree of difference in SWB upon going outside did not vary significantly with respect to population density, which concurs with previous findings (Maas et al., 2006; Tyrväinen et al., 2014; Van den Berg et al., 2014; Dennis and James, 2017; Coldwell and Evans, 2018).

We find neither population density nor type of greenspace (public vs. private) have a significant effect on the benefits to SWB of going outdoors during the COVID-19 pandemic, a finding consistent with that of Rice and Pan's study (2020). Interview results provide further insight, with interviewees actually reporting that they enjoyed a variety of greenspaces.

> My backyard and we have a vegetable garden, and then I have the park behind my house. I spend a lot of time there. There's also other little parks in the neighborhood, and there's another hill that you can go up and there's a water tower and I go up there, sometimes. I also just like… I don't know. … walking around and seeing people's gardens, because it's spring and everyone's flowers are in bloom. So, it's not just parks, but just walking around and seeing what people have growing in the yards. (A42, white rural woman, 5/25/2020)

Indeed, for many, the greatest contribution of greenspace to their SWB was, as one interviewee put it, "the fact that it exists" (A67, white suburban man, 6/16/2020). The salutary effect of greenspace *via* "simply existing" is also supported by studies that find positive or maintenance effects on SWB associated with visually accessing greenspace (Velarde et al., 2007; Amerio et al., 2020). While this study did not assess visual access, results clearly suggest the benefit of spending time outdoors appears to derive simply from accessing a greenspace, regardless of type or context.

Limitations

We identify two meaningful limitations to this study: study population and sampling time-frame. Firstly, our study is limited by the utilization of only university students as a research population. This population potentially introduces biases around age (of particular relevance for COVID-19 risk perception) and education level, and is not representative of the broader US population. Secondly, our study utilizes data from one point in time, during the first wave of the COVID-19 pandemic. As such, our results are not able to speak to changes in risk perception and outdoor access, and their effect on SWB, over the course of the pandemic.

RECOMMENDATIONS FOR FUTURE SOCIAL-ECOLOGICAL DISTURBANCE

Based on these findings, we draw two primary conclusions and subsequent recommendations. First is that access to greenspace is multidimensional. That is, several different dimensions shape the perceived accessibility of greenspace, and those which are present and more influential change over time and with context. Our results show both that maintaining and improving subjective well-being (SWB) during the COVID-19 pandemic is an important ecosystem service provided by greenspace, and that risk perception played a role in decreasing perceived accessibility of greenspace and SWB while outdoors. The association between outdoor greenspace and SWB is well-documented during normal conditions, and our results demonstrate that it persists during the pandemic. Prior scholarship has also shown the important role greenspace plays in supporting well-being during other crisis

events (Van den Berg et al., 2010; Campbell et al., 2016; McMillen et al., 2016). Our results suggest, however, that the persistence of the positive relationship between greenspace and SWB is only one part of the story. While this relationship remains unchanged during crisis events, dimensions of accessibility do not. The COVID-19 pandemic revealed barriers to access related to concerns with the safety and acceptability of outdoor recreation, blanket closure policies that severely reduced greenspace access for many individuals, fears over contracting or spreading the virus, and worries over the behaviors of others in public space. These barriers to access were the most frequently cited for our study participants. However, prior barriers, such as time constraints, lack of physical access, and racism, did not go away; COVID-19 specific barriers were layered on-top, adding more dimensions to greenspace accessibility and further inhibiting access to greenspace for many already marginalized, vulnerable people.

Given that we can expect further instances of social-ecological disturbance and social duress, particularly as a result of the ongoing climate crisis, the role of greenspace and the importance of ecosystem services like SWB, and the ways accessibility shifts and the multiple dimensions of accessibility shift with respect to one another, should not be overlooked. While maintaining the health and safety of the population during crisis events, particular outbreaks of infectious disease, is challenging and requires responses made with incomplete information, we argue that the important role of greenspace in SWB, as well as the mental and physical health of the population, should be taken into account (Samuelsson et al., 2020). Both public health messaging and planning for greenspace design and management should include the role of greenspace in maintaining and improving SWB, and should include provisions for the important role of greenspace, and changing greenspace accessibility, during future crisis events (Honey-Rosés et al., 2020; McCunn, 2020). Such provisions should also take account of the heightened vulnerability of BIPOC and impoverished peoples in such events (Watson et al., 2020; McPhearson et al., 2021).

Our second conclusion follows from this attention to the multidimensional nature of greenspace accessibility. We conclude there is a continued need for efforts toward creating and maintaining public greenspaces and their concomitant ecosystem services. Spending time in a greenspace has a positive effect on SWB regardless of the type of greenspace. Urban park or rural preserve, private yard or public space—we do not observe meaningful differences in levels of improvement to SWB associated with time spent in these outdoor spaces. Indeed, the most important thing appears to be simply spending time outside amidst vegetation. While access to a private greenspace, such as a yard, is beneficial, continued and increased provisioning of public greenspaces offers these benefits to the widest population. Moreover, expanding access to greenspace, particularly with attention to equitable distribution and community engagement in planning, can address critical issues regarding environmental justice and the disparities in access based on race and socioeconomic status observed in other studies (Heynen et al., 2006; Wolch et al., 2014; Nesbitt et al., 2019). Finally, the most frequently cited barrier to greenspace

access that we observed was the perceived risk of going outdoors due to COVID-19, and in particular, concerns about crowding. More greenspace, and more readily available public greenspace, has the potential to alleviate this concern by relieving pressure on existing greenspaces.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Barnard College IRB. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MM, EC, and BM: equal contribution to research, analysis, and writing. LY and OV: equal contributions to research and analysis. BO and PC: equal contributions to research and writing. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2021. 709997/full#supplementary-material

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Comparisons of Sustainability Behaviors Pre- and Early Pandemic Among Botanical Garden Members

Katilyn Mascatelli[1], Caitlin Drummond Otten[2], Richard V. Piacentini[1], Gabrielle Wong-Parodi[3] and Sarah L. States[1]*

[1] Department of Research and Science Education, Phipps Conservatory and Botanical Gardens, Pittsburgh, PA, United States, [2] School of Human Evolution and Social Change, Arizona State University, Tempe, AZ, United States, [3] Department of Earth System Science and the Woods Institute for the Environment, Stanford University, Stanford, CA, United States

The COVID-19 outbreak drastically altered the behaviors of millions of Americans in 2020, including behaviors that contribute to carbon emissions. As many Americans stayed home midyear, environmental groups noted the decrease in driving and transportation-related pollution, theorizing that the pandemic could have a positive impact on the environment by decreasing individuals' carbon emissions. However, it is dubious that individuals will behave in a more eco-friendly manner under the uncertain and stressful conditions of a global pandemic simply because they are more likely to be confined to their homes. We examined sustainability behaviors in 2018 and in the early pandemic in 2020 among a sample of members of a U.S., botanical garden. We surveyed members in May–July 2018, asking whether they had or had not done 11 sustainability behaviors (e.g., used alternative transportation, took shorter showers) in the past month. We resurveyed members about their engagement in those behaviors in April 2020 as well as to recall their engagement in those behaviors pre-pandemic in February 2020. We examined differences in self-reported behaviors among respondents who had taken both the May–July 2018 and April 2020 surveys (matched group $n = 227$), and then among respondents who had taken either the May–July ($n = 1057$) or the April 2020 survey ($n = 881$), but not both. Respondents in the matched group were more likely to report recycling, reducing red meat consumption, eating a plant-based diet, and reducing food waste in April 2020 compared to May–July 2018; they were less likely to compost, check the air in their tires, and use a smart thermostat. However, these differences also emerged when examining recalled behavior in February 2020, suggesting that matched group respondents' self-reports may reflect changes in behavior over time rather than due to the pandemic. The unmatched group was more likely to reduce food waste but less likely to use alternative transportation to commute, check the air in their tires for fuel efficiency, and recycle in April 2020 compared to May–July 2018. Thus, few changes in sustainability behaviors can be attributed to the pandemic, but those that do involve personal travel or home confinement.

Keywords: pro-environment behavior, sustainability behavior, COVID-19, eco-friendly behavior, individual behavior

INTRODUCTION

The global outbreak of COVID-19 drastically impacted the lives of Americans in 2020. Starting in March of 2020, as state and local authorities imposed lockdowns and stay-at-home orders to mitigate the spread of the deadly virus, many people were confined to their homes, lost their jobs, and experienced stress about the uncertainty of the pandemic. The lockdown measures touched nearly all facets of public and private life for the world's people, as well as countries' economies and the global environment.

In terms of environmental impact, there is some evidence for the contribution of lock-down measures to improved environmental outcomes, at least in the initial stages of the pandemic. Scientists observed large drop-offs in air pollutant levels during the initial lockdown phases of March and April 2020 (Berman and Ebisu, 2020; Muhammad et al., 2020), reduced demand for and use of fossil fuels (Wang et al., 2020), and enhanced wildlife activity (Manenti et al., 2020). Indeed, one study estimated that, as of May 2020, new emissions of global greenhouse gases had been reduced by 2.5 Gt, which the authors attributed to worldwide decreases in production and consumption (Lenzen et al., 2020). Another estimated an 8.8% reduction in CO_2 emissions in the first half of 2020 compared to the same time period in 2019 (Liu et al., 2020). Additionally, the popular media initially extolled the benefits of the pandemic for the environment, calling them the "silver lining" of the shutdowns (Cripe, 2020; Rochard, 2020; Walt, 2020).

An assumption of the pandemic-induced environmental benefits narrative is that these large-scale benefits are partially driven by individual behaviors—that people in lockdown, or with reduced socialization and mobilization due to the pandemic, have changed their consumption or carbon-emitting habits en masse. There is some evidence to support this pandemic-induced reduction in carbon emissions. For example, one survey of U.K. adults in April of 2020 found that food shoppers reported fewer shopping trips, increased preparation of home-cooked meals, and decreased food waste (Roberts and Downing, 2020). In the transportation sector, large decreases in traffic volume were documented in the initial months of the pandemic (Clark, 2020; Hudda et al., 2020) as the number of daily vehicle-miles decreased (Dutzik, 2020; Stavrinos et al., 2020). Additionally, residential sector emissions reductions were estimated to account for 3% of the global decrease in daily CO_2 emissions (Liu et al., 2020). We note that while most estimates of greenhouse gas emission reductions due to the pandemic include a mix of commercial or industrial sector estimates (e.g., steel production, infrastructure) as well as indices of individual behaviors (e.g., residential electricity use), there has not been a thorough comparison of individual-level versus commercial-level contributions to pandemic-linked environmental benefits.

However, there is also evidence that conditions specific to the pandemic are fostering more wasteful or higher carbon behaviors. In attempts to reduce contact with potentially virus-laden products, many people increased their consumption of single-use plastics (Patrício Silva et al., 2021), such as in food takeout containers. Market research firms have noted sharp pandemic-linked increases in online shopping activity (Rattner, 2020) that would be associated with increases in plastic and cardboard packaging as well as use of fossil fuels for transportation linked to e-commerce. Additionally, plastic and other single-use waste from disposable personal protective equipment (PPE) in the medical sector has increased (Rizan et al., 2021) along with waste associated with disposable face masks worn by members of the general public (Fadare and Okoffo, 2020; Sangkham, 2020).

In addition, it is possible that the pandemic's influence on sustainability behaviors is more strongly seen in specific populations. For instance, the pandemic and its associated economic downturn had disproportionate negative impacts on poorer Americans. Researchers found that while private sector employment decreased by 22% in the first months of the pandemic, the impact was greater among low income workers, who saw their employment decline by 35% compared to 9% for high income workers (Cajner et al., 2020). Additionally, the kinds of jobs that can be done from home (thus not requiring a carbon-intensive commute) are linked to education and income such that high income, well-educated people are more likely to be able to work from home during the pandemic (Baker, 2020; Hoenig and Wenz, 2020). Thus, to the extent that enacting sustainability behaviors requires financial resources or status-based privileges, those with higher incomes would be expected to enact more of those behaviors than low income workers. Alternately, some sustainability behaviors, such as reducing food waste or saving water, are associated with saving money. We might expect that people with lower incomes or more financial instability would enact these sustainability behaviors, to the extent that those behaviors are cost-saving.

One drawback to most of this research on specific individual sustainability behaviors early in the pandemic is that it lacks strong reference groups against which to measure changes in behavior. Some surveys rely on self-reports that explicitly ask respondents to describe their current pandemic behavior in contrast with pre-pandemic onset behavior (e.g., Roberts and Downing, 2020), and these retrospective comparisons might not be accurate as they depend on respondents being able to accurately recall past behavior. In addition, some studies report changes in large-scale trends of consumer behaviors but lack detailed reporting of behavioral shifts at an individual level. Studies that link individuals' behaviors over time are needed to rectify issues of retrospective self-report.

In order to overcome these deficiencies in methodologies to better understand the environmental impact of the pandemic, we need to better document how the pandemic altered sustainability behaviors that are linked to greenhouse gas emissions as well as waste. Accounting for changes in individuals' sustainability behaviors pre-pandemic to early pandemic will allow a more comprehensive understanding of the role that households play in characterizing the environmental impact of the pandemic.

The current study presents a glimpse into sustainability behavior changes in the early pandemic in a sample of botanical garden members in Pittsburgh, Pennsylvania. This sample is comprised of people who are environmentally engaged and have more education than the general population (Drummond et al.,

2020), and thus are an ideal sample to examine for changes in sustainability behaviors, as they likely had higher baseline engagement in eco-friendly actions. Due to the unprecedented nature of the pandemic and the exploratory nature of this work, we ask the following research question in lieu of establishing directional hypotheses: Are environmentally engaged individuals more likely, less likely, or equally likely to report engaging in various sustainability behaviors after the onset of the COVID-19 pandemic? In general, environmental beliefs tend to predict pro-environmental attitudes and behaviors (Gadenne et al., 2011), but this relation is highly dependent on the specific environmental beliefs and behaviors in question. For example, one longitudinal study of Americans found that those who had the strongest beliefs in and were most concerned about climate change were least likely to report engaging in individual sustainability behaviors but more likely to support policies fighting climate change (Hall et al., 2018). How these relations might play out in the unprecedented context of a global pandemic remains to be seen, as it is possible that a positive relation between concern about climate change and pro-environmental behaviors could be nullified by pandemic concerns. That is, a desire to act in environmentally friendly ways could be superseded by the more immediate demands of surviving a global pandemic. Interestingly, whereas recent research has highlighted the importance of future orientation in predicting pro-environmental behaviors (Beiser-McGrath and Huber, 2018), some have speculated that the trauma of the pandemic could disrupt positive expectations for the future (Holman and Grisham, 2020), which would decrease motivation to act sustainably. However, a recent longitudinal study of U.K. adults showed no change in climate concern from 2019 to June 2020, indicating that concern for climate change is robust to the assumed insecurities of the pandemic (Evensen et al., 2021). To the extent that climate concerns motivate sustainability behaviors, this would indicate that sustainability behaviors remained constant through the pandemic. Alternatively, it is possible that those with high concern for climate change increase their sustainable behaviors given coverage of the pandemic as environmentally beneficial. In this case, a social identity as an environmentalist motivates behaviors that are in line with the expectations of others (which would be that the pandemic is allowing for nature to heal, etc.), as social identification can influence behavior *via* the desire to act in accordance with group goals (Cialdini, 2003; Oyserman et al., 2007). Thus, this study aims to determine if environmentally-conscious people did, in fact, engage in more eco-friendly behaviors due to the pandemic.

Data from this project comes from two waves of surveys of those botanical garden members—the first administered in the summer of 2018 and the second in the summer of 2020. This novel study examines changes in self-reported completion of 11 sustainability behaviors. We examine these behaviors in two ways—first with a longitudinal design that assessed changes in the same sample of respondents over 2 years, and second with a cross-sectional design that examined differences between two samples of respondents surveyed pre-pandemic and in the early pandemic. This multi-method approach allows us to verify the robustness of any changes in sustainability behaviors.

METHODS

Participants

Members of a botanical garden were twice surveyed about their attitudes and behaviors regarding environmental issues. Between May and July of 2018, a survey was sent to 21,763 members of Phipps Conservatory and Botanical Gardens and 1,284 responses were recorded (response rate: 6%). Between June and August of 2020, a similar survey was sent to 30,480 Phipps members and 1,108 responses were recorded (response rate: 4%). Of these two waves of survey respondents, 227 respondents took both surveys, resulting in the matched sample. Removing the matched sample respondents from the pre-pandemic and early pandemic samples results in a pre-pandemic unmatched sample size of 1,057 and an early pandemic unmatched sample size of 881 respondents. See **Table 1** for comparisons of these samples in terms of self-reported demographic characteristics.

Compared to the 2019 demographics of the local population of residents within the county in which the botanical garden is located, our sample is more likely to be female (77.1% May–July 2018 unmatched sample; 77.3% April 2020 unmatched sample; 72.5% matched sample vs. 51.6% locally) and have at least a Bachelor's degree (83.9% May–July 2018 unmatched sample; 84.9% April 2020 unmatched sample; 92.4% matched sample vs. 42.9% locally) (U.S. Census Bureau, 2021).

Procedure and Design

Botanical garden members were sent a link to the survey *via* emails sent to the member listserv of Phipps. Detailed response rate information for 2018 are reported in previous reporting on these data in Drummond et al. (2020). In this 2018 survey, respondents provided information on their current sustainability behaviors. In the 2020 survey, a total of 30,480 households were contacted, out of which 1,587 (5%) households accessed the link to the survey. Of those that accessed the survey, 11 did not give their consent to participate in research and were not allowed to continue to the survey and 468 did not complete the survey, leaving a final sample of 1,108 with an overall response rate of 4%. In this 2020 survey, respondents provided information on their current sustainability behaviors as well as recalled information about their pre-pandemic sustainability behaviors.

Terminology and Timeline

See **Figure 1** for a timeline of the survey distributions and associated terminology. For ease of reporting, we will refer to the pre-pandemic time, assessed by the first survey, as "May–July 2018." We will refer to the recalled pre-pandemic time, assessed by the second survey, as "February 2020." Finally, we will refer to the early pandemic time, also assessed by the second survey, as "April 2020."

Survey Measures
Sustainability Behaviors

In the pre-pandemic survey, participants were presented with 11 individual actions and with the following description: "Below is a list of actions people can take to reduce a household's impacts on the environment. Please indicate which actions you

TABLE 1 | Sample characteristics.

	Pre-pandemic (May–July 2018) unmatched sample (n = 1,057)	Early pandemic (April 2020) unmatched sample (n = 881)	Pre- and early pandemic matched sample (n = 227)
Age (M, SD)	50.9 (15.6)	51.2 (15.4)	52.7 (15.3)
% Men	22.9	22.7	27.5
% with children	64.3	61.9	61.5
Educational attainment (% reporting each category)	Some high school: 0.1 High school: 3.6 Some college: 7.9 Associate's: 4.5 Bachelor's: 34.7 Graduate or professional degree: 49.2	Some high school: 0.0 High school: 1.4 Some college: 7.9 Associate's: 5.9 Bachelor's: 36.5 Graduate or professional degree: 48.4	Some high school: 0.0 High school: 0.9 Some college: 2.7 Associate's: 4 Bachelor's: 35.9 Graduate or professional degree: 56.5
Political party affiliation (% reporting each category)	Democrat: 50 Republican: 13 Independent: 19	Democrat: 52 Republican: 13 Independent: 18	Democrat: 53 Republican: 10 Independent: 19
Political conservatism-liberalism (5-point scale; 1 = very conservative; 5 = very liberal) (M, SD)	3.44 (1.01)	3.51 (0.98)	3.58 (0.95)
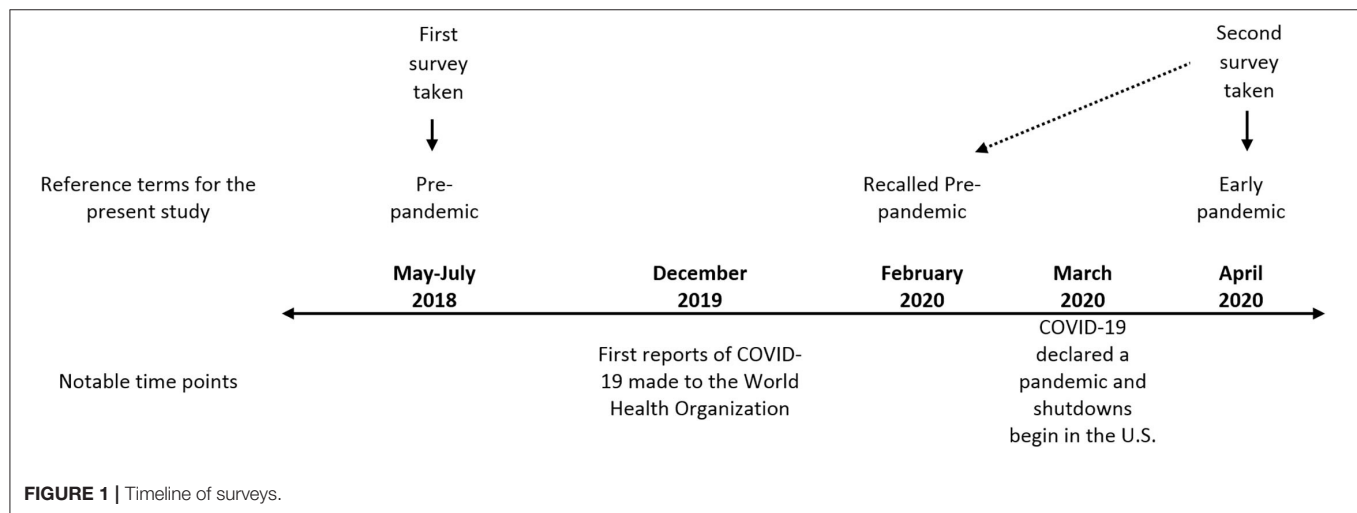
FIGURE 1 | Timeline of surveys.

personally took in the past month." The actions were drawn from prior research on environmental behavior (Gardner and Stern, 2010; Truelove and Parks, 2012) and estimates of greenhouse gas emissions (Hawken, 2017) and are as follows: used public transportation, biked, or walked to work instead of driving; used energy efficient lightbulbs such as CFLs or LEDs; recycled; taken shorter showers; driven a hybrid or electric vehicle; reduced red meat consumption; eaten a more plant-based diet; reduced food waste; composted waste; checked the air in your tires to ensure fuel efficiency; used a smart thermostat; installed or used low-flow shower heads or faucets. Participants could respond "Yes," "No," or "Not applicable."

In the 2020 survey, participants were presented with the same 11 behaviors and response options as the May–July 2018 survey in two response contexts. First, participants were asked to think back to their lives before the COVID-19 outbreak (the survey instructions for this section included the line "For many people, this will mean thinking about February 2020") and were instructed to indicate which behaviors they

had done in February of 2020. We note that these behaviors are recalled pre-pandemic behaviors and will be denoted by "February 2020." Then participants were asked to think about their household's behaviors during the COVID-19 outbreak (the survey instructions for this section included the line "For many people, this will mean thinking about April 2020") and were instructed to indicate which behaviors they had done in April of 2020. We will refer to these contemporaneous reports of behaviors as "April 2020."

Statistical Methods

We will present two parallel sets of analyses comparing May–July 2018 sustainability behaviors to April 2020 sustainability behaviors using two samples—a matched group and an unmatched group. For the purposes of this analysis, all "Not applicable" responses are treated as missing; "No" responses were coded as 0 and "Yes" responses as 1. For the matched group comparisons, we use McNemar's test to test for differences in the marginal probabilities of responses changing at two time points;

first comparing May–July 2018 responses to February 2020 responses and second comparing May–July 2018 responses to April 2020 responses. These analyses test for differences between changes from "No" to "Yes" responses compared to "Yes" to "No" responses. We use the McNemar's test with a continuity correction when a cell count in the contingency table is <5 and correct for multiple comparisons with the discrete Bonferroni-Holm multiplicity adjustment. For discordant pairs of cells (i.e., those changing their response over time from "No" to "Yes" or from "Yes" to "No") that are low-occurrence (<25), we do not perform McNemar's test due to the increased Type I error rate (Agresti, 2014; Fagerland et al., 2014). For the unmatched group comparisons, we use chi-squared tests to test for differences in the expected frequencies and the observed frequencies of the "No/Yes" responses May–July 2018 and April 2020, correcting for multiple comparisons with the Bonferroni adjusted alpha level of 0.0045 (0.05/11) per test.

RESULTS

Matched Group Analysis

The ratios of response changes, or discordant cells, for the matched sample can be found in **Table 2**.

Used Public Transportation, Biked, or Walked to Work Instead of Driving

Due to a low count in the discordant pair, McNemar's test was not performed comparing May–July 2018 to February 2020. The proportion of people reporting having done this action changed from May–July 2018 to April 2020, χ^2 (1, $N = 79$) = 7.22, $p = 0.007$ with continuity correction, such that the proportion of people responding "No" May–July 2018 and then "Yes" April 2020 (0.00%) is smaller than the proportion of people responding "Yes" May–July 2018 and then "No" April 2020 (65.91%). However, we note that an especially high proportion of respondents in the early pandemic selected "Not applicable" to this item-—58.6% compared to less than 17% for all other sustainability behaviors. Thus, we conducted an exploratory, *post-hoc* analysis to directly account for the "Not applicable" responses in the early pandemic. We tested for changes in paired responses in a 3 × 3 matrix of responses in 2018 ("Yes," "No," or "Not applicable") and in April 2020 ("Yes," "No," or "Not applicable") using the Stuart Maxwell test and found a significant difference, χ^2 (2, $N = 227$) = 62.10, $p < 0.001$ *post-hoc* pairwise comparisons revealed a significant increase from those who selected "Yes" in May–July 2018 to "Not applicable" in April 2020 (adjusted χ^2 $p < 0.001$), for those who selected "No" in May–July 2018 to "Not applicable" in April 2020 (adjusted χ^2 $p = 0.0024$), and for those who selected "Yes" in May–July 2018 to "No" in April 2020 (adjusted χ^2 $p < 0.001$).

Used Energy Efficient Lightbulbs

Due to a low count in the discordant pair, McNemar's test was not performed comparing May–July 2018 to February 2020. Similarly, due to a low count in the discordant pair, McNemar's test was not performed comparing May–July 2018 to April 2020.

Recycled

Due to a low count in the discordant pair, McNemar's test was not performed comparing May–July 2018 to February 2020. Similarly, due to a low count in the discordant pair, McNemar's test was not performed comparing May–July 2018 to April 2020.

Taken Shorter Showers

The proportion of people reporting having done this action did not change significantly from May–July 2018 to February 2020, χ^2 (1, $N = 223$) = 4.37, $p = 0.037$, as this comparison did not survive the discrete Bonferroni-Holmes multiplicity adjustment correction with alpha set at 0.0125. In addition, the proportion of people reporting having done this action did not change from May–July 2018 to April 2020, χ^2 (1, $N = 220$) = 4.12, $p = 0.042$, as this comparison did not survive the discrete Bonferroni-Holmes multiplicity adjustment correction with alpha set at 0.0167.

Driven a Hybrid or Electric Vehicle

Due to a low count in the discordant pair, McNemar's test was not performed comparing May–July 2018 to February 2020. Similarly, due to a low count in the discordant pair, McNemar's test was not performed comparing May–July 2018 to April 2020.

Reduced Red Meat Consumption

The proportion of people reporting having done this action changed from May–July 2018 to February 2020, χ^2 (1, $N = 211$) = 47.65, $p < 0.001$, such that the proportion of people responding "No" May–July 2018 and then "Yes" February 2020 (29.82%) is larger than the proportion of people responding "Yes" May–July 2018 and then "No" February 2020 (15.58%). In addition, the proportion of people reporting having done this action changed from May–July 2018 to April 2020, χ^2 (1, $N = 210$) = 36.10, $p < 0.001$, such that the proportion of people responding "No" May–July 2018 and then "Yes" April 2020 (27.59%) is larger than the proportion of people responding "Yes" May–July 2018 and then "No" April 2020 (22.37%).

Eaten a More Plant-Based Diet

The proportion of people reporting having done this action changed from May–July 2018 to February 2020, χ^2 (1, $N = 222$) = 42.36, $p < 0.001$, such that the proportion of people responding "No" May–July 2018 and then "Yes" February 2020 (16.95%) is larger than the proportion of people responding "Yes" May–July 2018 and then "No" February 2020 (15.34%). In addition, the proportion of people reporting having done this action changed from May–July 2018 to April 2020, χ^2 (1, $N = 223$) = 42.55, $p < 0.001$, such that the proportion of people responding "No" May–July 2018 and then "Yes" April 2020 (21.67%) is larger than the proportion of people responding "Yes" May–July 2018 and then "No" April 2020 (17.18%).

Reduced Food Waste

The proportion of people reporting having done this action changed from May–July 2018 to February 2020, χ^2 (1, $N = 222$) = 114.89, $p < 0.001$, such that the proportion of people responding "No" May–July 2018 and then "Yes" February 2020 (53.66%) is larger than the proportion of people responding

TABLE 2 | Ratios of response changes in matched sample ($n = 227$).

		May–July 2018 → February 2020	p	May–July 2018 → April 2020	p
Alternative transportation	No → Yes	3.92%	N/A	**0.00%**	**0.007**
	Yes → No	25.81%		**65.91%**	
Used energy efficient lightbulbs	No → Yes	66.67%	N/A	50.00%	N/A
	Yes → No	1.82%		4.98%	
Recycled	No → Yes	40.00%	N/A	20.00%	N/A
	Yes → No	0.50%		18.02%	
Shorter showers	No → Yes	22.22%	0.037	22.47%	0.042
	Yes → No	27.07%		27.48%	
Driven hybrid or electric vehicle	No → Yes	3.85%	N/A	5.66%	N/A
	Yes → No	4.00%		4.00%	
Reduced red meat consumption	No → Yes	**29.82%**	**<0.001**	**27.59%**	**<0.001**
	Yes → No	**15.58%**		**22.37%**	
Eaten more plant-based diet	No → Yes	**16.95%**	**<0.001**	**21.67%**	**<0.001**
	Yes → No	**15.34%**		**17.18%**	
Reduced food waste	No → Yes	**53.66%**	**<0.001**	**57.14%**	**<0.001**
	Yes → No	**9.39%**		**12.71%**	
Composted	No → Yes	9.24%	0.07	11.97%	0.037
	Yes → No	14.43%		19.59%	
Checked air in tires	No → Yes	**36.00%**	**<0.001**	**23.61%**	**0.002**
	Yes → No	**12.95%**		**28.68%**	
Used smart thermostat	No → Yes	**22.05%**	**0.005**	**18.25%**	**0.001**
	Yes → No	**25.88%**		**27.06%**	

Significantly different proportions that survived the discrete Bonferroni-Holmes multiplicity adjustment correction are bolded. N/A indicates that McNemar's test were not performed due to discordant cells adding up to <25.

"Yes" May–July 2018 and then "No" February 2020 (9.39%). In addition, the proportion of people reporting having done this action changed from May–July 2018 to April 2020, χ^2 (1, $N = 223$) = 111.36, $p < 0.001$, such that the proportion of people responding "No" May–July 2018 and then "Yes" April 2020 (57.14%) is larger than the proportion of people responding "Yes" May–July 2018 and then "No" April 2020 (12.71%).

Composted
The proportion of people reporting having done this action did not change from May–July 2018 to February 2020, χ^2 (1, $N = 216$) = 3.27, $p = 0.07$, as this comparison did not survive the discrete Bonferroni-Holmes multiplicity adjustment correction with alpha set at 0.025. In addition, the proportion of people reporting having done this action did not change from May–July 2018 to April 2020, χ^2 (1, $N = 214$) = 4.37, $p = 0.037$, as this comparison did not survive the discrete Bonferroni-Holmes multiplicity adjustment correction with alpha set at 0.01.

Checked Air in Tires to Ensure Fuel Efficiency
The proportion of people reporting having done this action changed from May–July 2018 to February 2020, χ^2 (1, $N = 214$) = 31.53, $p < 0.001$, such that the proportion of people responding "No" May–July 2018 and then "Yes" February 2020 (36.00%) is larger than the proportion of people responding "Yes" May–July 2018 and then "No" February 2020 (12.95%).

In addition, the proportion of people reporting having done this action changed from May–July 2018 to April 2020, χ^2 (1, $N = 201$) = 9.31, $p = 0.002$, such that the proportion of people responding "No" May–July 2018 and then "Yes" April 2020 (23.61%) is smaller than the proportion of people responding "Yes" May–July 2018 and then "No" April 2020 (28.68%).

Used a Smart Thermostat
The proportion of people reporting having done this action changed from May–July 2018 to February 2020, χ^2 (1, $N = 212$) = 8.00, $p = 0.0046$, such that the proportion of people responding "No" May–July 2018 and then "Yes" February 2020 (22.05%) is smaller than the proportion of people responding "Yes" May–July 2018 and then "No" February 2020 (25.88%). In addition, the proportion of people reporting having done this action changed from May–July 2018 to April 2020, χ^2 (1, $N = 211$) = 10.19, $p = 0.0014$, such that the proportion of people responding "No" May–July 2018 and then "Yes" April 2020 (18.25%) is smaller than the proportion of people responding "Yes" May–July 2018 and then "No" April 2020 (27.06%).

Unmatched Group Analysis
Raw counts of responses for the unmatched sample, as well as p-values from the chi-squared tests, can be found in **Table 3**.

TABLE 3 | Proportions and counts of responses and chi-squared results in unmatched sample.

| | May–July 2018 n = 1,057 | | April 2020 n = 881 | | |
	No % (n)	Yes % (n)	No % (n)	Yes % (n)	p
Alternative transportation	55% (412)	45% (338)	77% (328)	23% (98)	**<0.001**
Used energy efficient lightbulbs	4% (42)	96% (1010)	8% (60)	92% (799)	0.005
Recycled	4% (39)	96% (1011)	7% (62)	93% (802)	**0.001**
Shorter showers	39% (408)	61% (637)	45% (385)	55% (476)	0.014
Driven hybrid or electric vehicle	89% (880)	11% (113)	85% (636)	15% (114)	0.023
Reduced red meat consumption	33% (335)	67% (677)	35% (294)	65% (554)	0.51
Eaten more plant-based diet	32% (336)	68% (700)	34% (298)	66% (568)	0.39
Reduced food waste	24% (247)	76% (798)	18% (155)	82% (714)	**0.002**
Composted	62% (637)	38% (394)	64% (541)	36% (305)	0.36
Checked air in tires	37% (386)	63% (648)	48% (383)	52% (416)	**<0.001**
Used smart thermostat	60% (603)	40% (404)	60% (493)	40% (335)	0.92

Raw counts do not include "Not Applicable" responses. Significantly different proportions that survived the Bonferroni correction are bolded.

Used Public Transportation, Biked, or Walked to Work Instead of Driving

The proportion of people reporting having done this action differed by time, χ^2 (1, $N = 1176$) = 55.74, $p < 0.001$. Respondents were less likely to say that they had used alternative transportation to get to work in the past month in April 2020 (23.00%) than in May–July 2018 (45.07%). We additionally explored the selection of "NA" as an additional response option for this sustainability behavior, as we did for the matched group. In this case, the proportion of responses differed by time, χ^2 (2, $N = 1176$) = 155.69, $p < 0.001$. A series of *post-hoc* tests revealed that the proportion of people responding "Yes" differed by time such that fewer people responded "Yes" in April 2020 compared to May–July 2018 ($p < 0.001$), and the proportion of people responding "NA" differed by time such that more people responded "NA" in April 2020 ($n = 455$) compared to May–July 2018 ($n = 307$; $p < 0.001$).

Used Energy Efficient Lightbulbs

The proportion of people reporting having done this action did not differ by time, χ^2 (1, $N = 1,911$) = 7.80, $p = 0.005$, as the test did not survive the Bonferroni correction.

Recycled

The proportion of people reporting having done this action differed by time, χ^2 (1, $N = 1,914$) = 10.68, $p = 0.001$. Respondents were less likely to say that they had recycled in the past month in April 2020 (92.82%) than in May–July 2018 (96.29%).

Taken Shorter Showers

The proportion of people reporting having done this action did not differ by time, χ^2 (1, $N = 1,906$) = 6.02, $p = 0.014$, as the test did not survive the Bonferroni correction.

Driven a Hybrid or Electric Vehicle

The proportion of people reporting having done this action did not differ by time, χ^2 (1, $N = 1,743$) = 5.17, $p = 0.023$, as the test did not survive the Bonferroni correction.

Reduced Red Meat Consumption

The proportion of people reporting having done this action did not differ by time, χ^2 (1, $N = 1,860$) = 0.44, $p = 0.51$.

Eaten a More Plant-Based Diet

The proportion of people reporting having done this action did not differ by time, χ^2 (1, $N = 1,902$) = 0.74, $p = 0.39$.

Reduced Food Waste

The proportion of people reporting having done this action differed by time, χ^2 (1, $N = 1,914$) = 9.27, $p = 0.002$. Respondents were more likely to say that they had reduced food waste in the past month in April 2020 (82.16%) than in May–July 2018 (76.36%).

Composted

The proportion of people reporting having done this action did not differ by time, χ^2 (1, $N = 1,877$) = 0.44, $p = 0.36$.

Checked the Air in Your Tires to Ensure Fuel Efficiency

The proportion of people reporting having done this action differed by time, χ^2 (1, $N = 1,833$) = 20.38, $p < 0.001$. Respondents were less likely to say that they had checked the air in their tires in the past month in April 2020 (52.07%) than in May–July 2018 (62.67%).

Used a Smart Thermostat

The proportion of people reporting having done this action did not differ by time, χ^2 (1, $N = 1,835$) = 0.01, $p = 0.92$.

DISCUSSION

In a novel natural experiment, this research tracked changes in botanical garden members' self-reports of engaging in a variety of sustainability behaviors before and after the onset of the global COVID-19 pandemic. We tracked these changes in two ways. First, we identified a matched group of garden members who had responded to both a 2018 and a 2020 survey and we compared their responses over time. Second, we defined two unmatched groups of respondents who had either taken the 2018 or the 2020 survey, but not both, and compared their responses as independent samples.

Across both of our matched and unmatched samples, we find no evidence of a widespread shift in sustainability behaviors after the onset of the pandemic in either direction. While the small (n = 227) group of matched sample respondents were more likely to report engaging in sustainability behaviors after the onset of the pandemic than 2 years prior, this shift appears to have occurred prior to the onset of the pandemic, as respondents also were more likely to report engaging in these behaviors in February of 2020. Specifically, respondents were more likely to report that they reduced their red meat consumption and food waste, ate a more plant-based diet, and used a smart thermostat in both February 2020 and April 2020 compared to 2018. That these changes could be measured in February 2020 suggests that the pandemic, which began to impact most Americans in March 2020, is not a causal factor driving behavioral change.

This pattern of matched group respondents being more likely to report engaging in sustainability behaviors in both February and April of 2020 compared to 2018 reflects broad changes over time toward more sustainable behaviors that, while not pandemic-related, could be attributed to the composition of the matched group. This is a sample of 227 members of a botanical garden who responded twice, nearly 2 years apart, to environmental behavior surveys sent by that botanical garden. These respondents represent just 1.04% of the total botanical garden members contacted in 2018 and 0.74% of the total contacted in 2020. That is, the matched sample respondents represent a minority of all respondents who, based on their demonstrated reliability in taking multiple surveys from the botanical garden over time, might reasonably be viewed as categorically different from one-time respondents in a way that is related to their increased likelihood of engaging in sustainability behaviors over time. Indeed, the response patterns from this group may be a result of self-selection bias, whereby respondents from the first survey who wish to report on their more sustainable behaviors are more likely to participate in the second survey, but those who would not have more sustainable behaviors to report would be less likely to participate a second time. We additionally note that a larger proportion of the matched sample has a graduate or professional degree than both unmatched groups (**Table 1**).

We did find changes in two sustainability behaviors involving personal travel both pre-pandemic and in the early pandemic. First, *post-hoc* tests revealed that the matched group respondents selected "Not applicable" for using alternative transportation to get to work in the early pandemic when they had previously selected "Yes" in 2018. This shift could be explained by the fact that many people in the early pandemic switched to remote work, negating the need for a commute at all, or lost their jobs. This finding, paired with their decreased likelihood to check the air in their tires to ensure fuel efficiency in the early pandemic (the only behavior that showed an early pandemic effect), suggests that the pandemic reduced driving time and driving-associated behaviors.

The findings from our unmatched samples demonstrate the complexities of pandemic life for sustainable lifestyles. Compared to pre-pandemic respondents, respondents in the early stages of the pandemic were more likely to engage in one sustainability behavior—reducing food waste. However, these respondents were also less likely to engage in three sustainability behaviors: recycling, using alternative transportation to get to work, and checking the air in their tires, compared to pre-early pandemic respondents. Instead of a widespread shift toward or away from sustainable behaviors, these findings reflect a more nuanced view of how the realities of the pandemic, and its accompanying effects on employment and leisure, have downstream consequences for sustainability behaviors.

The increased likelihood of reducing food waste is consistent with other studies on the impact of the pandemic on food usage (Rodgers et al., 2021), and reveals a potential environmental benefit of the pandemic. Reducing individuals' food waste at the point of consumption has been identified as a top priority in creating a sustainable food system that will ultimately reduce global greenhouse gas emissions (Hawken, 2017; Willett et al., 2019). While it is possible that respondents in the early pandemic reduced their food waste in the interest of making more environmentally-friendly choices, the fact that this was the sole sustainability behavior that increased suggests that another explanation is needed. First, in the early weeks of nationwide shutdowns in the U.S., there were food shortages across the meat and dairy sectors (Peel, 2021; Weersink et al., 2021) and increases in panic-buying and stockpiling behavior among food shoppers (Keane and Neal, 2021). Thus, this scarcity, or perceived scarcity, of food may have caused respondents to reduce food waste as a means to maximize their food supply. Additionally, people may have been motivated to fully exhaust their pantries before risking exposure to the virus by venturing out to the grocery store. A final possibility is that, with pandemic-related losses in income, respondents were reducing food waste as a cost-saving measure.

The finding that unmatched group respondents were less likely to report recycling in the early pandemic compared to pre-pandemic demonstrates a potential environmental disadvantage of the pandemic. Recycling is a commonly cited example of an action that reduces one's carbon footprint (Attari et al., 2010, 2016), and it is frequently recommended in environmental literature despite having a low impact on reducing carbon emissions (Wynes and Nicholas, 2017). A multitude of individual-level factors have been positively linked to recycling behaviors (e.g., self-efficacy or pro-environmental values; Geiger et al., 2019), but these factors are likely to be relatively stable in our sample population of botanical garden members. For example, our measure of concern for climate change did not differ between the unmatched groups, indicating that the pandemic did not impact climate change perceptions. Thus, it

is unlikely that the pandemic reduced recycling by negatively impacting perceptions of the environment or recycling attitudes; instead, it is likely that the contextual or incidental factors related to the pandemic were the cause. Recycling is less likely to occur in households that lack a recycling bin (Geiger et al., 2019), and with people spending more time at home with fewer opportunities to recycle in public places due to the pandemic, those without established household recycling habits were perhaps less likely to encounter opportunities to recycle. However, we note that the recycling rates for both pre-pandemic and pandemic-era groups were high, and thus we caution against interpreting a decline in recycling from 96 to 92% as a particularly dire environmental consequence of the pandemic.

The findings that relate to transportation (i.e., taking alternative transportation to work and checking the air in your tires to ensure fuel efficiency) from the unmatched group comparisons reveal the extent to which the pandemic has influenced personal travel patterns. First, as with the matched group, unmatched group respondents may be less likely to report taking alternative transportation to work because they are working remotely and thus do not need to travel in any capacity to their workplace, or because they have experienced pandemic-related job loss and have no workplace that would necessitate a commute. Thus, this decreased likelihood of using alternative transportation, while on its face seems to imply an increased reliance on traditional, high-carbon commuting, may in fact represent a decline in all commuting behaviors, which is itself a sustainability behavior on par with using alternative transportation. Unfortunately, this research cannot definitively say whether this is the case, as we did not ask for the reason behind such responses. However, pandemic-related decreases in use of public transportation specifically (Ahangari et al., 2020; Teixeira and Lopes, 2020) and mobility generally (Warren and Skillman, 2020) are well-documented and fit with our findings. Similarly, unmatched group respondents' decreased likelihood of checking the air in their tires to ensure fuel efficiency may on its face seem like a decrease in sustainable behavior, but in actuality may reflect a decrease in personal vehicle usage.

This pattern of results from the unmatched groups may reflect more net-positive environmental benefits after pandemic onset than at first glance. First, unmatched respondents in the early pandemic were more likely to reduce food waste and possibly less likely to use personal vehicles than pre-pandemic respondents, which would reflect behaviors that are commonly cited as effective for reducing individual greenhouse gas emissions (Hawken, 2017). Additionally, while the reduction in recycling behavior is potentially vexing, we note that it is a small effect among people who were likely at ceiling for the behavior. Paired with the fact that individual recycling is a relatively low-impact sustainability behavior in terms of its carbon-reduction potential (Wynes and Nicholas, 2017), we cannot conclude that our sample's decrease in recycling behavior would have a large negative environmental impact. Thus, the change in sustainability behaviors of the unmatched sample are, on balance, likely to be modestly positive.

However, there is reason to be skeptical that these changes in sustainability behaviors will outlive the pandemic era. In countries where the recovery from the pandemic has begun, such as China, there has been an increase in domestic travel for leisure and work approaching pre-pandemic levels (Chen et al., 2020). Indeed, even in the U.S. there is emerging evidence of recoveries in traffic volume, such as in usage of toll roads (Conduent Business Services, 2020) and increased number of driver-reported trips (CNN Business, 2021). Some researchers, while acknowledging that nearly half of the global decrease in daily carbon emissions comes from the transportation sector, predict that the effect will be temporary as it does not reflect underlying changes in transport systems (Le Quéré et al., 2020).

Reductions in food waste could potentially have a long-lasting effect. Many have noted an aversion to food waste both culturally and individually after crises such as the Great Depression (Poppendieck, 1986). With the COVID-19 pandemic in particular, a recent study found that those experiencing pandemic-related unemployment spent less on food and had less confidence in their ability to afford food than those not experiencing unemployment (Restrepo et al., 2021), which could increase or perpetuate food waste reduction behaviors, as food waste minimization has been linked to a desire to not waste money (Graham-Rowe et al., 2014). To the extent that the pandemic imparts a lasting belief in frugality on those who lived through it, the transition to food waste reduction behaviors should be stable. However, to the extent that food waste reduction is linked to food or income insecurity, one would predict that this behavior would not continue post-pandemic when unemployment rates decline. Similarly, one might anticipate that a return to business-as-usual for our sample would result in a return to formerly high levels of recycling behaviors as well.

While these results are modestly positive, we recognize a primary limitation to this work is a potential lack of generalizability to the wider U.S. and international populations. The uniqueness of our sample of botanical garden members meant that they were ideal for studying changes in sustainability behaviors because they were more likely to be doing those behaviors pre-pandemic, but it also means that translating our effects to a less environmentally-engaged population is difficult. We also acknowledge that our sample could be at ceiling for these behaviors, and thus it would be fruitful for future studies to examine sustainability behavior change among those with low or average baseline sustainability behavior engagement. Additionally, our sample had higher education, and likely higher income, than a representative U.S. sample. This likely resulted in a sample that was economically secure and stable during the pandemic, so future research should clarify the role that income and financial security played in pandemic-related changes in sustainability behaviors. Future research could also examine engagement in sustainability behaviors not studied here, like reducing consumption of dairy products (Kause et al., 2019), purchasing energy-efficient household appliances, or insulating and weatherizing their home (Stern et al., 2016).

Despite the lack of certainty regarding the continuation of these sustainability behaviors, we can draw some general conclusions about the impact of the COVID-19 pandemic on sustainability behaviors in an environmentally

engaged sample. First, we find no evidence of changes in most of the sustainability behaviors measured that can be attributed to the pandemic. Second, many of the observed changes seem to center around decreases in personal travel behaviors that are probably linked to early pandemic stay-at-home orders. Finally, increases in reducing food waste and decreases in recycling were found, but further research into behaviors occurring beyond the early pandemic stage are needed to discern if these changes are long-lasting.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Michigan Institutional Review Board. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CD, RP, GW-P, and SS contributed to the design and implementation of the surveys upon which this study is based and provided feedback on the manuscript. KM, CD, GW-P, and SS contributed to the conceptual design of the study. CD organized and maintained the data. KM performed the statistical analyses and wrote the manuscript. All authors read and approved the submitted version.

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The Important Role of Environmental Stewardship Groups in Supporting Human Health and Well-Being

Rachel Dacks[1]*, Heather McMillen[2], Pua Heimuli[2], Kimberly Kahaleua[1], Sanoe Burgess[3], Christian P. Giardina[4], Kainana Francisco[4] and Tamara Ticktin[1]

[1] School of Life Sciences, University of Hawai'i at Mānoa, Honolulu, HI, United States, [2] Division of Forestry and Wildlife, State of Hawai'i Department of Land and Natural Resources, Honolulu, HI, United States, [3] Aloha 'Āina Corps Program, Honolulu, HI, United States, [4] Institute of Pacific Islands Forestry, Pacific Southwest Research Station, USDA Forest Service, Hilo, HI, United States

The human health and well-being benefits of nature are well-known. The COVID-19 pandemic has disrupted the work of environmental stewardship groups, especially those that facilitate access to and/or provide opportunities to engage with nature. To understand the impacts of this disruption on stewardship groups and their volunteers in Hawai'i, we: (i) conducted semi-structured interviews with 20 leaders of stewardship groups on O'ahu; and (ii) surveyed 85 individuals who volunteer with stewardship groups across the state. We found that some groups were negatively impacted by COVID-19-related funding losses, volunteer activity cancellations, and thus a reduced workforce. We also found that some groups were able to secure new pandemic-specific funding sources and increase their online presence. Many groups were able to strengthen their connections to community through efforts to respond to COVID-19 driven needs of the community, for example meeting nutritional needs of families through food or crop plant distributions. When asked what they missed the most about volunteering with stewardship groups, over half of surveyed respondents identified the social benefits of volunteering, including feeling a sense of community. Over a third of respondents said they missed engaging with the land/place. Nearly a third indicated that a lack of engagement with these groups during the pandemic had negatively affected them psychologically. Our results highlight the significant yet underappreciated role that stewardship groups play in community and individual well-being, and how a large-scale crisis can lead to innovative adaptations with important implications for social resilience.

Keywords: environmental stewardship, environmental stewardship groups, access to nature, benefits of nature, human well-being, COVID-19 impacts

INTRODUCTION

For individuals, households, extended families, and communities, the health and well-being benefits of being in nature are well-documented (see reviews by Bratman et al., 2012; Hartig et al., 2014; WHO Regional Office for Europe, 2016; Wendelboe-Nelson et al., 2019). The value of these benefits are now formally recognized by the medical community, with "nature-assisted therapies" or "green care" being prescribed as effective treatments for a diverse range of ailments (Annerstedt and Währborg, 2011). Other studies have examined the mental health benefits associated more

specifically with purposeful activity in nature, such as volunteering or citizen science (Coventry et al., 2019). These findings are consistent with studies that have found that several different types of volunteering (i.e., not limited to environmental volunteering) positively impacted the mental health of those who volunteer (Jenkinson et al., 2013).

Frequent experiences and purposeful activity in nature often foster a sense of nature connectedness and higher levels of eudaimonic well-being (Pritchard et al., 2020). Similarly, knowing, perceiving, interacting with, and living within an ecosystem can lead to developing a sense of place with important well-being benefits (Russell et al., 2013; Hausmann et al., 2016).

Further, in many Indigenous communities, caring for nature is a culturally driven, moral responsibility that is foundational for well-being (Jax et al., 2018). Many Indigenous communities have kincentric worldviews where people not only assume a strong responsibility for the care of nature, but view themselves as part of nature, with which they share genealogical connections (Salmón, 2000). In such cases, caring for nature is part of a reciprocal relationship in which nature is both "care-giver and care-receiver" (Jax et al., 2018). For example, Diver et al. (2019) describe how reciprocal relations are important to Indigenous peoples' guardianship, care, and management of marine resources in Hawai'i and Madagascar, and of forests in Canada, but also how these reciprocal relationships define resource stewardship of non-Indigenous people in Appalachia, USA. However, colonial appropriation of land, eradication of entire communities, and continued marginalization have caused massive displacement of Indigenous peoples worldwide, resulting in major disruptions to people's relationship with place and driving long-lasting impacts to health and well-being (Stephens et al., 2006; Gone et al., 2019; but see McMillen et al., 2017).

Access to Nature

Nature's health and well-being benefits are not evenly distributed across communities, with observed disparities having historical, geographic, and personal roots. Access to nature may be more limited in urban than rural areas, and within urban settings, opportunities to access nature within public green spaces (Kondo et al., 2018) may not be equitable, with parks, green and blue areas typically being more numerous, larger, and of higher quality in less densely populated neighborhoods of higher socioeconomic means (Shanahan et al., 2014; Nesbitt et al., 2019; Locke et al., 2021). Access issues are not limited to urban areas. For example, in rural areas, land privatization can make access to natural areas difficult (Ho-Lastimosa et al., 2019).

In areas that are home to Indigenous communities, urban green space design and maintenance may exclude culturally important native species, and may be unwelcoming to Indigenous people, including being misaligned with or even antagonistic to Indigenous views of and relationships with nature and natural spaces (Shackleton and Gwedla, 2021). As a result, not all individuals have quality access to "natural areas," some may be uncomfortable accessing "natural areas," and others may lack knowledge, skills, abilities, confidence, or financial resources to volunteer in the environmental sector.

Hawai'i is a historically and culturally complex Indigenous geography that provides a valuable opportunity for understanding the role of environmental stewardship groups in providing meaningful access to natural areas. As with many landscapes of North America, Hawai'i's colonial history, resource management infrastructure, and on-going land conflicts all add complexity to nature access and stewardship. In the mid-1800s, U.S. interests pushed for land to become privatized, resulting in the Māhele (McGregor, 1996). With the overthrow of the Hawaiian Kingdom by U.S. interests in 1893, 1,800,000 acres of Kingdom lands were illegally transferred to the Provincial Government, then to the U.S. Federal Government, and ultimately to the State of Hawai'i (MacKenzie et al., 2015). These "ceded" lands were used to establish State Forest Reserves, State and County Parks, Hawai'i's two largest National Parks, in addition to countless urban green spaces, State and Federal Department of Transportation right of ways, and the many campuses of the University of Hawai'i System (see 1993 U.S. Apology Bill). As a result of the complex colonial, racially motivated land theft, many Native Hawaiians lost access rights to lands their families had been stewarding for generations. Past and ongoing disruptions have severely constrained, but not eliminated physical access to nature, with psychological, spiritual, and cultural consequences resulting from these socio-political disruptions. Further, colonization has impacted the capacity of Hawai'i's Indigenous communities to maintain relationships and honor stewardship responsibilities to their native lands (McGregor, 1996). Compounding ceded land issues are the high prices for land and housing in Hawai'i, which are among the highest in the nation.

Past and present land management practices can degrade or even transform native ecosystems into alternative conditions such as non-native species dominated, heavily grazed, urbanized, or intensively farmed ecosystems. Today most forests in Hawai'i are now dominated by non-native and invasive species, non-native ungulates impact all unfenced forested areas of the state, residential and commercial development is rapidly expanding, and Hawaii's agricultural footprint is growing.

There is a great deal of variation, spatial and temporal, across Hawaii's agricultural production systems. Many Indigenous food production systems covering large areas of lowland Hawai'i were, over the past century, displaced by industrial monoculture production (e.g., sugar cane, pineapple, sheep and cattle ranching). In the past 20 years, much of this agricultural land base has ceased to be used for production, with abandonment resulting in rapid invasions by some of the state's most egregious plant pests. But throughout the archipelago, biocultural approaches to land stewardship now integrate diverse knowledge systems to care for people and place (Chang et al., 2019). For example, several environmental stewardship groups are focused on the restoration of lo'i, wetland agro-ecosystems, that provide essential habitat to many native, endangered waterbirds and can also be used for the cultivation of taro (*Colocasia esculenta*), a Native Hawaiian food staple and spiritually important plant (Harmon et al., 2021).

Environmental Stewardship Groups (ESGs)

Community-based groups often host environmental stewardship activities that provide individuals with physical access to natural areas and meaningful opportunities to steward nature. These groups (hereafter, environmental stewardship groups or ESGs) may operate formally (e.g., registered non-profit organizations, associations, civic groups) (Svendsen and Campbell, 2008; Wolf et al., 2013; Westphal et al., 2014) or informally (e.g., individuals, households, extended families, neighborhoods) (Lukacs et al., 2016; Vaughan, 2018). While these groups engage in some form of environmental stewardship, stewardship may not necessarily be a primary goal or central activity (Svendsen and Campbell, 2008; Wolf et al., 2013; Westphal et al., 2014). Given this broad definition of ESGs, the full list of groups that participate in environmental stewardship and the extent of their engagements are difficult to quantify, especially in landscapes comprised of mixed private and public ownerships. Further, because the primary mission of most ESGs is to improve environmental conditions, the role of these groups in supporting human well-being through providing access to nature and volunteer opportunities to engage with nature is not well-studied (Svendsen, 2011).

Many ESGs operate with small staffs and so often rely on volunteers to accomplish ESG goals (Svendsen and Campbell, 2008; Dacks et al., 2021). However, in the spring of 2020, the coronavirus disease 2019 (COVID-19) pandemic caused global-scale stay at home orders, social distancing, and cautionary avoidance of social gatherings. Logically then, the pandemic may have also reduced the capacity of many ESGs, many of which were already limited by small budgets (Dacks et al., 2021). One study suggested that the impacts of the pandemic to environmental education groups could be devastating, with the sector undergoing detrimental downstream impacts to broader education systems (Collins et al., 2020).

If the pandemic has brought challenges that threaten the existence of ESGs, it is important to know specifically how they have been impacted in order to know how they can be assisted. Further, if ESGs have adapted to the challenges posed, it would be important to share details of their adaptations for the greater good of the community. In addition, the COVID-19 pandemic provides a unique, albeit unfortunate, opportunity to assess how participants have been impacted by loss of access to ESG driven stewardship opportunities. In particular, what have been and so overall what are the contributions of ESGs to human health and well-being, as revealed by loss of access to ESG activities.

We aim to better understand how ESGs have been impacted by the pandemic and the role of ESGs in supporting human well-being by asking: (1) how has the pandemic affected the budgets, volunteer base, and types of activities of ESGs? and (2) how were individuals impacted by the change in engagement with ESGs? We expected ESGs to have funding, volunteer, and staff impacts and, when possible, to have shifted some of their efforts to programs more compatible with pandemic regulations, such as providing online educational resources. We also predicted that individuals would be psychologically impacted by the reduced number of opportunities to engage in environmental stewardship.

MATERIALS AND METHODS

Study Site Information

This study took place on the island of Oʻahu, in the densely populated districts of Kona and Koʻolaupoko. Oʻahu is the third largest island in the Hawaiian archipelago and is home to Honolulu, the state's capital city, one of the largest metropolitan areas in the Pacific, and to Waikīkī, a world-renowned tourist destination. The state of Hawaiʻi has a total population of about 1.4 million people, with just over two-thirds of these people living on the island of Oʻahu, most of whom reside in the greater Honolulu area (U.S. Census Bureau., 2020).

Interviews of ESGs

Twenty semi-structured interviews (**Supplementary Information**) were conducted in September and October 2020 with leaders of ESGs in Kona and Koʻolaupoko districts of Oʻahu. These leaders were a subset of those who had previously completed a survey on behalf of their group as part of the Stewardship Mapping and Assessment Project (STEW-MAP) (http://stewmaphawaii.net/) (Dacks et al., 2021). STEW-MAP broadly defines ESGs as groups that participate in one or more of the following activities: environmental advocacy, environmental resource management, environmental conservation, environmental education, engaging with land and/or ocean for health and well-being, ecological monitoring, place-based resource harvesting, restoration, transforming local environmental systems, and supporting other environmental work. In community meetings (pre-COVID) in which STEW-MAP results were shared, we asked attendees if there were questions they would like us to ask in follow-up interviews. We incorporated these ideas when developing our interview questions, after the pandemic had started. We also referenced a follow-up survey that was conducted by the New York City STEW-MAP research team (https://www.nrs.fs.fed.us/STEW-MAP/nyc/). The interview tool was then piloted with five individuals who are employed in the environmental stewardship sector and also volunteer with ESGs. The interview questions and protocol were refined based on their feedback.

The groups selected for interviews were non-randomly chosen to represent a stratified range of organizational characteristics. To do this, we considered age, size, capacity and stewardship focus of the organization (**Table 1**). The interviews were conducted by three interviewers (RD, HM, PH) who met weekly to discuss common themes, unique replies, and any logistical challenges that arose. All interviews were conducted via Zoom and lasted between 45 and 90 min. The interviews focused on questions that fell into three topic areas: (1) Why the group focuses on a particular site(s), (2) impacts of and adaptations to the pandemic, and (3) the role of group collaborations. Here, we report on responses to the second topic area, where questions addressed "How a group was impacted by the pandemic" by probing specific impacts to budget, staff, resources and volunteer programs. To ensure that each interviewer gave each

TABLE 1 | Organizational characteristics of the groups that participated in interviews.

Group	Year founded	# Regular volunteers	# Full-time employees	# Part time employees	Landowner/administrator of stewardship area	% Group effort focused on environmental stewardship	Group type
1	2013	300	35	0	City/County government	20–39%	Public-private partnership
2	2017	0	3	5	State government	80–100%	Federal-State partnership
3	2011	120	3	9	Individual	80–100%	501(c)(3)
4	2007	10	1	3	State government	60–79%	501(c)(3)
5	1987	200	320	380	Public and private lands	40–59%	501(c)(3)
6	1999	2	7	1	Public and private lands	80–100%	Public-private partnership
7	2007	0	41	3	State government	80–100%	501(c)(3)
8	2004	20	0	0	Public and private lands	80–100%	501(c)(3)
9	2006	15	2	2	State government	80–100%	501(c)(3)
10	2005	10	0	0	State government	80–100%	Informal group
11	2007	9	0	0	Public and private lands	80–100%	501(c)(3)
12	1970	20	2	1	State government	60–79%	501(c)(3)
13	2001	0	15	1	Public and private lands	80–100%	University Research Unit
14	1993	0	10	30	Public and private lands	80–100%	501(c)(3)
15	2001	40	8	2	Private landowner	80–100%	501(c)(3)
16	1969	0	0	0	State government	40–59%	501(c)(3)
17	1995	20	1	0	City/County government	40–59%	501(c)(3)
18	1951	0	75	10	State government	80–100%	501(c)(3)
19	1912	200	1	2	Public and private lands	80–100%	501(c)(3)
20	2018	6	3	4	Private landowner	20–39%	501(c)(3)

This data was collected as part of a survey of the Stewardship Mapping and Assessment Project that was conducted in 2019 (Dacks et al., 2021).

interviewee an opportunity to touch upon the same potential impacts and adaptations, each interviewer conducted interviews with a common outline of topic areas and subsetted questions. Prior informed consent was obtained from interviewees for both their participation in the interview as well as recording of the interview. All interview recordings were transcribed and transcriptions were checked and corrected for accuracy. We then used the transcriptions to characterize the impacts (e.g., positive, negative, adaptation) for each of the probes (e.g., budget, staff) that were discussed in the interview (**Table 2**).

Survey of Volunteers

We conducted a short survey from December 2020 to January 2021 of volunteers with ESGs across the Hawaiian Islands (**Supplementary Information**). The survey was designed to receive anonymous responses to questions focused on changes and impacts associated with the COVID-19 pandemic. The survey questions were developed by the research team, with input from leaders of ESGs. The survey was piloted with five individuals who are employed in the environmental stewardship sector and who also volunteer with ESGs. The survey was administered virtually using Google Forms following the advertising of the survey on social media and through

email distribution lists held by leaders of engaged ESGs. Some of these groups disseminated the survey opportunity to their volunteers. Informed consent was obtained from all respondents prior to each respondent beginning the survey. The survey consisted of five multiple choice questions (with an optional field for each question to provide additional details), three open ended questions, and a demographics section. All open ended and demographic questions were voluntary; the multiple choice questions were required in order to advance and submit the survey. Nine responses were not included because they were duplicate responses (respondent may have clicked "submit" multiple times). Survey responses were qualitatively analyzed using inductive coding and thematic analysis (Saldaña, 2011); RD and HM each independently came up with codes via an open coding scheme that identified key phrases and concepts (Lofland et al., 2005). These initial codes were compared and discussed iteratively until both researchers agreed on final codes, thereby enhancing reliability (Neuman, 2003). Each response was coded with up to three themes. RD then coded all responses with the final codes using NVivo 12 (QSR International Pty Ltd., 2018).

All interview and survey materials were approved by the University of Hawai'i Institutional Review Board. All authors on this paper are certified as having received and passed IRB training.

TABLE 2 | Impacts to ESGs as a result of the COVID-19 pandemic.

Group	Volunteers	New online engagement	Funding	Staff	Collaborations
Group 1	Canceled	Meetings and events	Not applicable	Not applicable	New partner(s)
Group 2	Not applicable	Not applicable	No change	No change	No change
Group 3	Canceled	New content	Decrease	More interns	No change
Group 4	Canceled	Events	Decrease	No change	Not applicable
Group 5	Not applicable	New platforms	Decrease	Reduced staff	New partner(s)
Group 6	Adapted	New content	No change	No change	New partner(s)
Group 7	Not applicable	Meetings and events	Pandemic relief	Increased staff	New partner(s)
Group 8	Adapted	New platforms	Adapted	Not applicable	New partner(s)
Group 9	Canceled	New content	No change	No change	Not applicable
Group 10	Less participants	Not applicable	No change	No change	Not applicable
Group 11	Canceled	Pending funding	Decrease	No change	No change
Group 12	Less students, more community	Events	Adapted	No change	New partner(s)
Group 13	Canceled	Events	Decrease	Reduced staff	No change
Group 14	Not Applicable	New content	Pandemic relief	Reduced staff	New partner(s)
Group 15	Canceled	Events	Pandemic relief	No change	No change
Group 16	More participants	Meetings	Not applicable	Not applicable	No change
Group 17	Canceled	Events	No change	No change	New partner(s)
Group 18	Canceled	Meetings	Decrease	No change	No change
Group 19	Canceled	Meetings	No change	No change	No change
Group 20	Adapted	Meetings	Decrease	No change	No change

Cells are shaded to represent positive impacts (green), negative impacts (red), and adaptations (yellow).

COVID-19 Context

As of May 2021, the state of Hawaiʻi had recorded a total of 31,800 cases of COVID-19, and had experienced the lowest per capita rate of infection in the country (https://health.Hawaiʻi.gov, https://www.npr.org). The state's first stay at home order was issued on March 23, 2020 and continued through May 5, 2020. During this time, only essential businesses were allowed to operate and a 14-day quarantine order was issued for any incoming arrivals; tourist numbers plummeted, and given the central role tourism plays in the state's economy, rates of unemployment skyrocketed. A mask mandate was issued on April 14, 2020 and remained in place to the time of this writing (October 2021), with high levels of compliance (https://health.Hawaiʻi.gov). After cases spiked following the 4th of July holiday in 2020, another stay at home order was issued on August 27, 2020; which lasted until September 24, 2020. It should be noted that some of our interviews took place during this second stay at home order, during which public parks, beaches, and trails were closed. Most responses to the volunteer survey were completed in December 2020, just before the first COVID-19 vaccine doses were administered.

RESULTS

The Impacts of the Pandemic on ESGs

The most widespread impact to ESGs was the cancellation of volunteer events and the resulting loss of labor, with half of all groups reporting this impact (**Table 2**). One group leader described the impact on her small group:

… it's been a huge impact because we are such a small staff that we've always really, really relied on volunteers to help us get the work done, get the invasives out, but more so that our staff rarely plants native plants. It's the volunteers that are planting native plants. And that's just kind of one of the things that I've come to love about our volunteer work days is that we pull weeds for two hours and then we spend an hour planting and 25 volunteers can plant 200 plants in an hour and a half an hour easily, but… it takes me half a day to plant 50. So, we fell really far behind, and on planting natives. (Group 4)

Another group leader described the challenge of reduced capacity:

… it was challenging for us to figure out how if we no longer have our monthly community open house where volunteers come, we no longer host the women's correctional facility, and we are no longer hosting up to three school groups, sometimes up to 120 students a month on the lands – How is that work going to get done? (Group 8)

In three of the interviews, the respondents described how the groups had adapted to the pandemic by making the in-person work environment as safe as possible for volunteers including coordinating independent volunteering, requiring reservations, relying only on small group sizes, and requiring and enforcing the wearing of masks. Since the interviews were completed, we have learned of other groups reopening volunteer events, including some of the groups that participated in our interviews, by relying on similar safety adaptations.

Many ESGs rely on student volunteers. Because in-person classes were largely replaced by virtual learning methods earlier

in the pandemic, most field trips to ESG served sites were also canceled. In order to remain engaged with these students and other volunteers, and to aid educators who were required to move their instruction online, several of the groups moved their content online, including virtually hosting events and field trips, and/or creating other educational materials. Operationally, several respondents mentioned that they moved their regular meetings online (**Table 2**).

While some respondents seemed to refer to the virtual shift with displeasure, others were more positive about the opportunities that came with virtual formats, including citing numerous benefits associated with the change. In more than a quarter of our interviews, respondents explained that they were able to reach a broader audience with their online content:

…we found that we can actually engage a broader audience… the [site name] stuff I put up in Google Maps– I've got 5,000 viewers! Right, so I wrote this grant to connect people to place and 300 people was like, "wow"! Now I've got more than an order of magnitude more. (Group 14)

Another respondent explained that virtual programming allowed them to engage more participants, including reaching people beyond Hawai'i:

… there were kūpuna [elders] from New York who dialed into our workshop on well-being. So this has kind of opened up a new awareness of how we can do outreach and maybe we can do it better. (Group 3)

Respondents also mentioned that going virtual had fostered new collaborations:

It's kind of nice because people are coming together…we realized that it doesn't make sense for everyone to do their own thing in their own spaces, it's like, how do we all work together? That's one benefit, the need for us to come together and address these problems. (Group 1)

Another respondent explained that virtual connections had made existing collaborations stronger and more efficient:

I don't know that we have developed any new collaborations with people. But I think that it has made them stronger simply due to the fact that it's so much easier to meet with people now because everyone's been virtually so I find that I've never had more meetings before in my life until COVID. But the good thing is that I never talked to these people as much as I ever have. And so I think that it's strengthened the partnerships that we already have. (Group 13)

However, the need for in-person, in-place gatherings was highlighted by three respondents. One respondent explained the challenges associated with not being able to follow sociocultural norms:

… you know what's challenging for Hawaiians through all of this, when we greet each other with honi [to touch noses and exchange breath in greeting] there's a lot of aloha. There's usually hugs and kisses when people greet each other, but to not be able to do that

leads to an awkwardly sterile gathering, especially when we aren't able to engage in these ways and these practices of establishing aloha, common aloha with one another. And so when you're not able to do that, it makes it hard to engage with each other in shared aloha and trust like we used to. (Group 2)

One respondent described that this was especially true for fishers, hunters, and farmers:
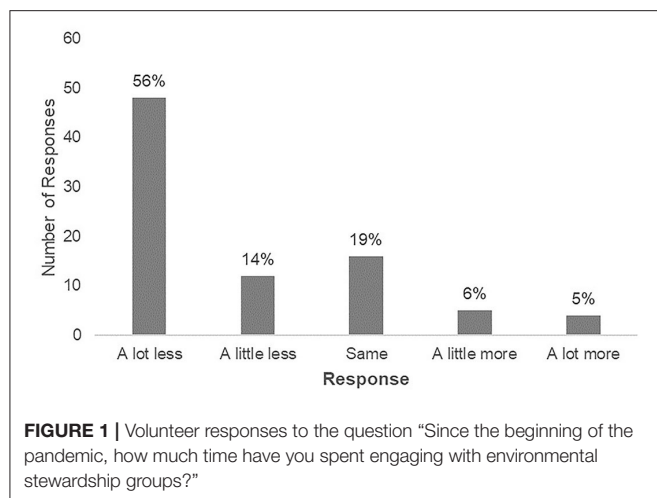
But I think going back to how we would have face to face meetings, face to face talking stories, that's really where a lot of the conversation is at its best…you know, hunters– it's a lot of tailgate talk, you know, like fisherman. A lot of people who are farmers, you know, a lot of those sunset, sunrise conversations happen on the back of one tailgate. So we can just kind of talk and kind of get at it. For myself personally within the culture and the upbringing that's just kind of how we did things… And we have to kind of respect that nature of it because there's things that we really never going to get unless we kind of be within each other's breath and be right there. (Group 16)

Despite their success at engaging with students virtually, one respondent noted that this change would not be long-term:

…delivering virtual content is brand new. Because we wouldn't choose to do it otherwise. Take away the pandemic, we not going to continue to do anything virtual. We want kids back on the 'āina [land]. (Group 15)

Interviewees responded that changes in funding had been another large impact to ESG operations (**Table 2**). Over half of the groups had reported a loss of funding, and a need to adapt their fundraising practices including applying for pandemic relief. The groups that had lost funding explained that some grants had been canceled by funders who shifted their giving to respond to emerging COVID-19 priorities. In a couple of cases, the loss of funding had resulted in the loss of staff. However, all the groups that had hosted interns before the pandemic had still been able to do so during the pandemic; in several cases, groups were able to host a larger number of interns through the Aloha 'Āina Corps (a program of Kupu, a Hawai'i based non-profit that hosts national Americorps, Youth Conservation Corp, and VISTA programs), which was supported by federal CARES Act funding.

Finally, several groups reported starting new programs or initiatives in response to community needs; some of the following programs were initiated out of a direct request from the community, while others came about as a result of perceived needs. Overall, ESGs aided parents, educators and families by: providing educational materials (7 ESGs); supporting food distribution (3 ESGs); distributing planting materials including food plants (2 ESGs); connecting people with food distributions and other aid (1 ESG); and providing grants to community partners impacted by COVID-19 (the national office of 1 ESG). Some of these efforts used existing resources or funds that were not being used as a result of changes caused by the pandemic; other efforts required groups to reach out to funders and/or collaborators for new forms of assistance.

FIGURE 1 | Volunteer responses to the question "Since the beginning of the pandemic, how much time have you spent engaging with environmental stewardship groups?"

Impacts of the Pandemic on Volunteers of ESGs

A total of 85 complete responses from ESG volunteers were recorded; of these, respondents identified as female (55), male (25), and non-binary/third gender (2). Respondents ranged in age from 21 to 92 with an average age of 51.5 (SD = 19.1). Respondents were able to indicate all ethnicities with which they identify; 66% of respondents identified as Caucasian, 31% as Asian, 20% as Native Hawaiian, and 6% as Other. A quarter of respondents identified with more than one ethnicity. On average, respondents had lived in Hawaiʻi for 59% of their lives (calculated as their age divided by the number of years they have resided in Hawaiʻi). Of the 80 respondents who indicated their zip code, 84% responded that they primarily resided on the island of Oʻahu (the island with the most number of COVID-19 cases).

The topics of focus of the organizations that the volunteers represent included: urban tree monitoring and planting, beach cleanups, wetland restoration, native forest restoration, traditional fishpond restoration, environmental education, and sustainable farming. Twenty-eight percent of respondents indicated that they had volunteered with at least one biocultural ESG before the pandemic (this was assessed by researchers checking the ESGs' mission statements for biocultural content). Many of these biocultural ESGs work on habitat restoration in areas that are important for both biodiversity and food production.

The survey ran from December 2020 to January 2021. On average, respondents engaged with significantly more groups before the pandemic (M = 3.1, SD = 3.7) than 9 months into the pandemic (M = 1.6, SD = 1.6). A paired sample t-test confirmed that this difference was significant [$t_{(84)} = 4.3, p < 0.05$]. Since the beginning of the pandemic, 56% of respondents spent "A lot less" time engaging with ESGs (**Figure 1**). The main reasons given for this were: volunteer events were canceled, government enacted restrictions, and their concerns for personal safety.

In the responses to the survey of volunteers, we identified several themes that describe how volunteers had been impacted

by their changing levels of engagement with ESGs (**Table 3**). Several responses received multiple codes, depending on the nature of the response.

Sixty-two percent of respondents mentioned that they "miss social aspects" of the volunteer experience. These social aspects ranged from individual encounters (e.g., meeting new people) to interacting with fellow members of an established community.

> *What we have lost is a more general understanding and connection to one another, the knowledge that comes with insight & perspective, the support that comes with commraderie* [sic] *and community, and the opportunities that arise from networking therein.* (R8)

Thirty-eight percent of respondents cited missing engagement with land or place. Responses coded under this category spanned different levels of engagement, from simply being outside (e.g., "*getting out in nature*"), to making physical contact with land (e.g., "*getting dirty*"), to connecting with and/or caring for the environment:

> *… [what I missed most was] the connection/relationship with the land. No greater feeling. Land is chief, man is servant.* (R2)

Twenty-eight percent of the responses that were coded as "engaging with place" had used the word ʻāina:

> *Being able to do good and much needed work with the ʻāina.* (R8)

In the Hawaiian language, one interpretation of the word ʻāina is simply land, although it also corresponds to a much broader concept of "that which feeds." ʻĀina can refer to terrestrial and/or aquatic systems and always includes people; land without people is not ʻāina.

Thirty-six percent of respondents noted that their decreased engagement with ESGs had reduced their sense of purpose:

> *The lack of engagement is isolating. I lose my sense of place and even purpose. I miss the community, the exchanges and the work.* (R48)

Twenty-three percent of responses coded as "sense of purpose" included language such as "giving back" or "mālama ʻāina" (caring for land), which may refer to the reciprocal relationship a respondent can have with place.

Thirty-one percent of respondents referred to varying impacts to psychological health because of reduced engagement with ESGs. Respondents reported emotional impacts:

> *It makes me sad that I do not have regular engagement with ʻāina.* (R26)

Impacts to mental health were also noted:

> *Feel less engaged, more stressed, anxious, antsy.* (R4)

One respondent noted that the lack of engagement has impacted her identity:

Code	Description	Number (and %) of respondents
Impacts		
Miss social aspects	Interacting with others, companionship, meeting new people, being with like-minded people, working toward a common goal, sense of community	53 (62%)
Miss engaging with place	Engaging/connecting to place, being outside, getting dirty, caring/helping the environment, mālama ʻāina	32 (38%)
No sense of purpose	Not feeling useful, productive, fulfilled; making a difference; contributing; working; helping; doing good; giving back	31 (36%)
Mental and/or emotional health effects	Sad, depressed, stressed, feel disconnected	26 (31%)
Miss learning	Learning and sharing knowledge	6 (7%)
Adaptations		
Engaged locally	Home gardening, walking in neighborhood, interacting with neighbors	16 (19%)
Engaged virtually	Online meetings and opportunities	11 (13%)
Found other ways to help	Made financial donations, purchased goods, found other ways to volunteer	6 (7%)
More time for other things	Nature-based activities, other hobbies or activities	6 (7%)

A total of 85 volunteer responses were recorded.

Not being able to go to the loʻi [Hawaiian wetland agro-ecosystem] or māla [garden] every weekend feels like I'm missing part of my personality. (R5)

Several respondents similarly reported feeling disconnected from people and/or place:

I do feel much more disconnected from the people around me and miss that feeling of aloha that you get when you are able to accomplish something for the ʻāina every Saturday morning. (R12)

One respondent noted that the impacts of reduced engagement with ESGs was the "*same as you would not seeing ones ʻohana* [family]" (R38). It is unclear whether this respondent was referring to the people she engages with or the place, or both, but this response may reflect the worldview found in many Indigenous cultures, from which people are seen as a part of nature and share a genealogy with other living things (Salmón, 2000).

Finally, 7% of respondents noted that they missed the learning aspects associated with ESG activities:

[I miss] watching our youth wonder out-loud and listening to their laughter about the things they are learning. (R47)

Volunteers also noted several ways that they had adapted to the pandemic by remaining engaged socially, with the environment, and/or with ESGs. When asked whether they had changed how they engage with the land around their own community, 27% of volunteers indicated no change, while 21% responded that they had taken up or focused more on gardening around their home and interacting with neighbors. Fourteen percent of volunteers also mentioned that they had remained engaged with ESGs through online meetings or other virtual events and opportunities. Eight percent of respondents noted that since they

could not volunteer their time with ESGs in person, they had found other ways to help, most often financially; another 8% of respondents noted that not being able to volunteer freed up time for other activities.

When asked what they needed to feel safe and comfortable to re-engage with ESGs (e.g., volunteering, attending work day) a majority of respondents indicated: social distancing (84%), face masks worn by all participants (84%), limiting the number of participants (61%), tools to be washed between uses or required to bring own tools (61%); no potlucks, and if there is a shared meal, safety precautions taken if food is eaten with group (59%); and safety questions asked of all participants upon arrival (53%). Critically the survey took place before any vaccines were available for general use. We expect that responses would likely be different had respondents all been vaccinated.

DISCUSSION

In this study, we conducted interviews with the leaders of 20 ESGs on Oʻahu, and 85 volunteers of ESGs across the state of Hawaiʻi, to understand: (1) how the pandemic affected the budgets, volunteer base, and types of activities of ESGs; and (2) how individuals affiliated with ESGs (as volunteers) were impacted by pandemic related changes to ESG operations. We found that ESGs were most negatively impacted by the cancellation of their volunteer opportunities and loss of funding. ESGs adapted by securing pandemic-specific funding and increasing their online presence. Over half of the volunteers with ESGs reported missing the social benefits of volunteering and over a third responded that they missed engaging with the land/place. These responses are consistent with stewardship typologies and motivations described in other studies (Measham and Barnett, 2008; Bennett et al., 2018; Enqvist et al., 2019). Almost a third

indicated that a lack of engagement with ESGs during the pandemic had negatively affected them psychologically. Although respondents to the survey were specifically asked about impacts due to changing levels of engagement with ESGs, it is likely that these impacts were not solely due to reductions in time spent volunteering with ESGs, but also the result of other pandemic related disruptions including stay-at-home orders, social distancing rules, and personal safety concerns.

ESGs Work Holistically, Not Just on Environmental Issues

A decrease in volunteer participation and funding losses were the most common impacts of the pandemic to the ESGs interviewed. Interviewees described several adaptations their organizations made in response to the pandemic including changes designed to better meeting the enormous, pandemic related needs of the communities where they were operating. Their adaptive nature may be due to many groups' biocultural approach; many are not solely focused on the "environment," but more broadly on the social-ecological system. For example, when asked about their groups' activities, ESGs on O'ahu listed the following activities most frequently: education (76% of groups), environment (73%), and community improvement (62%) (Dacks et al., 2021). As such, it is not surprising that some ESGs interviewed in this study had shifted their focus to responding to the needs of the community. Specifically, ESGs redirected their efforts to providing educational materials for teachers and parents, food distributions (including food grown on the land that they steward), and professional development (through hosting interns). Biocultural approaches are increasingly common in Hawai'i (Chang et al., 2019) but they are also growing globally in the conservation and restoration fields (Egan et al., 2011; Lyver et al., 2015; Velázquez-Rosas et al., 2018). As such, similar results may be found elsewhere.

While the health and well-being benefits that result from volunteering in nature have been reported elsewhere (Coventry et al., 2019), the important role of community-based groups in connecting people to place and the resulting benefits have not been well-documented. The value of ESGs to their volunteers became apparent when ESGs were no longer able to engage with volunteers and communities. Given their significant role, it would be advantageous for ESGs to be acknowledged, included, and where desired, supported by government agencies and non-government organizations who are tasked not only with environmental stewardship, but also public health (Dobson et al., 2021). In doing so, governments could potentially save money in the long-term by reducing public health expenses and resource management costs.

Currently, most ESGs track only a limited number of biophysical metrics related to volunteer impacts on the ecological system being stewarded (e.g., volunteer days, number of trees planted, invasive species removed, amount of area restored) (Dacks et al., 2021; but see Sato et al., 2021). One way that ESGs may more easily understand and publicize their public health impacts is by tracking the well-being benefits experienced by their volunteers (Seymour and Wood, 2021). While several groups track the number of participants they engage with and the number of volunteer hours, very few groups collect information on the personal impacts of engaging with ESGs (e.g., well-being benefits of volunteering).

Developing indicators that track physical, social and/or mental well-being may be beneficial for measuring and sharing ESG impacts more broadly (Sterling et al., 2017). Tracking the benefits accrued from engaging with ESGs on different landscapes could also help resource managers and policy makers better value our landscapes and seascapes in ecosystem service evaluations (Pascua et al., 2017). With thoughtful planning, indicators and metrics can be developed to assess the state of both the social and ecological dimensions of the system. Such measures may be referred to as biocultural indicators and may help ESGs track metrics that may be more closely linked to their own understandings of well-being (Dacks et al., 2019). Biocultural indicators are currently being developed and/or tested by some ESGs in Hawai'i. For example, in addition to measuring ecological indicators such as stream flow and non-native plant removal, one group uses an Indigenous evaluation methodology which involves compiling staff notes, ancestral stories, photographs, and participant evaluation data to assess indicators such as "the % of community participants who experience a deeper understanding of Hawaiian and ancestral practices around forest stewardship." In another example, a funder is currently supporting a pilot effort to better understand the impact of participants' connections to 'āina and place on their well-being in four organizations across Hawai'i; this effort is a collaboration including the funder, four place-based programs, and involves storytelling and self-evaluation using SenseMaker (https://loncollector.sensemaker-suite.com/) to produce both qualitative and quantitative understandings of the programs' impacts on well-being.

ESGs Provide Meaningful Access

Most ESGs that participated in STEW-MAP O'ahu reported that they do not own the lands that they steward (Dacks et al., 2021), meaning that ESGs facilitate physical access for participants to be on land that might otherwise be off limits to the public. By facilitating access, ESGs play an important role in connecting people to natural areas. For example, while much of the state's open spaces are owned or managed by just a few organizations, the largest being the state government (e.g., administrators of Natural Area Reserves), federal government (e.g., military), and a handful of private landowners (Hawaii Statewide GIS Program., 2017) (**Table 4**), access to these areas is often regulated. In some of these open spaces, stewarding nature (e.g., planting trees or removing invasive species) and even subsistence gathering may be allowed, but requires permission. However, while most public lands do allow some form of access, this fact may not be widely known and/or the process for gaining access may be difficult to understand. Thus, ESGs that

TABLE 4 | Major landowners/administrators in the study area.

Landowner/administrator	Total acres on O'ahu	Total acres in state
State Govt.	89,160	1,375,635
County of Honolulu Govt.	18,672	18,672
Federal Govt.	61,523	531,444
Kamehameha Schools	47,807	363,245
Kualoa Ranch	3,693	3,693
Ohulehule Forest Conservancy	1,471	1,471
HRT Realty LLC	1,488	1,761
Ko'olau Land Partners	1,036	1,036
State Department of Hawaiian Home Lands	61,523	198,896

Landowners/administrators listed own/administrate >500 acres in Kona and Ko'olaupoko Districts. Data from Hawaii Statewide GIS Program. (2017).

facilitate access to land they do not own are serving to expand options for the public to volunteer by taking the responsibility to acquire permission (e.g., right of entry, collecting permits, traditional protocol). For ESGs serving private lands, but also some publics lands, the ESG might be the only avenue for the public to access a site. Other ESGs that do own the land that they steward also may provide safe and well-organized opportunities for the public to access areas that might otherwise be difficult to access.

One ESG leader explained:

> *A lot of what we do is based around making restoration publicly accessible, making the native species publicly accessible so people start to see them and become acquainted with them.* (Group 4)

During COVID times when volunteers were restricted from working they continued to want to be connected to or even heightened their interest in stewardship work. S/he explained:

> *We had over 150 people respond that they wanted to foster native plants for us. It was insane!* (Group 4)

Beyond ESGs providing physical access to nature and natural areas, our results from Hawai'i emphasize that there is an additional layer to consider—the quality and character of the natural areas and the type of engagement people have with the place. As a result of COVID related restrictions, many respondents shared how much they valued and so missed having organized access to Indigenous biocultural land and seascapes. These respondents highlighted the value of accessing areas that were cultivated, in some cases over many generations, to sustain traditional agricultural, agroforestry, and aquacultural systems where native and Polynesian-introduced species thrive. In these spaces, some ESGs also provide access to experiences that enable reciprocal relationships with place (Chan et al., 2012; Pascua et al., 2017). These experiences are meaningful to Indigenous people who may no longer have access to their ancestral lands. They are also meaningful to diverse communities of residents living

in Hawai'i with little to no access to land ownership (Sato et al., 2021).

One director of an ESG focused on the biocultural restoration of traditional agriculture explained:

> *There's such a huge desire and want for these kind of experiences… [during COVID people are] having a desire to be connected to those sources of where their food comes from. So definitely wanting to care more about those places…* (Group 3)

Importantly, our survey was not accessible to minors (i.e., grade school students) or residents of the Women's Community Correctional Center, two groups who were mentioned by ESGs as part of their regular volunteer base. We would anticipate however, that the themes that emerged from our survey respondents—missing social aspects of ESG stewardship, missing being in nature, feeling disconnected, and missing a sense of purpose—had also been experienced, perhaps even in a heightened way, by these two groups. Certainly, more vulnerable groups have suffered disproportionately under COVID, and so they likely stand to benefit the most from re-engaging with ESGs. Further research is needed to begin exploring this idea.

ESGs provide opportunities to engage in reciprocal relationships, which enable people to fulfill personally held ethical obligations and values, often referred to as *kuleana* (rights/responsibilities) in Hawai'i. These include obligations to care for, restore, and protect places and resources that in turn support people's lives and well-being (Diver et al., 2019). ESGs then enable people in Hawai'i to engage in activities that connect them to places/practices that help reassert local and Indigenous rights, norms, and lifeways. Diver et al. (2019) identified the mobilization of reciprocal relations between people and their places as an important contributing factor to restoring places/practices across diverse Indigenous and non-indigenous communities caring for terrestrial and marine resources. Furthermore, they describe how increased visibility of reciprocal relations as an ethical practice can shift environmental governance and enhance communities' political influence over the 'management' of their resources. Landau et al. (2019) describe how ESGs bridge civic and public sectors by serving as brokers within governance structures.

Engaging with ESGs offers opportunities for learning and knowledge transmission—about one's place, culture, but also intercultural learning. For example, the chance to practice, celebrate, and share horticultural and culinary knowledge and practices with others is found in diverse communities in Vancouver with the Maya in Exile Garden (Nesbitt et al., 2021), in New York City with Korean families in community garden networks (McMillen et al., 2016), and on O'ahu with traditional taro and aquaculture. Having a shared sense of stewardship supports more equitable natural resource planning and access to benefits of nature (McMillen et al., 2020).

If restoring (and maintaining) relationships with place is an articulated value for communities, and we know this is

dependent upon their access, the function and value of ESGs is clearly beyond restoring places. They also restore community well-being and decision-making power. Diver et al. (2019: p. 422) explain that "the ability of an individual or community to benefit from resources is contingent upon having the ability to care for those resources, and the ability to give something back to place (e.g., through weeding, cleaning, monitoring, replanting, protecting, teaching, honoring through ceremony or prayer, etc.)."

Importance of ESGs in Helping Volunteers Address Pandemic Related Stress

Pedrosa et al. (2020) has documented the potential widespread and severe emotional, behavioral, and psychological impacts and challenges resulting from the pandemic. "Nature assisted therapies," including programs and/or activities involving living things (i.e., plants or animals) or in terrestrial and/or aquatic outdoor settings are prescribed for improving a variety of health ailments, including mental health issues (Annerstedt and Währborg, 2011; Bragg and Atkins, 2016; Britton et al., 2020). As such, volunteering with ESGs could be an effective method for healing from the impacts of isolation that accompanied the pandemic. While volunteer activities were largely canceled at the beginning of the pandemic, from our volunteer survey, we learned of the conditions that participants require in order to feel safe in returning to volunteering. In the interviews that were conducted in the later part of this study, we learned of some groups that had started offering volunteer opportunities again, with adaptations for safety (e.g., masks required, social distancing, reservations with group size limits, coordinated independent volunteering). One group has even begun officially calling its community workdays, in which volunteers are tasked with removing non-native, invasive plants, "group therapy" days.

CONCLUSION

Research from around the world describes stewardship as something that strengthens resilience at the community level (Krasny and Tidball, 2009; McMillen et al., 2016; Diver et al., 2019). Our study documents the role of ESGs in facilitating meaningful stewardship opportunities that contribute to both individual and community well-being. At the individual level, ESGs host volunteer events that are important for social, mental, and emotional well-being, and building and/or maintaining a sense of place and purpose. At the community level, ESGs not only focus on environmental stewardship, but also the health of the community, as evidenced by the innovative adaptations to respond to new, immediate needs of the community that resulted from the pandemic (e.g., need for educational materials because

of school closures, need for food because of drastic increase in unemployment). If we believe that the benefits of nature are related to the quality, depth and longevity of relationships between people and nature (McMillen et al., 2020), then ESGs should be recognized and supported not simply for the large benefits they foster and accumulate from tree planting and beach clean ups, but also for their contributions to community well-being.

DATA AVAILABILITY STATEMENT

The anonymous raw survey data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board, Office of Research Compliance, University of Hawaiʻi. The participants provided their prior informed consent to participate in this study.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2021.710355/full#supplementary-material

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The Impact of Scarcity on Pro-environmental Behavior in the COVID-19 Pandemic

Sonya Sachdeva[1], James Shyan-Tau Wu[2]* and Jiaying Zhao[2,3]

[1] Northern Research Station, USDA Forest Service, Evanston, IL, United States, [2] Institute for Resources, Environment and Sustainability, University of British Columbia, Vancouver, BC, Canada, [3] Department of Psychology, University of British Columbia, Vancouver, BC, Canada

As the world contends with the far-ranging impacts of the COVID-19 pandemic, ongoing environmental crises have, to some extent, been neglected during the pandemic. One reason behind this shift in priorities is the scarcity mindset triggered by the pandemic. Scarcity is the feeling of having less than what is necessary, and it causes people to prioritize immediate short-term needs over long-term ones. Scarcity experienced in the pandemic can reduce the willingness to engage in pro-environmental behavior, leading to environmental degradation that increases the chance of future pandemics. To protect pro-environmental behavior, we argue that it should not be viewed as value-laden and effortful, but rather reconceptualized as actions that address a multitude of human needs including pragmatic actions that conserve resources especially during scarcity. To bolster environmental protection, systematic changes are needed to make pro-environmental behavior better integrated into people's lives, communities, and cities, such that it is more accessible, less costly, and more resilient to future disturbances.

Keywords: scarcity mindset, pro-environmental behavior (PEB), COVID-19 pandemic, climate change, environmental degradation, sustainability, hierarchy of needs

INTRODUCTION

The COVID-19 pandemic has upended lives and laid bare numerous weak spots of modern society. Healthcare systems have failed, supply chains have broken, and poverty and food insecurity are on the rise (Pereira and Oliveira, 2020; Solomon et al., 2020). As such, many forms of scarcity have been exacerbated by the pandemic, leaving millions of people with insufficient resources to maintain a certain standard of living. The most poignant type of scarcity during this pandemic is the scarcity of physical resources, such as food and medical equipment, as well as financial scarcity due to a weakened economy. However, the pandemic has also resulted in a scarcity of cognitive resources, causing a notable neglect of environmental issues such as climate change and plastic pollution, which are relegated to a lower level of concern. In other words, the pandemic has imposed a form of cognitive scarcity on environmental issues that also deserve attention. This change of priorities is illustrated in the precipitous drop of climate-related media coverage at the onset of the pandemic in some countries (Medium., 2021), which had been increasing steadily in the preceding years (Barouki et al., 2021).

Although this attentional shift might seem intuitive given all the pandemic-induced socio-economic disruptions that have taken place, it may be ultimately counterproductive because environmental degradation could lead to future pandemics. Scientists have for years warned of the connection between disease outbreaks and anthropogenic environmental change such as climate change and habitat destruction (Weiss and McMichael, 2004; Barouki et al., 2021), and how ignoring this connection could set the stage for future pandemics and natural disturbances more generally.

The COVID-19 Pandemic's Impact on the Environment

A recent SDGs report shows that the world is off track to meet the goals toward environmental sustainability (United Nations, 2020). Most countries are not meeting their commitments to limit greenhouse gas emissions, to improve urban environments by reducing the number of people living in slums, increasing access to public transport, and reducing air pollution. Efforts toward sustainable and inclusive economic growth, energy provision, and infrastructure development have all been falling short during the COVID-19 pandemic (The Lancet Public Health, 2020).

Perhaps the most significant adverse environmental impact of the pandemic has been the astronomical increases in plastic waste generation (Silva et al., 2021), the effects of which are being observed already on coastlines (Chowdhury et al., 2021), wildlife (Hiemstra et al., 2021), and cities which are reporting increases in littering (Ammendolia et al., 2021; Time, 2021). Years of declines in plastic waste have been reversed during the pandemic due to increases in disposable personal protective equipment (Adyel, 2020; Benson et al., 2021). While it's necessary to use single-use plastics in some healthcare settings, a secondary impact of the pandemic has been an overall increase in plastic waste as restaurants have shifted to a takeout model or grocery stores ban the use of reusable bags (Vanapalli et al., 2021). To clarify, the point made here is not that the policy itself is problematic—communities should act in accordance with local health guidelines—rather, the issue is that our reliance on single-use plastics is a convenient fallback during the pandemic. On the other side of the plastic waste cycle, cities have cut recycling programs as budgets tighten due to pandemic responses (Waste Dive., 2019; PBS, 2021). This is further compounded by an increase in oil companies' investment in the production of virgin plastics, citing the reduced demand for recycled plastic products (Reuters, 2020).

THE SCARCITY MINDSET UNDER THE PANDEMIC

In addition to the health impact, the COVID-19 pandemic has presented a sudden perturbation in many aspects of people's lives. According to a recent report from the World Bank, the COVID-19 pandemic is estimated to push as many as 150 million additional people into extreme poverty, defined as living on less than US$1.90 a day, by 2021 (The World Bank, 2020).

It is estimated that during the first three quarters of 2020, nearly 500 million full-time jobs were lost worldwide due to workplace closures (International Labour Organization, 2020). In North America, 46% of Canadians reported being stressed financially (Gadermann et al., 2021), 52% of US adults say they have experienced negative financial impacts due to the pandemic (American Psychological Association, 2020), and 51% of US adults reported that the pandemic has made it harder for them to achieve their financial goals (Pew Research Center, 2021). Local COVID cases and deaths present an immediate health threat and lockdowns and travel restrictions present a threat to social relationships. The financial, health, and social threats may trigger an enormous sense of worry and concern, drawing attentional resources to the threats and creating what has been termed a scarcity mindset.

The Scarcity Mindset

Mullainathan and Shafir (2013) define scarcity as "having less than you feel you need" (p. 4). This could apply to many domains, though most commonly to financial scarcity. The idea of a scarcity mindset builds on research within cognitive psychology and behavioral economics, stating that scarcity acts like a cognitive load which affects many fundamental cognitive functions like how people think, reason, and decide. For instance, financial scarcity has been shown to impair cognitive performance on tasks measuring fluid intelligence and executive function (Mani et al., 2013). Financial scarcity also highlights an economic dimension to everyday experiences where thoughts about costs and money are top of mind (Shah et al., 2018) and price information captures visual attention away from opportunities to save (Zhao and Tomm, 2017). Other studies have suggested that perceiving scarcity might impact cognitive self-control where immediate needs become more salient than future ones (Cannon et al., 2019). This may result in several non-normative decisions from an economic or longer-term perspective (Zhao and Tomm, 2018), such as lower saving rates and greater debt accumulation, which may be why much of the work on the scarcity mindset has focused on participants from a lower socioeconomic background. Yet, this increased focus on short-term incentives has also led to better performance on other tasks. For example, people under financial scarcity exhibit greater price sensitivity, and are less likely to be fixated on proportional gains at the expense of absolute quantity (Shah et al., 2015; Frankenhuis and Nettle, 2020). That is, people under scarcity are equally likely to value saving 50% of $100 and saving 5% of $1000.

Despite what the literature may suggest, it is worth pointing out that scarcity is not synonymous with poverty. Rather, as a recent review by de Bruijn and Antonides (2021) notes, "not all low-income individuals experience feelings of having less than they need" and conversely, being objectively well-off is not an inoculation against perceiving the burden of scarcity. In other words, there is a conceptual divergence between being poor and feeling poor—a distinction not always clear in the literature. For most people, regardless of their level of income, scarcity may be a constant hum in the background guiding and constraining their thinking throughout much of their lives.

The Pandemic Increased Scarcity

The COVID-19 pandemic has turned that background hum into a roar for many of us. As a direct consequence of the pandemic and the subsequent lockdowns, scarcity of resources and time has become a hallmark of our lives (Hamilton, 2021). Lockdowns, designed to slow virus transmission, were intended to and were effective at lowering the burden on medical facilities. This led to a scarcity mindset in at least three ways: (1) by highlighting the limited healthcare resources available (i.e., the number of hospital beds available), (2) by inflicting an actual economic cost on people, which reverberated through the society as restaurants, bars, and other non-essential services closed down for weeks or even months in some cities, and 3) by inflicting an emotional cost on people via border closures that prevented families and friends from physical reunions (Solomon et al., 2020; Civai et al., 2021; Echegaray, 2021).

These factors disproportionately impacted lower-income countries, which often were unable or unwilling to monetarily compensate for the economic loss of the lockdowns, and communities of color who have less reliable access to healthcare and may be more affected by the closures of physical business due to systemic inequities in digital access (Mahmood et al., 2020). Further, labor shortages and outbreaks at factories and processing plants had wide-ranging impacts on supply chains leading to empty shelves at previously abundant grocery stores. The characteristic image of people hoarding toilet paper at big box stores is iconic because consumer goods that were taken for granted before the pandemic were suddenly in short supply. Of course, the impact of a dearth of consumer goods vs. a hospital bed or canisters of oxygen is incomparable and unevenly distributed over race, class, and socio-economic status. The psychological impacts of scarcity caused by the pandemic were similarly unevenly felt but still widespread and far-ranging.

SCARCITY IMPACTS PRO-ENVIRONMENTAL BEHAVIOR

The scarcity mindset can also have profound implications on pro-environmental behavior. Here we define pro-environmental behavior as any action that can potentially mitigate environmental degradation or increase awareness of environmental issues. As described earlier, perceptions of scarcity result in myopic thinking and foregoing future needs in favor of satisfying present constraints (Shah et al., 2012; Zhao and Tomm, 2018). However, environmental damage often occurs over a broad spatio-temporal horizon, which reduces motivation for sustainable choices via scarcity-induced myopia (van der Wal et al., 2018). Further, environmental sustainability also requires collective actions and cooperation within and between communities. Resource scarcity and the perception of scarcity, on the other hand, have been shown to reduce cooperation, increase ingroup preference and outgroup ostracization (Herzenstein and Posavac, 2019). Recent findings suggest that cooperative social norms which have arisen in times of plenty may dissolve when financial resources are scarce, and competition for those resources fierce (Nhim et al., 2019). However, not all types of

scarcity have the same impact on cooperation. For example, in one study, farmers acted more cooperatively to conserve water during times of water scarcity (Nie et al., 2020). In another study, scarcity of social interactions during the current pandemic increased people's willingness to cooperate with public health measures (Civai et al., 2021).

Other empirical work suggests that the scarcity mindset may curb willingness to engage in pro-environmental behavior (Sachdeva and Zhao, 2020). In a hypothetical shopping task, participants were given a choice between purchasing sustainably made consumer goods vs. conventionally sourced ones. They were more likely to choose the conventional products when in a scarcity mindset (i.e., not having enough money). Participants in an abundance mindset (i.e., having enough money) preferred the sustainably produced products, even when controlling for price. This work suggests that scarcity deters people from engaging in pro-environmental actions, presumably by devoting attention to the financial problem at hand and diverting attention away from environmental causes. This said, natural resource scarcity (e.g., water scarcity) can promote choices of sustainable products (Sachdeva and Zhao, 2020).

Threat perception, which draws tremendous attentional resources, can explain why people experiencing financial scarcity forgo environmental values and actions during the pandemic. Threats experienced during the pandemic elicit a high level of worry. Since the emotional capacity to worry is thought to be finite (Capstick et al., 2015), being worried about the pandemic can cause less worry about other things, such as the environment and climate change (Sisco et al., 2020; Botzen et al., 2021). To summarize, scarcity caused by the pandemic can be one of the factors that contribute to the environmental degradation during the pandemic.

PRO-ENVIRONMENTAL BEHAVIOR RECONCEPTUALIZED

To some extent, these findings on scarcity curbing pro-environmental behavior are counter-intuitive. Some pro-environmental actions inherently conserve financial resources (e.g., those that reduce waste, promote reuse, and minimize reckless consumerism) and in times of economic crisis, this appears, prima facie, to be reason enough to reduce waste and overconsumption (Vox., 2020). Why then, as previous research suggests, are people under scarcity unwilling to engage in pro-environmental behavior?

One explanation is that the unwillingness may arise from the traditional conceptualization of pro-environmental behavior in the broader psychological literature. Since at least the mid-1970s, pro-environmental behavior has been conceptualized as driven by higher-level needs, and are often value-laden and effortful (Dunlap, 1975; Stern et al., 1999). Consider **Table 1**, showing an early version of(Maslow, 1954 theory on the hierarchy of needs. In the original formulation of this hierarchy, the satisfaction of more fundamental needs such as physiological needs for food, water, and shelter, can lead to the pursuit of higher-order needs. At the highest level, self-actualization and transcendence needs

TABLE 1 | Pro-environmental behaviors that satisfy each level of needs based on Maslow (1954) motivational theory on the hierarchy of needs.

Hierarchy of motivational needs (in descending order)	Examples of specific needs at each level	Types of pro-environmental behavior that may support each need
Self-actualization	– Altruism	– Support vulnerable communities
	– Pro-sociality	– Educate and inspire future generations
	– Goal pursuit and achievement	– Engage in activism
		– Donate to environmental organizations
		– Become a champion in environmental sustainability
Esteem	– Social prestige	– Engage in conspicuous consumption
	– Social recognition	– Use public praise and recognition to promote energy conservation
	– Legacy concerns	– Use legacy motives to increase pro-environmental actions
	– Freedom of choice	– Self-educate on environmental issues
	– Competence	
Love and belonging	– Community membership	– Engage in environmental stewardship; support parks and conservation areas
	– Social stability and support	– Engage in constructive dialogue on environmental issues; reduce polarization on climate change
	– Leisure and relaxation	– Visit parks for nature connectedness and mental well-being
		– Promote urban green spaces and access to nature
Safety	– Financial security	– Reduce consumption (e.g., frugality)
	– Energy security (e.g., energy independence)	– Reduce reliance on the grid; transition to renewables (e.g., solar panels)
	– Safe home environment and buffer from disasters	– Employ mitigation measures to protect homes (e.g., vegetation management in wildfire prone areas)
	– Food security	– Consume locally grown food
Physiological	– Physical health	– Get out to nature for clean air and health benefits
	– A place to live	– Reduce carbon emissions to reduce air pollutants (e.g., eat less meat, drive less, fly less)
	– Access to clean water and air	– Reduce water consumption; avoid single-use plastics to reduce water pollution
	– Sufficient food	– Reduce food waste; buy sustainably grown food

Self-actualization needs are at the top of the hierarchy and physiological needs are at the bottom.

are thought to drive pro-environmental behavior that yields benefits beyond the self. Note that we are not suggesting a reliance on (Maslow, 1954 specific rank order of needs, nor are we indicating agreement with his seeming belief in these needs mirroring stages of maturity or human development (Maslow, 1967). Rather, we argue that this is not only an inaccurate depiction of why people engage in pro-environmental behavior, but makes pro-environmental behavior seem out-of-reach and inaccessible for many people. Particularly, in times of scarcity, there are other pathways to sustainability that do not depend on higher-order needs. Emphasizing these distinct pathways, satisfying a multitude of human needs, may help reconceptualize pro-environmental behavior more broadly and bolster environmental protection as the world faces increasingly severe natural disturbances (**Table 1**).

For instance, reducing energy consumption also reduces energy bills and financial stress, in addition to being pro-environment; and reducing vegetation and debris around a house can help protect the house from wildfires and also limit their spread (Olsen et al., 2017). In other words, although most pro-environmental behavior has been value-driven (Corraliza and Berenguer, 2000; Liu and Guo, 2018), there are many pragmatic reasons to be pro-environmental (Sachdeva and Zhao, 2020).

Moreover, as experiences and perceptions of scarcity lead to an increased emphasis on the more foundational physiological and safety needs (Yuen et al., 2021), pro-environmental behavior that is better aligned with these lower-level needs may become easier to adopt.

PROTECTING PRO-ENVIRONMENTAL BEHAVIOR

The perspective that we have put forward in this piece stems from an observation in the early days of the COVID-19 pandemic. In the midst of all the other pain, suffering, and loss experienced by millions across the world, the looming (and present) impacts of climate change were relegated to a lower rank of priorities (Medium., 2021). To some extent, this demotion of environmental concerns may have seemed justifiable—after all, millions of people are suffering right now. Yet, as researchers raising the alarm about the increase in plastic waste have said, if pro-environmental behavior is demoted during these disturbances, we are only creating more dire future scenarios and trading one crisis for another (Vanapalli et al., 2021). Scientists have been sounding the alarm for years that anthropogenic

environmental degradation could lead to more frequent and deadly future pandemics (Weiss and McMichael, 2004; Barouki et al., 2021). For example, the destruction of natural habitats tends to drive wildlife out of their original living space and into contact with humans, thus increasing the risk of animal-to-human disease transmission (Roe et al., 2020; McNeely, 2021; Pelley, 2021). Furthermore, anthropogenic climate change could directly lead to deadlier future pandemics, as many diseases spread faster (Carlson et al., 2021) or expand their range and active season under higher temperatures (Curseu et al., 2010).

The path to mitigating these disturbances may rely on systemic change, which the COVID-19 pandemic can help catalyze (BBC, 2020; Saiz-Álvarez et al., 2020; Stanford Social Innovation Review., 2021). Nascent research already suggests that the COVID-19 pandemic has disrupted materialism (Briggs et al., 2020; Mehta et al., 2020) and increased people's desire to engage with nature during the lockdown (Robinson et al., 2021; Johnson and Sachdeva, under review[1]). The latter in particular has been demonstrated to promote cooperation and act as a gateway to future environmental action (Zelenski et al., 2015). To make nature more accessible to as many people as possible, cities should continue to invest in green infrastructure as many have already done as part of social distancing protocols (Hanzl, 2020; Kleinschroth and Kowarik, 2020). Integration of green spaces into cites can be rethought as a tool to restore and promote mental health (Roe and McCay, 2021), since mental health has been severely impacted by not only the pandemic (Usher et al., 2020) but climate change and environmental crises (Berry et al., 2010; Afifi et al., 2012; Clayton, 2020). Furthermore, evidence suggests that if people are more future-oriented, scarcity can reinforce pro-environmental behavior, such as conserving water (Gu et al., 2020). Early education promoting civic participation and participatory governance may be an important resource in fostering a sustainability and future-oriented culture (Bäckstrand, 2003), which can ultimately transform scarcity into a driver of pro-environmental behavior, as opposed to a stressor.

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[1]Johnson, M., and Sachdeva, S. (under review). The multi-faceted impact of COVID-19 on social media users' wellbeing and relationship with urban nature. *Front. Sustain. Cities.*

Other institutional interventions on urban planning can ensure that pro-environmental actions are easier to execute in daily life and do not present an additional cognitive load for people. This includes investing in robust and convenient recycling and composting infrastructure and programs, more convenient public transportation, and subsidies for sustainable products. These measures should make pro-environmental behavior better aligned with scarce conditions so that the decision to behave sustainably is no longer a tradeoff between current needs and future needs. As noted earlier, scarcity, real or subjective, captures our attention often resulting in narrow, present benefits at the expense of future or more abstract gains. As Morton (2017) notes, if a behavior becomes habitual and in the service of current needs, it is more likely to persist even under scarcity. The micro and macro-level interventions suggested by the literature reviewed in this piece require significant investment and are difficult to implement in the best of circumstances. However, the pandemic offers a chance to make these substantial changes so that our societies, mindsets, and the environment itself become more resilient in the face of future disturbances.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

SS and JZ conceived the framework of this paper. SS did the majority of the writing. JW wrote portions of Scarcity Impacts Pro-environmental Behavior, Pro-environmental Behavior Reconceptualized, and Protecting Pro-environmental Behavior sections, and made **Table 1**. JZ did the majority of editing. All authors contributed to the article and approved the submitted version.

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Brief Research Report: Case Study on the Early Impacts of COVID-19 on Urban Natural Areas Across 12 American Cities

Sophie Plitt*, Clara C. Pregitzer and Sarah Charlop-Powers

Natural Areas Conservancy, New York, NY, United States

The COVID-19 crisis has impacted the lives of the entire nation. As city residents faced lockdowns, they turned to their public parks and open space for respite from the confines of city living. Many residents sought solace in natural areas, wishing to hike, bird, and experience the sights and sounds of a forest during this fraught time. To understand the impacts of the COVID-19 crisis on the public use of natural areas and organizations' ability to care for them, we deployed a survey in May of 2020 to known partners in 12 US cities that are leaders in the management and care of urban natural areas. These cities represent a combined population of over 18 million people and collectively manage 284,906 acres of natural area parkland. We found that most organizations (83%) reported an increase in use of natural areas but concurrently 72% reported a decrease in the ability to care for natural areas during the pandemic. All organizations reported canceled public programs, and 94% saw a decrease in volunteer events. As these organizations look to the future, only 17% were confident in their organization having adequate funding in 2021. Cutting budgets to care for urban natural areas could have significant impacts on the health and sustainability of urban life. These 12 cities serve as examples of a pattern that could be occurring nationally and internationally. As cities reopen, budgets and priorities for the future will be determined as will the fate of resources to care for nature in cities.

Keywords: COVID-19, pandemic, urban green space, urban natural areas, urban natural area forests, urban natural area planning and management, access to nature

INTRODUCTION

As a result of the COVID-19 pandemic the use of public green space increased, particularly in urban areas (Geng et al., 2021). Urban areas have higher population densities than rural areas, meaning citizens have less space, and may rely more heavily on public parkland and open space to spend time outdoors and in nature, which is increasingly important for public health and wellness (Twohig-Bennett and Jones, 2018). The pandemic resulted in new restrictions, and work from home orders resulted in urban residents searching for opportunities to spend time outdoors, local parkland became increasingly more important to their daily lives or city residents. However, not all urban parkland offers the same recreation opportunities or ability to socially distance.

Unlike more designed forms of parkland (e.g., playgrounds, picnic areas, lawns), natural areas (e.g., forests, wetland, grasslands) offer nature-based experiences such as hiking trails, which can have positive outcomes on physical and mental health and are often larger in area which could offer better opportunity to safely socially distance (Zorbaugh, 2005). Natural areas make up 68% of city parkland in the U.S. (Pregitzer et al., 2021), and despite being a dominant type of parkland, these spaces often lack funding for conservation and management and volunteer stewardship was a focal point of their care before COVID-19 (Pregitzer et al., 2018; Henderson-Roy et al., 2020). As the pandemic progressed, it was observed that urban natural areas were offering respite to an increased number of city dwellers, but at the same time public programming and volunteer stewardship events were being canceled, all while city budgets were being adjusted in response to the crisis. These events highlighted the importance of urban parkland, but also how reliant their management is to local budgets and circumstances.

In order to document and understand how the COVID-19 pandemic could be impacting visitation rates and funding and the care of urban natural areas, we worked with known partner organizations from 12 U.S. cities to document observational patterns in changes in public use, programming, and funding to care for urban natural areas. We asked the following questions (1) Did you observe any changes in access to and public use of natural area parkland? (2) Did you experience any changes to your staffing, programming, or ability to care for natural areas? (3) Have you experienced, or do you anticipate any changes to your budget supporting natural areas care? We offer unique observations and context from selected cities around each question.

METHODS

To document observed changes in urban natural areas visitation, care, and funding we developed and deployed a survey to known organizations working specifically in urban forested natural areas in 12 U.S. cities that are part of the Forests in Cities Network (Natural Areas Conservancy, 2021). Across these 12 metro regions there are 284,906 acres of urban natural area parkland and over 18 million people live within these cities. Variation exists in city size, park system, and acreage of natural areas. The acres of natural areas represented per organization or city is 220–117,00 acres. The responses to the survey ($n = 18$, listed in **Supplemental Material**) represents at least one response from each city, and in some cases multiple organizations within the same city responded. Different organization types include municipal government, county government, and non-profit organizations. The results summarized the 18 responses collected across the 12 cities and each response reflects the views and patterns of the organization rather than an individual. It was suggested to coordinate among multiple individuals rather than a single person's reflections.

We chose to use the Forests in Cities network as a sampling frame for this survey as they represent a group of practitioners who are thought leaders in the field of urban natural area management, and we could easily gather a response during the pandemic. We leveraged an existing network of 12 cities that we know actively work in urban natural areas. Due to this we were able to receive a 100% response rate, which we use here as a case study that represents patterns that could be more broadly reflective of urban natural areas care and use during the early months of the COVID-19 pandemic. While we can't guarantee this case study is broadly representative of all organizations, or cities, our sample comes from cities of varying populations (~109,000–8,300,000), total city park spending per resident (~$41–$346, Trust for Public Land 2019), and geographies (e.g., Miami, Seattle, Indianapolis, New York). The survey was administered online using Qualtrics Survey Software (Qualtrics, Seattle, WA, USA) under site license to Yale University. The survey questions were developed based on feedback and observations of the impact of COVID-19 the use of open space and park land and are included in the **Supplementary Material**. All responses were tallied and analyzed in Microsoft excel. For each question we allowed the respondents to provide a quote or example of the observed pattern, and we share those in the results anonymously.

The survey was distributed and completed in Summer of 2020. While the data is limited, and includes a relatively small sample size, taken early in the pandemic, we feel this could be representative of larger patterns or shifts of natural areas in other U.S. cities or global cities. We present these results as a snapshot in time and as a case study of a subset of cities that were able to leverage a response easily and quickly during the COVID-19 pandemic.

RESULTS

Access to Natural Areas and Increased Use

We found that overall, the majority of cities (87%) had public parkland (including natural areas) under some combination of closures or restrictions. While many natural areas were restricted, overall, natural areas were less restricted during COVID-19 compared to urban parkland in general with only 6% of traditional parkland open with no restrictions and 38% of natural areas parkland open with no restrictions. Urban land managers cited that they were able to be adaptive to the parks closing and new restrictions in order to allow the public to access natural areas during the pandemic in a way that met health guidelines. These adaptations included posting signs and launching social media campaigns encouraging social distancing in parks. As one survey respondent stated;

"Parks remained open for hiking and biking; however, citizens were encouraged to maintain social distance and wear face masks. Certain amenities, particularly those involving shared surfaces or confined space, were closed. These included recreation centers, swimming pools, bathrooms, and playgrounds."
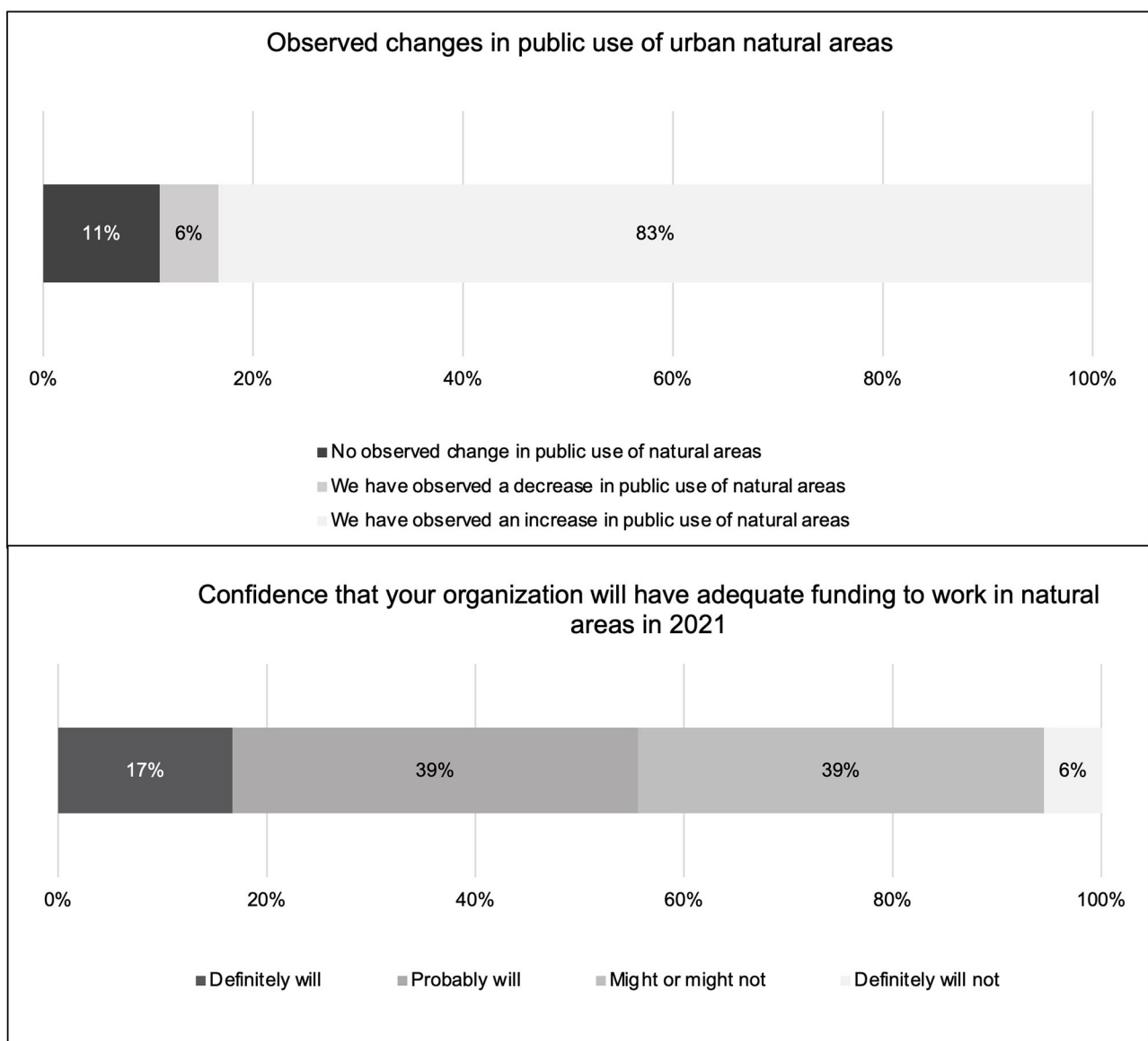
FIGURE 1 | Responses from a survey conducted in Summer 2020 of organizations in 12 cities that care for urban natural areas. (Top) Observed changes in public use in urban natural areas and (Bottom) anticipated changes to the budget as a result of the COVID-19 pandemic.
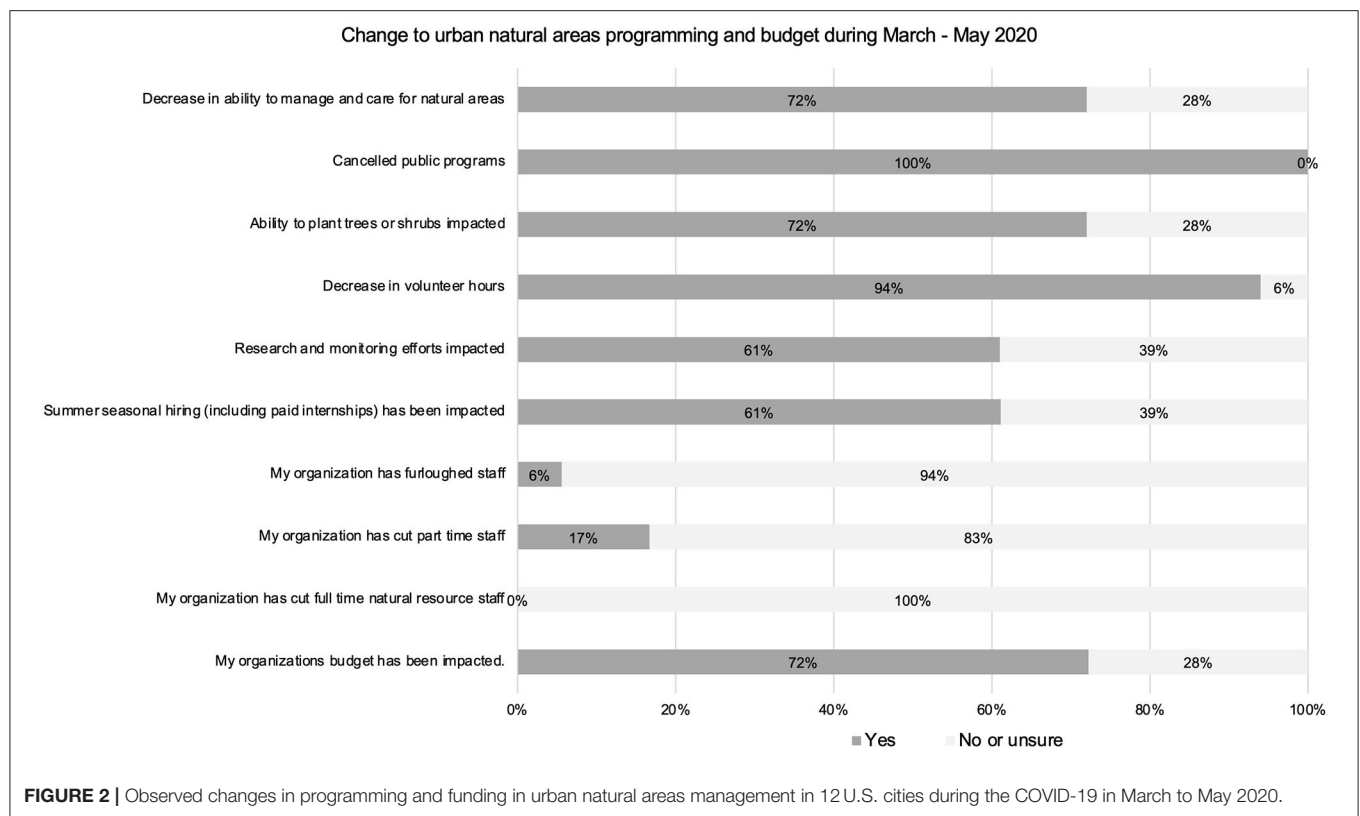
We found that 83% of respondents observed an increase in public use of urban natural areas (**Figure 1**) during COVID-19 (11% reported no change and 6% reported a decrease) with some organizations specifically citing that natural areas trails were observed to be much busier than usual on weekdays as noted here by two survey respondents:

"[We observed] *less accidental public use and an increase of intentional public use—people birding, going on family walks in the woods, etc.*"
"*More people are using ALL parks, but especially natural area trail systems as they try to stay close to home and don't have access to county or federal public lands.*"

Funding and Ability to Care for Urban Natural Areas

Overall, we found that a majority (72%) of the organizations have experienced a decreased ability to care for and manage urban natural areas (**Figure 2**). Nearly all (94%) of organizations cited a decrease in volunteer hours and all organizations (100%) cited public programming had been canceled as of May 2020. The majority (61%) cited that research efforts had been impacted in natural area parkland and 72% reported planting trees and shrubs had been impacted (**Figure 2**). In some cities, there had been a moratorium on field work. In other cases, natural areas managers reported that they were making adaptations to find creative ways to continue work. One land

FIGURE 2 | Observed changes in programming and funding in urban natural areas management in 12 U.S. cities during the COVID-19 in March to May 2020.

manager described a new method for planting trees that ensured social distancing:

> "*Our team is all working from home. However, tree plantings require creative solutions, like ramps for one person to move a tree from the truck to the site and assembly line planting: one person digs the hole, another plants the tree, another mulches and waters. Partners are continuing to provide basic services while keeping staff spaced.*"

Furthermore, many cities rely on volunteer work to handle many management activities such as planting and invasive species removal, most of which was canceled due to social distancing requirements. This loss of volunteer labor was a hard loss for many managers.

> "*Almost all work done in natural areas is done by volunteers. We could not leverage volunteers during the pandemic, and several cleanups, invasive species control, and trail building projects were canceled.*"

As of May 2020, most of the respondents (72%) reported that their budget had already been impacted (**Figure 2**). Then, we asked organizations how confident they are that their organization will have adequate funding to continue work in natural areas in 2021 and found that only 17% of organizations were confident that they will have adequate funding to care for urban natural areas in 2021 (**Figure 1**). While about half of the respondents suggested they will or probably will receive

adequate funding, the other half were less confident and some certain they would not have adequate funding in the future to care for urban natural areas. While no organizations had described laying off full time natural resources staff as of May 2020 (**Figure 2**), other seasonal and part time staff had been eliminated by some organizations, and in some cases hiring had been frozen. Organizations from two separate cities describe staffing and budget impacts:

> "*All hiring is frozen, including three Natural Area Crew positions that were set to start the first week of the COVID-19 crisis, and we have limited volunteer programming including stipend work with youth and elders.*"
> "*Our two major fundraising events (gala and 5k race) have either been changed or canceled in a way that will severely impact our restoration work.*"

DISCUSSION

Our results show that during the pandemic more people were visiting natural areas, but funding for their care is declining, which suggests a paradoxical shift in patterns of care and use of these places in cities that could have long term impacts. These results provide a window into one of the many ways that COVID-19 has impacted social, economic, and ecological life in cities, specifically parkland. This finding is in accordance with several other studies that have observed increased use in urban parkland

throughout the pandemic (Alizadehtazi et al., 2020; Xie et al., 2020; Geng et al., 2021).

The fact that we observed an increase in use suggests that natural areas provided a unique space for many cooped-up city residents to socially distance, and find peace, respite during the pandemic. Many urban residents could have been discovering these natural areas for the first time. Due to the pandemic, these new visitors were able to experience the unique benefits of natural areas which one study found allowed visitors to "recharge the body, spirit, and mind, immersing themselves in the restorative and reflective space of nature" (Svendsen et al., 2016). Before the pandemic many city residents may travel outside the city to experience nature (Auyeung et al., 2016) but this suggests those same residents may have shifted to experiencing nature within the city limits. Access to these spaces also has equity implications. While many urban residents had the means to leave urban areas to access nature before during the pandemic, lower income populations may not, and rely on urban parks as their primary way of accessing nature. In New York City, 50% of park users reported experiencing nature ONLY in urban parkland (Auyeung et al., 2016). Proximity to urban parkland and a sense of belonging were ibid to be important factors in New Yorker's access to nature during the pandemic (Pipitone and Jović, 2021). This reinforces public parkland that offers diverse experiences, and especially nature-based experiences (such as those in natural areas) should be understood as unique and considered as a priority for investment and protection among city governments.

While increased use of natural areas was a boon to these spaces, with an increase in use, also comes a potential increase in trampling of vegetation and illegal use. In some cities reports of foraging of rare plants, and vandalism had increased. However, despite those potential negative outcomes of increased use, we hope and believe that the pandemic offered an opportunity for city residents to look deeper for nature locally, and that this was positive. The increased use could catalyze a new generation of city dwellers that appreciate, value and advocate for urban natural areas, which over time could lead to better cared for natural areas.

Despite new users and a new appreciation for urban natural areas, we found that funding for their care was projected to decline. Reduced funding for city parkland and support of healthy urban nature could have significant social and ecological consequences to the health and sustainability of urban life. Before the pandemic, many challenges existed to caring for urban natural areas including limited funding, awareness, policy as well as socio-ecological challenges such as invasive species and climate change (Pregitzer et al., 2021). Looking forward, with reduced funding the magnitude and consequences of these challenges on the quality and condition of natural areas could be exacerbated. For example, the city budget dedicated to city parkland in New York, NY historically receives only 0.5% of the total budget and during the pandemic funding to natural areas was cut by 14% (New Yorkers for Parks, 2020; Whalen, 2020). This halted major momentum to increase investment in natural areas care (Pregitzer et al., 2018). For all our respondents at the time of the survey, the immediate outcomes were a decrease in field efforts, management, research, and planting for one season. If city tax revenue and budgets can rebound this could be a minor pulse in the social-ecological fabric of urban natural areas, but if these budgets are cut and not replenished for years to come, the consequences could be much more severe.

This pandemic has reinforced the importance of access to healthy and high-quality nature for people, but access to urban nature is important for everyday life and requires long term and sustained support. The social disturbance of the pandemic could also have ecological consequences. While this data provides a snapshot in time and profiles only 12 US metro-regions, we believe that these responses are indicative of a broader pattern within the country, and perhaps globally. As America's cities begin to recover and reopen, and municipal and organizational budgets are determined, we must look ahead to envision a future that includes support for natural areas in cities.

CONCLUSION

Forests in cities require investment and protection. The increased use and perceived value of these spaces during the COVID-19 pandemic, along with the paradoxical cuts in budget to share for these spaces indicated the need for more funding and protection for urban natural areas. A sharper focus on managing and supporting forested natural areas is essential to ensuring healthy urban communities for the future. This will require cross-silo cooperation and investment from the scientists, practitioners, federal agencies, researchers, and the philanthropic community. Success will require increased study and analysis of the benefits of urban natural areas in order to make a case to decision makers to continue to protect and invest in these important natural resources.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

SP wrote the paper, contributed to the creation of the survey questions, distribution of survey, and analysis of results. CP wrote the survey questions, contributed to the distribution of the survey, analysis of results, and contributed to paper writing. SC-P conceptualized the survey, contributed to writing the survey questions, reviewed the analysis, and helped secure funding. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

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Paradise Regained? Localised and Limited Nature Connexions in the UK's Covid-19 Lockdown

Julian Dobson [1*†], Tony Gore [1†], Kim Graham [2†] and Kate Swade [2†]

[1] Centre for Regional Economic and Social Research, Sheffield Hallam University, Sheffield, United Kingdom, [2] Shared Assets CIC, London, United Kingdom

Research has suggested that connexions between humans and the natural world lead to increased well-being and generate pro-environmental attitudes, which in turn benefit nature. This article asks whether users of outdoor public spaces in the UK during the Covid-19 pandemic in 2020 experienced greater connectedness with nature, consistent with the five "pathways to nature connectedness" identified in previous research. Semi-structured interviews were conducted with a purposive sample of 42 individuals on their use of green and public spaces during the UK's lockdown, while a further 29 participants responded to an online survey. While the research revealed the importance of nature connectedness, only three of the five pathways were well-evidenced, and these connexions were frequently mediated by social activities. The article advances the study of nature connectedness by identifying challenges in applying the pathways framework and suggesting areas for further research to understand how the pathways operate in real-world conditions.

Keywords: nature connexions, green space, COVID-19, parks, human-environmental relationships, well-being

INTRODUCTION

The Covid-19 pandemic and the associated lockdowns in early 2020 prompted sudden shifts in public behaviour. Notable among these were changes in the use of public parks, green spaces such as woodlands and riversides, and public open spaces, both in the UK (Office for National Statistics, 2020a) and internationally. During the first phase of the pandemic, parks and green spaces were among the few public spaces that remained open in the UK. We refer to these henceforth as green and blue spaces (Geary et al., 2021).

The changes resulting from lockdown differed between locations and jurisdictions and at different stages of the pandemic, but an increased use of parks and green spaces was a common factor (Ugolini et al., 2020; Venter et al., 2020). In Chengdu, China, a survey with 386 respondents revealed that visiting green spaces "even once a week" during lockdowns could be beneficial (Xie et al., 2020). A further international survey (Pouso et al., 2021), with 5,218 respondents from nine countries, found that access to nature and "blue-green spaces" mitigated the deleterious mental health impacts of lockdowns. In the UK, the increased use of green and blue spaces contributed to a lively debate about their value, levels of public investment, and the continuing damage done by humans to the natural environment (Geary et al., 2021; Mell and Whitten, 2021).

Covid-19 thus generated a natural experiment (de Vocht et al., 2021) in public use of and engagement with green and blue spaces, in that it significantly changed familiar patterns of use, while leaving individuals able to engage in a variety of ways with the spaces that remained accessible.

These forms of engagement are important because there is increasing awareness of the public health benefits of green and blue spaces, supported by extensive recent research. A range of reviews summarise and analyse this evidence base (World Health Organization, 2016; Houlden et al., 2018; Dobson et al., 2019; Hunter et al., 2019; Wendelboe-Nelson et al., 2019).

Among this research, there has been growing interest in the importance of "nature connectedness" or "nature relatedness" (Richardson and Sheffield, 2017) for mental health and well-being. Nature relatedness is defined as "a strong subjective connexion to nature" (Nisbet and Zelenski, 2013). Researchers have posited that if people experience a greater connexion with nature, they are more likely to take pro-ecological actions (Davis et al., 2011; Lumber et al., 2017). In this article we refer to "nature" rather than using alternative terms such as the "more-than-human" (Andrews, 2019) because it correlates to the concept of "nature connectedness"; we acknowledge that it is problematic in its tendency to characterise nature as "other" and reinforce the "nature-culture divide" (Braun, 2005).

This article draws on research on nature connectedness to explore how the lockdown both enabled and limited connexions with the natural world. We consider which types of space facilitated nature connectedness; how the lockdown reinforced the importance of nature for human well-being; and how the enjoyment of nature was restricted and unequally shared. Our examination of the evidence shows, as might be expected, that the lockdowns in the UK heightened participants' connexions with nature and afforded opportunities for new connexions. However, the circumstances of the lockdowns meant that such connexions were predominantly very local (often within walking or cycling distance) and therefore some connexions were no longer available to people. Nature connectedness was also constrained by the significantly increased use of some green and blue spaces, and by restrictions on social activities. Access to nature was also unequal, with many people—especially those without gardens, the clinically vulnerable and residents of more deprived neighbourhoods—unable to enjoy the natural world to the same extent as more privileged members of the public. This issue was observed by some participants in our research, but not directly experienced by them.

Lumber et al. (2017) propose five pathways to nature connectedness (discussed in more detail below): contact, beauty, emotion, meaning, and compassion. We examine which of these pathways were activated among users of green and blue spaces, and how this happened. Our analysis shows that connexions with nature during the lockdown were predominantly through contact (e.g., being in a green space); beauty (the aesthetic appreciation of the natural world); and emotion (the feelings prompted by experiences of nature). We consider these issues in more detail in our presentation of findings, analysis, and conclusions. Our study highlights the need for a better understanding not only of the pathways to nature connectedness but of the relationships between them, and the degree to which they are mediated by social activities and conditions.

This paper is based on an analysis of interview and survey material gathered between May and July 2020 from two research projects, both of which included an examination of the use of green and blue spaces in the UK during the initial lockdowns imposed to curb the spread of Covid-19. These data were re-examined to identify examples and types of nature connectedness. This analysis served two purposes: first, to categorise and understand the data generated from our research; and second, to examine in the light of real-world evidence the utility and applicability of the five pathways to nature connectedness, areas where further research is required, and potential applications to policy and practise.

We thus focus on two questions:

- How did the Covid-19 lockdowns affect participants' connexions with nature in green and blue spaces?
- How does the pathways to nature connexions framework enable us to understand how such connexions might influence behaviour change in the context of a climate and biodiversity emergency, and can it be adapted to real-world rather than experimental conditions?

CONTEXT AND LITERATURE: GREEN SPACES AND NATURE CONNEXIONS

Covid-19 offered a critical juncture (Schmidt, 2010): a moment at which behaviours and understandings are re-examined, with the potential to diverge from prior trajectories. The pandemic coincided with increasing public and political realisation of the impact of the climate and biodiversity crisis (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IBPES), 2019). This crisis had been brought to popular attention in the UK through the films of the naturalist David Attenborough, and raised up the political agenda, notably through the UK Government's 25 Year Environment Plan (HM Government, 2018), with its commitment to "environmental net gain" in development decisions, as well as the UK presidency of the COP26 climate summit in 2021 (United Nations, 2021).

In the UK, the initial period of the lockdown imposed to curb the spread of Covid-19 between 23 March and 4 July 2020 was characterised by the closure of most indoor facilities and, at first, a dramatic reduction in traffic, with private and commercial road traffic dipping to a low of 23% on 13 April compared with the previous year, before gradually increasing (Department for Transport, 2020). As the lockdown continued, weather improved and restrictions were gradually eased, there was a significant increase in the use of urban parks and public green spaces. While the overall proportion of the population using "public green and natural spaces" did not increase significantly during April 2020 (Office for National Statistics, 2020b), the ban on unnecessary travel resulted in a greater intensity of usage of urban green and blue spaces and a reduction in visits to national parks and countryside.

As mentioned above, there is a significant body of literature demonstrating the different ways in which access to, and time in, green spaces is conducive to improvements in health and well-being. A recent review of nearly 400 peer-reviewed studies published between 2009 and 2019 (Dobson et al., 2019) highlights the benefits associated with parks and urban green spaces, including supporting physical health and mental well-being;

creating opportunities for social integration; and enabling people to connect with nature. Affordance theory (Gibson, 1979; Heft, 1988) underlines that the benefits of green spaces arise not from a process of causality but because green spaces generate opportunities, or affordances, for different forms of activity. A tree, for example, can be a site for children's play, a shady place to sit and enjoy a picnic or conversation, or can activate a sense of connexion with the wider natural world. It can be a place of discovery through watching birds or animals, or provide aesthetic pleasure as it changes through the seasons. Over time natural spaces can generate a sense of place attachment, a phenomenological state of "the bonding of people to places" (Low and Altman, 1992).

Nature connectedness can be an important aspect of such attachments to place, and attachments to particular places can amplify the links between nature connectedness and well-being (Basu et al., 2020). However, Gosling and Williams (2010) suggest that connecting with nature is more important than place attachment in driving pro-environmental behaviours. The theory of nature connectedness draws on the "biophilia hypothesis" (Wilson, 1984) which argues that humans have an innate need to connect with all living species because of their evolutionary beginnings. The natural world is thus a requirement for human health and development. Research has suggested that connexions between humans and the natural world lead to increased well-being (Howell et al., 2011; Pritchard et al., 2019; Duke and Soulsbury, 2021) and generate pro-environmental attitudes, which in turn benefit nature. Capaldi et al. (2015) link nature connectedness with both hedonic ("flourishing") and eudaemonic ("functioning") well-being. Nisbet and Zelenski (2013) report that "[h]igh nature relatedness, or a strong subjective connexion with nature, is typically associated with greater happiness and environmental concern." Davis et al. (2011) suggest that people who are "satisfied with and invested in the natural world" are more likely to act with the well-being of the natural environment in mind. Yang et al. (2018) found that people who experience "awe" at the natural world were more inclined to pro-ecological behaviours.

Research attention has recently been drawn to the practical application of the concept of nature connectedness to address what has been described as a need for "a new relationship with nature" (Richardson et al., 2020) in order to halt environmental destruction and reverse the negative relationships between humans and nature (Ison and Straw, 2020). To operationalise the application of nature connectedness, Lumber et al. (2017) devised the "pathways" framework, based on a series of experimental studies conducted at the University of Derby, UK. The studies formed an iterative process (described in detail in Lumber's article) of translating five of Kellert's nine domains of biophilia (Kellert, 1993) into five "pathways" by which humans experience and connect with the natural world. The pathways correspond to the types of relationship that best predict connectedness with nature (**Table 1**).

The framework has informed subsequent research designed to increase nature connectedness, including a study in which participants were encouraged to note "three good things" in nature for 5 days (Richardson and Sheffield, 2017); a large-scale public engagement campaign in which participants were invited to interact with nature for 30 days (Richardson and McEwan, 2018); and another using a smartphone app that encouraged urban residents to notice good things in nature (McEwan et al., 2019). Richardson et al. (2020) also provide examples of the operationalisation of the pathways into practise, though this evidence is self-reported rather than the subject of empirical research.

This paper complements existing research by seeking to understand how the pathways might be used as an analytical framework to understand real-world experiences, as opposed to data generated under experimental conditions. It aims to offer additional insights that can assist the development and operationalisation of the framework in practical situations. The Covid-19 lockdown provided an opportunity to apply the framework to analyse qualitative data about experiences of public spaces, including connexions with nature, generated through contemporaneous research. Our approach is outlined in the next section.

METHODS

This article considers data generated from two studies, each of which involved a series of interviews considering the use of public paces during the Covid-19 pandemic. Both projects were led by teams at the Centre for Regional Economic and Social Research (CRESR) at Sheffield Hallam University, and the lead authors of this article were involved in both projects. All the interviews took place in the summer of 2020.

Project 1 was an evaluation of Parks for People, a programme of investment in park improvements funded by two non-government bodies, The National Lottery Heritage Fund and The National Lottery Community Fund. As part of this evaluation, 21 members of the public in three locations were asked about their use during the pandemic of three parks where improvements had been funded through Parks for People. The three parks were in different locations: a low-income area in the east of Edinburgh, Scotland; Quorn, a village in Leicestershire in the English Midlands; and Tunbridge Wells, a commuter town south of London. Participants were recruited through snowball sampling initiated via local voluntary organisations, or volunteered to take part via an online survey that was part of the evaluation (survey respondents were contacted to check that they lived locally and/or used the parks being studied). Interviews were conducted by telephone or videoconferencing.

Project 2 was a scoping study on the health benefits of public spaces, with a particular focus on health inequalities, funded by a research charity, the Health Foundation. As part of this work 21 individuals with a range of professional expertise on green spaces, who had taken part in a policy forum at an earlier stage of the research, were interviewed about their own experiences of the lockdown and their awareness of the use of public spaces more generally during the pandemic. These interviewees worked for a variety of government departments, professional bodies, non-profit organisations and academic institutions. In addition, a short online survey covering a similar set of questions was

Biophilic value	Definition	Pathway	Definition
Naturalistic	Pleasure from contact with nature	*Contact*	The act of engaging with nature through the senses
Aesthetic	Appeal of nature's physical beauty	*Beauty*	The perception of aesthetic qualities including shape, colour, and form that please the senses
Symbolic	Expressing ideas through nature based language and metaphors	*Meaning*	Using nature or natural symbolism to communicate a concept that is not directly expressed
Humanistic	Emotional bond with, and love for nature	*Emotion*	An affective state or sensation that occurs as a result of engaging with nature
Moralistic	Ethical concern/judgements and revering nature	*Compassion*	Extending the self to include nature, leading to a concern for other natural entities that motivates understanding and helping / co-operation

Source: Lumber et al. (2017, p. 19).

TABLE 2 | Data analysed to inform findings.

Type of data	Data source	N of participants
Qualitative interviews (project 1)	Park users, Edinburgh	6
	Park users, Quorn	5
	Park users, Tunbridge Wells	10
Qualitative interviews (project 2)	Public space professionals	21
Survey respondents (project 2)	Online survey	29
Total		71

conducted with a wider group of individuals ($N = 42$, with 29 respondents) who had attended stakeholder consultations in three locations—Sheffield, Glasgow and London. These included members of local voluntary and community organisations concerned with the use and activation of public spaces.

Interviewees from Project 1 were aged between the mid-20s and 83 and included a mix of couples, families with children and single people. Demographic information was not collected in Project 2 as participants were selected on the basis of their professional or community activity. All the interviews were audio-recorded and transcribed verbatim, and the analysis is based primarily on these transcripts, plus the responses and free-text comments provided by participants in the online survey. **Table 2** shows the location and type of interviews conducted for both research projects.

There were common themes in the questions asked of each group. These are shown in bold in **Table 3**. Both groups were asked about their experience of connexions with nature during the lockdown. Questions to both groups were based around four types of affordance offered by public open spaces: opportunities for physical activity; social activity; rest and relaxation; and connexions with nature. These are shown with illustrative examples in **Table 4**. The three groups of park users in Project 1 were only asked about their own experiences; the group involved in Project 2 were also asked for their more general views as professionals involved in the provision and use of public spaces. Respondents to the online survey were asked whether benefits of public spaces had increased or decreased during the Covid-19 pandemic. They were questioned about four types of benefit,

matching the four affordances in **Table 4**, and asked to rate their experience on a 5-point Likert scale (from "greatly reduced" to "greatly increased," with the addition of a "don't know" option). They applied this rating to four types of space in each category of affordance: green spaces, blue spaces, indoor spaces, and outdoor built spaces (such as streets or public squares). In addition, they were given the opportunity to provide free-text responses to each question.

Approach to Analysis

Our analysis takes a realistic rather than a theory-led approach (Pawson and Tilley, 1997), applying the framework retrospectively to data already generated rather than using the framework to generate the data. The questions we asked (**Table 3**) elicited information about which spaces participants had used and the activities they had engaged in, as well as the benefits they perceived from doing so. We hypothesised that if participants were connecting with nature, such connexions (and, by extension, the pathways to these connexions) would likely be revealed in their comments and recollections about how they were using public spaces and which activities they enjoyed.

We adopted an iterative approach to analysis, sharing the work between the article's authors in order to triangulate our understandings of the qualitative data and agree the central themes (Flick, 2007). First the lead author undertook a trial analysis of five of the 42 interview transcripts, using an open coding process to identify types of behaviour, types of spaces, and positive or negative experiences noted by research participants. These were then used to generate four tables categorising places where interviewees had experienced a connexion with nature, mapped against Lumber's five pathways; typologies of restrictions and limits on nature connectedness during the lockdown; numbers of participants experiencing probable (implied) or actual (explicitly stated) connexions to nature, mapped against the five pathways; and phrases used by participants to describe connexions with nature. All the transcripts were analysed using these tables as a starting point, sharing the work between the authors and then compiling and sense-checking the results. Additional categories were inserted where the data suggested gaps in the initial framework. Summary versions of the first three of these tables are included in the Findings section below as

TABLE 3 | Interview questions for each research group (summarised).

Topic focus	Project 1 questions	Project 2 questions
Benefits of green spaces experienced by users	Before 23 March, what activities did you take part in at [name of park]?	
Extent of use of green spaces	Did you use any other parks or green spaces in your area?	
Affordances of green spaces—matched against categories in **Table 4**	Which activities did you enjoy most?	
Impact of lockdown on use of space	**Since the lockdown, have you used local parks and green spaces at all?**	**Have you noticed any changes locally because of COVID-19? Including those that differ from national guidance (e.g., closure of parks or footpaths)?**
Continued benefits of green/public space during lockdown (mapped against affordances)	**If you have been using green spaces, which activities have you been able to continue?**	**In what ways has COVID-19 highlighted the health benefits of public spaces and enabled people to access them?**
Loss of benefits during lockdown (mapped against affordances)	**What have you had to stop doing?**	**In what ways has COVID-19 limited the health benefits of public spaces, including indoor spaces?**
Displacement effects – have users changed their behaviours in response to lockdown?		In what ways have people been able to find alternative ways of gaining these health benefits when their regular spaces or venues have been closed?
Unexpected consequences of lockdown—have new spaces become available?		Have people been able to take advantage of spaces that are temporarily not being used in the usual way?

Themes common to both groups are in bold.

TABLE 4 | Types of space and affordances considered in interviews, with illustrative examples listed below each mode of activity (Research project 2).

Types of space	Physical activity	Social activity	Relaxation & rest	Connexions with nature
Green space	Parkrun	Walking groups	Mindfulness, "forest bathing"	Wildlife observation
Blue space	Wild swimming	Boating clubs	Fishing	Conservation volunteering
Built space	Skateboarding	Gatherings at community hubs and centres	Use of libraries	Community gardening, appreciating street trees and urban greening

Research Project 1 considered the same range of affordances, but only within the three green spaces that were the focus of attention.

Tables 5–7. After completing the analysis, the authors merged a number of categories in the first two tables where there were obvious overlaps.

In analysing the data, we extended the idea of "meaning" from Lumber's framework (Lumber et al., 2017: 19), where it is considered in terms of rhetoric and symbolism—"using nature or natural symbolism to communicate a concept that is not directly expressed." The data we considered, because they were concerned directly with experiences of natural or semi-natural places such as urban parks, did not lend themselves to the use of nature as a rhetorical device. We took the view that the nearest proxy within our material would be references to nature as shaping a participant's identity or worldview. Our working definition, therefore, is that meaning involves *providing a sense of value to the individual, involving connectedness to the natural world—* while acknowledging that such a definition overlaps with the "emotion" and "compassion" pathways.

Similarly, it was difficult to map our material directly onto the compassion pathway as defined by Lumber: "extending the self to include nature, leading to a concern for other natural entities that motivates understanding and helping/co-operation." Our research concerned people's experiences and feelings, rather than their conceptual understandings of their relations with the natural world. That said, it was evident that there were instances where participants expressed care and concern for the natural world, leading to acts of nurturing and tending. We note that the biophilic values that underpin Lumber's framework depict food growing as an example of a utilitarian attitude to the natural world. Our reading of participants' experiences of growing during the lockdown suggests that this is not necessarily the case: food growing can be evidence of a symbiotic and nurturing approach. We have therefore adapted our working definition of compassion to encompass *a sense of care for the natural world, evidenced by activities to nurture or look after non-human species.*

In substituting these definitions, we took the view that our understandings of participants' connectedness with nature should be driven by their self-reported actions and attitudes, rather than primarily by the theoretical framework.

TABLE 5 | Places of nature connexion identified from interview data.

Places of nature connexion (sorted by type)	Probable (suggested by interview material) [n. of interviews suggesting]	Actual (specifically mentioned by interviewee as connecting with nature) [n. of interviews mentioning]	Relevant pathways to nature connexion
Parks and/or "green spaces"	29	7	Contact, beauty, emotion, compassion (care)
"Blue spaces" including riversides, lakes, canals	14	7	Contact, beauty, emotion
Private gardens	12	3	Contact, beauty, emotion, meaning, compassion (growing)
General local environment, public spaces, roads (including derelict land)	9	3	Contact, beauty, emotion
Allotments, community gardens or orchards, gardening projects	7	4	Contact, beauty, compassion (food growing, volunteering), meaning (ecology)
Woodland, trees	5	6	Contact, beauty, emotion
Golf courses and other private spaces opened to the public in lockdown	10	0	Contact
Agricultural land, countryside (including cycle routes)	5	0	Contact
Footpaths	2	1	Contact, beauty, compassion
Tree/bird feeder outside flat	0	2	Contact, beauty, emotion (birdsong)
Nature reserve	2	0	Contact, beauty, emotion
Beaches	2	0	Contact
City farms	1	0	Contact
No connexions mentioned or implied	0	0	

FINDINGS: SPACES OF AND PATHWAYS TO NATURE CONNEXIONS

Our analysis suggests that connexions to nature were experienced in some types of places more than in others during the lockdown. The most commonly cited spaces were parks or places referred to generically as "green spaces"; this is not surprising, particularly as half the interviewees were users of particular parks. Six other types of space were consistently mentioned as sites of nature connexion, with probable or actual connexions identifiable in at least 10 cases (**Table 5**). "Blue" spaces, including streams, riversides, lakes and canals, were mentioned specifically as places to connect with nature in seven interviews and implied in 14 cases. Woodlands or trees were mentioned specifically six times and implied in five cases. Gardening projects, including community orchards, allotments and community gardens, were mentioned specifically by four respondents and implied in seven interviews as places to connect with nature. Private gardens were mentioned specifically three times and implied as sites of nature connexion in seven cases. The general local environment, including public spaces, streets and derelict land, were mentioned specifically as places to connect with nature three times, and implied in nine interviews.

One unexpected category was apparent in several interviews: golf courses. This is likely to be an anomaly resulting from the lockdown. In the UK, golf courses were closed for sport but many were either opened to the public for exercise or were appropriated as quasi-public green spaces because they were accessible.

Some types of space featured less than might be expected. Nature reserves were only mentioned by two respondents, possibly because many were closed or inaccessible because of travel restrictions; it is also possible that they may have been described by respondents as woodlands or green spaces rather than as nature reserves. City farms were almost all closed and were only mentioned by one participant. Similarly, only two mentioned beaches: the locations of our research were largely inland (Edinburgh was the exception) and travel restrictions would have prevented access to beaches except to local residents. There were no interviews where the participant did not mention or suggest any connexions with nature at all.

Activating the Pathways to Nature Connexion

It was clear from the interview material that the spaces mentioned enabled at least three of the pathways to nature connexions to be activated: contact, beauty and emotion. We found much less evidence of the two other pathways, meaning and compassion. As noted on page 5, we also found it difficult to correlate these two pathways with the self-reported experiences of participants in our research.

One example of contact with nature was described by a parent of a small child, who spoke of how her son instinctively engaged with the natural world in their local park: "he does like to run around and so I think he's just really enjoyed that there's more to do, and we found a tree that he can kind of climb in … he's still quite little but he can still kind of climb in it and he loves picking up sticks and we've kind of just sat and looked for bugs in the grass." (*Participant 30*). Another interviewee spoke of exploring their local urban green spaces: "We've seen a kingfisher and we've seen loads of ducklings and goslings and a heron and an egret." (*Participant 12*). Another directly equated exploring with connecting with nature: "I think that bit around ecology,

TABLE 6 | Limits on nature connexion identified from interview data.

Restrictions on nature connexion (by type)	Probable (suggested by interview material) [n. of interviews mentioning/ suggesting]	Actual (specifically mentioned as preventing nature connexions) [n. of interviews mentioning]
Cessation or closure of community activities/facilities	13	2
Overcrowding/conflicts between users/avoidance of constricted areas	9	
Fear of antisocial behaviour	8	
Green spaces and play areas cordoned/fenced off	7	
Unequal access to (quality) green space (e.g., because of class, race, age, disability)	7	
Closure of public toilets	5	1
Restrictions on travel/closure of car parks	4	3
Fear of/problems with dog mess	4	
Closure of entire green or outdoor spaces (e.g., National Trust properties)	4	
Lack of places to stop and sit/meet outdoors	3	
Lack of access to private gardens	2	
Shorter opening hours	2	
Anxiety about leaving home	1	
Notices discouraging use of parks	1	
Lack of footpaths in countryside	1	

TABLE 7 | Number of interviews suggesting pathways to nature connectedness.

Pathways to nature connexions	Probable [n. of interviews suggesting]	Actual (specifically evidenced in interview) [n. of interviews mentioning]
Contact	25	17
Beauty	12	11
Meaning	1	2
Emotion	11	8
Compassion	7	3

particularly when we were only allowed out once a day, I think that made people investigate their local spaces a bit more, I think people have been trying to find where their local nature is." (*Participant 19*).

Beauty and aesthetic pleasure featured strongly in participants' descriptions of being outside. Participant 39 described the "fabulous" planting in their local park near a river, while Participant 10 commented on the pictures of spring flowers shared on social media. Participant 30 mentioned paying more

attention to the trees in the local park: "for me, it was somewhere that I'd walk through quite quickly and not really notice anything whereas now, you know, we're looking at the trees and what kinds of trees they are…"

This pleasure and appreciation of natural beauty was often coupled with an emotional response. At times this could be described as a "cuteness factor," and several participants spoke of their joy at seeing ducklings, goslings and baby moorhens. But alongside this was a sense that being in the natural world enabled participants to handle the mental health challenges of the pandemic, which for many parents included the stress of having to homeschool for the first time. Participant 28 commented: "…it makes a big difference to both of my daughters… it's an anxious time for them, and they both definitely benefited mentally from being able to kind of go to the park, it's helped us all mentally."

Participant 29 linked the pleasure of being able to see ducklings and moorhens with a sense of relief at being outside in the natural world: "it was such a stressful time, you know, no-one knew what was going on […] Just to be able to actually have somewhere to go and you know, the ducks, there were ducklings and baby moorhens on the pond … it just was so nice. Again, that whole nature thing, to get out and to actually be able to, you know, breathe and sort of, yes, just de-stress really by having somewhere that's nice to walk around."

Another talked about being able to "almost lose yourself in a wood": "I went for a walk last night which wasn't entirely through the park, but it took me into the park, you know, and felt just invigorated when I got back from that. And a lot of that was walking through the park and, you know, spending time looking at the trees, just absorbing things that I probably wouldn't normally notice." (*Participant 26*).

Limits on Nature Connexion and the Importance of the Social

We also asked participants about the restrictions on access to natural spaces they faced during the lockdown, and explored how these affected their connexions with nature. An important theme here is that the loss of social activities limits experiences of nature, but an excess of people can also impact on nature connexions. **Table 6** shows the type of restrictions faced most frequently. While some respondents, unsurprisingly, mentioned the closure of particular green spaces and restrictions on travel as significant barriers to use, more talked about the closure of community facilities or cessation of activities such as volunteering in green spaces. One interviewee specifically mentioned the loss of volunteer-led nature walks: "…with nature walks and park groups, because they've had to stop, and volunteer groups and friends of park groups … that aspect of being able to connect has had to stop" (*Participant 15*).

Outdoor organised activities, such as woodland maintenance in Grosvenor and Hilbert Park in Tunbridge Wells, ceased during the lockdown because they were not regarded as essential work and because of the risk of infection, aggravated by the vulnerability of many volunteers. Often volunteers are retirees or people with long-term physical or mental health problems that limit their ability to work full-time.

While some were less able to connect with nature because the social activities that provided the occasion for engaging with nature ceased, others felt unable to connect because their local green spaces had become overcrowded and—in some cases—characterised by incidents of, or fears of, antisocial behaviour such as outdoor drinking and drug-taking. Typical comments included: "(It) has become so busy because of the lockdown … so I can imagine it is quite difficult for people to get that nice, relaxing stroll" (*Participant 18*); and "When [teenagers] are bored, they hang around in groups, they can be quite intimidating" (*Participant 38*).

Another factor mentioned by interviewees—though usually without direct experience—was the impact of socioeconomic inequalities. Public access to green spaces in the UK, as in many other countries, is not equal, and even where there may be an equivalent amount of space per capita, the quality of that space tends to be poorer in more disadvantaged areas (Lee and Maheswaran, 2011; Brindley et al., 2019). The absence of private gardens also disproportionately affects people on low incomes, who may thus be doubly disadvantaged by having no access to private green space, and poorer quality public green and blue spaces. Long-term illnesses and mental health conditions are also more heavily concentrated in disadvantaged areas of England (Office for National Statistics, 2019), and many people with underlying health conditions were instructed to "shield" by staying at home entirely during the initial lockdown, preventing or severely constraining access to experiences of the natural world. As one greenspace professional told us: "Some of our projects we know provide a lifeline to people who already feel isolated and who are isolated because their health … if somebody's genuinely anxious or fearful about coming out, as many are, then they potentially miss out on that benefit." (*Participant 14*). Even for those who could go out, sometimes the closure of public toilets created added anxiety and discomfort: one interviewee described this as "a major deterrent for certain groups of the population in using public spaces, particularly the elderly, others with certain health conditions, and also families with young children" (*Participant 6*).

In drawing conclusions from these data, we were conscious of the limitations of the sample size (42 interviews and 29 survey respondents). The sampling for both projects was purposive rather than representative. While we were made aware through our interviews of inequalities of access to and enjoyment of natural spaces during the lockdown, participants were not able to provide first-hand evidence. We therefore cannot comment from our data on whether nature connectedness is experienced differently by disadvantaged groups, although other recent research (Boyd et al., 2018; Birch et al., 2020) highlights the need to recognise the different ways in which people suffering disadvantage through race, age, mental health, and/or economic status connect with nature and construct meaning in their lives through such connexions.

Additional Findings From Survey Responses

The material from the 29 respondents to our online survey reinforced in general terms our findings of increased appreciation of or connectedness to nature during the lockdown, but tempered by limitations on access. Almost all of these respondents lived in the large UK cities where the consultations for the original research for Project 2 were held—Glasgow, Sheffield and London. The survey results revealed a mixed picture across all four affordances. Only in the case of health benefits associated with social activities was there an outright majority perceiving an overall reduction in benefit—supporting the findings from the qualitative material. For the other three affordances opinions were more divided; however, ten respondents said their connectedness to nature had increased in green spaces during the lockdown and 11 said it had greatly increased, while only four said it had reduced, three said it had greatly reduced, and one said there had been no change. Smaller numbers reported connectedness to nature within blue spaces—nine said it had increased or greatly increased, four reported no change, and ten said it had reduced or greatly reduced. Seven participants reported an increase in nature connectedness in outdoor built spaces, although nine reported a reduction and five said there had been no change.

Restrictions on nature connectedness evident from survey responses (based on free text comments) highlighted the impact of the closure of green spaces or play areas (10 instances); overcrowding or conflicts between users (four examples) and the closure of public toilets (two examples). There were also two comments suggesting that unequal access to green space was an issue, and one mentioning the cessation of community activities.

Evidence of "Meaning" and "Compassion"

While the connexions with nature evident from our data mapped strongly against the contact, beauty and emotion pathways, it was more difficult to evidence "meaning" and "compassion." This is significant because Lumber's work suggests that "enhanced contact with nature" (Lumber et al., 2017, p. 19), involving activities focused on emotion, meaning or compassion, result in greater nature connectedness than simply going for a walk in a natural environment. As discussed on page 5, we considered how we might extend Lumber's definitions and whether that might give us more insights into how these pathways were activated. In **Table 7**, which shows the instances of evidence for each pathway in our qualitative data, we include connexions that might fit a broader definition of meaning and compassion, but we offer these as exploratory rather than conclusive observations.

The data suggested several instances where, on these broader definitions of meaning and compassion, there was evidence that these pathways were activated during the Covid-19 lockdown. It was easier to identify instances of compassion than meaning, even using these broad definitions, and as **Table 7** shows, the number of instances was much lower than for the other three pathways.

Examples of possible compassion include caring for plants and trees, either within parks (for example, in community orchards) or on allotment sites or in private gardens. One park user in Tunbridge Wells spoke of planting trees and returning to see how they were faring: "We planted some cherries and crab apples at the Upper Grosvenor Road entrance in February, so I've been up there a few times just to check

they've settled in and so on" (*Participant 23*). It was noteworthy that this individual was already familiar with such activities through their prior involvement in volunteering at this park—in other words, there was a social element to the expression of compassion. Most of the other instances of compassion involved descriptions of volunteering activities in green spaces. One greenspace professional spoke more generally of a "shift in consciousness around environmental responsibility" perceived during the lockdown, but with the caveat that "we're all just trying to figure out if it's real or it's going to stick."

We noted examples of meaning when participants spoke about being in nature as informing a sense of self. One participant spoke of children enjoying connecting with nature in the outdoor environment of an allotment site:

"It's interesting, there always has been the Polish family that used to bring all their children down to their allotment, at least once a week, if not twice and they'd have a picnic up by the shed and they'd set up things to do … and there are, oh ten, eleven families doing something very similar and the allotments are clearly a treat for people and a huge, hugely beneficial resource, not just for growing vegetables for a healthy diet, it's far, far wider than that and [for] children to learn … there's a lot of lovely wild birds around and interesting butterflies, moths, insects, frogs, newts and the children are learning, interestingly, they love it." (*Participant 25*).

It is quite possible that examples of meaning and care existed more widely among participants, but were unstated because of the questions they were asked. However, especially in the case of meaning, this raises the issue of what form of research would be needed to identify such actions and attitudes within real-world, as opposed to experimental, contexts.

DISCUSSION

Our experience in applying the pathways to nature connectedness framework to empirical data raises a number of issues, which we consider here under four headings: (a) the utility of the pathways framework; (b) the extent and effects of nature connectedness during lockdown; (c) links between the pathways; and (d) the possible effects of the lockdown on nature connectedness and the importance of social activities.

The Utility of the Pathways Framework

We begin by acknowledging the value of the pathways framework in foregrounding the different routes to nature connectedness and the different impacts of these forms of connexion. However, our experience in attempting to retrofit the framework to existing empirical data highlights a gap between the clarity of theory and the messiness of practise. Even using the broader working definitions of "meaning" and "compassion" that we employed, it was difficult to demonstrate conclusively that participants in our research were constructing meanings or exercising compassion in their relationships with nature, although we consider this is probable in some cases. If it is only possible to demonstrate meaning and compassion under experimental conditions designed to elicit appropriate responses, such studies would carry a risk of confirmation bias.

Without a conclusive means of demonstrating the meaning and compassion pathways from the real-world evidence to hand, we are left with two contrasting sets of data. In the first case, there is clear evidence of the pathways of contact, emotion and beauty being activated among the participants we interviewed. In the second, there is the probability that in a small proportion of cases the pathways of meaning and compassion were activated, but additional research would be required to demonstrate this with any degree of certainty. Given that one of the values of the framework is to highlight the importance of meaning and compassion in reframing humans' relationship with the natural world, more thought may need to be given to how such pathways might be robustly demonstrated in practise. Further empirical research will be needed to explore this.

Extent and Effects of Nature Connectedness

Our research supports evidence (Robinson et al., 2021) that nature connectedness, and reliance on nature to support well-being, increased during lockdown. Among the participants in our research, there were links between nature connectedness and physical exercise (such as walking) and mental well-being (several spoke of relieving stress by being in natural environments or observing nature). The particular circumstances of the first lockdown in the UK, coinciding with a period of warm, bright spring weather, both created additional opportunities to observe and experience nature and—probably—increased the feelings of well-being associated with being outdoors. As one participant commented: "…it does smell a bit nicer out there and maybe the colours seem a bit more vivid, but then it's May so of course the colours seem vivid cos it's not a gloomy day in November…" (*Participant 9*). The dramatic falls in traffic on urban streets during the first lockdown, referenced above, probably contributed to this heightened awareness of nature.

From our research it is not possible to evidence longer-term effects of this increased nature connectedness. None of our participants expressly said they would behave differently in future as a consequence of being more aware of the natural world. Had they done so, it would still be necessary to take account of the likely drop-off between expressed intentions and actual behaviour once the restrictions imposed during the pandemic are lifted. It is possible that the increased contact during the lockdown will have primed some participants in our research, and members of the public more widely, to engage with the natural world more often and more deeply, but longitudinal studies would be required to demonstrate this.

Links Between the Pathways

One reason for using the pathways framework in our analysis was to investigate whether there was any evidence of links between the pathways to nature connectedness. Could more time spent in the local park, for example, lead to more engagement in volunteering or supporting conservation organisations? Lumber et al. (2017, p. 19) suggest that "enhanced contact with nature" is needed to boost individuals' nature connexions. The short answer from this study is that no such development could be evidenced. Those who demonstrated care or compassion were largely those

who were already involved in voluntary groups concerned with local green spaces, or were involved in the natural world in their professional capacities, or already grew food on allotment sites. This would suggest, in line with Lumber's findings, that activation of the more complex pathways of meaning and compassion are more likely to be associated with purposive activities—which suggests there is likely to be a social element to these pathways.

Effects of Restrictions and the Importance of Social Activities

The lockdown affected participants' use of outdoor spaces in four main ways, and these in turn had implications for their connexions with nature. A significant proportion (15 of 42 interviewees) were affected by the cessation of activities or closure of community facilities. Overcrowding of outdoor spaces or conflicts between different users affected nine participants, while eight were concerned about antisocial behaviour. Seven mentioned the closure of spaces such as play areas. Another seven were concerned about unequal access to green spaces, but it was notable that these inequalities were not experienced directly by participants.

Two contrasting themes emerge from the interview data. One is that connexions to nature are often experienced socially. Working alongside other volunteers in natural spaces, planting flowers, trees or vegetables in communal settings, or walking and observing the natural world with others, can be significant in activating the pathways to nature connectedness. For many of our participants, nature connectedness was entangled with connexions with other members of the human species.

The second theme, conversely, is that too many humans in one place can remove the sense of quiet and tranquillity that can also activate the pathways to nature connectedness. Participant 7 said that 'spaces which have perhaps been a bit busier are feeling quite threatening, people are feeling quite anxious going out there, [with] conflict between different users in terms of cyclists and runners on shared use paths and in very busy parks', while participant 18 spoke of using side streets rather than a waterside path because of the difficulty of maintaining a safe distance from others. An overriding concern with how others are using shared spaces and anxiety about personal safety (see, e.g., Arnberger and Brandenburg, 2007; Morris et al., 2011) is likely to reduce the benefits of contact with nature and close off the other pathways to nature connectedness. It is worth recalling that pioneers of public parks such as Frederick Law Olmsted envisaged them as "a cultural fix to the crowded and purportedly degenerative conditions of urban public spaces, tenement housing, and industrial workplaces" (Loughran, 2020).

CONCLUSIONS

Our research advances the study of nature connectedness in several ways. It shows that certain types of spaces are particularly important in people's experiences of nature connexions: woodlands and "blue" elements such as rivers and lakes, as well as gardens, were more strongly associated with nature connectedness. It also shows the importance

of social connexions and conditions as mediators of nature connectedness. There was evidence, not all of it direct, that the limits on the organised use of and access to public spaces during the lockdown restricted opportunities to connect with nature, or potentially removed them for some groups. These social links may be particularly important in activating the pathways of meaning and compassion. Caring activities performed alongside others may reinforce individuals' sense of the value and significance of the natural world. Such activities were clearly limited during the Covid-19 pandemic. This is an area that needs further research, considering how different groups and communities experience nature connectedness through social and communal activities.

We found evidence that connexions with nature map strongly against three of the pathways in Lumber's framework—contact, beauty and emotion. We found that the definitions of meaning and compassion used in the framework made it difficult to trace connexions that may well have existed, and even when using broader definitions it was difficult to retrofit the interview data to the framework. Longer-term or ethnographic research—which was not possible in the context of Covid-19—could shed more light on this challenge.

While underlining that this analysis is exploratory, our conclusion is that more empirical testing of the pathways framework is required, particularly around the "meaning" and "compassion" pathways, in order to investigate how they can be activated and to ascertain whether a redefinition of these pathways might more accurately reflect people's experiences of connectedness to nature. Work is needed too to identify links and possible routes of progression between the pathways. Such studies will likely need to be longitudinal and cover a much longer period of time than the circumstances of early 2020. Our findings suggest that while the lockdown may have provided additional opportunities for many to connect with nature, there is not yet evidence that those connexions deepened to the extent that they activated new pathways to nature connectedness or resulted in changes in behaviour concomitant with the compassion pathway. While contact with nature may be a necessary condition to activate meaning and compassion, our evidence suggests it is not a sufficient condition. This raises the question of whether nature connectedness is, at least in part, socially generated.

A second conclusion is that our participants' experiences reveal a strong underlying connectedness to nature across all the groups we interviewed. Given the wide variety of uses of natural spaces (for social activities, exercise and sports, for example), the data suggest that the natural element of outdoor spaces is a significant factor in their use and appreciation. This reinforces the research on green spaces and well-being cited earlier, but also suggests that the design of public spaces should aim to highlight and increase the proportion and variety of natural or naturalistic features and "wild spaces" (Threlfall and Kendal, 2018).

Thirdly, our findings highlight the importance in urban policy and design of natural landscapes and features. Three factors stand out from our data. Spaces need to be accessible and diverse in order to provide multiple opportunities for people to connect with nature, and thought needs to be given to how to prevent overcrowding—for example, by offering a range of alternative

routes to and through parks and green spaces. Our findings also reinforced the need for a variety of typologies of natural spaces to promote nature connectedness. Woodlands, watercourses, gardens and allotments were significant for our participants, suggesting that investment in parks and green spaces should focus on creating or preserving natural features and habitats and providing spaces where local residents can engage in planting and growing.

While work still needs to be done to investigate how the pathways to nature connectedness can be better activated, the experiences of participants in our research during the lockdown showed the benefits of enabling people to connect with nature in urban environments. To provide more opportunities for such connexions, urban planners and designers should consider a number of changes or improvements to current practises. These could include strengthening guidance on green spaces within new housing developments, including the provision of private and communal gardens; undertaking regular greenspace audits to test provision and accessibility against environmental justice criteria (Rigolon et al., 2018); green retrofitting to introduce natural habitats on streets, pathways and in vacant sites; and funding and support for community-led environmental and growing projects. The last of these may be particularly important, given the evidence we have found that connecting with nature is often a social and purposive activity.

DATA AVAILABILITY STATEMENT

The data analysed in this study are subject to the following licences/restrictions: The data analysed for this article form part of two larger datasets created for the two research projects cited in the article. These data are covered by GDPR regulations in the UK and are held securely by Sheffield Hallam University. Requests to access these datasets should be directed to e.smith@shu.ac.uk.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Emma Smith, Information Governance lead at the Centre for Regional Economic and Social Research, Sheffield Hallam University as part of the University's regular ethical approval process. The participants in both projects provided written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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How People Foraging in Urban Greenspace Can Mobilize Social–Ecological Resilience During Covid-19 and Beyond

Mallika Sardeshpande [1,2]*, Patrick T. Hurley [3], Eefke Mollee [4], Hesekia Garekae [5], Annika C. Dahlberg [6], Marla R. Emery [7] and Charlie Shackleton [5]

[1] Centre for Transformative Agriculture and Food Systems, School of Agriculture, Engineering, and Environmental Science, University of KwaZulu-Natal, Durban, South Africa, [2] Ashoka Trust for Research in Ecology and the Environment, Bangalore, India, [3] Department of Environmental Studies, Ursinus College, Collegeville, PA, United States, [4] School of Natural Sciences, Bangor University, Bangor, United Kingdom, [5] Department of Environmental Science, Rhodes University, Makhanda, South Africa, [6] Department of Physical Geography, Stockholm University, Stockholm, Sweden, [7] Forest Service, US Department of Agriculture, Burlington, VT, United States

Informal foraging for food and other natural materials in urban greenspaces is an activity undertaken by many across the world. For some, foraging is a necessary means of survival and livelihood, while for others, it provides cultural and recreational opportunities. In the socioeconomic crises induced by Covid-19, foraging can help communities, especially (but not exclusively) vulnerable people, cope with the impacts of lockdowns, and associated economic decline. In the long run, foraging can help improve social–ecological resilience in urban systems, particularly in response to climate, economic, and disease disruptions. First, we elaborate the ways in which urban foraging can provide immediate relief from the shocks to natural, human, social, physical, and financial capital. We then describe how over time, the livelihood, food, and income diversification brought about by foraging can contribute to preparedness for future uncertainties and gradual change. Cities are increasingly becoming home to the majority of humanity, and urban foraging can be one of the pathways that makes cities more liveable, for humans as well as other species we coexist with. Through the capitals framework, we explore the role foraging could play in addressing issues of biodiversity conservation, culture, and education, good governance and social justice, multifunctional greenspace, and sustainable nature-based livelihoods in urban areas.

Keywords: capital, climate change, pandemic, resilience, urban foraging, urban greenspace, urban green infrastructure, adaptation

INTRODUCTION

Zandile picks various wild berries for her family and for sale in the neighborhood on her way to work and back in Durban (South Africa). Hal, the son of Chinese immigrants, harvests ginkgo nuts from the sidewalk during walks in a nearby park in his New York (USA) neighborhood, incorporating these in traditional Chinese dishes served at community celebrations. These urbanites are engaged in urban foraging, the practice of collecting naturally growing materials such as fruits, fungi, herbs, craft materials, and wood from urban greenspaces (Shackleton et al., 2017b).

Examples of urban greenspaces include public gardens and parks, riversides, sidewalks, and vacant lots. During pre-covid times, many people across the world foraged in urban areas for various reasons. For example, in some households, foraging helps supplement food supply or save expenses on food or firewood (Shackleton et al., 2017a). In some places, foragers collect craft materials and medicinal herbs for their own household needs, for recreation, or for sale (Poe et al., 2013). For others, foraging is part of cultural practices such as preparing traditional food cuisines using ingredients sourced from the urban wild and lighting firewood at night as a way of connecting with ancestors (Garekae and Shackleton, 2020). Some foragers may sell the materials they gather, in raw form (e.g., fruits, blossoms, and grass blades) or as processed products (e.g., jams, tinctures, baskets, brooms, and mats), to earn an income (Landor-Yamagata et al., 2018). Foraging holds multiple values in people's lives, supporting cultural, economic, and recreational needs.

Covid-19 lockdowns have had various cascading impacts on almost all walks of life. The loss of 195 million jobs, combined with an impending recession, has increased global poverty drastically (IMF., 2020). Disruptions in food supply chains have resulted in food shortages in many countries, making the poor and unemployed even more vulnerable to malnutrition (Torero, 2020). The focus on the pandemic response has deprived other patients of healthcare in some cases. Lockdown restrictions and drastic changes in socioeconomic conditions have also affected people's mental health (Pierce et al., 2020). With Covid-19, many nations across the world imposed varying degrees of lockdowns, affecting urban foraging behavior differently; in some cities, access to greenspaces and hence foraging has been restricted, while in other cities, people are spending more time in urban greenspaces (Kleinschroth and Kowarik, 2020; Ugolini et al., 2020; Venter et al., 2020). The impacts of the pandemic and related restrictions on foraging are yet to emerge, but foraging has been well-documented as a coping strategy during times of natural, economic, and political crises (Erskine et al., 2015; Hofman, 2016; Weyer et al., 2018). In this article, we first elaborate how foraging can help urban communities cope with the short-term impacts of the Covid-19 pandemic. Then, we consider the longer-term implications of adapting urban systems to better respond to future disruptions, including climate change. We use the five capitals framework (natural, human, social, physical, and financial) to assess the changes brought about by Covid-19 and foreseeable climate change impacts and the ways in which urban foraging can ameliorate them.
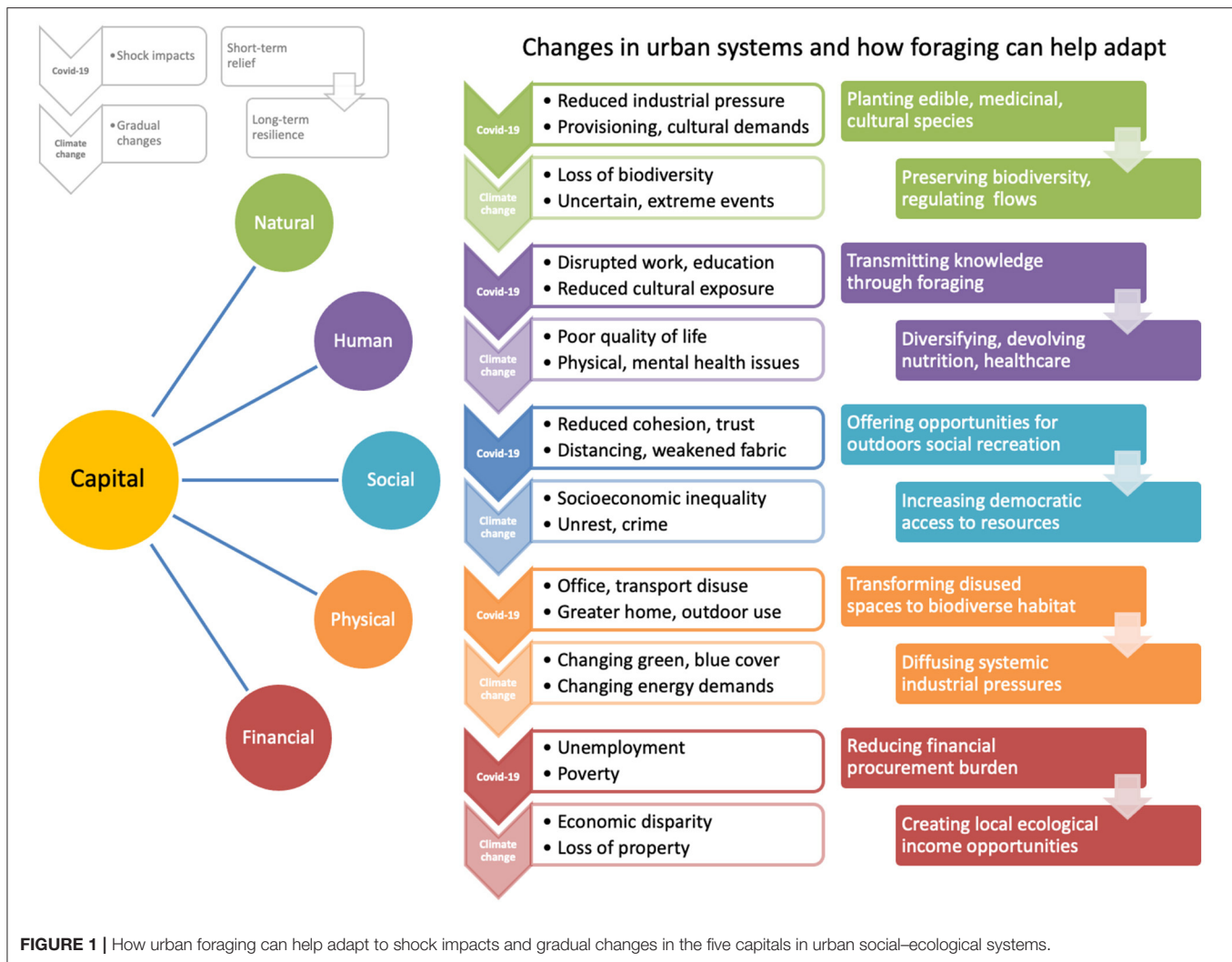
FIVE CAPITALS FRAMEWORK

The five capitals framework provides an assessment of the status of a social–ecological system, based on its components. These components are natural (the ecological context), human (individual and household capacity), social (community and institutional networks), physical (built infrastructure), and financial (the economic context) capitals. The five capitals form a subset of the sustainable livelihoods framework (Serrat, 2017), which additionally also includes the contexts of vulnerability,

policy, processes, and institutions, and sustainable livelihoods outcomes. We choose to use the five capitals framework because foraging is generally not considered a livelihood, but a part of a suite of livelihood activities (Reyes-García et al., 2018), and has little interaction with policies or institutions. We document and speculate on short-term and long-term changes in these five capitals and how forging may be influenced by or induce adaptation in the face of these changes. The five capitals framework can be used to plan sustainable development by setting specific targets and comparing capital combinations under various scenarios (Davenport et al., 2019). It can also be used to analyze the capacity of an existing system to adapt to gradual changes driven by deliberate motivation or exogenous factors (Cafer et al., 2019). Furthermore, in the event of unforeseen disasters, the framework also helps to measure risk and resilience and plan relief and rehabilitation (Laurien et al., 2020). We use the five capitals framework to conceptually assess the impacts of the systemic shocks delivered by the Covid-19 pandemic lockdowns on urban systems. We then extend this assessment to foreseeable gradual transitions driven by climate change. In each case, we elaborate the benefits foraging can offer to ameliorate the short- and long-term impacts on the five capitals (**Figure 1**).

SHORT-TERM RELIEF

In addition to the impacts listed above, Covid-19 has had far-reaching effects on almost every aspect of life. Stay-at-home measures and restricted movement have redistributed demand and pressures across various industries. For example, the use of transport and office infrastructure has reduced, with a steep increase in the demand for energy and electronics at home (Parker, 2020). As industrial fuel and energy consumption reduced, domestic electricity demands rose, and carbon emissions dipped beneath their usual levels temporarily (Aruga et al., 2020; Dantas et al., 2020; Wang and Su, 2020). In some cases, the workforce from large factories has had to forgo a period of earnings and depend on local food charities and gardens instead (Clay and Rogus, 2021). Communal structures of work, education, and care have been disrupted, reducing the benefits to households that depend on these services (Blundell et al., 2020). Distancing measures have also put a strain on the social fabric and reduced opportunities for collective interaction and recreation (Majumdar et al., 2020). Thus, natural capital in urban areas has experienced a fluctuation and reconfiguration of anthropogenic demands and, particularly, an increase in small-scale provisioning and cultural services in the form of household and individual use of greenspaces for food and recreation. Similarly, physical infrastructure has experienced a shift from packed offices and public transport to staggered and spaced use of public facilities including roads and parks (Barbieri et al., 2021). In some cases, this has allowed for wilderness to "reclaim" some urban landscapes, which is perceived positively by many city dwellers. The onus of managing human capital has, to an extent, been devolved to the household (Power, 2020), with reduced capacities of schools, child, and elderly

FIGURE 1 | How urban foraging can help adapt to shock impacts and gradual changes in the five capitals in urban social–ecological systems.

care, and offices to accommodate their usual volumes. Social capital is similarly weakened by the outlawing of gatherings or physically close interactions between people (Arthi and Parman, 2021). Financial capital is decimated not only by job losses but also by reduced spending due to pay cuts, business losses, and dwindling savings (Piyapromdee and Spittal, 2020; Walmsley et al., 2020).

Foraging in urban greenspaces provides people with alternatives in more ways than one. For one, it increases food accessibility: allowing people to procure food and other resources for free, saving costs for those in need, and providing options to others. For example, commercial produce may be too expensive or government food aid too meager for some households. While some urban residents turn to growing food in their home gardens (Sofo and Sofo, 2020), this may not be possible for apartment dwellers or migrant workers. Foraging is a source of fresh and local food, crucial at a time when global food supply is constricted (Laborde et al., 2020). Foraged food is a source of micronutrients from foods such as wild

fruits and vegetables (Ejoh et al., 2019; Ray et al., 2020) and proteins from foods like wild seaweed and insects (Manditsera et al., 2019; Skrzypczyk et al., 2019). These micronutrients and proteins may be unavailable or unaffordable to many (Headey et al., 2020) yet may be important in building the immune response to various diseases (Jayawardena et al., 2020). In addition to sustenance and nutrition, foraging can also improve prospects for physical and mental health for city dwellers. Some foragers collect medicinal herbs and are holders of knowledge of traditional therapies and cures for various ailments (Mollee et al., 2017). This decentralized form of medicine can aid those unable to access mainstream healthcare systems for various reasons. This is especially important in the time of this pandemic, where Covid-19 cases are being prioritized over other patients with curable or chronic illnesses (Chudasama et al., 2020), and people are finding themselves without income or medical cover to pay for health-related expenses (Ahmed et al., 2020). Furthermore, the practice of foraging has therapeutic and enriching benefits similar to other recreational activities

in greenspaces (Engemann et al., 2019). Thus, foraging could contribute to the health and well-being response to the current crises in the short- and long-term, by supporting human and social capital.

Beyond food and health alternatives, foraging can help people save expenditures on a number of household materials (Kazungu et al., 2020). Among the most prominent of these is electricity or fuel for cooking and heating, which can be replaced with foraged firewood or other foraged plant fuels (Maroyi, 2014). Another important aspect of foraging is the ability to generate income. Those with knowledge of useful species and processing techniques can sell their products, such as tinctures, baskets, and mats, to earn money that might be critical to surviving the loss of other sources of income (Weyer et al., 2018). Thus, by providing opportunities to save and earn money, foraging can allow urban residents of all socioeconomic backgrounds to attain a level of self-sufficiency and sovereignty over their household economy, by building financial capital. Foraging in public spaces can act as an educational activity, allowing for transfer of knowledge about food production, ecosystem flows, and urban governance (Colinas et al., 2019). We suggest that the current situation presents several opportunities for urban foraging to bolster socioeconomic recovery. In addition to answering to increased demands on natural and financial capital, urban foraging can diversify means of maintaining and augmenting human and social capital. For example, foraging affords people the opportunity to attain personal spiritual satisfaction (Chou, 2018; Nyman, 2019) and promotes intergenerational interaction and knowledge transfer (Hake, 2017; Fischer and Kowarik, 2020). The changes in the use of physical infrastructure also offer new avenues for integrating provisioning features through planting for and legitimizing foraging in public spaces (e.g., Pinheiro and Luís, 2020; Sardeshpande et al., 2020). Once in place, these decentralized and diversified systems of generating capital can help insure cities against a range of shocks and gradual changes in the future (Lai et al., 2020). Advances in natural and physical capital are likely to be observed under more long-term scenarios.

LONG-TERM RESILIENCE

Cities are at the forefront of human development, with landscapes in constant flux and dynamic demographic and socioeconomic structures (Iveson et al., 2019; Morrow and Martin, 2019). Disruptions and changes of any nature tend to be amplified in cities, due to their institutional, financial, and physical capacity (Petrescu et al., 2020). Climate change is severely impacting natural systems, with cascading effects on human and social capital and damage to physical and financial assets. Rising temperatures and sea levels, along with unpredictable and extreme weather events, are contributing to the global loss of biodiversity and habitats (Pecl et al., 2017). This loss is exacerbated by related disaster events such as droughts, floods, and fires, which also render more habitat unsuitable for humans and wildlife (Anderson et al., 2018). The loss of biodiversity (animals, plants, and lots more) disrupts the flow of greenhouse gases, soil nutrients, and water (among other

things) in ecosystems, making them less efficient at regulating weather, growing crops, holding fresh water, and so on (Ullah et al., 2018). This reduction in habitable land, potable water, and access to food will have grave consequences for human society and quality of life, particularly for the poor (Robinson and Shine, 2018). Furthermore, frequent and unforeseen natural disasters may threaten infrastructure and financial resources. The causes and effects of climate change are diffused across time and space and interconnected in a myriad of ways. Much of the contribution to climate change comes from industrial production and processing of resources and their distribution across the globe (Sarkodie et al., 2020). Industrial production converts large tracts of land spanning diverse ecosystems for a single use, often with intensive inputs that are sourced from other industrial ecosystems (Dumaresq and Pittock, 2018). For example, industrial agriculture uses fertilizers, fuel, and water transported across large distances to grow a single species of crop (Rockström et al., 2020). Similarly, cities are designed to deliver secondary production of goods and services in factories and offices, with low priority given to provision of accessible and interactive natural spaces. Localizing and diversifying resource production can reduce the impact of industries (e.g., Downs et al., 2020; Piñeiro et al., 2020), including through foraging. De-densifying and interspersing industrial spaces with multifunctional natural spaces (e.g., Leclère et al., 2020) will help conserve urban biodiversity while also providing ecosystem services for human well-being.

Some plant species that are foraged by humans are also attractive to other animal consumers and pollinators like birds, insects, and mammals, allowing them to safely inhabit urban greenspaces or pass through them to other wilderness areas (Champness et al., 2019; Zietsman et al., 2019). Therefore, planting and maintaining spaces and species for foraging is likely to allow for greater coexistence and diversity of plant and animal species alongside humans in cities (Bonthoux et al., 2014; Botzat et al., 2016), therefore enhancing natural capital. By utilizing foraged species that are not part of mainstream economies, foragers preserve and propagate important knowledge. Many lesser known and underutilized species are packed with more micronutrients than staple crops, and some are resistant to harsh weather conditions (Mabhaudhi et al., 2017). These species may be very useful as the deepening effects of climate change challenge conventional agriculture and call for more locally adapted and efficient crops (Hadebe et al., 2021). In some cases, these nutrient-rich and hardy species are already widely available in urban environments (Phillips et al., 2014). Incorporating natural and local diversity into production systems helps regulate ecosystem flows and buffer against disasters (Kremen and Merenlender, 2018), forming resilient ecological infrastructure, which can be considered physical capital. Because moderation in industrial landscapes reduces environmental damage, it also reduces the risk of health hazards from pollution and zoonoses precipitated or exacerbated by industrial use (Ahmed et al., 2019; Rohr et al., 2019). Thus, foraging is part of a suite of strategies to diffuse pressure on conventional and industrial systems while simultaneously strengthening the self-sufficiency and functionality of natural and physical capital in urban areas.

Foraging can offer people additional control over and options for their food, health, income, and expenditure. In doing so, it also requires people to govern their resources more locally and sustainably. For example, citizens in Copenhagen have developed an app to promote information about sustainable foraging in greenspaces within the city (Buijs et al., 2019). Furthermore, people who forage often also tend to the spaces they forage in, by managing waste, removing invasive alien species, and educating interested people about such practices (Hake, 2017; McLain et al., 2017), thereby maintaining their ecological infrastructure and physical capital. In this way, foraging can mobilize good governance specific to the local context in the interest of the common good. Such governance mechanisms can then also be extended to collaborations with municipalities for better urban planning and management of urban biodiversity (Colinas et al., 2019; Sardeshpande and Shackleton, 2020). In particular, improving the provision of and access to greenspaces across the socioeconomic spectrum could help ensure that the benefits related to foraging are distributed equitably (Kabisch and Haase, 2014; Wolch et al., 2014), improving the distribution of physical capital and the development of social capital. Foraging does and will continue to play an important role in democratizing access to and co-production of ecosystem goods and services in cities. Furthermore, foraging also allows people to derive nature-based livelihoods in cities, building financial capacity, and diversity. The culture and knowledge of indigenous food, medicine, and materials form an integral part of the relationship between nature and humans (Elands et al., 2019). This relationship may also emerge through engagements with cosmopolitan species and novel plant communities in cities (Hurley et al., 2015; Fischer and Kowarik, 2020), and foraging is a potent expression of this relationship. Thus, foraging is a potentially important contributor to social, physical, and financial capital through improved quality of life, devolved governance, and sustainable livelihoods.

Urban greenspace, and the material resources contained therein, is unevenly distributed within cities, raising concerns about access and other issues of environmental justice with foraging (Poe et al., 2013; Hurley et al., 2015; Rigolon, 2016; Hurley and Emery, 2018). Following Schlosberg (2007), access is defined here along several dimensions, including distribution: having a greenspace such as a park near to you; recognition: that all stakeholders must be recognized for the values they seek in a greenspace; procedural justice: that stakeholders are involved in decision-making at different stages in urban planning; and capabilities: that people have individual capabilities to transform their situation. Capabilities differ enormously among individuals, and several scholars highlight the risk of seeing communities as homogenous in planning and decision-making processes (Walker and Hurley, 2004; Svarstad and Benjaminsen, 2020). These scholars further point out the importance in recognizing how power issues shape planning processes and may challenge environmental justice assumptions. In an urban context, research must widen from a focus on greenspace function and management to study what residents want in decision making (Rutt and Gulsrud,

2016), including incorporation of the values and needs of urban foragers in these processes (Poe et al., 2013; Hurley et al., 2015).

EMERGING EVIDENCE FROM 2020

As the world moves on from drastic socioeconomic change into a "new normal," foraging offers an opportunity to contribute to the resilience of urban social–ecological systems and physical infrastructure. An example of an emerging response to shock is the Wild Foodies of Philadelphia, a social group founded in 2010 that "promote[s] public wild edibles" (Wild Foodies of Philadelphia., 2016). With about 5,000 members, the group organizes visits to diverse urban greenspaces; maintains an online library detailing utility of various plant species; and publishes a weekly newsletter featuring common as well as historical uses of native, non-native, and cosmopolitan species found in the city. The arrival of Covid-19 in March 2020 brought forceful but relatively short-lived "stay-at-home" orders to the Philadelphia metropolitan area, which included closure of public parks and some community gardens. While such orders made the typical spring meet-ups of the past illegal, email communications by group members explored how foraging could be incorporated into outdoor exercise (biking, running, and walking), which was still permissible. Newsletters continued to circulate, focusing on new edible species beginning to appear in new places in the landscape, including along sidewalks or roadsides in the countryside, and announcing locations for curbside pick-up of wild gathered foods in the city. By early May, the easing of these limits meant that residents of the city and its suburbs could use public parks, and the group resumed its foraging meet-ups. As summer continued, new locations featured in meet-ups and waitlists to participate in events became a regular occurrence. Through summer and fall, emails about newly emerging plants were featured in the group's online library or newsletters. In winter 2020, for the first time, the group embraced Zoom to organize virtual meet-ups on winter foraging. The event went so well, that the group has launched a new series of monthly digital meet-ups, featuring 10 different useful plant taxa, in which participants are provided with information to study in advance of the digital session. This example highlights the evolution of social capital linked to foraging to adapt to new forms of connection and communication. The communications and documentations of the Wild Foodies of Philadelphia may also provide information on changes in natural and physical capital (e.g., species and spaces related to foraging) and human and financial capital (e.g., participant motivations and foraged product sales).

QUESTIONS FOR THE FUTURE

The example above indicates that foraging has adapted to changing circumstances, by adopting new ways of fulfilling the need for human social interaction, and that natural and physical environments may indeed have undergone changes that

favor foraging. In light of these observations, we propose that upcoming studies on foraging investigate if and how

1. Demands on and interest in the local natural environment have increased (natural and physical capital): Has the quantum of extraction increased or decreased in response to restrictions and socioeconomic conditions across different geographies? Is foraging being forgone or undertaken in places previously used, unused, or used differently?

2. Personal motivations for and social connections in foraging have changed (human and social capital): Has the proportion of people foraging for subsistence or recreation changed significantly? Are different demographics engaging in foraging? Has knowledge transmission changed due to pandemic-related restrictions?

3. Foraging has made significant economic and other contributions to people's lives (financial and human capital): Besides intrinsic motivations, has foraging been driven by extrinsic factors such as unemployment, reskilling, mental health, financial difficulties, etc.? Can the contributions of foraging to people's lives be qualified or quantified?

4. Foraging has and can be incorporated into socially just urban design (social and physical capital): Has foraging created, strengthened, or weakened social connections and sense of community over time, particularly during the pandemic? Has foraging brought to light gaps or bridges in planning and production of physical infrastructure?

While urban foraging is not a panacea, it offers one widely accessible strategy with low barriers to entry for short-term relief, mid-term recovery from the crises, and long-term resilience in the face of both disruptive changes such as the pandemic and more gradual ones such as climate change.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

AUTHOR CONTRIBUTIONS

MS drafted the article with critical and intellectual contributions from all other authors. All authors contributed to the article and approved the submitted version.

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Self-Reported Effects of the Covid-19 Pandemic on Stewardship Organizations and Their Activities in Southeast New England, USA

Casey Merkle[1], Bryce DuBois[1]*, Jesse S. Sayles[2], Lynn Carlson[3], H. Curt Spalding[3], Ben Myers[3] and Shreya Kaipa[1]

[1] Liberal Arts Division, Rhode Island School of Design, Providence, RI, United States, [2] ORISE Fellowship Program at the U.S. Environmental Protection Agency, Office of Research and Development, Center for Environmental Measurement and Modeling, Atlantic Coastal Environmental Sciences Division, Narragansett, RI, United States, [3] Institute at Brown for Environment and Society, Brown University, Providence, RI, United States

In many communities, regions, or landscapes, there are numerous environmental groups working across different sectors and creating stewardship networks that shape the environment and the benefits people derive from it. The make-up of these networks can vary, but generally include organizations of different sizes and capacities. As the Covid-19 pandemic (2020 to the present) shuts down businesses and nonprofits, catalyzes new initiatives, and generally alters the day-to-day professional and personal lives, it is logical to assume that these stewardship networks and their environmental work are impacted; exactly how, is unknown. In this study, we analyze the self-reported effects of the Covid-19 pandemic on stewardship groups working in southeast New England, USA. Stewardship organizations were surveyed from November 2020 to April 2021 and asked, among other questions, "How is Covid-19 affecting your organization?" We analyzed responses using several qualitative coding approaches. Our analysis revealed group-level impacts including changes in group capacity, challenges in managing access to public green spaces, and altered forms of volunteer engagement. These results provide insights into the varied effects of the Covid-19 pandemic and government responses such as stay-at-home orders and social distancing policies on stewardship that can inform the development of programs to reduce negative outcomes and enhance emerging capacities and innovations.

Keywords: environmental stewardship, Covid-19, environmental governance, resilience, public space

INTRODUCTION

The Covid-19 virus was identified in Wuhan, China, in December 2019 (CDC, 2021). In the months to follow, life was altered as entire countries went into lockdown to contain and slow the spread of Covid-19. Various approaches were taken including physical or social distancing from other people in both indoor and outdoor settings, working from home, and closure of various businesses and public and private spaces (CDC, 2021). In response to Covid-19, physical interaction decreased.

In times of crises and disturbance, environmental stewardship groups, in this case, predominantly civic and non-profit groups that make claims to specific places and engage in acts of caretaking of air, land, and waters (Svendsen and Campbell, 2008; Campbell et al., 2021), emerge and shift as communities cope with changing social-ecological dynamics (Svendsen, 2010). Examples of such adaptations in practices include making gardens during wartime (Helphand, 2006), the creation of living memorials following the 9/11 attacks on the World Trade Center in New York City (Tidball et al., 2010), and new tree planting efforts following hurricane Katrina (Tidball and Stedman, 2013). The act of responding to these crises, drawing on memories and social relations (Tidball et al., 2010), in turn creates a feedback that supports community resilience (Masten and Obradovic, 2008; Gunderson, 2010; Tidball and Krasny, 2013). While sometimes considered less visible, and more ephemeral, than government-led environmental efforts (Campbell et al., 2021), the direct management, advocacy, education, collaboration, and contestation carried out by environmental stewardship groups are a key component of modern environmental governance and resulting social and environmental outcomes (Connolly et al., 2013; Campbell et al., 2021). The Covid-19 pandemic is a public health crisis that may have impacted environmental stewardship groups and shifted their work; we seek to understand how.

In this brief research report, defined by *Frontiers in Sustainable Cities* as succinctly presenting original research, including preliminary results, we begin to address how the Covid-19 pandemic has impacted environmental stewardship groups, focusing on a case study in southeast New England, USA. We qualitatively analyze 111 responses to the open-ended question: "How has Covid-19 impacted your organization?" which was asked as a part of a larger survey to document and understand stewardship organizations working in the region. Our research is a preliminary step that lays a foundation for future research on the effects of the Covid-19 pandemic on environmental stewardship.

When selecting groups to survey, we included the full diversity of groups that make communities and their environment healthy and safe places. This includes groups who work to conserve; manage; monitor; transform; care for specific living things; build partnerships; engage in place-based traditional gathering of resources for consumption; fund or provide in-kind material support; educate; and advocate for the environment. In essence, this forms a stewardship network connected by organizations working at various local and regional levels (Bixler et al., 2016; Bodin, 2017). This network manages ecosystem services, protects human and ecosystem health, and educates broader publics about their environments. It comprises various combinations and dynamic relationships between individual, civic groups, state, and business actors (Svendsen, 2010).

The Covid-19 pandemic may impact such a network in several ways. Stewardship organizations are composed of individual people, both professional and volunteer (Svendsen, 2010), that are often personally motivated to do stewardship (Tidball, 2012; Bennett et al., 2020). Changes in people's capacities as they work from home, or in their emotional state in response to a major public health crisis, likely affects their stewardship

practice (Alagona et al., 2020; Ammar et al., 2020). Organizations themselves may also be impacted (e.g., loss of income or shutting down). Networks are relational, thus impacts to one organization may impact others as stewardship processes and outcomes often result (or emerge) from these interactions (Janssen et al., 2006; Bodin and Crona, 2009; Bodin and Prell, 2011). For example, multiple groups may work across land and sea resulting in a coordinated ecosystem-wide response to environmental problems (Pittman and Armitage, 2017; Sayles and Baggio, 2017a). We consider a spectrum of impacts ranging from effects on individuals and their motivations, to organizational capacity and function, to larger interagency interactions within the region.

Our research is consistent with other assessments of Covid-19 that look at the pandemic's impacts on networks at multiple levels, from individual to structural (Bennett et al., 2020; Lambert et al., 2020). Responses are also likely to be varied. A certain sense of "getting back to normal" is desirable (Quay et al., 2020); for example, bird watching with friends. Covid-19, however, may present opportunities to reimagine and transform many aspects of stewardship, such as education (Quay et al., 2020), government support (Bennett et al., 2020), vibrant public spaces (Honey-Roses et al., 2020; Low and Smart, 2020) and the pace and direction of society's impact (Wells et al., 2020) on southeast New England.

Current Case

Southeast New England includes three economically, socially, and ecologically important estuary watersheds (Narragansett Bay, Buzzards Bay, Cape Cod and adjacent islands), spanning the states of Rhode Island and Massachusetts, USA [**Figure 1**, (EPA, 2021b)]. While several local, state, and federally supported watershed management programs have existed since the late 20th century, many of the region's stakeholders recognized the potential benefits of a broader regional funding and coordination framework. In response, the US Congress established the Southeast New England Program (SNEP) in 2012, an interagency group effort to respond to deteriorating conditions in southeastern New England estuaries that would be administered by the US. Environmental Protection Agency (EPA, 2021b).

The SNEP program consists of several committees and subcommittees with representatives from federal, state, tribal, and local governments, non-governmental organizations (NGOs), and regional planning associations (EPA, 2021b). Committees guide the program's allocation of funding through several grant programs as well as the SNEP Network (a collaborative of 17 partner entities, see **Appendix A2** for details) that provides direct technical assistance, trainings, and capacity building activities to the region's 133 municipalities (located wholly or partially within the SNEP watershed boundary; 94 in MA and 39 in RI), tribes (three federally recognized and four non-federally recognized) and numerous NGOs.

These stakeholders work across a diverse land and seascape. The region is a patchwork of forested, agricultural, and urban lands, plus estuaries, rivers, and coastal shores. Eelgrass, saltmarsh, and floodplain areas weave into the region, providing critical storm and flood protection. Conserving and restoring
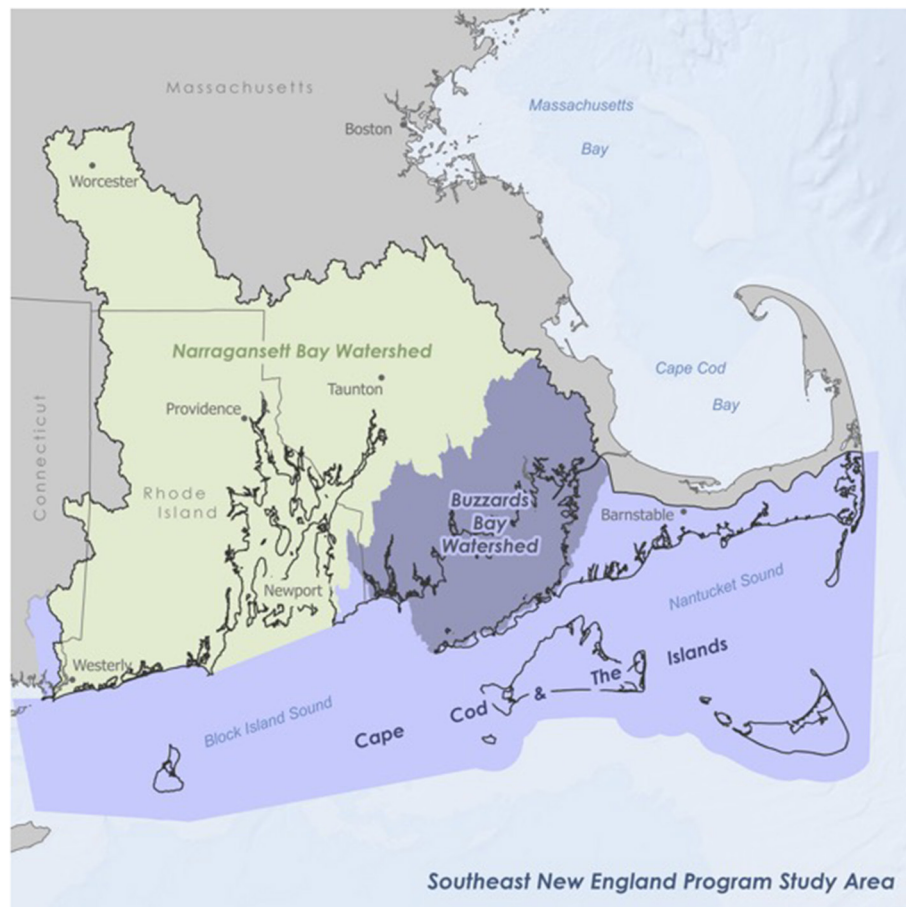
FIGURE 1 | Study area map of the SNEP region showing the three major estuary watersheds (Narragansett Bay, Buzzards Bay, Cape Cod and adjacent Islands), spanning parts of the states of Rhode Island and Massachusetts, USA. Data Sources: ESRI, Inc., USGS, and SNEP.

those habitats, along with generating new green infrastructure to manage stormwater and non-point source pollution, are important issues for many of the region's stakeholders and SNEP (EPA, 2021b).

The SNEP region has a population of about 2,558,732 people, 74.8% who identify as white non-hispanic, 11.5% who identify as Hispanic non-white, and 6.1% who identify as Black/African American (ESRI, 2021). Household median income is $63,912 [mean $66,208, interquartile range = $44,451 - $84,324; (ESRI, 2021)]. The region includes both rural and urban land, working farms, aquaculture, a large fishing industry, several universities and colleges, and the state capital of RI. Three federally recognized tribes [the Narragansett Indian Tribe, the Mashpee Wampanoag Tribe, and the Wampanoag Tribe of Gay Head (Aquinnah) of Massachusetts] and four non-federally recognized tribes (the Nipmuc Nation, Pokanoket Nation Manissean Tribe and the Eastern Pequot Tribal Nation) have a presence in the SNEP region. There are also a number of communities of environmental justice (EJ) concern (EPA, 2021a), which have a disproportionate burden of environmental impacts and often lack access to many of nature's benefits. Communities with

EJ concerns have often been historically underrepresented in environmental decision making processes (Bullard, 1993). The EPA identifies EJ communities of concern at the neighborhood level and there are EJ communities in most of the the region's cities including, but not limited to, Providence, Central Falls, Narragansett, Newport, Warwick, East Providence, Worcester, Brockton, Fall River, New Bedford and Taunton. Supporting and building partnerships with communities to address EJ concerns is an important priority of SNEP (EPA, 2021b) and is detailed in its five year Strategic Plan.

The research reported here was developed as a project supported by the SNEP Network. This survey had been planned before the Covid-19 pandemic began, but we used the opportunity to add a question related to Covid-19 (see methods). The survey was launched in November 2020, nine months after a state of emergency was declared in the region which shutdown local businesses, non-profits, and governmental agencies. Sampling for this paper's analysis concluded in April 2021 while mandates were rapidly changing from recent developments in vaccination dissemination. This study investigates the varied impacts of the Covid-19 pandemic as

organizations were in the midst of the pandemic, and thus it is not a conclusive review of the impacts, but rather a snapshot of the issues within the first year of the pandemic.

METHODS

Participants and Sample

We collected data using the Stewardship Mapping and Assessment Project (STEW-MAP) methodology (USDA, 2021), which uses a standardized survey to (1) document stewardship organizations' activities, staff and volunteer capacity, funding, and similar attributes, (2) map where they work, and (3) record the social and funding networks that support them. As mentioned, this report analyzes responses to the open-ended question, "How is Covid-19 affecting your organization?" which we added to the survey.

Survey participants were recruited through snowball sampling, wherein an initial set of organizations ($n = 390$), was compiled from environmental coalition websites and SNEP Network partner outreach lists. We sought responses from individuals who were best suited to answer questions about the group. Following the initial data collection phase, we engaged in two additional rounds of survey recruitment to contact any new groups that were named in the network questions (see **Appendix A3** for details).

In total, we contacted 718 groups out of which we had 134 responses to the survey (only one response per group). While responses represent approximately 20% of the initial list, this does not represent a survey response rate. Our sampling relied on groups to self-identify as doing stewardship in the SNEP region based on a broad definition of stewardship (see **Appendix A3**). Several groups declined because they did not consider that they were doing stewardship work or were excluded because they did not work in the region (but may have been listed as an information provider in the network questions, for example). Among respondents, 125 provided answers to the Covid-19 impacts question. We removed fourteen responses that fell outside our research focus for this paper (see **Appendix A3**) for a final dataset of 111 groups.

Our survey focused on civic organizations such as non-profits (86% of responses; details in **Appendix A1**, **Table A1**), school and community groups, and quasi-government agencies, as such groups often represent unknown stewardship actors (Fisher et al., 2012). In contrast, municipal, state, and federal agencies are well documented. In addition to the focus on the aforementioned civic groups, we also invited the region's tribes to participate because of their active stewardship commitment and history and in order to be consistent with the SNEP Program's five year strategic plan goals and the mission of the SNEP Network. Our data includes one response from a Tribal government that responded before we downloaded responses in preparation for this journal special feature. Taken together, because of the respondents who completed the survey in time for analysis for this special issue, our results predominantly reflect non-profit and citizen groups and may not be generalizable to other kinds of groups.

The majority of respondents identified conservation work as their primary focus (**Table 1**); education, advocacy, and management followed closely behind. The most common "sites" where groups worked were conservation lands, protected properties, and/or open spaces (32%), followed by watersheds (15%). **Appendix A1**, **Table A2** provides a complete list. While groups worked on properties under a variety of ownerships, about one quarter only worked on lands they owned (**Appendix A1**, **Table A3**).

Coding and Analysis

We used thematic, process, and causation coding to analyze a single open ended survey question. Additional descriptive statistics about where groups work and their stewardship focus are included in the **Appendix**. Responses were open-coded (Saldaña, 2013) by the first author, who read through all responses to create an initial set of codes and themes, which were then reviewed and discussed by the first three authors. Several rounds of thematic coding were done, until agreement between the three first authors was reached regarding the accuracy and saturation.

Coding was based on categorical domains and subdomains that emerged in an iterative coding process, focused on impacts of the Covid-19 pandemic. We also assigned a value attribute to all codes to account for the kind of impacts reported (i.e., positive, negative, or neutral/unstated). We then coded for a sense of agency where organizations expressed that they had an ability to actively address or respond to the described impact (i.e., no agency, could not assess, or have agency). Finally, causation and process coding (Saldaña, 2013) were utilized to understand what groups attributed the cause of the impact to, and where a group changed their stewardship processes. See **Tables 2**, **3** and **Appendix A3**, **Table A4** for names of specific codes, which are presented along with the tabular coded results.

RESULTS

Nearly all groups ($n = 99$) mentioned a process change or adaptation to how they were going about engaging in stewardship (see **Appendix A3**, **Table A3** for more information) and these themes are embedded within the impacts theme sections. A smaller portion ($n = 35$) made explicit reference to the causes of these impacts, which are reported in a final causation section.

Capacity

Sixty-three groups described how various aspects of their organizational capacity were impacted by Covid-19 ($n = 63$; **Table 2**). Capacity impacts were primarily neutral ($n = 28$) or negative ($n = 33$), though two groups described positive impacts in the form of increased funding and new opportunities created through remote work. Internal collaboration was the most common impact, primarily through staff transitions from in-person to remote work or implementation of social distancing protocols. For example, a non-profit monitoring group responded: "Most people work from home when possible. Staff and interns that monitor ponds, salt marshes or herring runs work individually in the field and use face coverings and social [distance in the] lab. All meetings are held *via* Zoom."

Primary stewardship activities	Number of organizations (n = 111)
Conserve or preserve the local environment (e.g., perpetuate cultural values and practices related to stewardship, hold conservation easements, protect water resources, protect open space, etc.)	34
Educate the public about the local environment (e.g., promote cultural values and practices related to stewardship; provide/develop curriculum; conduct research, science, training, outreach)	18
Advocate and/or plan for the local environment (e.g., planning, organizing, direct action, fundraising)	18
Manage or take care of a place in the local environment (e.g., beautify, improve, or restore a garden, trees, yard)	11
Participate in, partner with groups, or support other environmental work	7
Monitor the quality of the local environment (e.g., air or water quality, dumping, species monitoring, citizen science)	5
Restore native habitats, native species, (e.g., remove invasive species, control deer, restore anadromous fish runs), traditional and customary systems and/ or structures (e.g., for ritual, agriculture, water, navigation, aquaculture, trails/travel)	7
Care for specific living things or places in the local environment (e.g., plants or animals, or special cultural sites or places)	5
Fund or provide other in-kind material support	1
Respond to or prepare for disturbances (e.g., hurricane, flood, Covid-19, fire/drought, etc.)	1
Transform local environmental systems (e.g., changing the waste stream; transitioning toward sustainable energy; stormwater management)	2
None of the above	1
Missing	1

Domains	Sub-Domains	Descriptions	Instances				Reported Agency
			Negative	Neutral	Positive	Total	
Capacity (n = 63)	Internal Collaborations	Some aspect of internal workflow was affected	7	26	1	34	20
	Budget	Budget was mentioned in response, including reductions in giving, cuts, and/or cancelations of fundraising events.	21	1	2	24	2
	External Collaborations	Working relationship and approach with other organizations have been impacted.	8	12	3	23	8
	Staff	Staff were impacted by shifting responsibilities, staff shortage or office closures. Also, staff hiring and staff cuts or delays in hiring.	8	1	0	9	3
Engagement (n = 78)	Programs	Opportunities for learning, especially youth education opportunities (ten groups), direct stewardship, training, and/or activities.	34	16	0	50	14
	Events	Public events, including recurring and one time.	27	4	1	32	5
	Volunteers	Public volunteer programs were impacted.	28	1	0	29	3
	Visitation	Visitors (non-volunteers) to site/property, either passive or active.	7	7	1	15	4
	Policy	Legislative-focused policy work	2	0	0	2	0
Direct Stewardship (n = 30)	Research/monitoring/ citizen science	Collection of data for restoration projects, fieldwork, species monitoring, land surveying, and including citizen science.	13	3	0	16	3
	Cleanup/Trail maintenance/Trees	Active stewardship activities such as park cleanups, trail maintenance, tree maintenance and other management activities.	17	3	0	20	0

Thematic coding results presented as thematic domains and sub-domains. Sub-domains are not mutually exclusive and thus, the total count of negative, neutral, positive counts, of sub-domains do not necessarily equal the reported counts in column 1 (i.e., domains). The reported agency code documents if organizations expressed that they had an ability to actively address or respond to the described impact (for table legibility, only positive accounts are reported here).

Organizations also reported a range of external collaboration impacts including moving to virtual meetings and reducing or canceling collaborative meetings for many months. One stakeholder non-profit group, for example, described how the cessation of in-person meetings made it "...challenging to build community and continue momentum in moving projects forward." However, for many groups this impact was neutral or even positive because remote work created new opportunities.

TABLE 3 | Self-reported causes of impacts on environmental stewardship organizations.

Causation codes	Descriptions	Instances
Social/physical distancing	Described as general issues of social/physical distancing.	11
Guidelines (Federal/State/Local)	Specific restrictions were named and the related federal, state, and local entities that developed them	9
Increased visitation	Described increases in visitors to their sites/stewardship turfs	5
Legislature Delays	Mentioned delays in the legislature due to Covid-19-related regulations	2
Total		35

For example, a watershed-focused non-profit described stronger relationships and an increased ability to accomplish projects in two committees they oversee, which they attributed to virtual meetings.

Beyond collaboration, groups also experienced a range of budgetary impacts that included a reduction in giving, cuts from parent organizations, or reductions in fundraising events. Across these budgetary impacts, groups mentioned little agency in their ability to respond. Several groups expressed fear that reduced public profiles will lead to future donor reductions.

Additional impacts included staff shortages, staff reductions, delayed hiring, cutting part-time or seasonal staff positions, and reducing overall hours. Taken together, organizational capacity was impacted primarily by how people worked together, internally and externally. Fortunately, groups felt they had agency to shift to these new contexts and continue with their work.

Engagement

A large number of participants ($n = 78$; **Table 2**) described impacts to their public engagement activities, including: events, visitation, programs, youth education programs, volunteer events and policy efforts. Most of these impacts were negative ($n = 62$; **Table 2**) or neutral ($n = 15$). The most common impacts were to youth education, direct stewardship, and training programs. While many of these impacts were negative, fourteen groups mentioned having some ability to develop strategies to respond to these impacts. For example, a non-profit described that they altered their educational programs, stating, "In 2020, we did not visit the elementary school to run garden education programs. Instead, we provided virtual lessons…" They also adjusted how they worked in their community gardens: "We were not able to allow the public into some of the community gardens due to rules set forth by the owners of the property. Instead, staff grew vegetables to donate to community members in need." As a result, programs continued, but lack of property ownership reduced access and opportunities for engagement with participants. Groups also struggled to retain volunteers and struggled with social distancing when working with volunteers.

The most common strategy to adapt engagement efforts was canceling events. The ramifications are likely quite large. One nonprofit described canceling an event where they "…normally work with over 1000 volunteers and connect residents to the Greenway…" canceling events often resulted in negative impacts ($n = 24$), such as reduced fundraising. For example, one non-profit canceled their largest event which accounts for 25% of their income.

In contrast to canceling such social gatherings, fifteen groups that conserve or manage properties mentioned increased passive and active recreation at their sites. For some groups this was positive, "[there is] more demand for our trails and open spaces. The value of open space has never been more clear to most of our supporters." But several groups struggled with the increase and one respondent made sure to emphasize this change: "LOTS AND LOTS more recreational traffic! (We are struggling with capacity!) [sic].". In response to these impacts, groups made a number of process changes to their outreach and engagement. For example, education groups reduced programs such as field trips and summer camps.

Finally, many organizations mentioned reductions in the number of volunteers invited or the cancelation of entire events such as cleanups, monitoring, citizen science, and tree plantings, and few groups identified any ability to develop alternative strategies to work with volunteers. Taken together, engagement was overall negatively impacted, and few organizations mentioned having agency to respond other than to cancel or reduce events, an issue due in part to property ownership and access.

Direct Stewardship

A relatively small number of groups ($n = 30$; **Table 2**) mentioned impacts to specific stewardship activities. Those direct stewardship activities that were impacted included research projects, monitoring, citizen science as well as clean ups, trail maintenance, and tree planting and management. Most impacts were described as negative ($n = 26$), and few organizations described having agency to continue their stewardship. Most impacts to direct stewardship activities were due to physical distancing. A number of groups explained that they reduced or eliminated volunteer opportunities but continued with their research and monitoring activities. For example, a water quality monitoring program that had been conducted by volunteers was carried out by staff. Another organization, a watershed monitoring non-profit, described how they changed their approach to working with volunteers by, "Limiting [their] direct contact with […] volunteers (switched to contact-less equipment/sample exchanges)…" While some groups made shifts in their volunteer engagement, many canceled monitoring or citizen science activities entirely. For example, a non-profit with a main stewardship focus on education said they were, "Unable to use volunteer citizen scientists to test water quality during 2020, reducing the number of ponds tested and the number of actual tests performed." Taken together, research

and monitoring activities were reduced, while many programs decreased volunteer participation in these same activities.

Causation

While the Covid-19 pandemic impacted every group in this analysis in one way or another, just less than one-third ($n = 35$; **Table 3**) mentioned a specific Covid-19-related cause and its related effect on some aspect of their stewardship activities. The most common causes were local, state, or federal guidelines followed by general social distancing requirements. For example, one conservation non-profit said social distancing did not really hinder their research activities, but it did impact their public engagement: "... [social distancing] has been very challenging; we have not been able to engage with the public or hold group events as much as usual, fundraising has been very challenging..." Contrarily, five groups mentioned that increased visitation rates overwhelmed staff, impacted their ability to host volunteers, and required them to reduce programs "...We had to close one of our most popular preserves," said one conservation nonprofit, "because there were too many people on the trails and cars were parked on the street, potentially blocking emergency vehicles..." These increases in visitation challenged groups in a range of ways given social / physical distancing guidelines. Finally, changes in state legislature proceedings slowed some policy-related activities.

DISCUSSION

Environmental stewardship organizations form a vital social infrastructure network that helps protect and restore the environment, engage citizens to make them aware of nature's importance, and advocate for these benefits in socio-political arenas (Svendsen, 2010). In times of crisis, environmental stewardship provides opportunities to come together and rebuild both the environment and community (Masten and Obradovic, 2008; Gunderson, 2010; Tidball and Krasny, 2013). Understanding how Covid-19 has impacted stewardship groups in the SNEP region may enable the region's stakeholders and decision makers to support various initiatives or develop programs to improve resilience and social justice. The following sections describe each of the main findings of our study, as well as possible management implications and suggested actions.

Capacity and Environmental Governance

Our analysis revealed that changes to capacity occurred within and between environmental stewardship organizations, potentially changing the dynamics of environmental stewardship collaboration in the SNEP region. Groups pulled back from volunteer work and adapted workflows to leverage internal group strengths and work from home, sometimes also reducing part-time and temporary opportunities. However, working from home presents an emotionally challenging and isolating work environment (Alagona et al., 2020; Ammar et al., 2020) that may not be sustainable.

The shift in virtual external collaboration, while not positive for all groups, led to greater participation and ease of access for community-engaged projects and potentially offers an opportunity to build a more resilient environmental governance structure. As described by Wells et al. (2020), rather than return to "business as usual," there is a possibility to leverage these new forms of work and collaboration. Virtual platforms may promote broader accessibility, more shared work and greater collaboration amongst groups with capacity to work online.

Engagement, Access, and Social Benefits

While many events were canceled or postponed during the pandemic, programs often shifted from in person stewardship to online activities; similar to environmental education groups that adapted teaching, coursework, class time and fieldwork to online environments (Quay et al., 2020). While converting to digital environments may seem successful, concerns and questions remain about the loss of social connections for environmental education in a digitally mediated environment (Quay et al., 2020). Future work should monitor the impacts of this digital transition and help stewardship groups develop capacity and build agency so that they can direct needed changes.

The establishment of new access protocols and regulations that were developed by, and also affected, environmental stewardship organizations raises concern over the potential long-term constraining of public space and is an environmental and social justice issue. Specifically, Low and Smart (2020) argue that broad narratives of the danger of being in contact with infected people and the emphasis of moving public lives online and away from public space may be maintained beyond the pandemic and used to reduce future public space access. Two related access issues were discussed by respondents in our study. One is the decision made by land-owning conservation organizations, to keep open or prohibit public access to their lands. These organizations were challenged by increased visitation rates and also with developing safe and effective social distancing protocols, especially when state-owned lands were shut.

The other issue was loss of access amongst groups who do not own the lands they work on, such as those organizations who work on community gardens on school grounds. In each case, there is a danger of social fragmentation in deciding who is allowed access, use, and care for landscapes both during and following the Covid-19 pandemic. Groups, including the SNEP Network, that are interested in environmental justice should continue to monitor such trends in public space and access, especially where groups lack property ownership, and work with stakeholders to build capacity where and when needed.

Engagement and Nature Contact During and Following Disturbances

While individuals sought sites for socially distanced recreation in nature, many organizations mentioned reductions in their volunteer opportunities and thus an inability to participate in the restoration of loved places, what Tidball (2012) describes as a restorative topophilia. In this process, stewardship activities and engagement are catalyzed by crisis and can develop into a positive feedback, where stewardship activities increase public and government awareness of ecosystem services, resulting in further stewardship engagement. Such processes occurred, for example, in New Orleans post-hurricane Katrina where people

recognized the storm buffering role of urban trees, resulting in a massive increase in tree-planting efforts by community groups and public agencies (Tidball and Krasny, 2013). However, for many groups in the SNEP region, a similar opportunity was deferred during covid because of social distancing protocols that reduced volunteers and public engagement. Whether the increased visitation will lead to future volunteer engagement at these sites; or conversely, that organizations will continue to keep volunteer engagement low, is still unknown. This is yet another area where continued vigilance, capacity building, and creative solutions may be needed to ensure that the region's volunteers can participate, especially in advancing stewardship needs in EJ communities of concern.

Direct Stewardship and Environmental Outcomes

Finally, direct stewardship was also impacted by the pandemic both in terms of reductions in overall practice as well as decreases in research. This included reductions in water testing, environmental cleanups, and urban tree maintenance. Worldwide, volunteers have become increasingly involved in the management and monitoring of natural resources, monitoring species, and conserving protected areas (Conrad and Hilchey, 2011) and interactions among groups in any given network may affect environmental outcomes such as clean ups, tree plantings, and invasive species removal (Romolini et al., 2016). In our study, groups involved with invasive species monitoring programs described cancelations or difficulties with managing volunteers; and water quality monitoring groups reduced their citizen science programs. While groups were successfully able to develop internal collaborative approaches, volunteers are a critical component of the environmental governance of the region. Covid-19 has reduced the scale of that work, leaving future capacity uncertain and potential gaps in citizen science-generated data, which is especially relevant for entities interested in advancing environmental justice.

Next Steps

This paper contributes to growing evidence of the social and environmental impacts of the Covid-19 pandemic. While an important first look at the effects of Covid-19 on the region's stewardship, there are several limitations present in this research that are worth noting. First, our inquiry was limited by the need to fit into the bounds of our existing survey. For next steps, we recommend follow-up interviews with a series of more detailed questions about the impacts of Covid-19 on stewardship. Our current analysis can form a basis for these interview themes and questions. Second, while we sought a comprehensive assessment of all stewardship groups, we recognize that the snowball sampling approach is not necessarily statistically generalizable to all groups or to other regions, and that our sample and results predominantly reflect non-profit and citizen groups. Specifically, we call for research that focuses on how the pandemic has affected groups working in communities of EJ concern in order to understand equity concerns impact the scope of stewardship services a community experiences. Finally, the timescale of the

implications discussed are unknown and while any negative changes are hopefully temporary, the longer-term implications remain unknown. Our work represents an early opportunity to interpret the impacts of the pandemic on a large group of environmental stewardship actors in southeast New England. We are hopeful that the impacts and opportunities identified in this and related contributions in this special issue can support continued resilience and recovery to the pandemic.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Rhode Island IRB. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

CM and JS: data collection, data analysis, and writing. BD: data collection, data analysis, and writing and principal investigator. LC: data collection and figures. HS: data collection and paper edits. SK and BM: data collection and data cleaning. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

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Pandemic-era Participation in Public Lands Governance: Lessons From the USDA Forest Service

Kristin Floress[1]* and Alice Cohen[2]

[1] Northern Research Station, United States Department of Agriculture Forest Service, Evanston, IL, United States, [2] National Forests in North Carolina, United States Department of Agriculture Forest Service, Asheville, NC, United States

Public participation processes influencing National Forest management in the United States have shifted significantly because of the global COVID-19 pandemic. Although the United States Forest Service has used virtual participation tools in the past to support participation, the pandemic was the first time staff had to solely rely on such methods. Using the Trinity of Voice theory concepts of access, standing, and influence, we discuss how each has been and can be impacted by virtual vs. in-person public participation in federal land governance. Lessons are drawn from two peer-to-peer learning sessions among Forest Service staff in Fall 2020 and a case from the National Forests in North Carolina. Virtual participation can broaden access to processes that would primarily have taken place in-person as people were not limited by travel time or distance. Virtual methods may allow for greater use of adaptive technologies and therefore may increase participation access. Web meeting alternatives (e.g., telephone calls) can be used to increase participation access for those without reliable or affordable internet. However, planners trained in facilitating in-person meetings may not have the technical competencies necessary to ensure participants are able to effectively participate during virtual meetings, and misunderstandings that might be easily addressed in face-to-face settings can be more difficult to solve and ground rules for participation ignored more easily during virtual participation. We expect these lessons will support the work of other practitioners interested in supporting access, standing, and influence when designing virtual participation processes.

Keywords: Trinity of Voice, virtual participation, access, standing, influence

INTRODUCTION

Public participation in national forests and grasslands governance is carried out by the United States Department of Agriculture Forest Service (USDA-FS) in accordance with federal laws and administrative rules and directives impacting the extent to which stakeholders can influence decisions and how decisions are implemented. While numerous engagement frameworks exist (e.g., see Kliskey et al., 2021 review), in this Perspective, we describe the Trinity of Voice theory—and its key participation constructs of access, standing, and influence—and general considerations for supporting these in virtual (not necessarily digital) engagement. We outline investments USDA-FS made in developing public participation competencies to achieve participation goals. We draw upon general lessons as well as specific examples from North Carolina National Forests shared

during two peer-to-peer virtual engagement learning sessions organized by USDA-FS headquarters to discuss how the pandemic accelerated movement toward broadening virtual engagement as well how challenges with doing so were addressed. While this Perspective is not representative of all USDA-FS engagement approaches during the pandemic, it is intended to highlight issues and considerations that apply across contexts.

Public participation processes generally are intended to ensure all groups benefitting from, burdened by, or with any stake or interest in decisions have opportunities to affect the outcomes. Participation is a vital component of well-functioning societies, as evidenced by its presence in the United Nations (UN) Sustainable Development Goals: SDG 16 aims to, among other things, "Ensure responsive, inclusive, participatory, and representative decision-making at all levels," (UN General Assembly, 2015). Numerous approaches can be used to achieve engagement goals ranging from consulting with stakeholders to empowerment or co-ownership (Kliskey et al., 2021), but all require that stakeholders have access, standing, and some degree of influence in the process (Senecah, 2004). Access is the opportunity to not only participate in the process but also "to access sufficient and appropriate support, for instance, education, information, so that [one] can understand the process in an informed, active capacity, not as a reactionary," (Senecah, 2004, p. 23). Generally, stakeholder participation trends have increased access to information (Fusi, 2020) but may not ensure information literacy—the access and skills needed to assess and use information (UN Educational, Scientific and Cultural Organization, 2021). Indeed, UNESCO believes that "…universal access to information is key to building peace, sustainable economic development, and intercultural dialogue," (UN Educational, Scientific and Cultural Organization, 2021). Standing legitimizes stakeholders' perspectives and results from developing processes thoughtfully so once participants have access their opinions, concerns, and knowledge can be expressed and heard (Senecah, 2004). Together, having access and standing support influencing outcomes. Senecah (2004) states influence "…means that my ideas have been respectfully considered along with those of other stakeholders and… I was part of the process that, for example, determined decision criteria and measured alternatives against it," (Senecah, 2004 p. 25). Influence is essentially synonymous with the definition of, "…power as the capacity to affect outcomes ("power to")," (Beland, 2010, p. 146). Developing engagement processes that support access, standing, and influence is difficult in the best of conditions and more so during times of social upheaval.

Twenty years prior to the COVID-19 pandemic, Coleman and Gøtze (2001) wrote, "two convergent developments…are likely to have a profound effect upon the future shape of democracy,": the first they noted was that it would be difficult to avoid governance crises without addressing inadequacies in how the public are engaged in governance (in other words, access, standing, and influence), and the second was the rise of digital engagement. Digital engagement—in this case, public participation in formal governance processes—had then and continues to have problems that can exacerbate inequalities in power. One significant problem is physical and resource limitations on access: high-speed internet access, necessary skills to use online platforms that enable participation in synchronous activities and discussion boards, as well as access to library and other resources that provide supports needed to fully participate. Participation processes may be designed for "the general public, sometimes the interested public and sometimes smaller circles of representatives of key stakeholder groups," (Quick and Bryson, 2016), and digital access issues have various levels of impact dependent upon who the process is intended to reach.

USDA FOREST SERVICE AND PUBLIC PARTICIPATION

Investments in Participation Competence

Prior to the pandemic, USDA-FS had worked toward strengthening public participation in land management planning—the process that sets the broad, strategic direction for a particular national forest or grassland (e.g., Dockry, 2015). The 2012 Planning Rule (36 CFR §219.4) and associated internal operations procedures altered the timing of involvement by requiring public engagement early and often in developing land management plans rather than relying primarily on public comment on drafted plans as is typical with many regulatory processes (e.g., OECD, 2021a). During land management planning USDA-FS encourages participation by all interested at local, regional, and national levels—including agencies at all levels of governance—as well as federally recognized Indian Tribes or Native Corporations, youth, and underserved populations (Executive Order 13175 of November 6, 2000).[1] To support forests and grasslands with this work, the agency invested in resources such as: an institution-wide International Association for Public Participation (IAP2) membership; timely trainings and peer networks; and various resources linked to the IAP2 participation spectrum. The USDA-FS uses IAP2 resources to design engagement processes that are appropriate for the type of project/decision and goals for public involvement. For example, sharing information on an already planned prescribed fire requires *informing* stakeholders but stakeholders have no further impact on the decision once the planning process concludes. *Collaboration* (not control or co-management) used during land management planning is the highest level of influence stakeholders may have on any decision given USDA-FS by law must retain decision space for its resource management decisions. Support from USDA-FS collaboration specialists is available for individual forests and in agency headquarters to provide to develop tools, templates, and a community of practice to enhance participation competencies of USDA-FS staff. Public engagement specialists

[1]The emphasis the 2012 Planning Rule placed on engaging Indian Tribes is in addition to the long-standing government-to-government formal consultation with federally recognized Indian Tribes that is required and an important part of federal decision making that may affect Tribal lands, resources or areas of historic significance—see Executive Order 13175.

fulfill another key function: they allow other resource specialists to use their time focusing on their area of expertise rather than trying to learn about and facilitate engagement processes, and this results in higher quality technical products as well as participation processes. Though the 2012 Planning Rule is specific to the land and resource management plans that are periodically revised or amended, the participation resources are developed and available for all future participatory activities a forest or grassland may undertake—often in partnership with groups who help to share information, convene stakeholders, and hold the agency accountable—setting the foundational groundwork for on-going collaborative projects and efforts in implementation of the plan. For example, stakeholders typically participate in on-going project activities related to place-based forest restoration, fuels mitigation, and trail building projects.

The 2012 Planning Rule and subsequent adoption of IAP2's spectrum of participation has led to many USDA-FS employees becoming conversant in tools available to "do" public participation, but it is important to explicitly consider how different choices alter the access, standing, and influence of stakeholders. Engagement efforts that aim to equitably govern the use and management of national forests and grasslands are based in principles of democratic participation, and much of this literature, as Quick and Bryson (2016) note, has evolved from Arnstein's (1969) seminal work that described "citizen engagement [as] a categorical term for citizen power. It is the redistribution of power that enables the have-not citizens, presently excluded from the political and economic processes, to be deliberately included in the future," (Arnstein, 1969). While much of public agencies' engagement work is not described as righting societal power imbalances the difficult work of ensuring the maximum number of groups, individuals, and interests have access to the resources necessary to participate meaningfully serves to highlight that any process can deepen or lessen those imbalances. Further, the "Alienation Index," which has been included in the Harris Poll of US residents since 1966, indicates that 68% of residents "believe that what they think does not count very much anymore," (Birth and Simon, 2016). As Coleman and Gøtze (2001) note, during the Vietnam War (around the same time Arnstein wrote about ladders of participation) only 1/3 of those polled agreed with that statement. The USDA-FS, to fulfill its obligations to the public, grapples with who is participating, who is not, and how processes can be designed to support public confidence in governance of public lands.

Who Are Considered Stakeholders?

The USDA-FS manages 174 national forests and grasslands that comprise 192.9 million of the 640 million acres of federal land in the United States (Vincent et al., 2020). Nearly half of the US population lives within 50 miles of these lands: drawing a 50 mile buffer around each national forest places nearly the entire country that falls within the mountain and pacific time zones within those bounds as well as significant portions of the south, southeast, and upper Midwest United States (e.g., English et al., 2015). The majority of visits to national forests are from those who travel <100 miles and visitation during the pandemic has increased three-fold over normal rates in some cases (e.g., North Carolina April 7 2020 media release). In 2010, there were 58 national forests and grasslands that had nearby populations of over 1 million people and several with more than five million nearby residents (English et al., 2015). Further, monitoring data suggest that recreational use of Forest Service sites is largely by those who identify as white, even in racially diverse areas. For example, 96.1% of Midewin National Tallgrass Prairie visitors in 2018 were white (USDA Forest Service, 2018), though the Prairie is within and adjacent to counties and the city of Chicago that have some of the most racially diverse populations in the nation (Olson, 2014). Of course, USDA-FS stakeholders are not limited to nearby residents, groups, and interests, but comparing who lives near vs. who visits national forest lands can be useful for thinking about who may or may not consider themselves to be stakeholders in decision processes and especially how engagement might be designed to increase participation. The proximity of USDA-FS lands to a significant portion of US residents serves as a reminder that stakeholders are inclusive of people who reside in large and small cities, suburbs, and exurbs as well as rural areas, and who have varying access to resources that enable them to participate in decision processes.

ACCESS, STANDING, AND INFLUENCE IN NORTH CAROLINA NATIONAL FOREST DECISIONS

Trinity of Voice: Efforts to Support Access

The USDA-FS, in its efforts to increase access to information and stakeholders' ability to inform decisions, expanded its use of websites and asynchronous tools to share information that would allow stakeholders to participate in planning meetings prior to the pandemic, but accelerated these efforts in 2020 to account for lost face-to-face engagement opportunities. For example, National Forests in North Carolina were updating a 1987 land management plan and in the middle of their public participation process when the global pandemic hit. Their planning process had already included over 300 face-to-face meetings with varying audiences, sizes, and formats over several years. They had utilized some social and online communication tools, though significantly increased use of these due to COVID-19. The Forest website included five virtual stations offering information on the land management planning process and topics, simulating formerly planned open house public gatherings that would have been offered pre-pandemic (**Box 1**). Videos, a Reader's Guide, story maps, and an overview of information were developed or modified to provide broader access to the essential materials facilitating participation in the planning process. Planned engagement activities were redesigned to address virtual-only options for interaction during the pandemic. For example, six of seven in-person deep-dive discussions were transitioned to the web. This required redesigning the scheduling and format of the information sharing and interaction parts of the webinar, with greater consideration

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BOX 1 | Planned in-person and alternative virtual engagement processes, North Carolina National Forests

Open Houses
Pre-pandemic: Seven in-person Open House events planned. One was held and included 40 participants.
Post-pandemic: Converted website to approximate an Open House format with 7 stations including videos, StoryMaps, webinar recordings, documents and other resources. The link was shared with a listserv of 15,000, plus general social media hits on various pages.
Station 1: Getting started
Station 2: Digging into the proposed plan
Station 3: Exploring the influence of management
Station 4: Exploring unique topics
Station 5: Comment consideration and Next Steps
Four Q&A conference call sessions were offered to the public to address connectivity issues in rural communities. There were 10-33 participants in each call, depending on the time of day and day of the week. There was more attendance during evening calls.
Two Q&A conference calls were offered to county staff and representatives to address connectivity issues in rural communities and provide an opportunity to hear local community concerns. There were 32 participants representing 18 counties.
Pre-pandemic: Seven Deep Dive discussion planned upon request from collaborators. One held with 15 collaborators participating.
Post-pandemic:
Shifted to pre-recorded presentations posted to the website.
Solicited written questions, then posted Q&A content to the website.
The link was shared with a listserv of 15,000, plus general social media hits on various pages.
Pre-pandemic: An online comment analysis and response application was the primary email option for submitting comments and otherwise contacting the planning staff.
Post-pandemic: The forest plan revision internet inbox, normally rarely utilized, was a significant tool for communication at times during the planning process. We received more than 1,900 emails in the project inbox that were manually handled by staff.

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for the progression of how and when the information would be received.

In the absence of personal interaction and the opportunity to clarify issues relating to the interdependence of topics, there was greater potential for collaborative process derailment. To address differences in access to adequate broadband and technology, the Forest worked directly with county and regional representatives to identify best options. As a result, the Forest offered and facilitated engagement opportunities that solely relied on phones rather than computer hardware, software, and strong internet connections. The Forest's supervisory leaders participated in each call to communicate directly with stakeholders, rather than the typical in-person procedure where a small subset would attend each open house. Facilitation guides were drafted and roles assigned and outlined in advance, and during calls an internal online messaging channel was utilized by all Forest leaders for internal communication to assure smooth facilitation. Numerous communications were required during each virtual presentation offered to county staff and officials. The Forest also created and monitored an email account to facilitate directly receiving questions in advance or in lieu of attending the call. Numerous engagement opportunities were also designed to address diverse and inclusive audiences. For example, engagement opportunities were offered to new audiences on different days and at different times to address common work and family time constraints and numerous reminders were sent through USDA-FS and partner channels to reach the broadest audiences. Additional informational/educational videos and materials were created and added to the website for greater public access to materials that had been slated to be delivered, hardcopy, to local county offices and libraries. Staff spent many hours communicating with collaborators to assure

clear communication was taking place in the absence of face-to-face meetings that would have allowed for more immediate and clarifying reactions and interactions. For example, 12 phone conversations took place to clarify one misunderstanding that could have been resolved during a face-to-face meeting. It is generally accepted by the Forest and partners that the outreach efforts were a success as evidenced by the broad acceptance and support of the draft materials released. Where staff perceived there would typically be significant negative reaction in the media and organizational communication channels on a number of hot button topics, there was not. Collaborators broadly supported the process and continue to work together to resolve issues.

However, the ready *availability* of information does not mean all stakeholders have equitable *access*. Even if all participants have access to necessary equipment (personal technology, computers) they may not have access to the internet or reliable cell service. Wheeler (2020) notes that availability (in rural areas) and affordability (in urban and rural areas) of internet services perpetuate inequalities that limit economic and social participation. Chiou and Tucker (2020) state that, "…the combination of high-income and high-internet diffusion appears to be a large driver in observed inequality," (p. 3). The US Public Participation Playbook, an open government initiative of the Obama administration, offers a number of suggestions to "design for inclusiveness," including accessibility for those with disabilities and who speak languages other than English as well as providing physical and digital versions of materials needed to participate. Even the best efforts, however, may not be able to overcome participation access issues without equitable access to digital resources. For example, 25% of stakeholders were unable

to be reached digitally for inclusion in energy research engagement processes (Susser et al., 2021). While Senecah noted in 2004 that, "Access is easy to provide. Standing is far trickier," (p. 24), we suggest that access may be eas*ier* to ensure than standing, but the "digital chasm" during a global pandemic is nearly impossible to close to ensure participation opportunities for those without computer technologies in their homes. Further, ensuring access also requires ensuring that conveners have the software, platform, and skills necessary to offer digital information and participation opportunities, and potential participants have corresponding skills that allow them to participate.

Some benefits of virtual engagement noted by USDA-FS staff include the broadening of participation opportunities for those who otherwise may not be able to travel to meeting locations due to distance, time, and expense constraints. If we consider even the people within 50 miles of a given forest or grassland, more than 2 hours away from jobs or home may be required just for travel to a meeting that is held on or near the site. Specific software programs being used for virtual engagement increase access for certain participants; for instance, closed captioning provides access for those with hearing impairments and recordings allow those who are unable to make some meetings to be able to review a meeting in its entirety rather than just notes. Facilitating active conversations with interested stakeholders *via* phone allowed for better storytelling, context and valuable input than through web-based feedback forms. And innovative, visual materials remain readily available for those seeking to reference them at a later date.

Trinity of Voice: Efforts to Support Standing

Once the public has access to a process and necessary information, a process must be designed that supports "good" participation. A short list of characteristics of good participation processes includes skilled facilitation that allows all voices to be respectfully and empathetically heard, clearly defined bounds on time investment expectations, a physical arrangement that does not suggest or reinforce power structures, and opportunities for two-way communication and debate (Senecah, 2004). Design to ensure and increase standing is relevant for both synchronous (activities taking place at a specific point in time, like a virtual public meeting) and asynchronous activities (those not requiring participation at a specific point in time, but on one's own schedule with an end-date) like engaging with material and submitting comments and ideas to a virtual workspace. Asynchronous activities may be somewhat easier to administer but may not be as useful for brainstorming, collaboration, or deliberation.

The skills needed to support standing are extensive: competency in traditional meeting facilitation skills (e.g., designing breakout group activities), technical skills to operate systems behind the scenes and manage multiple digital documents that may be referenced throughout a meeting, as well as the digital savvy to sort potentially hundreds of participants into breakout groups while also moderating those groups for adherence to behavioral guidelines. Participants, too, need technical skills to bolster their standing: knowing the layout of the virtual space, for example how to raise one's hand if that's required for the facilitator to unmute speakers, or how to unmute

oneself when they would like to speak. Some USDA-FS staff running these processes have noted that enforcing behavioral guidelines, such as taking turns to speak and avoiding situations where the loudest/most persistent voices receive the majority of the attention, can be more challenging virtually than they are in-person. Other staff, however, feel that online platforms allow conveners controls to prevent such behaviors and lead more balanced and civil calls. The clear behavioral guidelines noted earlier accompanied by protocols for technical support to decide under which circumstances participants should be muted have aided staff leading synchronous activities.

Discussion: What of Influence?

Influence is dependent upon access and standing, and the pandemic has caused shifts in how engagement is structured to support these across a number of institutions and countries (e.g., Mouter et al., 2021; Susser et al., 2021). Attempts to replicate the same activities virtually as are held in person may require additional considerations for digital engagement (for those with internet access), and perhaps lessons from the marketing literature can be used to structure engagement experiences according to the ways individuals prefer to engage with online content instead of (or in addition to) designing involvement based upon best practices in the participation literature. For example, the consumers' online brand related activities (COBRA) continuum (Muntinga et al., 2011), widely applied in the marketing literature, explains three types of online usage: consuming (reading information, passive engagement), contributing (responding to questions/comments, active engagement), and creating (developing new content related to a product or brand). This could be used to support influence by designing experiences that appeal to the ways in which public lands stakeholders enjoy interacting with online content. In contrast to synchronous meetings or calls asynchronous content engagement may provide different, or more, opportunities for stakeholders to collaborate by creating content to which other stakeholders may reply. For example, users could upload pictures and videos—of favorite spots for certain activities, maintenance needs on trails, places in other open spaces that users would love to see—to a national forest's Facebook post requesting such. Two examples of interactive online content that facilitate contributing and creating input are ArcGIS interactive maps and StoryMaps. Both provide visuals and content in an accessible format, more so with the increase in online experience resulting from the COVID-19 pandemic. Stakeholders can identify and reply to specific areas and related management proposals in ways that were previously underutilized and less accessible. Individuals resistant to online formats may find these tools support their desires to offer direct, localized input.

The USDA-FS considers all public comments throughout the land management planning process, including incorporating or otherwise responding to comments within the NEPA process. The 2012 Planning Rule requirements (36 CFR 219.4) and NEPA outline opportunities for and requirements to engage the public. However, federal law dictates the level of decision-making and implementation powers both the agency and the public have, and subsequently the

agency cannot offer stakeholders (or other Tribal, state, or local governments or governmental agencies) full decision-making or implementation power and responsibility (i.e., comanagement). The process of incorporating public input involves internal consideration as well as collaboration with the public to clearly understand and best utilize and incorporate the ideas the public provides. It is difficult to evaluate the level of influence the public has had on decisions over the course of the pandemic that may be different than what would have been achieved during business-as-usual planning. However, supporting increased engagement opportunities can lead to additional avenues for information sharing, connections among stakeholders, and potentially increase the likelihood of decision influence within the boundaries of law.

Multiple options for engagement that requires limited participation (e.g., Finland's eParticipation platform, OECD, 2021b) or simple surveys exist already and have been put to use in policy processes—even for setting policies related to reopening options during COVID-19 (e.g., Mouter et al., 2021). Many of these, though, provide public comment windows on draft proposals rather than seek input early enough to influence the direction of a policy or plan. As virtual planning processes and desires to equitably distribute power proliferate, access, standing, and influence will depend upon planners who can skillfully integrate methods that support these goals (e.g., through planning wisdom gained through practice, Flyvbjerg, 2004; Xiang, 2016). We hope this Perspective has provided options and considerations for broadening engagement opportunities to maximize access, standing, and influence during the pandemic and into the future.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

KF wrote the first draft and conceived of the initial ideas in this paper with Bradley Kinder and Kenli Kim (see acknowledgments). AC contributed writing to all sections and wrote the North Carolina case example. Both authors contributed to manuscript revision, read, and approved the submitted version.

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Exploring the Relationships Among Experiences in Nature, Wellbeing, and Stewardship During the COVID-19 Pandemic

Dietlinde Heilmayr[1]*, Erica N. Baranski[2] and Travis J. Miller[3]

[1] Psychology Department, Moravian University, Bethlehem, PA, United States, [2] Department of Psychology, University of Houston, Houston, TX, United States, [3] Department of Psychology, Tulane University, New Orleans, LA, United States

The COVID-19 pandemic brought sudden and dramatic changes to our daily lives. From shifting to remote work, to following shelter-in-place orders, to increased concerns about the health and wellbeing of one's self and family, individuals were required to make changes to their daily habits and to find new methods of coping with stress and maintaining wellbeing. In the present study, we surveyed participants in the United States ($N = 192$) with open-ended questions and individual difference measures to capture how changes to daily life due to the COVID-19 pandemic affected individuals' engagement with the outdoors. Specifically, using descriptive and inferential statistics, we (1) describe how people experienced the outdoors during the beginning stages of the COVID-19 pandemic; (2) evaluate how individuals' experiences outdoors relate to individual differences; and (3) report whether environmental experiences and COVID-19 concern relate to whether individuals chose to donate their participation payment to The Trust for Public Land, to the Center for Disease Control's COVID-19 fund, or to keep the payment for themselves in the form of a gift card. This work enhances our understanding of how the pandemic affected the relationship between people and the outdoors and contributes to knowledge about how nature can be used to help individuals and communities during times of crisis.

Keywords: green space, wellbeing, human-environment relationships, mental health, physical health, nature spaces

INTRODUCTION

On March 11, 2020, the World Health Organization declared COVID-19 a global pandemic (WHO, 2020). By April 7th, 2020, 39 U.S. states had mandated that citizens "shelter-in-place" to reduce the spread of the contagious virus (Feyman et al., 2020), requiring individuals to remain home except in the case of permitted activities. Even individuals not under mandated shelter-in-place orders were likely to engage in some level of self-quarantine (Nelson et al., 2020). These mandates and recommendations, along with the pandemic itself, caused sudden and dramatic shifts in the lives of Americans. From changes to employment status and structure (Brynjolfsson et al., 2020), to adjustments to health behaviors (Arora and Grey, 2020; Meyer et al., 2020), to declines in mental health (Meyer et al., 2020; Nelson et al., 2020), individuals faced significant challenges in the early phase of the COVID-19 pandemic. While researchers have recently begun to assess the psychological impacts of COVID-19, there has yet to be an investigation into how changes to physical environments during the early stages of the pandemic—specifically changes to time spent outdoors—might relate to psychological wellbeing.

Regardless of individual state policies, the early weeks of the COVID-19 pandemic was a time of drastic change in which individuals could no longer rely on routine indoor activity and thus provides a unique opportunity to explore how individuals reported changing their outdoor behaviors. The present study aims to capture how changes to daily life due to the COVID-19 pandemic affected individuals' engagement with the outdoors. Specifically, we explore how people spent time outdoors in the early weeks of the COVID-19 pandemic (i.e., March 25th through April 3rd, 2020) in the United States and assess how time spent outdoors related to individuals' relationship to natural environments and to a healthy adaptation to stay-at-home orders.

The changes and adaptations required in the early phase of the COVID-19 pandemic may have altered how people engage with the outdoors. For example, with fitness centers closed, individuals may have turned to the outdoors for exercise and recreation. Some people may have chosen to socialize outdoors, viewing it as a safer alternative to indoor gatherings. Other individuals may have sought refuge in the outdoors as a means to cope with the new emotional challenges and stressors. Regardless of the reason, people who increased their time spent in nature during the pandemic may have benefitted from these experiences. Correlational studies converge with experimental research to suggest that nature promotes psychological wellbeing (e.g., improved mood and life satisfaction; Bratman et al., 2015; Mcmahan and Estes, 2015; Biedenweg et al., 2017; Cox et al., 2017); decreases stress (Hartig et al., 2003; van den Berg and Custers, 2011); and improves physiological markers of health (Ulrich et al., 1991; Lee et al., 2011; Tsunetsugu et al., 2011). Several literature reviews and meta-analyses on the relationship of nature experiences with health, wellbeing, and psychological flourishing also underscore the importance of nature in promoting mental and physical health (Hartig et al., 2011a,b; Capaldi et al., 2014, 2015; Oh et al., 2017).

Supportive of the idea that outdoor experiences may have buffered the stress of the COVID-19 pandemic, one recent study on the emotional correlates of how a nationally representative sample of individuals in Ireland spent their time early in the pandemic (surveys were completed on March 25th, 2020), found that the outdoors was the location most strongly associated with positive affect, while the behaviors most strongly associated with positive affect were exercising, going for a walk, and gardening (Lades et al., 2020). The present study builds upon this work by exploring how, where, and why Americans spent time outdoors in the early weeks of the COVID-19 pandemic and how these experiences related to individual differences and wellbeing.

Finally, the present study explores whether outdoor experiences in the early weeks of the COVID-19 pandemic relate to prosocial behavior. Past work has found that nature experiences predict prosocial behavior (Weinstein et al., 2009; Zhang et al., 2014; Joye and Bolderdijk, 2015; Castelo et al., 2021; Pirchio et al., 2021), in particular, environmentally protective prosocial behavior (Lawrence, 2012; Klein and Hilbig, 2018; Rosa et al., 2018). As such, we explored whether changes to outdoor experiences (e.g., increased time in the outdoors) related to two possible types of prosocial behavior: prosocial behavior directed toward other humans, and prosocial behavior directed at the environment. To do this, we used donations (to a COVID-19 relief fund or to an environmentally focused non-profit) as a proxy for prosocial behavior.

In summary, the present work is organized around three research questions.

1. How, where, and why do individuals spend time outdoors during the early weeks of the COVID-19 pandemic?
2. How do outdoor experiences relate to various individual differences (e.g., wellbeing, concern for COVID-19)?
3. Do outdoor experiences and environmentally relevant individual differences relate to prosocial behavior?

The current study describes the changing relationship between humans and their outdoor environment during the COVID-19 pandemic, offering insight into how dramatic upheavals to daily life may shift the way in which individuals experience, engage with, and appreciate the outdoors. In describing the shifting landscape, we also begin to distill how the changes in nature experiences relate to individual differences. In particular, we highlight the importance of outdoor experiences during a unique time of stress. Thus, this work focuses on the important role nature plays during times of change and contributes to knowledge around how nature can be used to help individuals and communities during times of crisis.

METHODS

Participants in this study completed an online survey and were compensated $5.00 for completing the full survey. The study was preregistered (https://osf.io/fnbuc/) and approved by the principal investigator's Institution's Human Subjects Institutional Review Board before data collection. The complete dataset, analysis script, preregistration (including power analyses), and additional **Supplementary Materials** can be found at https://bit.ly/31m533T.

Participants

Participants ($N = 191$) were mostly female (82%), and White (97%). The average age of participants was 32.33 years ($SD = 12.87$; range $= 18–69$). Participants came from 27 unique states in the United States (**Table 1**) and roughly a third (35%) of participants identified as essential workers who had to continue working during the shutdowns. Thirty-six participants dropped out before full completion, so only partial data is available for these individuals, and demographic data is missing for all of these participants. Participants with partial data are included in analyses with variables for which they provided data. For a two tailed correlation, with an alpha of 0.05, power of 0.80, and effect size of 0.25, the total required sample size is 120.

Procedures

Participants were primarily recruited using Facebook *via* a post on the first author's personal Facebook page, which was shared through her social network. An email was also sent to the first author's campus community, and 10% ($n = 20$) of the sample was from the local community. The survey remained open from March 25th through April 3rd, 2020. After completing the informed consent, participants answered several

TABLE 1 | Participant Demographics.

Demographics	
Gender	82% female
Ethnicity	97% white
Age	*M* = 32.33
	SD = 12.87
	Range = 18–69
Identified as essential workers	35%
States	27
Zip codes	127

Participants were located in Pennsylvania (83 participants from 45 zip codes), New Jersey (16 participants from 15 zip codes), Minnesota (13 participants from 11 zip codes), California (10 participants from 10 zip codes), Massachusetts (5 participants from 5 zip codes), New York (4 participants from 4 zip codes), Maryland, Oregon, Virginia, and Washington (each with 3 participants form 3 different zip codes), Connecticut, Florida, Illinois, Missouri, Montana, Tennessee, Texas, and Wisconsin (each with 2 participants form 2 different zip codes), Hawaii (2 participants from 1 zip code), and 1 participant each from Colorado, Delaware, Indiana, Louisiana, Michigan, North Carolina, New Hampshire, and Utah. N = 191. Most participants from any 1 county were PA 18018: 11 and PA 18017: 9.

open-ended questions regarding their recent experiences spent outdoors followed by several individual difference measures. The final page of the online survey asked participants how they would like to receive their $5.00 compensation for participation. Participants had a choice among a gift card to an online store, a donation to the Trust for Public Land, and a donation to the Center for Disease Control's (CDC) COVID-19 Relief Fund. Within a week of survey completion, participants received their gift card or a confirmation of a donation to their selected organization.

Materials
Open-Ended Questions
Participants first responded to several open-ended questions assessing their experiences outdoors. Specifically, participants reported whether their time outdoors increased, decreased, or stayed the same during the pandemic; the activities and location of their time spent outdoors; and whether COVID-19 has changed their appreciation in the outdoors. Participants also reported whether they anticipate spending more time outdoors after the pandemic-related restrictions are lifted. Please see our online **Supplementary Materials** for the list of open-ended questions (https://osf.io/fnbuc/). See below for a detailed description of coding procedures for these open-ended questions.

Quantitative Measures
After completing the qualitative portion of the survey, participants completed a series of quantitative measures. We use the measures reported here as past work has demonstrated that these measures are sensitive to outdoor experiences (Mayer et al., 2008; Passmore and Holder, 2017; Heilmayr and Miller, 2021). Participants completed the Single-Item Connectedness to Nature Scale, which measures how connected to nature participants are (Mayer and Frantz, 2004). For this measure, participants respond

to the statement "My connectedness to nature is" on a 1 (*very low*) to 7 (*very high*) Likert scale.

Participants also completed 5 items from an environmental identity scale (Clayton, 2003; α =0.78). For this scale, participants respond on a 1 (*strongly disagree*) to 5 (*strongly agree*) to statements such as "When I am upset or stressed, I can feel better by spending some time outdoors 'communing with nature."

The Elevating Experiences Scale (Ryan et al., 2008) consists of 13 items (α = 0.93) and measures constructs such as transcendence, awe, inspiration, and deep appreciation that make up an "elevated experience." Participants respond to how they typically felt during the past 2 weeks on a 1 (*not at all*) to 7 (*extremely*) Likert scale. Feelings on this scale include "inspired;" "in awe," and "part of something greater than myself."

Participants also completed the 54-item Comprehensive Inventory of Thriving (CIT; Su et al., 2014), which measures a broad range of psychological wellbeing constructs relevant to positive functioning and health. The dimensions measured by this scale are Relationships, or the degree to which an individual has enriching relationships; Mastery, the degree to which an individual has a sense of accomplishment; Subjective Wellbeing, including life satisfaction and positive emotion; Engagement, which assesses the degree of engagement in daily activities; Control, or feelings of autonomy; Meaning, or purpose in life; and Optimism (Su et al., 2014; αs = 0.65–0.93). Three of these dimensions can be further broken down into several facets: Relationships is made up of support, community, trust, respect, loneliness, and belonging; Mastery is made up of skills, learning, accomplishment, self-efficacy, and self-worth; and Subjective-Wellbeing is made up of life satisfaction, positive feelings, and negative feelings. For all CIT dimensions, participants respond to a series of statements (e.g., "There are people I can depend on to help me"; "I get fully absorbed in activities I do") on a 1 (*strongly disagree*) to 5 (*strongly agree*) Likert scale.

Two items were included from the SF-36 to assess self-reported health (Ware and Sherbourne, 1992; McHorney et al., 1993). To measure Subjective Health, participants respond to the question "In general, would you say your health is," on a 1 (*excellent*) to 5 (*poor*) scale. To measure Change in Health, participants respond to the question "Compared to one year ago, how would you rate your health in general now?" on a scale of 1 (*much better now*) to 5 (*much worse now*).

We developed two additional single-item measures to assess change in time spent outdoors and concern about COVID-19. To measure individuals' change in time spent outdoors, we asked participants to respond to the item "Have you spent more time than usual outdoors due to COVID-19?" rated on a 1 (*No, much less time than usual*) to 5 (*Yes, much more time than usual*) scale. To measure concern about COVID-19, participants responded to four items (e.g., "During the past week, how often have you worried about COVID-19?") on a 1 (*Never*) to 4 (*All of the time*) scale (α = 0.69).

Finally, participants were given the choice to keep the $5.00 compensation as a gift card to an online store, to donate it to the Trust for Public Land, or to donate it to the CDC coronavirus emergency response fund. For studies using donation behavior or intended donations as a proxy for prosocial

TABLE 2 | Qualitative coding categories and example responses.

Category	Examples responses
Change in direction of time spent outdoors (κ = 0.83)	
Increased	"I've spent more time outdoors because I've gotten laid off from work and I live in a remote area with a small population of people."
Decreased	"Reduce outdoor activities and my family won't allow me to go out"
Stayed the same	"I'm not an outdoors person so I haven't gone outside more or less since covid hit."
Motivation for change (κ = 0.43)	
Exercise/physical activity	"Spending time outdoors is the only place i can really go to leave my house and it's a way to get exercise rather than sitting at home on the computer or watching tv all day"
Improvements to wellbeing	"I've been enjoying siting outside during the day to clear my head and get some fresh air."
COVID risk concern	"My time outdoors has decreased majorly because from what I have heard, the virus can be spread by someone who doesn't have symptoms but is a carrier very easily."
Lifestyle change due to shelter in place mandate	"My time outdoors has decreased as my college workload has increased"
Content of activities κ = 0.73)	
Yardwork/gardening	"Gardening and backyard play with kids."
Walking	"long walks/hikes throughout my neighborhood and nearby parks"
Biking	"Cycling—only within the county and during lower bike-traffic times of the day."
Sports	"We have a golf net hitting golf balls, dribbling a basketball."
Sitting outside	"Just sitting outside while I do my work."
Other type of activity	"Outdoor construction work."
Type of activity (κ =0.81)	
Leisure activity	"Cycling—only within the county and during lower bike-traffic times of the day."
Non-leisure activity	"we took a couple of days as a family to clean up our yard and make some improvements."
Level of activity (κ = 0.64)	
Completely stationary	"I have also gone on a few car rides around town with my mom, but we never got out of the car."
Little activity	"I have gone for a few walks on the beach."
Moderate amount of activity	"Walks around the neighborhood [I never go on walks!] And hikes and runs."
Quite a bit of activity	"Bike rides, online workouts on my own at the park, walking the dog, playing with a soccer ball or tennis ball with my roommate."
Outdoor location (κ = 0.76)	
Backyard	"Only in the backyard"
Parks/forest	"City parks and nature preserves"
Neighborhood	"Close to my neighborhood"

(Continued)

TABLE 2 | Continued

Category	Examples responses
At their job	"I work in a garden center, so I have been outside"
Other outdoor location	"Less populated towns"
Level of nature immersion (κ =0.76)	
No immersion at all	"I drove around in my car with my mom"
Minimal immersion	"Around y suburban neighborhood"
Moderate immersion	"Trails, our yard, and neighborhood."
Complete immersion	"Trails and forested areas that I know that will not be heavily populated."
Content of change in appreciation for the outdoors[a] (κ =0.51)	
Physical health	"Yes, I noticed my physical health is affected. I breath better when I spend more time outdoors."
Mental health	"It's nice to be able to be out and feel grounded, but as soon as I get back inside everything comes rushing back"
Community involvement/ socializing	"Being stuck inside and realizing how long its been since I had been outside made me feel stuck and disconnected from the outside world, so I have been trying to go outside more."
Appreciation for nature	"It has changed my appreciation slightly, because I have always loved being outdoors, but now that I have more time to spend outside, I have grown closer to nature and try to integrate outdoor activity into my everyday routine"
Complexity of meaning for outdoor experience (κ =0.55)	
What the event was without including any lesson or meaning	"Nothing in particular, just enjoying the sun, fresh air, and alone time while running"
Vague meaning associated with experience, but is not deep or complex	"I went on my favorite hiking trail and noticed that there were a lot of people on it when usually it is very secluded. I also noticed more litter/dog feces. It's probably not going to influence my future behaviors, but it makes me feel better to know other people are outside because they also have nothing to do."
Events with insights to transformations in one's understanding of oneself or the world	"It was a very serene experience and there was nothing but quietness. It reminds me that there in an entire universe full of amazing sights that sometimes I forget about, and it really puts my problems and feelings in perspective. It is easy for me to get wrapped up in my own life and material items, but taking a step back and reminding myself of the beauty and simplicity of the world calms be down."
Source of appreciation for the outdoors[a] (κ =0.68)	
Opportunities for introspection or personal growth	"Going on long runs makes me feel like I've accomplished something and builds my confidence."
Time spent with others	"I walked through a reservation with my friend. We found it very pleasing and I think it helped us out a lot to just walk around and talk about what is going on."
Nature/outdoors in general	"One of the biggest difference is, I am not taking a closer look at things I have been by a ton of times and just never noticed. Example, I noticed that there seem to be a lot more squirrels in our neighbor than I realized."

(Continued)

TABLE 2 | Continued

Category	Examples responses
Bigger picture or society in general	"I tend to just go for a walk around my neighborhood and see the places where it used to be busy which is the one road and barley see any cars so how much you appreciate things in your life."

[a] *"Content of change in appreciation for the outdoors" was coded from the question "Has the COVID-19 pandemic changed your appreciation for the outdoors?" These responses reflect change in appreciation for the outdoors. "Source of appreciation for the outdoors" was coded from the question asking participants to report a specific experience during the pandemic in which they took refuge in the outdoors. These responses reflect a more static source of appreciation for the outdoors.*

behavior, see Exline et al. (2012), Park and Shin (2017), and Guan et al. (2019).

Coding of Open-Ended Questions

To quantify participants' responses to the open-ended questions, we developed a coding framework that enabled the assessment of the objective (e.g., location, activity) and subjective (e.g., source of appreciation for the outdoors) qualities of participants' experiences outdoors. This inductive, content coding analysis (Schwab and Syed, 2015) was developed in three stages. In Stage 1, the first and second authors reviewed 10% of the responses and developed an initial set of coding categories. In Stage 2, two undergraduate research assistants coded another 10% of responses using the framework developed in Stage 1. In the final stage of development, we revised the initial coding framework based on feedback from Stage 2.

For all six open-ended questions, two research assistants used this final coding framework to independently code all responses along a total of 12 non-mutually exclusive categories. The initial agreement across all categories was sufficient and ranged from κ = 0.43–0.83 (see **Table 2** for examples and reliabilities for each category). The first and second authors resolved all discrepancies among research assistants to determine the final coded dataset.

Each question required research assistants to code responses into several categories. Categories relating to changes to outdoor experiences included the direction of change for time spent outdoors (i.e., increased, decreased, or stayed the same) and the motivation for increasing or decreasing time spent outdoors (i.e., lifestyle changes due to shelter in place mandate/recommendation, COVID concern, wellbeing/general enjoyment). Categories quantifying more objective qualities of participants' time spent outdoors included the content of the activity (e.g., biking, yard work), location of participants' outdoor experiences (e.g., neighborhood, park), and the level immersion of nature experience and activity associated with their time spent outdoors. More subjective coding categories included whether participants reported a change in appreciation for the outdoors and the source of that appreciation (e.g., physical health, mental health, community engagement, appreciation for nature), as well as the complexity of meaning of participants' outdoor experiences.

For example, for the question "Has the COVID-19 pandemic changed your appreciation for the outdoors? Please explain.",
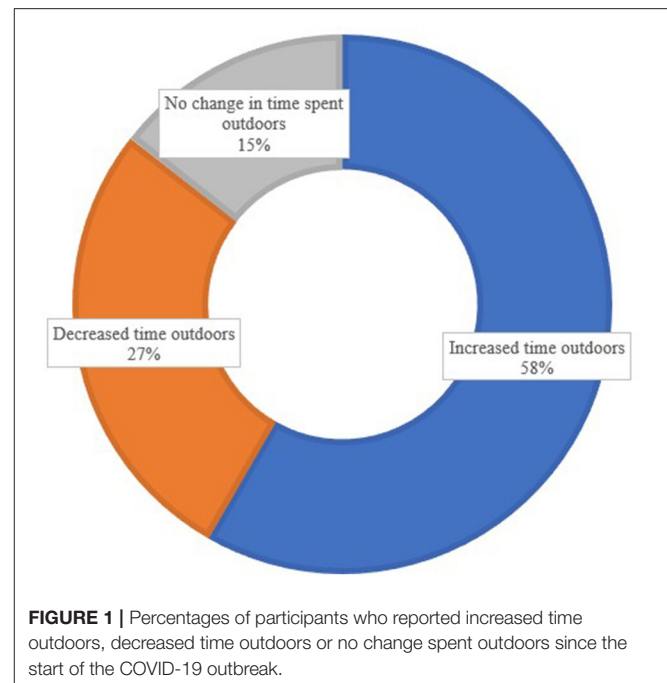
FIGURE 1 | Percentages of participants who reported increased time outdoors, decreased time outdoors or no change spent outdoors since the start of the COVID-19 outbreak.

research assistants coded responses along binary categories representing participants' who reported increased appreciation or no change in appreciation (no participants reported a decrease). Then, for participants who reported an increase in appreciation, research assistants coded whether the appreciation change related to physical health, mental health, community engagement, appreciation for nature itself, or something else (i.e., "other"). Similarly, for the question "Where have you been spending time outdoors since you started taking precautions due to the COVID-19 pandemic?", responses were coded into content categories to capture where participants were spending their time (e.g., in the backyard, parks/forest, neighborhood), and also the level of nature immersion of these outdoor experiences (i.e., no immersion, minimal immersion, a moderate amount of immersion, and complete immersion). See **Table 2** for the full list of categories with examples. The full coding manual was preregistered at https://osf.io/fnbuc/.

RESULTS

Research Question 1: How, Where, and Why Do Individuals Spend Time Outdoors During the Early Weeks of the COVID-19 Pandemic?

How: Descriptions of Outdoor Activities

When participants were asked to describe how their time in outdoor spaces had changed since the start of the COVID-19 outbreak, the majority of participants (58.3%) reported increasing the amount of time spent outdoors, while 27.3% described spending less time outdoors, and 14.4% reported no change in the amount of time they spent outdoors (**Figure 1**).

	Change in time outdoors		
	Decrease (N = 47) (%)	No change (N = 19) (%)	Increase (N = 107) (%)
Exercise	0	47	38
Wellbeing	2	16	51
COVID risk	47	16	3
Shelter in place	68	68	64

N = 173; participants could report more than one motivation for their change in behavior; percentages are based on the N associated with each "Change in time outdoors" category.

Most participants described engaging in only leisurely outdoor activities (80.4%), while 1.1% described engaging in only non-leisure activities, and 18.5% described engaging in both leisure and non-leisure activities. On average, participants describe engaging in 2.2 (SD = 1.06; *Range: 1–7*) different outdoor activities. The majority of participants spent time outdoors walking (85%), running (34%), biking (24%), doing yard work/gardening (21%), sitting on their porch (18%), and playing sports (7%). Activities based on whether participants increased, decreased, or did not change their time outdoors can be viewed in **Supplementary Table 1** on our Open Science Framework (OSF) page (https://osf.io/t37dq/). Participants reported outdoor activities were moderately high in activity level with an average activity of 1.71 (SD = 0.64) on a scale of 0 *(completely stationary)*−3 *(quite a bit of activity)*.

Where: Descriptions of Outdoor Locations

On average, people described spending their time in 1.8 different locations (SD = 0.71, *range: 0–3*). The majority of participants (81%) reported spending time in their neighborhood or in their own backyard, while 46% of people reported spending time in a park, wooded, or forested area. On average, participants spent time in moderately nature-dense locations with an average density score of 1.6 (SD = 0.69) on a scale of 0 *(no nature immersion at all)* to 3 *(complete nature immersion)*.

Why: Motivation for Spending Time Outdoors

When discussing their motivation for spending time outdoors, most participants (66%) described the change as a response to shelter in place mandates. Among those who reported increasing their time outdoors, most reported doing so because of the shelter in place rules where they lived and to improve their wellbeing, while 38% reported increasing their time outdoors to exercise (**Table 3** and **Figure 2**). Among those who reported decreasing their time outdoors, most reported doing so because of the shelter in place rules where they lived, and 47% out of concern for the risk of COVID-19 (**Table 3** and **Figure 2**). We discuss the interesting finding that some participants reported increasing their time outdoors due to restrictions while others reported a decrease for the same reasons further in the Discussion Section.
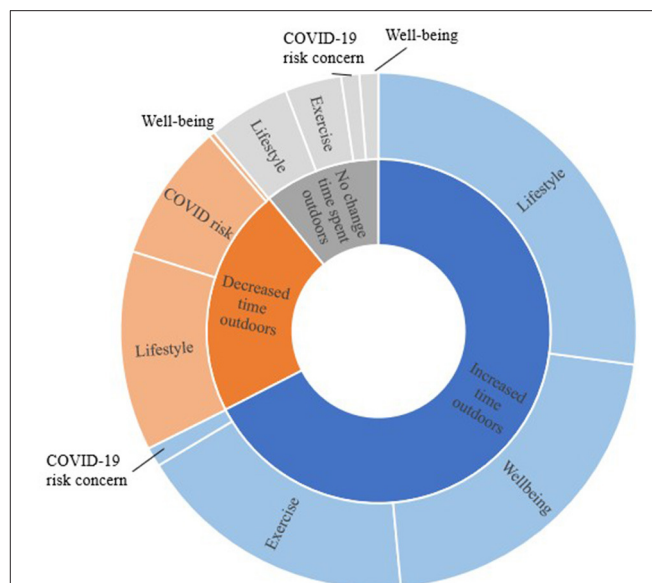
FIGURE 2 | What motivation did participants report for changing their time spent outdoors? Percentage of the motivation participants reported for increased time outdoors, decreased time outdoors, or no change spent outdoors from March 25 to April 3rd, 2020.

Change in Appreciation

When discussing how the pandemic had changed their appreciation for the outdoors, 30% did not report a change in their appreciation, and 70% described an increase in their appreciation. No participants reported a decrease in nature appreciation.

Research Question 2: How Do Outdoor Experiences Relate to Individual Differences?

We next sought to assess the extent to which individual differences relate to participants' outdoor experiences. To ensure we did not capitalize on Type I error, we used randomization tests when appropriate, as described in Smith (2000) and Sherman and Serfass (2015). These tests evaluate whether a set of variables are more related to an outcome than we should expect by chance. Randomization tests were used when a variable (i.e., the individual difference variables) could be represented by a set of subscales. For example, randomization tests were used to evaluate the relationships between the Relationships dimension of the CIT (represented by the set of subscales Community, Trust, Respect, Belonging, and Loneliness) and outdoor experiences (i.e., change in time outdoors, motivation for outdoors, complexity of meaning of an outdoor experience, source of outdoor appreciation and degree of nature immersion). If these randomization tests found that the strength of the relationship between the Relationships dimension and outdoor experiences was statistically significantly greater than could be expected by chance, we assessed these relationships on the subscale level.

TABLE 4 | Randomization test results for correlations of outdoor experiences with comprehensive inventory of thriving.

Predictor	Outdoor experience	N	Average absolute r	r expected by chance	SE	p-value
Relationships (CIT)	Change in time outdoors	166	.23	.06	.024	<.001**
	Motivation for outdoors	155	.09	.06	.013	.02*
	Complexity of meaning	161	.09	.06	.024	.15
	Source of appreciation	157	.05	.06	.013	.94
	Nature immersion	165	.05	.06	.024	.71
Mastery (CIT)	Change in time outdoors	166	.10	.06	.029	.11
	Motivation for outdoors	155	.07	.06	.015	.41
	Complexity of meaning	161	.04	.06	.030	.81
	Source of appreciation	157	.04	.06	.017	.93
	Nature immersion	165	.08	.06	.029	.21
Subjective well-being (CIT)	Change in time outdoors	166	.18	.06	.038	.001**
	Motivation for outdoors	155	.07	.06	.020	.32
	Complexity of meaning	161	.07	.06	.038	.38
	Source of appreciation	157	.04	.06	.021	.87
	Nature immersion	165	.02	.06	.038	.93
Engagement (CIT)	Motivation for outdoors	155	.09	.06	.026	.21
	Source of appreciation	157	.05	.06	.026	.68
Control (CIT)	Motivation for outdoors	155	.04	.06	.025	.85
	Source of appreciation	157	.06	.06	.026	.58
Meaning (CIT)	Motivation for outdoors	155	.12	.06	.026	.03*
	Source of appreciation	157	.06	.06	.026	.53
Optimism (CIT)	Motivation for outdoors	155	.04	.06	.026	.82
	Source of appreciation	157	.03	.06	.026	.95
Subjective health	Motivation for outdoors	155	.04	.06	.026	.78
	Source of appreciation	157	.08	.06	.026	.23
Change in health	Motivation for outdoors	155	.06	.06	.026	.45
	Source of appreciation	157	.04	.06	.027	.78
Connectedness to nature	Motivation for outdoors	161	.07	.06	.025	.35
	Source of appreciation	163	.09	.06	.026	.18
Environmental identity	Motivation for outdoors	162	.07	.06	.025	.42
	Source of appreciation	164	.10	.06	.026	.08
Concern about COVID-19	Motivation for outdoors	155	.06	.06	.026	.53
	Source of appreciation	156	.08	.06	.027	.22

*Note. *p < .05; **p < .01.*

The results of all randomization tests are reported in **Table 4**, but only sets with relationships stronger than we would expect by chance are reported in text.

Relationships Between Outdoor Experiences and the Comprehensive Inventory of Thriving

As described in the Materials Section, the dimensions of the Comprehensive Inventory of Thriving (CIT; Su et al.,

TABLE 5 | Correlations between change in time outdoors and individual differences, as warranted by randomization tests.

CIT Dimension	CIT Subscale	Increased time spent outdoors	Motivation for time spent outdoors			
			Exercise	Wellbeing	COVID-19 risk	Shelter in place
Relationships	Support	0.13	0.05	0.17*	−0.05	−0.07
	Community	0.34***	0.20*	0.10	−0.08	−0.09
	Trust	0.21**	0.10	0.04	−0.07	0.10
	Respect	0.18*	0.20*	0.09	−0.15	−0.02
	Loneliness	−0.26***	−0.11	−0.08	0.03	0.08
	Belonging	0.27***	0.12	0.09	−0.12	−0.06
Subjective wellbeing	Life satisfaction	0.22**	–	–	–	–
	Positive feelings	0.16*	–	–	–	–
	Negative feelings	−0.15	–	–	–	–
Meaning	Meaning	–	0.09	−0.19*	−0.01	0.19*

*N for relationships and subjective wellbeing = 166; N for meaning = 155; *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001.*

2014) includes measures of Relationships, Mastery, Subjective Wellbeing, Engagement, Control, Meaning, and Optimism. The Relationships, Mastery, and Subjective Wellbeing dimensions are further made up of 6, 5, and 3 subscales, respectively, that were explored by the randomization tests.

The Relationships dimension of the CIT was related to whether individuals increased or decreased their time spent outdoors *via* randomization tests (**Table 4**). The Relationships subscales of Community, Trust, Respect, and Belonging relate positively to change in time outdoors, such that participants high in these facets increased their time outdoors, whereas Loneliness related negatively to change in time outdoors, such that participants high in this facet decreased their time spent outdoors (**Table 5**). Randomization tests further revealed that the Relationships dimension related to why individuals were motivated to spend time outdoors (**Table 5**). Specifically, individuals high in Support and Positivity tended to report spending time outdoors during the pandemic to increase their wellbeing, whereas individuals high in sense of Community and Respect were motivated to spend time outdoors to exercise.

The randomization tests also revealed that the Subjective Wellbeing dimension of the CIT was related to whether individuals increased or decreased time spent outdoors in response to the pandemic (**Table 4**). Further analyses revealed that the subscales of Life Satisfaction and Positive Feelings were positively related to change in time outdoors (**Table 5**), such that individuals high in these facets reported increasing their time outdoors early in the pandemic.

The Engagement dimension of the CIT was related to the degree to which individuals felt immersed in nature such that those higher in Engagement tended to be less immersed in nature, $r_{(163)} = -0.16$, $p = 0.04$. Interestingly, Engagement was not related to whether individuals increased or decreased in their time outdoors, $r_{(164)} = 0.12$, $p = 0.12$, nor the complexity of meaning individuals attributed to their experiences outdoors, $r_{(159)} = 0.11$, $p = 0.17$. The Control dimension of the CIT was not related to whether individuals increased or decreased their time spent outdoors, $r_{(164)} = -0.15$, $p = 0.054$, complexity of meaning

attributed to time spent outdoors, $r_{(159)} = -0.03$, $p = 0.67$, nor nature immersion, $r_{(163)} = -0.12$, $p = 0.13$.

Randomization tests revealed that the Meaning dimension of the CIT was statistically significantly related to the motivation participants reported for changing their outdoor behavior (**Table 5**). Specifically, individuals high in Meaning reported being motivated to change their time spent outdoors for COVID-19 related lifestyle changes due to shelter in place mandate or restrictions (e.g., inability to go to restaurants or friend's houses, working from home), whereas those low in Meaning reported being motivated to change their time spent outdoors to increase their wellbeing (**Table 5**). Meaning was not related to whether individuals spend more or less time outdoors in response to the pandemic, $r_{(164)} = -0.14$, $p = 0.08$, the complexity of meaning attributed to time spent outdoors, $r_{(159)} = 0.07$, $p = 0.37$, nor their degree of nature immersion, $r_{(163)} = 0.11$, $p = 0.16$.

The CIT dimension of Optimism was not related to change in time spent outdoors, $r_{(164)} = 0.09$, $p = 0.26$, the complexity of meaning attributed to an outdoor experience, $r_{(159)} = -0.01$, $p = 0.85$, or individuals' level of nature immersion, $r_{(163)} = -0.02$, $p = 0.78$.

In summary, we found that experiences outdoors in the early days of the COVID-19 pandemic related to various dimensions of the Comprehensive Inventory of Thriving, which measures a range of dimensions related to psychological wellbeing.

Relationships Between Outdoor Experiences and Health

We next sought to assess the extent to which outdoor experiences during the COVID-19 shelter in place orders were related to self-reported health. Results indicate that Subjective Health (i.e., "In general, would you say your health is") was not related to whether individuals increased or decreased their time outdoors, $r_{(164)} = 0.04$, $p = 0.64$, the complexity of meaning for their time spent outdoors, $r_{(159)} = 0.08$, $p = 0.32$, nor level of nature immersion, $r_{(163)} = 0.13$, $p = 0.09$.

Individuals who reported improved health as compared to last year reported that their time spent outdoors increased since shelter in place orders, $r_{(164)} = 0.16$, $p = 0.04$. Change in Health

(i.e., health compared to last year) also related positively with the complexity in meaning of outdoor experience, $r_{(159)} = 0.18$, $p = 0.03$, such that participants who reported better health also tended to report more meaning in their outdoor experience. However, Change in Health was not related to individuals' level of nature immersion, $r_{(163)} = 0.10$, $p = 0.19$.

Relationship Between Outdoor Experiences and Nature Identity

We next tested whether individuals' nature identity was related to their experiences outdoors since COVID-19 stay-at-home orders. Connectedness to Nature was related to the complexity of meaning attributed to an outdoor experience, $r_{(165)} = 0.19$, $p = 0.01$, and the degree of nature immersion experienced, $r_{(170)} = 0.33$, $p < 0.001$, such that individuals high in Connectedness to Nature enjoyed more meaningful and immersive experiences outdoors. Interestingly, Connectedness to Nature was not related to change in time spent outdoors, $r_{(171)} = 0.05$, $p = 0.51$.

Those relatively higher in Environmental Identity had more complexity of meaning, $r_{(166)} = 0.19$, $p = 0.01$ and higher nature immersion, $r_{(171)} = 0.18$, $p = 0.02$, in regard to their reported outdoor experience, but Environmental Identity did not relate to change in time spent outdoors, $r_{(172)} = -0.03$, $p = 0.72$.

Relationship Between Outdoor Experiences and Concern About COVID-19

Concern about COVID-19 related positively to the complexity of meaning attributed to and outdoor experience, $r_{(158)} = 0.18$, $p = 0.02$, but was not related to whether individuals increased or decreased their time spent outdoors, $r_{(163)} = -0.02$, $p = 0.81$, nor their level of nature immersion: $r_{(162)} = -0.04$, $p = 0.61$.

Research Question 3: Do Outdoor Experiences and Environmentally Relevant Individual Differences Relate to Prosocial Behavior?

Our last research question was concerned with whether participants' experiences outdoors impacted donation behavior. Specifically, we tested whether participants' experiences outdoors (e.g., increased or decreased time spent outdoors; motivation for time spent outdoors) related to whether they donated their participant compensation to a charity, and if yes, if these experiences inspired them to donate to a charity focused on COVID-19 relief or environmental conservation. Importantly, donation was not a measure of prosociality in general, but rather a behavioral measure used as a proxy for prosocial behavior in the moment, and we tested whether outdoor experiences related to this measure. The most common compensation allocation choice was to receive an Amazon gift card (44%), with 36% of participants choosing to donate to the CDC's COVID Relief Fund and 20% opting to donate to the Trust for Public Lands.

To identify if individuals who choose to donate differed from individuals who did not donate in terms of their degree of environmental identity, elevated experiences, and/or concern over COVID-19, we ran a series of independent samples t-tests between those who donated (to either the Trust for Public Land, or to the CDC's COVID Relief Fund) and those who choose to receive an Amazon gift card. There were no statistically significant differences between those who donated and those who did not donate in Environmental Identity [$M_{donation} = 5.49$, $SD_{donation} = 1.18$, $M_{Amazon} = 5.25$, $SD_{Amazon} = 1.16$, $t_{(154)} = 1.315$, $p = 0.19$, $r = 0.11$], the Elevating Experiences Scale [$M_{donation} = 3.87$, $SD_{donation} = 1.24$, $M_{Amazon} = 3.88$, $SD_{Amazon} = 1.24$, $t_{(155)} = 0.039$, $p = 0.97$, $r = 0.003$], nor COVID-19 Concern [$M_{donation} = 3.65$, $SD_{donation} = 0.59$, $M_{Amazon} = 3.48$, $SD_{Amazon} = 0.72$, $t_{(155)} = 1.67$, $p = 0.10$, $r = 0.13$].

Finally, we assessed whether participants' experiences outdoors impacted donation behavior; that is, we investigated not if there were differences in whether participants donated, but rather if there were differences in *where* participants donated. Chi-square tests of independence showed that neither change in time spent outdoors [$\chi^2_{(4)} = 1.10$, $p = 0.894$, $\Phi = 0.08$], the source of participants' appreciation of the outdoors [$\chi^2_{(8)} = 4.82$, $p = 0.777$, $\Phi = 0.18$], the complexity of the meaning participants found in refuge outdoors [$\chi^2_{(6)} = 2.43$, $p = 0.877$, $\Phi = 0.13$], nor level of nature immersion [$\chi^2_{(4)} = 5.64$, $p = 0.227$, $\Phi = 0.19$; those who scored a zero on nature immersion were removed from this analysis due to extremely low base rates] were associated with where participants allocated money.

Finally, there was no statistically significant difference between men and women in donation behavior, $\chi^2_{(4)} = 2.36$, $p = 0.307$, $\Phi = 0.12$ (the participant who had a gender of "3" was removed from this analysis due to extremely low base rates). There was also no statistically significant age difference between those who kept the money (gift card) and those who donated, $t_{(153)} = 1.260$, $p = 0.210$, $r = 0.10$.

In sum, individual differences in environmental identity, COVID concern, and experiences outdoors did not predict donation behavior.

DISCUSSION

The mandated and recommended restrictions put in place in response to the COVID-19 pandemic impacted all aspects of individuals' lives. The current project explored how individuals' outdoor experiences changed during the early weeks of the pandemic when stay-at-home restrictions were largely in place. To accomplish these goals, we asked participants a series of open-ended questions to assess the objective and subjective qualities of their time spent outdoors. We also asked participants to complete several quantitative individual difference measures. We then used these data to describe how, where, and why individuals spent time outdoors, and to examine how outdoor experiences early in the pandemic relate to individual differences. Finally, we captured how these measures relate to prosocial behavior by providing participants the opportunity to keep their $5 participant compensation as an Amazon gift card, or to donate it to a COVID-19 Relief Fund or an environmentally focused non-profit.

In regard to how, where, and why individuals spent time outdoors, the majority of participants' reported spending time

near their house (e.g., in their yard or neighborhood), or at a park or forest. Their activities included those with a moderate amount of activity including walking, running, and yardwork. For participants who reported decreasing activity outdoors, the majority explained the change as a result of their state's advisory to stay at home to stop the spread of COVID-19 or general concern about contracting the virus. When participants reported increasing their time outdoors, most attributed the change being due to shelter-in-place recommendations or mandates, as a means to increase their wellbeing, and/or to facilitate exercise. That some participants reported increasing their time outdoors due to restrictions while others reported a decrease for the same reason highlights the variability in response to the COVID-19 pandemic. It is possible, for example, that individuals living in more densely populated areas were less likely to go outdoors due to not being able to maintain distance, while those living in more rural locations were more likely to go outdoors because they were able to follow distancing advisories in their area. Though the present study cannot answer why some individuals increased time outdoors due to advisories and some decreased time outdoors for the same reason, these results make sense given the wide range of participants' ages, locations, and other unmeasured variables such as risk tolerance.

Next, we sought to understand variation in participants' experiences outdoors by relating the six dimensions of the Comprehensive Inventory of Health (CIT), health, environmental identity, and to attributes of individuals' outdoors experiences. Results indicate that those high in the Relationships and the Subjective Wellbeing dimensions of the CIT tended to report spending more time outdoors. In other words, participants in this study with enriching relationships and high subjective wellbeing reported spending more time outdoors. While it may be that outdoor experiences promoted positive relationships (e.g., by providing a safe space to commune) and wellbeing, it may also be that enriching relationships and wellbeing causes individuals to spend more time outside, or that these relationships exist due to some third variable. Though past research provides support for nature-based experiences promoting social connections (Passmore and Holder, 2017), no causal conclusions can be drawn from the present study. We also found that individuals high on the Engagement dimension of the CIT tended to report less immersion in nature while they were outdoors, perhaps because they had less of a need to be immersed in nature to feel energized and engaged. (Example items from the Engagement scale include "In most activities I do, I feel energized;" and "I get fully absorbed in the activities I do.")

In terms of self-reported health, participants who spent more time outdoors in the early weeks of the pandemic also reported increased health over the last year (in response to the question "Compared to one year ago, how would you rate your health in general now?"). However, this relationship was not observed for overall health (i.e., "In general, would you say your health is[…]"). Though more research is required to understand the causal mechanisms, it may be that individuals who improved in health in the past year wanted to maintain their health and wellbeing as various outlets to achieve these goals were being closed (e.g., gyms and community spaces), and thus turned to the

outdoors for to exercise and positive affect. That is, individuals may have had extra motivation to maintain positive changes in health that they had achieved in the past year and may have worked to achieve this goal by spending time outdoors.

Unsurprisingly, those who felt highly connected to nature report experiences outdoors that are highly meaningful and immersive. These results, taken together with those discussed above, indicate that individuals who already feel connected to nature may have felt an added benefit to spending time outdoors during early weeks of the COVID-19 pandemic. However, results should be interpreted with caution as the sample is not generalizable to all populations and some reported effects are small.

Finally, we explored whether experiences outdoors was related to donation behavior. We expected that individuals who benefited from time spent outdoors during the pandemic to be motived to donate to a nature conservation fund in lieu of an Amazon gift card or a COVID-19 Relief Fund. We expected this because past work has found that experiences in nature promote prosocial behavior (Weinstein et al., 2009; Zhang et al., 2014; Joye and Bolderdijk, 2015; Castelo et al., 2021; Pirchio et al., 2021), especially prosocial behavior directed toward the environment (Lawrence, 2012; Klein and Hilbig, 2018; Rosa et al., 2018). Contrary to our expectations, individuals' experiences outdoors did not relate to how they chose to allocate their study compensation. These results indicate that while spending time outdoors early in the COVID-19 pandemic was associated with psychological benefits, these positive associations do not motivate discrete prosocial behaviors, which may be more influenced by financial security or general philanthropic tendencies. As such, future studies should aim to measure possible variables that may have had a confounding effect in the present study, such as socioeconomic status, to disentangle when and why donation behavior may relate to experiences outdoors.

The Implications of Spending Time Outdoors During a Pandemic

Our results illuminate the ways that spending time outdoors could potentially serve as a low-cost and easy-to-implement intervention to promote wellbeing during times of stress, as we found that participants who reported spending more times outdoors reported better relationships and higher wellbeing. Spending time in nature may be particularly beneficial during the COVID-19 pandemic because spending time outdoors is relatively low-risk compared with indoor activities (Bhagat et al., 2020).

The present study also points to the possibility that the pandemic increased individuals' appreciation for nature and outdoor experiences. When participants in the present study were asked, "Do you anticipate spending more time in the outdoors after the restrictions due to the COVID-19 are lifted?", 76% of participants reported anticipating spending more time outdoors, while 18% anticipated no change, and 6% reported an anticipated decrease. It may be that as the pandemic forced individuals to use the outdoors for leisure and exercise in lieu of indoor options, people found a renewed sense of appreciation

of outdoor experiences and found themselves motivated to spend more time outdoors even when indoor opportunities become available again. In this way, spending time outdoors may turn into a self-reinforcing pattern. This is a ripe area for future research. Interestingly, 80% of individuals who reported decreasing their time outdoors during the pandemic also reported planning to increase their time outdoors after the pandemic restrictions were lifted, highlighting the possibility that not having the opportunity to go outside (e.g., due to safety or increased daily burdens) is associated with the motivation to spend time outdoors. In other words, spending time outdoors seems to increase our appreciation for the outdoors while being prevented from spending time outdoors may also increase our appreciation for the outdoors by reminding us of what we are missing. These results highlight how the pandemic may be shifting the relationship between humans and nature.

Of note, however, self-reported outdoor experiences did not translate to behavior that is protective of the environment (i.e., donation to The Trust for Public Land) nor to prosocial behavior toward others (i.e., donation to the CDC COVID-19 Relief Fund). That is, while the majority of individuals reported appreciating nature and planning to spend more time outdoors, these indicators did not translate into prosocial behavior. It may be that the pandemic caused people to have a more egoistic (self-focused) appreciation of nature rather than a biospheric (concern for living things) or altruistic (concern for other people) appreciation (Schultz, 2001). Importantly, we did not measure socioeconomic status, which may be confounding the lack of relationship between outdoor experiences and donation behavior. We did not measure the structure of participants' environmental concerns in the present study, but future work may look to investigate whether type of appreciation may explain donation behaviors (or the lack thereof). Additionally, it is possible that these trends would change over the course of the pandemic, so these results should be considered in tandem with other studies of donation behavior during various points of the COVID-19 pandemic.

Limitations and Future Directions

While this study provides important insight into how individuals utilize their time outdoors during the early stages COVID-19 pandemic, it is not without its limitations. First, this study relied on self-report assessments of nature experience and health. Future research should assess more objective assessments of these variables. For example, nature immersion could be assessed *via* the amount of green space individuals live near. Inclusion of non-self-report data would limit common method bias and help generalize the current findings in assessing causes and consequences of time spent outdoors.

Additionally, the sample included in this study in limited in its generalizability. Though we included participants from 27 unique states who reflected a wide range of ages, the participants are not reflective of the U.S. population. Additionally, we cannot test the effect of different COVID-19 policies or rates on the effects we report here, so it may be that some of the effects are only relevant to specific populations during specific times.

Importantly, the results of this study are cross-sectional and correlational, meaning that we cannot draw causal conclusions about the relationship between outdoor experiences and mental and physical health. Though the present study provides evidence that outdoor experiences are related to wellbeing and health, future research should employ experimental approaches to establish temporal precedence and to rule out potential third variables. Recently published findings indicate that the relationship between spending time outside during the pandemic and wellbeing may depend on who is spending time outdoors and the period within the pandemic that they are outdoors. Specifically, Büssing et al. found that individuals high in wellbeing may benefit more from time outdoors than individuals low in wellbeing, and that the benefits of outdoor experiences may have declined over the course of the pandemic (Büssing et al., 2021). Thus, more research is necessary to understand the full landscape of this relationship. Moreover, while the present work points to promising relationships to capitalize upon for intervention work, we first must identify the causal mechanisms through which outdoor experiences may promote health and wellbeing.

CONCLUSIONS

Taken together, the results reported here suggest that we may see a shift in how people engage with the outdoors as we emerge from the COVID-19 pandemic. As indoor spaces closed, people turned to the outdoors for safer socialization and exercise opportunities, which was associated with a plan to increase time outdoors after the pandemic restrictions were lifted. Even the majority of individuals who decreased their time outdoors due to safety concerns or increased daily burdens reported wanting to increase time outdoors after the pandemic restrictions were lifted. In short, the majority of individuals in this study expressed an appreciation for the outdoors during the COVID-19 pandemic, and a plan to increase time outdoors when the pandemic restrictions were lifted.

The shifting relationship between humans and outdoor experiences may ultimately promote human thriving. In the present work, we found that spending more time outdoors was associated with attributes of thriving. While not new (for reviews of the relationship between connectedness with nature and wellbeing see Hartig et al., 2011a,b; Capaldi et al., 2014, 2015; Oh et al., 2017), this relationship has yet to be deeply explored in regard to the COVID-19 pandemic. Though these results are not conclusive, it points to the possibility that if individuals follow through with their plans to spend more time outdoors, they may experience boosts to health and wellbeing.

In sum, it seems that the pandemic may shift the relationship between humans and their environment, and that nature experiences were associated with healthy adaptations to stay-at-home orders. Future work should continue assessing these trends to understand how these relationships change alongside the severity of the pandemic.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/**Supplementary Material**, https://osf.io/fnbuc/.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Human Subjects Institutional Review Board at Moravian College. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DH developed and ran the study and also did the majority of the writing of the manuscript. EB assisted in the development of the coding manual and in coding qualitative responses, in addition to assisting with manuscript writing. TM was primarily responsible for statistical analyses and created the tables in addition to assisting with manuscript writing. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2022.694054/full#supplementary-material

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Changes and Disparities in Nature Access During the COVID-19 Pandemic

Hilary Byerly Flint [1][*][†], Courtney Hammond Wagner [2] and Keri Watson [3]

[1] Institute of Behavioral Science, University of Colorado, Boulder, CO, United States, [2] Water in the West, Woods Institute for the Environment, Stanford University, Stanford, CA, United States, [3] Department of Earth and Environmental Systems, University of the South, Sewanee, TN, United States

Time in nature is associated with a range of physical and psychological benefits. These benefits tend to be unevenly distributed, with non-white and low-income communities often having lower access to nature than richer, more white neighborhoods. When the COVID-19 pandemic hit the United States in Spring 2020, changes in daily routines, restrictions on public nature access, and risk perceptions may have affected whether and how much people spent time in nature. We explore how nature access changed during the COVID-19 pandemic and how those changes were experienced by different demographic groups. We surveyed representative samples of California and New York residents ($n = 2,036$) in May and June of 2020 and examined differences in nature access and nature-related COVID restrictions and risks by gender, income and race. We find that, on average, the pandemic was associated with reductions in frequency of nature access and less time in nature for all respondents. However, these trends were greatest for women, people of color and people who are low-income. Moreover, the pandemic seems to have widened prior inequalities: low-income and non-white people accessed nature even less frequently and had fewer nature access options than they did prior to the pandemic. Given the disparities in broader pandemic impacts by gender, income, and race, these results further demonstrate the inequalities laid bare by COVID-19.

Keywords: nature, equity, COVID, environment, greenspace

INTRODUCTION

In Spring 2020, the COVID-19 pandemic upended routine across much of the United States. People were forced to adapt to changes in daily movement to reduce the spread of the disease. These included reductions in work hours for non-essential workers, remote work for those who were able, and closure of schools and public gathering spaces. Spending time outdoors became one of the few options for leisure outside the home. At the same time, pandemic-related restrictions and risk perceptions may have influenced whether and how people spent time in nature.

Time in nature can benefit human wellbeing. Contact with various types of nature is associated with increases in positive affect, happiness, repetitive, and other measures of psychological health (Bratman et al., 2019). These benefits may be accrued through multiple pathways, including air quality, physical activity, repetitive, and stress reduction (Hartig et al., 2014). Public open spaces, such as parks, can provide areas to gather, enabling a sense of community and social cohesion (Fan et al., 2011; Francis et al., 2012). Residents of neighborhoods with more greenness tend to have better mental health and mortality outcomes (van den Berg et al., 2015). However, these neighborhoods also tend to be more white and higher income (Schwarz et al., 2015; Nesbitt et al., 2019). Low-income neighborhoods have

been found to have less greenspace (Astell-Burt et al., 2014), and low-income and non-white people often have fewer acres of urban parks and access to parks of lower quality, safety, and maintenance than higher income and white people (Wolch et al., 2014; Rigolon, 2016). Hispanics, Blacks and Asians are more likely than whites to report safety of the outdoors as a barrier to spending time in nature, even though nature is highly valued across all racial groups (Kellert et al., 2017). Racial discrimination and policing of white boundaries has historically dispossessed or excluded people of color from public nature areas (Schelhas, 2002; Scott and Lee, 2018). Given the benefits of time in nature, these disparities could exacerbate income- and race-related health inequalities.

The COVID-19 pandemic generated widespread psychological stress (Cooke et al., 2020; Boden et al., 2021). For some, nature experience may have functioned as a coping mechanism to manage mental health. Greenspace use and nature views were associated with reduced depression and anxiety during the pandemic (Pouso et al., 2021; Soga et al., 2021b). People who reported spending more time in nature compared to before the pandemic also reported better mental health[1]. At the same time, pandemic-related restrictions and perceptions were likely to influence people's ability to spend time in nature. There is evidence of increased interest in spending time outdoors (Kleinschroth and Kowarik, 2020) and substitutions of outdoor recreation in lieu of pandemic-restricted leisure activities (Day, 2020). In urban cities, those who had private gardens or yards were seen as privileged over those who did not (Blackall, 2020). Closures and restrictions put national park visits at a 40-year low, but 15 national parks set annual visitation records—several of which are near densely populated metropolitans (Ziesler and Spalding, 2021). Global and local analyses of public greenspace usage report increases from 2019 (Geng et al., 2021; Soga et al., 2021a). However, these aggregate numbers do not capture demographic-level changes in nature access during the pandemic.

Research focused on other aspects of the pandemic has established its disparate effects across different populations in the United States. People of color were more likely to suffer adverse COVID-19 outcomes and morbidity than whites (Bui, 2020; Andrasfay and Goldman, 2021; Karaca-Mandic et al., 2021; Poulson et al., 2021). While many workers switched to working from home, frontline "essential" workers were forced to continue working on site and in close contact with colleagues. People of color and women are disproportionately represented in frontline industries, including healthcare, grocery, childcare, public transit, warehouse, and cleaning services (Rho et al., 2020). The burden of this work has also been borne by low income workers (Blundell et al., 2020). Women have experienced greater employment disruption from the pandemic than men, as well as negative outcomes related to violence and health (McKinsey Company, 2021; United Nations, United Nations). These differences may be exacerbated by household characteristics. U.S. Census Bureau data shows an increase of 1.4

million mothers with school-age children not actively working in January 2021, compared to January 2020 (Heggeness et al., 2021). During the pandemic, childcare demands were cited as the reason for not working among three times as many women than men (Heggeness and Fields, 2020).

In this study, we examine changes in nature access during the pandemic and whether those changes vary across three demographics: gender, income, and race. In Spring 2020, we surveyed demographically representative samples of Californians and New Yorkers. The survey asked participants about their frequency of time spent in nature before and during the pandemic, changes in time in nature since the pandemic started, types of nature access, and perceptions of COVID restrictions and risks related to nature access. We tested how those measures differed for respondents who were female, low-income, or non-white, compared to those who were male, higher income, or white. Many of the studies on nature use during the pandemic use convenience sampling and acknowledge their samples' bias toward high-income or frequent nature users (e.g., Derks et al., 2020; Grima et al., 2020; Venter et al., 2020; Maurer et al., 2021). The goal of our study is to provide evidence from a demographically representative sample on changes in nature access during the COVID-19 pandemic along gender, income, and racial divides, and whether the pandemic seems to have exacerbated or assuaged prior inequalities. The investigation was guided by four research questions.

RQ1. How did frequency of nature access change during the pandemic?

First, we explored how time spent outside changed overall during the pandemic and within demographic groups, as well as demographic differences before the pandemic and whether those differences grew or shrank during the pandemic. We used responses about frequency of time spent in nature before and during the pandemic to test for differences over time and within demographic groups.

RQ2. How did time in nature change during the pandemic?

Next, we explored how participants reported changes in the time they were able to spend in nature. Participants reported whether they were spending less, more or the same amount of time outside, compared to before the pandemic. We tested for differences in experiences overall and within demographic groups.

RQ3. How did the type of nature (public vs. private) people accessed change during the pandemic?

Third, we investigated where people spent time in nature. Participants reported on whether they spent time in a private yard, in a public park, both, or neither (had no access to nature). We tested for changes in types of nature accessed and demographic differences in private vs. public nature access before and during the pandemic.

RQ4. Did perceptions of nature-related COVID restrictions and risks vary within demographic groups?

Finally, we explored whether perceptions of nature-related COVID restrictions and risks were different for women, low-income participants, and non-white participants, as these might help explain differences observed above. Using responses to questions about stay-at-home requirements, nature closures, and

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[1]Watson, K. B., HammondWagner, C., Byerly, H., Niles, M. T., and Ricketts, T. H. (In preparation). *Nature Exposure and Mental Health During COVID-19.*

discomfort with pandemic risks outdoors, we tested whether responses varied within demographic groups.

Additionally, we explored whether demographic group membership (i.e., being female, low-income, or non-white) predicted changes in time spent in nature when controlling for one-another, and whether those relationships held when accounting for other household characteristics, nature preferences, and pandemic-related variables. We also examined whether being a woman with children at home was associated with changes in time spent in nature and moderated any observed effect of gender.

METHODS

Sample

In May and June 2020, when COVID-19 pandemic lockdown measures were in effect for much of the United States, we surveyed demographically representative samples of New York and California residents ($n = 2,036$). These two states were two of the earliest to experience the pandemic in the United States and experienced the pandemic onset around the same. The states also enacted broadly similar quarantine policies, although California enacted a stay-at-home policy a few days earlier than New York (Jalali et al., 2020). These samples provide insight into the diversity of experiences for two states with large metropolitan areas and diverse populations. The sample size was determined by a power analysis for the effect sizes sought in another study that examines the relationship between nature access and mental health (see text footnote 1).

Survey participants were recruited through Qualtrics (www.qualtrics.com), which uses a variety of sources to find participants, including website intercept recruitment, email lists, customer loyalty web portals, and social media. We instructed Qualtrics to set quotas for the demographic characteristics of the two state populations following census data on race, household income, education level, and age (U.S. Census Bureau, 2019a,b). The U.S. Census implements gender as a binary male/female variable. To allow for the inclusion of non-binary respondents, we adjusted the quota to allow up to 4% of respondents from each state to identify with a gender other than male or female. The survey ran from May 19 to June 16, at which point the quotas had been filled. The survey had a 60% response rate. Qualtrics compensated survey respondents for their time variably based on the context. Primary forms of compensation included gift cards, airline miles, and cash payments. The study design was approved by the University of the South Institutional Review Board.

Survey Design

Sampled California and New York residents were invited to participate in an online research study on nature access and mental health, and informed that the purpose of the study was partly to investigate how access to nature and greenspace had changed during the pandemic. Participants first responded to a set of mental health questions, then reported on the current status of the COVID-19 pandemic in their community and their access to nature, green space and natural areas. Participants were also asked about their relationship with nature and greenspace using the short-form version of the Nature Relatedness Scale (NR-6) (Nisbet and Zelenski, 2013). The survey finished with questions related to demographics and household characteristics.

Data

To explore disparities in nature access during the COVID-19 pandemic, we focused on how outcomes varied for three demographic groups: female (vs. male), low-income (vs. high-income), and non-white (vs. white). These groups were defined as binary categorical variables using responses to questions in the survey.

A participant's gender was defined as "female" if she selected "female" as that which best describes her gender identity. The comparison gender group was male because this contrast best captures the possible inequities in household dynamics we sought to examine through our analysis (United Nations, United Nations). Those who identified as transgender or non-binary, or preferred to self-describe or not to answer were excluded from our analyses that focused on gender.

A participant's income was defined as "low-income" if their household income range in 2019 before taxes was within the lowest quartile of survey participants. For our sample, this cutoff was $25,000, and it was the same value for both California and New York residents. This cutoff aligns with the U.S. Census Bureau 2019 Poverty Threshold for a family unit of four people, which is $26,172 (U.S. Census Bureau, 2021). The comparison group is participants in the highest quartile, whose household income was at least $100,000. Participants in this group were considered "high-income". Participants in the middle quartiles were excluded from the analyses that compared income groups.

A participant's race was defined as "non-white" if they had indicated the race with which they most identify as any other than White (i.e., American Indian or Alaskan Native, Asian, Black or African American, Hispanic or Latino, Native Hawaiian or other Pacific Islander, or Other). Although federal policy defines Hispanic as an ethnicity, "Hispanic or Latino" is included in the racial breakdown of census data by state. Many Hispanics consider their ethnic and cultural background to be part of their racial identity (Rodriguez, 2000; Gonzalez-Barrera and Lopez, 2015). However, this perspective is not universal and Latinos in the United States experience race differently (Rodriguez, 2000; Rothenberg, 2007). Participants in our survey were asked to select the "race with which you most identify," with "Hispanic or Latino" and "White" as two options. We use this self-identification process as justification for classifying those who selected "Hispanic or Latino" as "non-white". We focus on the white/non-white dichotomy because it is the racial divide for which evidence suggests there might be the greatest differences in access to urban greenspace (Wolch et al., 2014; Rigolon, 2016), barriers to spending time in nature (Kellert et al., 2017; Scott and Lee, 2018) and experience during the pandemic (Gross et al., 2020; Andrasfay and Goldman, 2021; Karaca-Mandic et al., 2021).

The nature access outcome measures were also defined according to survey responses (**Supplementary Table 1**). Participants indicated the frequency of time they spent in nature before and during the pandemic using a scale ranging from

never (0) to daily (4). These variables were coded as continuous. Participants also reported how the amount of time they spent in nature had changed since before the pandemic, choosing either less, same or more (coded as categorical). Type of nature access was coded categorically based on where participants indicated they spent time—in public parks or natural areas (*Park*), in a private yard or garden (*Home*), both or neither. Perceptions of nature-related COVID restrictions and risks include binary (true/not true) responses to statements about quarantine conditions (required to stay at home, closed public natural areas) and risk preferences (uncomfortable about COVID risks outdoors).

Additional individual characteristics were coded to include in the descriptive statistics and regression models described below. A participant's "nature relatedness" was determined by averaging responses to the NR-6 questions, which assess subjective connectedness with the natural environment (Nisbet and Zelenski, 2013). This is a continuous measure bounded by one (low) and five (high). We control for nature relatedness in order to account for differences in propensity toward nature, which has been shown to vary by gender (Wyles et al., 2019; Rosa et al., 2020). A participant had children at home if they indicated they lived with children under age 18. A participant was considered to have experienced a change in employment if they responded that the pandemic had increased or decreased the number of hours per week that they spend doing paid work (compared to those who responded "no change"). A participant was considered to live in an urban area if their zip code was classified as within a metropolitan area by the Office of Management and Budget as of October 2010 (USDA Economic Research Service ERS., 2013).

The initial data set used for the analysis was prepared by Watson et al. (see text footnote 1). In that study, 186 of 2,041 responses had missing values, which were replaced using an iterative regression imputation technique (Gelman and Hill, 2006).

The data used in this study will be made publicly available on Open Science Framework (doi: 10.17605/OSF.IO/7VEMJ).

Analysis

To test for differences in frequency of nature access before and during the pandemic (RQ1), we first checked the assumption of normally distributed differences for a paired *t*-test using the Shapiro-Wilk normality test. Because the differences were not normally distributed, we used the non-parametric Wilcoxon signed-rank test to compare change in frequency between time periods for the full sample. For differences within each demographic group (e.g., female vs. male, low-income vs. higher income, and non-white vs. white) at each time period, we used *t*-tests. Pandemic-related changes in nature access were analyzed by comparing time spent in nature during the pandemic to before the pandemic using mixed analysis of variance (ANOVA) within demographic groups and between time periods.

Changes in time spent in nature (RQ2) were tested using chi-squared tests overall and within each demographic group.

Differences in type of nature access (RQ3) were tested using McNemar's chi-squared test for the full sample between

time periods, which is appropriate for paired nominal data (Agresti, 2002). Chi-squared tests evaluated differences within each demographic group at each time period.

Differences in perceptions of nature-related COVID restrictions and risks (RQ4) were tested using chi-squared tests for perceived requirement to stay home, perceived closure of public access points, and discomfort about COVID risks outdoors.

We also provide descriptive statistics for each outcome variable by racial subgroup in the **Supplementary Materials** to check whether the aggregation of non-white races is masking opposite trends between subgroups.

Finally, to explore how changes in time spent in nature are explained by demographic, pandemic, and individual characteristics, we estimated multinomial logistic regression models. The dependent variable was categorical, with three levels of time spent in nature since the pandemic: Less, Same, or More, where Same (or "no change") is the reference level. The main estimation included the demographic groups as predictors, possible pandemic-related effects on nature access (type of nature access, COVID restrictions, and discomfort about COVID risks outdoors), and individual-level covariates, including age, nature relatedness, kids at home, and change in employment. To compare how results changed when controlling for fewer factors, we estimated simpler models that include just subsets of those variables. We also estimated an additional full model that included an interaction for the effect of kids at home on women. All models included controls for state of residence and time period (week) in which the survey was taken.

All statistical tests included corrections for multiple comparisons using the Benjamini-Hochberg method with a false discovery rate of 5% (Benjamini and Hochberg, 1995). We pre-registered our analysis plan on Open Science Framework prior to conducting the analysis described herein. The scope of investigation and analytical methods have largely followed the plan, with a few variations. The research questions have been reorganized to better communicate the results. We initially planned to remove responses that failed a check for internal consistency using survey responses related to nature access, however, we subsequently decided that the questions were sufficiently different to negate the validity of that procedure. Additionally, we had intended to test for moderator effects of changes in employment and urban residence but lacked strong evidence regarding the direction of the effect of employment change and had too imbalanced a sample to test for urban vs. rural effects. For kids at home, we focused just on its effect on gender and changed this analysis to be more exploratory than confirmatory.

RESULTS

Overall, 2,036 people participated in the survey (**Table 1**). The most commonly represented race was White (46%), followed by Hispanic (30%), Black (11%), and then Asian (9%), with other races making up 4% of the sample. Household income in 2019 before taxes ranged from <$25,000 (24%) to $100,000

TABLE 1 | Descriptive statistics of sample.

Race	Asian	Black	Hispanic	Other	White
	178 (8.7%)	219 (11%)	611 (30%)	84 (4.1%)	944 (46%)
Income	<$25,000		$25,000–99,999		$100,000 or more
	496 (24%)		886 (44%)		654 (32%)
Gender	Female		Male		Other
	1,038 (51%)		960 (47%)		38 (1.9%)
Age	18–29		30–49		50 or older
	731 (36%)		643 (32%)		662 (33%)
Political preferences	Liberal		Moderate		Conservative
	642 (32%)		735 (36%)		659 (32%)
State of residence	California				New York
	1,029 (51%)				1,007 (49%)
Lives in an urban area					1,845 (94%)
Has kids at home					902 (44%)
Experienced a change in employment in the pandemic					1,024 (50%)
Had COVID-19					228 (11%)
Know someone who had COVID-19					687 (34%)
Total participants					$N = 2,036$

Cells show number of observations (percent of sample).

or more (32%). Half of the sample self-identified as female (51%), 47% as male, and 1.9% as transgender, non-binary, or self-described. The age range was split between 18 and 30 years (36%), 31–49 years (32%), and 50 or older (33%). Political preferences of respondents are similarly equally divided, with 32% describing their views as liberal, 36% as moderate, and 32% as conservative. Due to sampling design, the sample is split evenly between California and New York residents and matches the demographic profiles of those states for race, household income, education level, and age (U.S. Census Bureau, 2019a,b). Almost all respondents (94%) live in urban areas; this proportion is similar to the urban-rural split of California (95% urban) and slightly higher than that of New York (86% urban) (U.S. Census Bureau, 2010). About half of respondents have kids under the age of 18 at home (44%) and have experienced a change in employment since the start of the pandemic (50%). At the time of the survey, only 11% of the sample reported having had COVID-19 symptoms or been diagnosed with the illness, while 34% knew someone who had symptoms of or been diagnosed with COVID-19.

Following the demographic groupings described in the Methods, the samples used in the analyses were split between 52% female (48% male), 43% low-income (57% high-income), and 54% non-white (46% white).

Changes in Frequency of Nature Access (RQ1)

Before the pandemic, respondents, on average, reported spending time in nature once or twice a week (mean = 2.07). Pre-pandemic reported time in nature was less for low-income and non-white groups compared to those who are high-income (diff = −0.35, $t = -4.82$, $p < 0.001$) and white (diff = −0.26, $t = -5.06$, $p < 0.001$).

During the pandemic, the average reported time spent in nature for all respondents decreased (mean = 1.75, $V = 442,912$, $p < 0.001$). All demographic groups reported a decline in time spent in nature during the pandemic (**Figure 1**; **Supplementary Table 3**). As with before the pandemic, reported time in nature during the pandemic was less for respondents who are low-income (vs. high-income; diff = −0.63, $t = -8.60$, $p < 0.001$) and non-white (vs. white; diff = −0.52, $t = -9.37$, $p < 0.001$). Pairwise comparisons and statistical results are shown in **Supplementary Table 2**.

Differences in reported frequency of nature access increased during the pandemic within all groups (**Figure 1**; **Supplementary Table 4**). Compared to before the pandemic, there was a greater decrease in the frequency of time spent in nature during the pandemic reported by women (difference from male respondents = 0.17, $F = 8.84$, $p < 0.01$), low-income respondents (difference from high-income = 0.28, $F = 13.06$, p

FIGURE 1 | Time spent in nature before and during the pandemic. Dots show mean ± SE. Significance at demographic group level (left brackets) is from mixed ANOVAs for differences between groups over time. Significance at group level is from t-tests for differences between groups at each time period (results are the same for pre-pandemic and mid-pandemic comparisons). $^{**}p < 0.01$, $^{***}p < 0.001$.
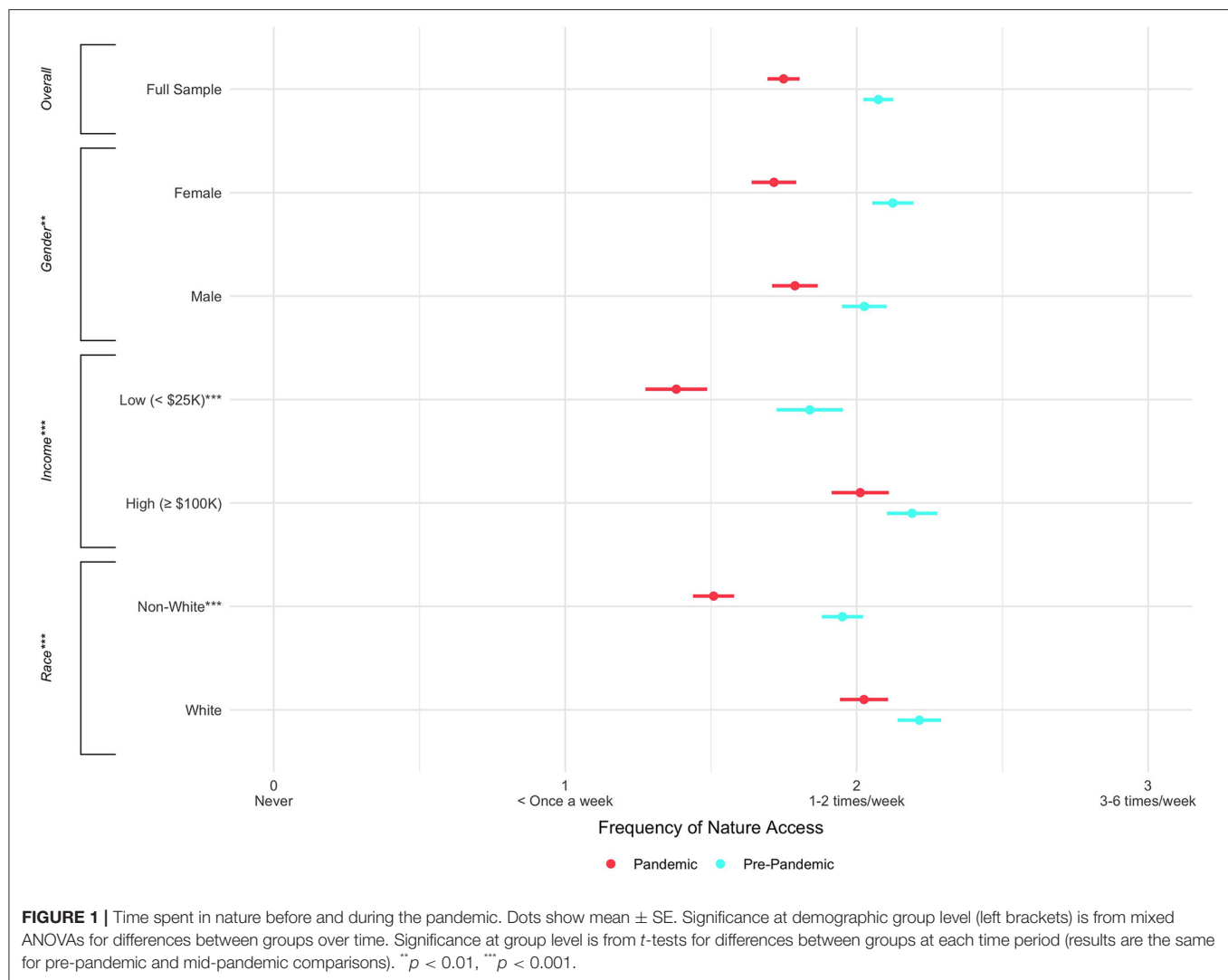
< 0.001), and non-white respondents (difference from white $= 0.25$, $F = 19.38$, $p < 0.001$; **Supplementary Table 3**).

Changes in Time Spent in Nature (RQ2)

Matching the results above, the most commonly reported experience for survey participants was spending less time in nature during the pandemic (52%), compared to 23% who reported spending more time in nature and 25% who reporte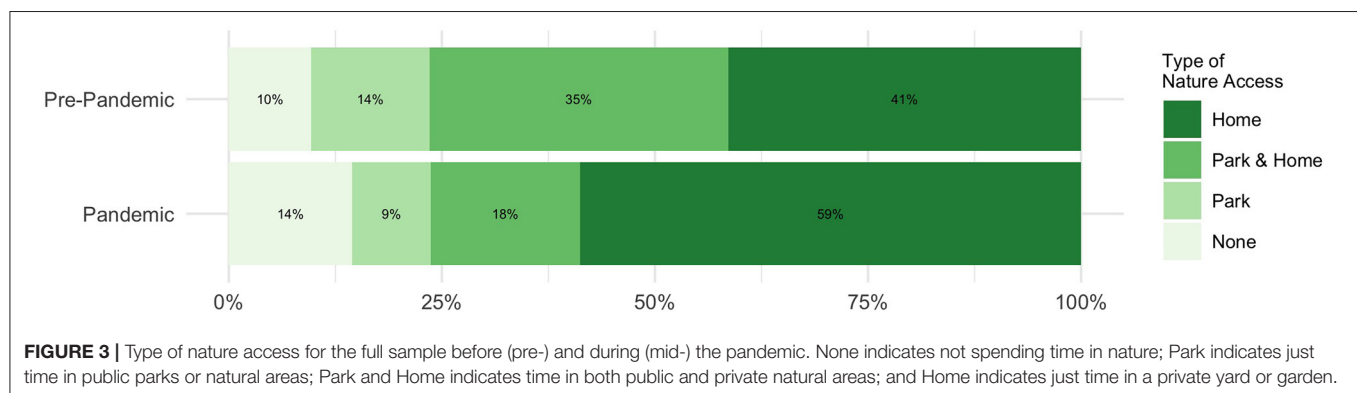d they spent the same amount of time in nature. Loss of time in nature was the majority response for each group (**Figure 2**). Within demographic groups, women ($\chi^2 = 15.8$, $p < 0.001$), low-income ($\chi^2 = 11.06$, $p < 0.01$), and non-white participants ($\chi^2 = 43.9$, $p < 0.001$) reported different pandemic nature experiences than their counterparts (**Figure 2**; **Supplementary Table 5**).

Type of Nature Access During the Pandemic (RQ3)

Prior to the pandemic, about 10% of the sample reported not typically spending time in nature or greenspaces at least once a week, while 14% spent time just in public parks or natural

areas, 35% in both public natural areas and a private yards or garden, and 41% in just a private yard or garden (**Figure 3**). During the pandemic, the proportions of the sample in two groups grew: those who reported not being able to spend time in nature (14%) and those who reported using only private nature access (59%). Whereas, the proportions who reported spending time just in public (9%) or in both public and private (18%) natural areas declined. This shift in nature access before and during the pandemic for the full sample is statistically significant (McNemar's $\chi^2 = 327$, $p < 0.001$; **Supplementary Table 6**).

Type of nature access before the pandemic differed within each demographic group (**Supplementary Table 7**). During the pandemic, types of nature access differed for some demographic groups but not all (**Figure 4**; **Supplementary Table 8**). Women and men reported similar nature access ($\chi^2 = 4.56$, $p = 0.21$), which was similar to the full sample distribution described above. Type of nature access during the pandemic was different, however, for low-income (vs. high-income; $\chi^2 = 72.2$, $p < 0.001$) and non-white (vs. white; $\chi^2 = 58.5$, $p < 0.001$) respondents. These groups were more likely to report not being able to

FIGURE 2 | Changes in time spent in nature during the pandemic by demographic group. Error bars represent SE of mean. Significance is from chi-squared tests within demographic groups. **$p < 0.01$, ***$p < 0.001$.

FIGURE 3 | Type of nature access for the full sample before (pre-) and during (mid-) the pandemic. None indicates not spending time in nature; Park indicates just time in public parks or natural areas; Park and Home indicates time in both public and private natural areas; and Home indicates just time in a private yard or garden.

spend time in nature (Income$_{diff}$ = 15.0 percentage points; Race$_{diff}$ = 7.7 percentage points) or to have spent time just in public nature areas (Income$_{diff}$ = 5.2 percentage points; Race$_{diff}$ = 6.5 percentage points). They were also less likely to report having spent time in a private yard (Income$_{diff}$ = −8.5 percentage points; Race$_{diff}$ = −8.7 percentage points) or both a private yard and public nature areas (Income$_{diff}$ = −11.6 percentage points; Race$_{diff}$ = −5.4 percentage points; **Supplementary Table 5**).

Perceptions of Nature-Related COVID Restrictions and Risks (RQ4)

Regarding nature-related COVID restrictions, 18% of the sample reported that they were required to stay at home in the previous 2 weeks. This experience was different for all three demographic groups (**Figure 5**; **Supplementary Table 9**). Women reported stay-at-home requirements 4.5 percentage points more than men (χ^2 = 6.74, $p < 0.01$), low-income respondents 8.7 percentage points more than high-income respondents (χ^2 = 13.2, $p <$

FIGURE 4 | Type of nature access during the pandemic by demographic group. None indicates not spending time in nature; Park indicates just time in public parks or natural areas; Park and Home indicates time in both public and private natural areas; and Home indicates just time in a private yard or garden. Significance is from chi-squared tests within demographic groups. ***$p < 0.001$.
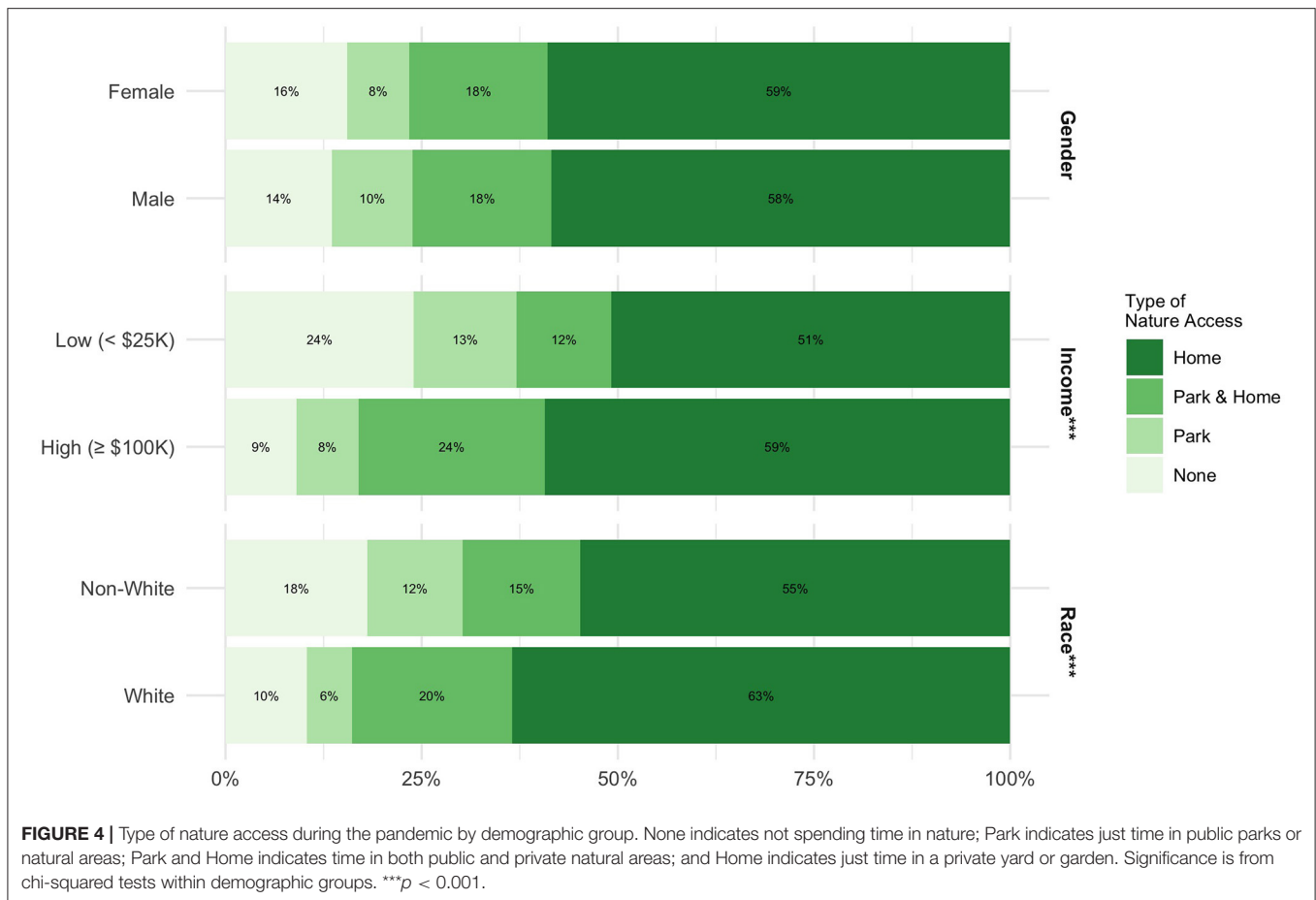
0.001), and non-white respondents 9 percentage points more than white respondents ($\chi^2 = 27.6$, $p < 0.001$).

About a quarter (23%) of the full sample indicated they were permitted to leave their homes to access public parks or natural areas but the public access points they typically use were closed. Gender ($\chi^2 = 0.18$, $p = 0.67$) and income ($\chi^2 = 0.0$, $p = 1$) groups experienced this COVID restriction similarly (**Supplementary Table 10**). However, non-white respondents reported closed access points more than white respondents (5.9 percentage points, $\chi^2 = 9.48$, $p < 0.01$).

A fifth (20%) of the sample said they were permitted to spend time outside but felt uncomfortable about the risk of exposure to or spreading COVID-19. While there was no difference in risk preferences by income ($\chi^2 = 1.14$, $p = 0.28$), discomfort was expressed by 23% of women (compared to 16% of men; $\chi^2 = 16.9$, $p < 0.001$) and 22% of non-white respondents (compared to 17% of white respondents; $\chi^2 = 6.28$, $p < 0.05$; **Supplementary Table 11**).

Non-white trends for each outcome measure described above (frequency of nature access, change in time spent in nature, type of nature access, and perceptions of nature-related COVID restrictions and risks) appear consistent across Hispanic, Black, and Asian respondents (**Supplementary Table 12**). As with the aggregate "non-white" grouping, each these races averaged

greater losses in the frequency of nature access and spending less time in nature than white respondents.

Predicting Changes in Time Spent in Nature

Results from the main multinomial regression model (**Table 2**) support those described above. When controlling for all three demographic characteristics and additional pandemic and household factors, women and non-whites were more likely to report spending less time in nature during the pandemic than men and whites [female = 5%, 95% CI (1, 9%); non-white = 9%, 95% CI (4, 14%)]. Non-whites were also less likely to report spending more time in nature than white respondents [−5%, 95% CI (−9%, 0%)].

As one would expect, having access to public parks, a private yard, or both were all associated with spending more time in nature compared to having no access to nature during the pandemic [public = 16%, 95% CI (9, 23%); private = 13%, 95% CI (8, 17); both public and private = 29%, 95% CI (23, 35%)]. The relationships between type of nature access and less nature are less clear—only those who had access to both public and private nature were less likely to report spending less time in nature compared to those who had no access [−17%, 95% CI (−25, −9%)].

FIGURE 5 | Perceptions of nature-related COVID restrictions and risks by demographic group. Error bars represent SE of the mean. Significance is from chi-squared tests within demographic group for each statement. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.
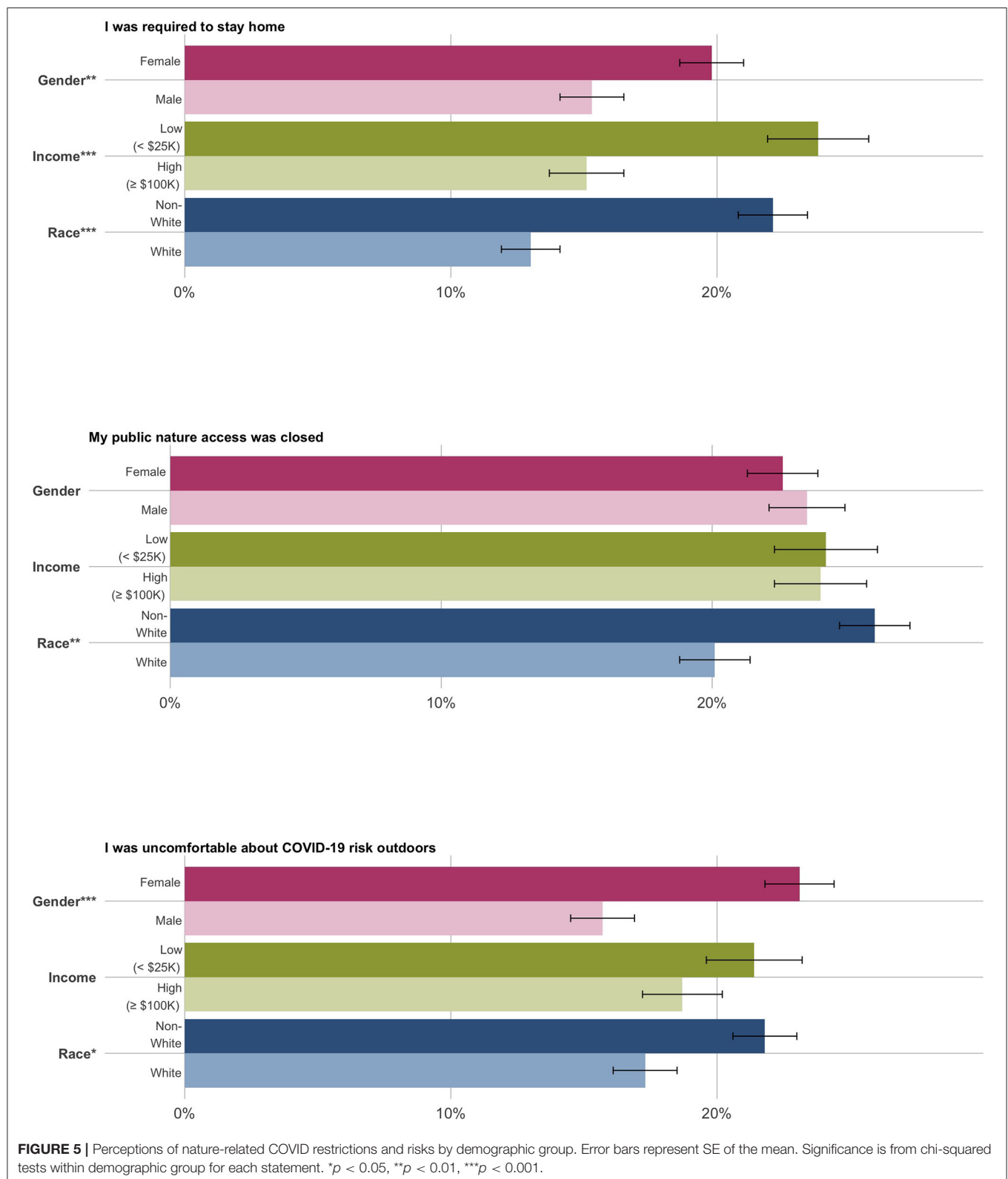
Perceptions of nature-related COVID restrictions and risks were associated with reported changes in time spent in nature. Less nature was associated with requirements to stay at home [16%, 95% CI (10, 21%)], closed public parks [9%, 95% CI (4, 14%)], and discomfort with the risks of catching or spreading COVID-19 outdoors [23%, 95% CI

TABLE 2 | Average marginal effects of demographic, pandemic, and household characteristics on reported change in time spent in nature since the pandemic.

	Less nature	More nature
Female	0.050	−0.008
	(0.006, 0.094)	(−0.046, 0.029)
	(0.025)	(0.663)
Low-income	−0.033	−0.023
	(−0.084, 0.018)	(−0.067, 0.021)
	(0.208)	(0.298)
Non-White	0.088	−0.045
	(0.039, 0.137)	(−0.087, −0.004)
	(0.000)	(0.032)
Access: public parks	−0.031	0.155
	(−0.121, 0.059)	(0.085, 0.225)
	(0.495)	(0.000)
Access: private yard	0.009	0.127
	(−0.055, 0.074)	(0.084, 0.170)
	(0.778)	(0.000)
Access: both public and private	−0.167	0.290
	(−0.245, −0.089)	(0.227, 0.352)
	(0.000)	(0.000)
COVID: stay at home	0.157	−0.080
	(0.101, 0.213)	(−0.126, −0.034)
	(0.000)	(0.001)
COVID: parks closed	0.092	−0.019
	(0.041, 0.142)	(−0.060, 0.022)
	(0.000)	(0.362)
COVID: risks outdoors	0.226	−0.102
	(0.175, 0.277)	(−0.144, −0.061)
	(0.000)	(0.000)
Change in employment	0.068	0.077
	(0.024, 0.111)	(0.040, 0.115)
	(0.002)	(0.000)
Kids at home	0.020	0.030
	(−0.026, 0.066)	(−0.009, 0.069)
	(0.386)	(0.129)
Nature relatedness (NR-6)	0.027	0.019
	(0.003, 0.050)	(−0.001, 0.040)
	(0.026)	(0.069)
30–49 years old	−0.018	0.002
	(−0.072, 0.035)	(−0.045, 0.049)
	(0.498)	(0.925)
Over 50 years old	−0.005	−0.058
	(−0.067, 0.056)	(−0.110, −0.007)
	(0.865)	(0.027)
Number of observations	1,998	1,998

Estimates are from multinomial regression on change in time spent in nature since the pandemic comparing against a baseline of "no change." Model coefficients can be found in **Supplementary Table 12**, *under Model (3). Low-Income indicates participants whose household income (hhi) is <$25,000; the comparison group in the model is all participants whose hhi ≥ $25,000.* **Supplementary Table 12** *shows results where the comparison group is high-income participants (hhi ≥ $100,000), which excludes nearly half of the observations, as described in Methods. Variables beginning with "Access" or "COVID" are based on responses to the survey questions in* **Supplementary Table 1**. *The model includes controls for state of residence and week in which the survey was completed. Coefficients (first row within each variable) show average marginal effects; confidence intervals in brackets; p-values in parentheses.*

(18, 28%)]. Conversely, more time in nature was negatively associated with stay-at-home requirements [−8%, 95% CI (−12, −3%)] and COVID risks outdoors [−10%, 95% CI (−14, −6%)].

Regarding individual characteristics, changes in employment and nature relatedness were associated with both less and more time in nature.

Simpler models that do not include all covariates show similar but stronger relationships between demographic characteristics and reported changes in nature (**Supplementary Table 12**). Adding an interaction term to the full model indicates that women with children at home were more likely to report spending less or more time in nature, compared to the same nature, and this moderation effect seems to drive the relationship between women and changes in nature (which becomes insignificant when including the interaction).

DISCUSSION

In Spring 2020, when the COVID-19 pandemic and associated lockdowns were at their height, the majority of respondents in our representative samples of California and New York residents reported losing nature exposure. This was true both for the frequency of nature access and for time spent in nature, regardless of gender, income or race. Most reported accessing nature less often and spending less time in nature than before the pandemic. This overall loss of nature was associated with perceptions of risks and restrictions from the pandemic, as well as reporting fewer options for nature access.

Importantly, this reported loss of nature was greater for women, low-income and non-white people than for their male, high-income, white counterparts. These findings parallel those from other studies using different methodologies: lower-income, communities of color reported losing time in and access to nature during the pandemic (Larson et al., 2021; Pearson et al., 2021). We also find that the pandemic seems to have exacerbated prior inequalities in nature access: low-income and non-white people reported spending even less time in nature and having fewer nature access options than they did before the pandemic. Such disparities have critical implications given the potential benefits to wellbeing of time in nature (Russell et al., 2013; Samuelsson et al., 2021; Stieger et al., 2021).

These results provide a new lens with which to view studies highlighting increases in nature use during the pandemic (e.g., Derks et al., 2020; Grima et al., 2020; Venter et al., 2020; Geng et al., 2021). While those aggregate numbers suggest people may have increased their nature exposure during the pandemic, we find the opposite to be true overall and especially among more vulnerable groups. Instead, others' results showing increases in nature usage during the pandemic may have been driven by a select population (male, higher-income, or white people) who had sufficient resources (time, money, access) and comfort to spend time outdoors.

Responses to our survey suggest how access and comfort may have influenced nature access for some groups. We found evidence for inequalities in the ways that different demographic

groups reported accessing nature. While reports of public nature access shrank overall, greater proportions of high-income and white respondents reported being able to spend time in a private yard or garden compared to low-income and non-white respondents—more of whom reported having just public nature access or no nature access at all.

Non-whites were also more likely than whites to report that they were required to stay home, their public nature access was closed, and they were uncomfortable about the risks of catching or transmitting COVID-19 outdoors. Regarding restrictions, it is unclear whether those are differences related to location (i.e., true differences in stay-at-home orders and park closures) or differences in perceptions of the personal relevance of those restrictions. Perhaps people of color expressed a heightened awareness of public orders because they were more sensitive to possible consequences of violating those orders or because they were more likely to hold an "essential" job that required leaving home. High-income respondents were also less likely to report that they were required to stay at home—a distinction that could be similarly related to privilege in employment options, perceptions of restrictions or actual differences in policy by location.

Women reported they were required to stay at home and uncomfortable about COVID risks outdoors more often than men. Different perceptions of restrictions could be related to rule-following: evidence has shown that women show a greater preference for acting according to moral norms (i.e., what's right) rather than possible consequences, compared to men (Friesdorf et al., 2015). Women also tend to be more risk averse than men (Eckel and Grossman, 2008). For gender differences, which often operate within a household, it is also possible that responses to the statement "I was required to stay in my home" were the result of household obligations rather than policy restrictions. Women have carried the burden of childcare during the pandemic and given up employment to do so (Heggeness and Fields, 2020; Heggeness et al., 2021); perhaps staying at home was seen as a function of those factors.

Finally, reported differences in nature loss for women and for nature loss and lack of gains among non-whites are robust when controlling for overlap between demographic characteristics and other factors, including job loss, children at home, and nature relatedness. This adds further support to the interpretation that systemic inequities in society and within the household were exacerbated during the pandemic in terms of access to nature. Our regression results also suggest that women were more likely to lose nature in part because they were shouldering the burden of kids at home more so than men.

Our results identify disparities in reported access to nature during the COVID-19 pandemic for certain demographic groups that have been disproportionately burdened by the pandemic's disruption and costs. Although we provide evidence from representative samples of two densely populated and pandemic-stricken regions of the United States, we cannot say whether our results generalize to people in other parts of the country or world. Populations in rural areas and regions with lower pandemic risks and restrictions likely experienced different or lesser changes in nature exposure. It is also likely that the pandemic had

different effects on certain subgroups within our demographic groupings (e.g., low-income vs. high-income women or Asian Americans vs. Hispanics). Interviews conducted around the time of our survey identify anti-Asian racism as a barrier for Asian Americans to spending time outdoors in public spaces (Maurer et al., 2021). Thus, while Black, Hispanic, and Asian survey participants reported a loss, on average, of time in nature during the pandemic (**Supplementary Table 12**), the reasons for this change could be distinct and related to racial identity. Possible differences between Asian and Hispanic respondents in nature access and risk perceptions, in particular, may point to the unique experiences of these two non-white groups. While these subgroup effects are beyond the scope of our investigation, we encourage future research to explore these important differences and move beyond the binary categorizations used in this study.

It is worth noting that the measures used in this study are self-reported and comparisons to pre-pandemic baselines are sensitive to the reliability of respondents' recall. The pandemic's disruption to people's schedules and wellbeing may have influenced how well people were able to remember their prior nature experiences. Surveying participants before and again during the pandemic would have provided more reliable responses. Still, asking participants to report how their time in nature has changed provides insight into their perceptions of how the pandemic has affected their ability to spend time in nature. These results also complement recent work using objective measures of greenspace to identify dual disparities in nature access and COVID-19 case rates (Spotswood et al., 2021). While prior evidence shows time spent in nature can improve wellbeing, we recognize that the COVID-19 pandemic generated unprecedented stress in daily life. Although we do not offer evidence on the possible benefits of the nature-related outcomes measured, subsequent analysis will test for associations between these outcomes and participants' self-reported mental health (see text footnote 1).

We also note that preferences for time in nature are not universal, and some people may choose to spend less time outdoors. While these preferences may vary by gender—women often score higher than men on scales measuring connectedness to nature (Cervinka et al., 2012; Wyles et al., 2019; Rosa et al., 2020)—it is not clear that nature preferences vary consistently by race or income. Literature that claims blacks and other non-white groups are disconnected from nature has been challenged by more recent and nuanced work, which finds little or no difference in nature affinity between races and calls for greater cultural sensitivity in how preferences are measured (Kellert et al., 2017; Taylor, 2018, 2021). In our study, women and non-whites were more likely to report losing time in nature even when controlling for nature relatedness, a scale that is similar to others used to measure nature affinity (Howell et al., 2011; Tam, 2013). Future qualitative research could help illuminate the complexities between racial identity and preferences for and barriers to accessing nature (e.g., Maurer et al., 2021). Although our results do not allow us to say *why* we observe demographic differences in frequency of nature use before and during the pandemic, the observed racial and socioeconomic disparities echo results from other studies: non-white and

low-income groups have fewer urban green spaces (Rigolon, 2016; Landau et al., 2020; Spotswood et al., 2021) and greater barriers to spending time in nature (Kellert et al., 2017; Scott and Lee, 2018). Regardless of preferences, these inequities mean that such groups are deprived the opportunity to capture nature's benefits to health and wellbeing. Populations living in the greenest environments have the lowest income-related health inequality (Mitchell and Popham, 2008).

The results from our study can also be viewed as contribution toward understanding the unequal effects of disturbances on vulnerable populations. Our results show that the COVID-19 pandemic affected groups differently in how they reported accessing nature and exacerbated existing inequalities. This is consistent with the literature showing the unequal impacts of the pandemic on other outcomes, including morbidity (Bui, 2020; Gross et al., 2020; Karaca-Mandic et al., 2021), employment (Montenovo et al., 2020; Weill et al., 2020), and childcare (Heggeness and Fields, 2020; Heggeness et al., 2021). Together, these trends are in line with broader research showing that economic downturns, natural disasters, and climate change tend to widen inequalities (Diffenbaugh and Burke, 2019; Hong et al., 2021; van Bavel and Scheffer, 2021). On the other hand, the COVID-19 pandemic may be unique in its effect on nature exposure and access. By simultaneously limiting peoples' movement and limiting social engagement to outdoor settings, the pandemic and associated lockdown measures acted to prohibit and facilitate nature access *via* mechanisms that are unlikely to exist in other disruptive events.

In addition to strict pandemic lockdowns during our survey period, the United States saw heightened racial tensions. The death of George Floyd and subsequent Black Lives Matter protests occurred nationwide while our survey was in the field. While it is unlikely that these events affected the nature access outcomes measured in our survey, they do highlight the relevance of this investigation. Racial inequities in the United States persist in the criminal justice system, public health, education, and other public services. Although access to nature is a minor concern in comparison, environmental injustices are impactful and widespread. Many of these injustices are related to where people live—in green neighborhoods with park access, or in under-resourced neighborhoods with poor infrastructure or near polluting industries. Moreover, projections of population and land use changes find that non-white and lower income populations are more likely to lose out on a range of benefits from nature in the future (Gourevitch et al., 2021). Nature access may be part of a suite of policy interventions to address public health inequalities. We hope that these results are useful to organizations working to advance environmental justice, policymakers who determine the location of and investment in greenspace in urban areas, and decision makers who can foster resilience against future disturbances.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

This study was reviewed and approved by Sewanee: University of the South IRB. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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SUPPLEMENTARY MATERIAL

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The Multifaceted Impact of COVID-19 on Social Media Users' Wellbeing and Relationship With Urban Nature

Michelle L. Johnson[1]* and Sonya S. Sachdeva[2]

[1] USDA Forest Service, Northern Research Station, New York City (NYC) Urban Field Station, Bayside, NY, United States,
[2] USDA Forest Service, Northern Research Station, Evanston Field Office, Evanston, IL, United States

As the coronavirus disease 2019 (COVID-19) pandemic has unfolded, the media is increasingly recognizing the value of urban nature, with greenspace use increasing. In cities, where people often lack access to private greenspaces, parks and other urban greenspaces offer opportunities for exercise and physically distanced socializing. Previous research has demonstrated the benefits of urban greenspaces to both physical and mental health, during times of relative stability. Here, we seek to examine how people's responses to greenspace are affected by a global pandemic, which uniquely affects both physical movements and mental wellbeing in the population at large. We compare tweets focused on nature- and greenspace-related keywords and hashtags from March to July 2019 with tweets from the same period in 2020 for metropolitan regions in the United States. We also examine the influence of stay-at-home restrictions in 2020. These posts reinforce findings from conventional survey approaches showing that people's relationship to greenspace is multifaceted. Furthermore, the results of our pre–post analysis of people's outdoor use suggest that the pandemic has had a differential impact on these multifaceted dimensions of people's engagement with nature. By applying a multidimensional construct of wellbeing, we identify *Positive emotion*, *Positive relationships*, and *Meaning* as subfactors of wellbeing that potentially can be increased by urban nature. These findings are important in demonstrating that greenspace in cities played a critical role in individuals' resilience and wellbeing during the early months of the pandemic and highlighting the need for maintaining and expanding access to urban greenspaces in the future, for the benefit of all city residents.

Keywords: wellbeing, socializing, COVID-19 pandemic, urban nature, greenspace, nature connection

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic is a new type of disturbance in its spatial and temporal reach. At the time of publication, more than 5 million individuals died of COVID-19 worldwide, since November 3, 2019 (World Health Organization, 2021). Physical distancing measures (Perra, 2021), necessary to stem the transmission of airborne illnesses, in particular, uniquely affect people's physical movements (Stockwell et al., 2021) and mental wellbeing (Pfefferbaum and North, 2020; Twenge and Joiner, 2020). Gym closures and other movement constraints from lockdowns contributed to reductions in physical activity, which can in turn affect mental health (Maugeri et al., 2020). As physical health and mental health during the

COVID-19 pandemic are intertwined, quarantine-induced psychosocial stress also affects physical health factors, such as cardiovascular risk burden (Mattioli et al., 2020). Anecdotal evidence suggests that the pandemic and its resultant stressors, including limitations on travel and other recreation activities, have sent people in droves to seek respite in natural spaces. For instance, much has been made of a "mass" urban migration for city dwellers seeking to move to suburban and rural areas with more outdoor space (Whitaker, 2021) and the observed record-breaking visitation rates at public parks (Geng et al., 2021), which in some instances are to the detriment of the physical distancing measures (Wynveen et al., 2021). Some evidence supports benefits to residents' mental and physical health from exposure and access to greenspace in times of stability (Hartig et al., 2014; Kondo et al., 2018), but in the case of a profound disturbance such as the COVID-19 pandemic, little is known about the role greenspaces may play in fostering resilience, wellbeing, and mental health.

Greenspaces have also played roles in individual and community recovery after natural and anthropogenic disturbances. Often after disturbances, greening activities are taken up by communities, as a way to memorialize what is lost, as happened in New York City after September 11 and in New Orleans after Hurricane Katrina (Tidball et al., 2010). Tidball (2012) theorizes the concept of "urgent biophilia", or seeking out nature during a crisis, can act as and activate a source of resilience in postdisaster settings. Place attachment held by individuals can affect individuals' wellbeing and resilience postdisaster. After destructive fires in Australia, a strong attachment to the environment was associated with a reduction in stress, fewer depression and fire-related posttraumatic stress disorder (PTSD) symptoms, and higher resilience, posttraumatic growth, and life satisfaction (Block et al., 2019). With COVID-19 continuing as a pressing stressor, there is a need to examine these relationships among greenspace, behaviors, wellbeing, and individual and community resilience.

Advances in technology have enabled a revolution in data availability about people's attitudes, behaviors, and experiences. Traditional social science methods include interviews, surveys, participant observation, and focus groups; these methods have high reliability and validity but are time-intensive and, aside from surveys, more challenging to implement during social distancing measures imposed by the COVID-19 pandemic. With the advent of "big data", social media can provide crowdsourced, geotagged data about people's experiences and interactions in parks and greenspaces that enable us to study visitor use and experience in new ways (Wilkins et al., 2021). At the same time, rigorous, automated approaches are needed for expanding such analyses when analyzing social media texts (Johnson et al., 2019). Topic modeling, or segmenting text datasets into categories or topics, is one type of approach that enables the examination of social media content as applied to park experiences (Schertz et al., 2018). Standardized lexicons are another form of content analysis increasingly applied to social media texts (Schwartz and Ungar, 2015). In this work, we aimed to understand the impact of the COVID-19 pandemic. Using social media data paired with county-level measures of greenspace, social vulnerability, population density, and stay-at-home orders, we rapidly collected data to examine wellbeing and greenspace relationships with linguistic approaches to tweet content (i.e., a validated wellbeing lexicon and topic modeling) within cities and urbanized areas in the United States (US), in order to examine the following hypotheses:

- H1: Human wellbeing at the county scale (e.g., county-level wellbeing) is associated with the amount of greenspace available in a county, both prepandemic and during the COVID-19 pandemic.
- H1b: Some components of wellbeing are more associated with greenspace during the COVID-19 pandemic than in the prepandemic data period.
- H2: Nature-based topics, particularly those that describe the use of nature to cope with stressors, are more strongly and positively associated with county-level wellbeing than other nature-based topics.

Background
Subjective Wellbeing

Multiple approaches exist to both define and measure subjective wellbeing, with no single definition. The World Health Organization defines mental health as "a state of wellbeing in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community" (World Health Organization, 2005). Rather than defining wellbeing as the lack of negative psychological states, positive psychologists consider wellbeing to be a measure of flourishing (Seligman, 2011). Subjective wellbeing studies have shown a positive correlation between emotional resilience (self-adjustment and recovery from stress) and the restoration of wellbeing and positive emotions (Bonanno, 2004; Pan and Chan, 2007).

One approach for measuring subjective wellbeing is the PERMA model by Martin Seligman (2011, 2018). PERMA is a multidimensional approach to measuring wellbeing, incorporating *Positive emotion* (P), *Engagement* (E—psychological connection to activities or organizations), *Positive relationships* (R—socially integrated, cared about, supported by), *Meaning* (M—belief one's life is valuable, connected to something greater than oneself), and *Accomplishment* (A—progress toward goals, capable of daily activities, having a sense of achievement) (Seligman, 2011). For application, global measures offer little guidance on how to increase level of wellbeing. In contrast, PERMA provides more specific information to better meet wellbeing needs of communities through offering multiple dimensions that may relate in different ways to different phenomena, rather than a coarser measure of overall wellbeing (Kern et al., 2015).

Wellbeing and Greenspace Access and Use

The relationship between wellbeing and greenspace is well-studied, although mechanistic evidence is mixed. Two main theories focus on the causal mechanism for the benefits of greenspace: stress recovery theory (Ulrich et al., 1991)

and attention restoration theory (Kaplan, 1995). Neither of these theories addresses social context (Marselle, 2019). Biophilia's (Wilson, 1993; Tidball, 2012) role in wellbeing is increasingly examined through the concept of nature connectedness (Capaldi et al., 2014; Cleary et al., 2017), alongside self-determination theory (Ryan and Deci, 2000), which differentiates intrinsic and extrinsic motivations. Other explanations for wellbeing/greenspace relationships hypothesize that natural environments are lower in environmental "bads" such as air pollution (MacKerron and Mourato, 2013), and greenspaces encourage positive behaviors (Barton and Pretty, 2010). Being outdoors in greenspace can allow for physical activity and increase social contact, both of which can positively affect psychosocial wellbeing (Fox, 1999; Kawachi and Berkman, 2001; Houlden et al., 2018). Further unpacking this relationship, Barton et al. (2012) found support for higher self-esteem and mood for individuals engaging in green exercise vs. socially focused indoor exercise, highlighting that exercise, nature, and social factors all are critical to wellbeing. In a review of urban greenspace and overall health, Kondo et al. (2018) found positive associations between urban greenspace exposure and attention, mood, and physical activity, but mixed or no association with depression, stress, or physical health factors. Mechanisms that may explain relationships between subjective wellbeing and nature connection include the psychological need of relatedness (in greenspaces, non-human relatedness) and a fostering of intrinsic value around nature, satisfying an innate biophilic need (Cleary et al., 2017).

Increasingly, large-scale datasets, including social media, are used to examine wellbeing/greenspace relationships. In a study of US cities, park quantity was a strong predictor of survey-derived overall wellbeing at the city scale, in part driven by parks' contributions to physical and community wellbeing (Larson et al., 2016). Schwartz et al. (2020) applied sentiment analysis to tweets for 10 major US cities, finding people write happier tweets inside parks as compared with tweets outside of parks. Recent lexicon and data-driven efforts have been developed to examine subjective wellbeing using social media datasets; an early article in this field of work found subjective wellbeing *via* a validated PERMA-weighted lexicon across the United States to be correlated with three nature/outdoor topics (Schwartz et al., 2013). A similar analysis applied Schwartz's PERMA lexicon to Chinese cities, finding a positive relationship between the amounts of greenspace in cities with subjective wellbeing for all cities in the analysis (Zhao et al., 2019). Validation efforts have found the PERMA-weighted lexicon to perform better than other word-based lexicons, but not as well as data-driven methods for automated text analysis, which are emerging (Jaidka et al., 2020). Such big data efforts enable the scale of analyses to readily expand, but also have potential issues with biases that representative surveys do not, such as only certain segments of the broader population can access or choose to use social media (Gruebner et al., 2017).

Nature as Coping Strategy During Disturbances

Greenspace may serve as treatment for populations who experience traumatic events (Poulsen, 2017). When examining relationships among post-traumatic stress disorder (PTSD) symptoms, neighborhood greenness, neighborhood social cohesion, and emotional resilience, Li et al. (2021) found support for emotional resilience to mediate the relationship between greenness and reduced PTSD after Hurricane Harvey. Nature attachment was associated with fewer symptoms of depression and PTSD post-bushfire in Australia (Block et al., 2019). Emotions can become intensified during disasters, leading the everyday and taken-for-granted, like nearby nature, to become of critical importance.

Recent research of the ongoing COVID-19 pandemic has provided further insight into the role of nature in relation to subjective wellbeing (Jackson et al., 2021) and as a coping mechanism (Robinson et al., 2021). Activity changes around nature have also been identified during the pandemic, with increased gardening, hiking, and wildlife watching, along with changes in socializing; activity changes also vary by demographics such as gender, urban/rural location, and employment status (Morse et al., 2020). Greening both indoors and outdoors (Dzhambov et al., 2021) and both in public and private spaces (Poortinga et al., 2021) is associated with higher subjective wellbeing. In addition, greenspace research during the pandemic has highlighted how existing inequities in access to greenspace have been maintained and exacerbated by the pandemic; Burnett et al. (2021) in the United Kingdom and Jay et al. (2021) in the United States point to differential access and use of greenspace as a function of movement restriction through stay-at-home orders during the pandemic. The amount of greenness in a neighborhood also positively affected physical activity during the pandemic (Yang et al., 2021).

To further examine wellbeing/greenspace relationships, we examine the online discourse around nature and greenspace in cities and urbanized regions in the United States before and during the early months of the COVID-19 pandemic. In doing so, we evaluate county-level wellbeing in relationship to nature characteristics and experiences. We apply a validated PERMA-weighted lexicon and topic models to tweets to examine these relationships.

METHODS

We collected tweets with nature- and greenspace-based keywords and hashtags originating in the United States from January 1, 2019, through July 31, 2020 (**Table 1**). These keywords and hashtags were selected *via* a manual, iterative process beginning with the primary search terms of interest (e.g., nature AND park) and expanding by assessing which words and hashtags seem to occur most frequently in tweets that discussed nature and parks. In particular, the seasonal terms were not part of our initial search but rather derived from this iterative process from observing that users talking about outdoor recreation were also quite likely to mention seasonal terms. This methodology ensured that we focused on nature and greenspace conversations in our analysis. We used Python (v3.8.6) and Twitter's Application Programming Interfaces to collect, parse, and preprocess this json dataset (Sanner, 1999). Preprocessing steps include word lemmatization (as an alternative to stemming), stop word and punctuation removal, and deduplication (including omitting retweets). Preprocessing steps utilized the spaCy library (v3.0.0)

TABLE 1 | Nature and greenspace keywords and hashtags included in search parameters for collecting tweets.

Outdoor* AND recreat*

Forest AND recreat*

Outdoor* AND fun

Time AND outdoor*

Natur* AND fun*

Natur* AND recreat*

Park AND natur*

Park AND outdoor*

Park AND natur* AND outside

Walk* AND natur

Trail AND natur*

Trail AND outdoor*

in Python. This led to a corpus of 2,586,435 tweets; we excluded tweets without latitude/longitude or a city location (e.g., state-only location, no location), resulting in 971,968 tweets retained for analysis.

To understand the semantic content contained within the set of tweets, we fit an unsupervised latent Dirichlet allocation (LDA) topic model with 20 topics using the gensim library (v3.8.0) in Python. Topic models are a widely used class of methodologies to infer semantic structure within text corpora (Valdez et al., 2018). The LDA-based topic model used here resulted in a set of 20 topics, which are represented as groups of semantically related words, with each group comprising an idea or "topic". Of the 20 unsupervised topics, we retained the 10 topics for analysis that addressed aspects of nature and/or greenspace we believed to be relevant to the hypotheses being tested (**Table 2**, see **Supplemental Material 1** for most abundant words for all 20 topics). Other emergent topics appeared to be unrelated to nature for the current purposes (e.g., topics about natural hair and beauty) or tangential to the topic of study (e.g., topics about patio furniture). The full set of topics can be explored further *via* the **Supplementary Materials**. To derive topic labels, we reviewed the most characteristic and salient terms for each topic, as well as analyzing the top 30 tweets most representative of each topic by topic proportion. This iterative analysis allowed us to get a sense of the idea or theme each topic touched upon and label it accordingly.

To derive a measure of wellbeing, we also applied the PERMA-weighted lexicon (see Schwartz et al., 2013, 2016) to each tweet. The PERMA lexicon consists of 12,642 terms that have been assigned scores on the negative and positive dimensions of each PERMA category (i.e., *Positive emotion, Engagement, Positive relationships*, etc.). We then matched the words within each tweet to the PERMA lexicon, finally summing the weight of each relevant word within the tweet for each of the 10 components (negative and positive) of the PERMA model. Individual values for positive and negative components were then standardized using z scores before combining to create overall measures of each subfactor and an overall index of wellbeing, per Zhao et al. (2019), as each component had different ranges.

We then tagged all tweets, with their 10 topic model themes and positive PERMA measures, to county-level data using

a geocoded city location or, if available, exact latitude and longitude from individual tweets to US counties (see Schwartz et al., 2013). The majority of tweets occur within cities and/or urbanized areas (**Figure 1**). We joined additional variables to this county-level dataset, including percent conserved greenspace in county (US Geological Survey and Gap Analysis Project, 2020), county-level social vulnerability indices [SVI, Centers for Disease Control and Prevention (CDC), 2018], population density [American Community Survey 5-year 2013-2018, Centers for Disease Control and Prevention (CDC), 2018], and state-level stay-at-home orders during the pandemic (Argonne National Laboratory, 2020). We selected these variables in order to control for variation across counties (county-level social vulnerability, population density) or to examine hypotheses (percent greenspace, stay-at-home orders). The SVI dataset ranges from 0 = lowest vulnerability to 1 = highest vulnerability. Percent conserved was calculated from the Protected Areas Database, including only protected lands that are publicly accessible; these lands could either be public or private lands with conservation easements and public access (US Geological Survey and Gap Analysis Project, 2020). Population density was calculated as the number of people per square mile in a county, using the total population values from the US Census provided in the SVI dataset [Centers for Disease Control and Prevention (CDC), 2018]. Year was coded as a factor. Stay-at-home orders were coded as a 0 (not present) or 1 (present) for tweets' dates that overlapped with stay-at-home order durations by state. Datasets were joined using both ArcGIS Pro [Environmental Systems Research Institute (ESRI), 2019] and R version 3.2.3 (R Core Team, 2015). We compared differences in medians between 2019 and 2020 using the Mann–Whitney U-test in R (R Core Team, 2015); for all topic and wellbeing comparisons, the data had the same distribution for the two years.

Finally, we developed four sets of mixed-effects models regressed against the PERMA index: (1) including all tweets from January 1 to July 31 for the years 2019 and 2020; (2) only including tweets from January 1, 2019, to July 31, 2019; (3a) only including tweets from January 1, 2020, to July 31, 2020, during the early months of the COVID-19 pandemic; and (3b) including stay-at-home orders in the 2020-only model, as these data did not exist for 2019. All model analyses were developed using the lme4 package (Bates et al., 2015) in R version 3.2.3 (R Core Team, 2015). The pandemic tweets model (2020-only, with stay-at-home orders) also was regressed against all five individual subfactors, P—*Positive emotion*, E—*Engagement*, R—*Positive relationships*, M—*Meaning*, and A—*Accomplishments/achievements*. Individual subfactors included both positive and negative aspects. All models included county and week as random effects.

RESULTS

Tweet-Level Analysis
Nature-Themed Topics
Our 10 retained topics addressed various facets of nature and greenspace, including conditions (*Seasonal weather*,

TABLE 2 | Exemplar tweets by retained topic, in order of prevalence.

2019 (Prepandemic)	2020 (During pandemic)
T13: Seasonal weather	
Definitely like spring semester better actually wake light cold body wanna fall semester hella gloomy dark of outside cold of morning bed comfy	*Outside degrees inside degrees today forecast says high heat getting trapped inside feel hotter gotten peak summer looking forward fire season*
Stepped outside warm car literally feels like going snow went warm weather freezing okay cause winter ready lol stay warm	*Bedroom window open smell hear rain outside nice breeze coming love miss alabama summer nights girl south girl*
T7: Socializing outdoors (safely)	
Summer safety tips summer great time kids enjoy different indoor outdoor activities young children teens learn ways kids safe healthy enjoy	*Summer officially 4th July weekend want community members lots fun sun encourage safe enjoying outdoor activities check seizure safety*
Summer activities plan pet beautiful long days ahead place outdoors time planning exciting summer adventures spending time exploring making	*Lots great ways stay fit active summer aware ways safely getting outside lower risk opportunity enjoy summer sunshine fun stay safe*
T6: Nature appreciation	
Heart filled omnipresence nature shall life filled love words true love exists fall love earth divine love	*Meditation walks nature beautiful music brings love joy bliss etc. consciously moment focus living love heart know need love light*
Choose memories things choose peace stress choose nature hustle bustle city choose love ones choose instead	*Blessed beautiful heart powerful child god image fall nature warrior extraordinary human respect treat love amazing*
T15: Urban ecology/climate change concern	
People live city urban growth mean nature asks empower cities plan positive natural future read+ blog rt	*Interested role forests storing carbon natural climate solutions talk role forest management working lands*
Biodiversity crisis directly threatens human loss wide variety nature services share agree protect ocean 30 by 30 sea hope save the ocean	*Sheer idea stop planet natural evolution shows huberious species multiple cities ocean species built cities dah*
T12: Birds/wildlife	
Went walk morning Beth baby got big turtle lots little ones Florida get outside turtle	*Went walk tonight usual spot dog seen deer times close good shot tonight got lucky enjoy the world we live in enjoy the small things deer nature*
Little fuzzy babies hatched days ago look big nature spring robin nest bird	*Good morning early birds night owls heard different birds morning hear wonder sun today rain kindergarten rocks remote learning*
T1: Urban nature as amenity	
Immersed natural splendor surrounded water Charleston boasts beautiful wide beaches island offering guests unique experience minutes	*Novel coworking river north building Chicago private offices gorgeous natural light modern amenities historical setting book virtual tour location*
Looking privacy nature miss beautiful river valley property stunning river views rolling hills nature amenities property offer exitdubuque	*Real view midtown Manhattan wollman rink central park manhattan nyc arrandr piaf New York Central park architecture nature*
T19: Hiking/camping/beach/vacation	
Howdeeplures killamarikokanee fishing fish nature fishing life outdoors bassfishing ocean fisherman fly fishing angler kokanee addicts like	*Great trail hikingutah awesome ljtrekker hiking mountains nature adventure outdoors hike forest trail trekking trails Utah adventures wanderlust*
Conquer kyndley adventure coolerbag outdoors hiking camping trails beach paradise summer travel nature California free solo Yosemite climbing	*Raidas_life California favorite hikes hiking hike outdoors California trail traveling hiker traveler scenery Cali girls who hike hiking adventures*
T10: County/state/national park status	
U.S forest service says soon begin repairs land lakes national recreation area t	*Joshua tree California south entrance national park Joshua tree south entrance*
Icymi volunteers helped Joshua tree national park open shutdown desert park close	*Great outdoor spaces historic national road Washington county md open recreation*
T11: Outdoor events	
Set ready today gumbo limbo park pm gumbo limbo environmental center nature complex	*Outdoor fun continues august free person programs park details registration arlingtonva*
Officially start summer hours today museum open Monday Saturday p.m. Sunday p.m. kiddie land outdoor rides open Wednesday Sunday	*Fun learn history muscoot farm nature centers Saturday Jan times details my Westchester*
T18: Gardening	
Spring blooming backyard flowers flowerstagram garden gardening beauty nature natural bloom zinnia	*Grow elderberries super easy visit elderberry elderberries herbs garden gardens home gordening flowers landscaping nature diy flower summer*
Flower dirt flowers flower socialenvy petal petals nature beautiful love pretty plants blossom sopretty spring summer flowerstagram	*Cozy British house colorful garden spring home gardens nature flower*

County/state/national park status), activities (*Socializing outdoors, Hiking/camping/beach/vacation, Outdoor events*, and *Gardening*), experiences (*Nature appreciation, Birds/wildlife*), values (*Urban nature as amenity*), and concerns (*Urban ecology/climate change concerns*) (**Table 2**). *Seasonal weather*,

which comprised seasonal terms such as "summer," "winter," "spring," and "fall," was the most prevalent nature-related topic at 9.83%. *Socializing outdoors* (8.95%), which comprised terms such as "time," "outdoors," "summer," "fun," and *Nature appreciation* (6.57%), with terms such as "nature," "love," "life," "walk," were
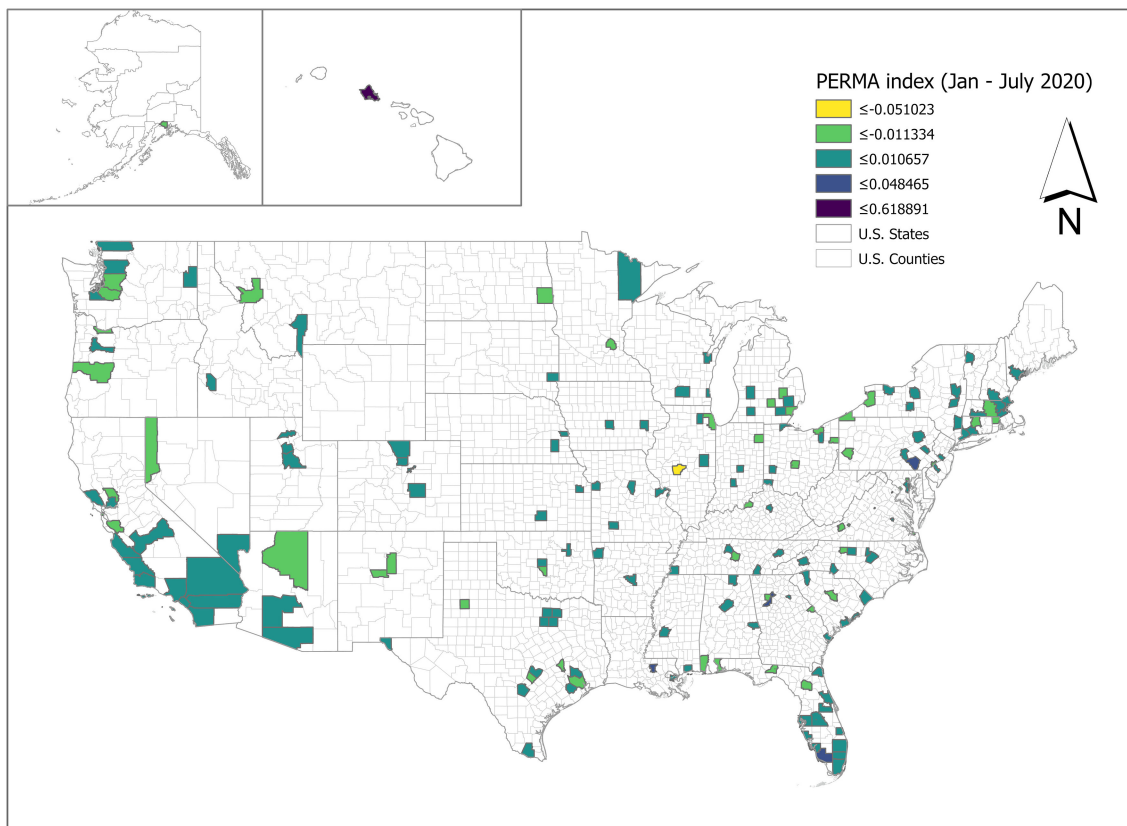
FIGURE 1 | Overall PERMA index for counties with $n \geq 300$ tweets (January to July 2020).

the next most prevalent. The topic labeled *Outdoor events* (4.44%), made up of terms such as "join," "outdoor," "p.m.," "summer," and *Gardening* (3.92%), with terms such as "garden," "spring," "nature," and "flower," were the least prevalent of the nature-related tweets (**Table 3**). Overall, nature-themed topics occurred in 60.4% of the overall tweet dataset.

Plotting topics over 2019 and 2020 revealed both similar and different trajectories of topics across time. For example, the topic labeled *Seasonal weather* showed a distinct cyclic pattern, peaking in early spring in both 2019 and 2020, although the peak was somewhat dampened in 2020 as the onset of the pandemic became clearer. Topics about socializing outdoors increased over time and became more prevalent in 2020, as compared with 2019. Similarly, the *nature appreciation* and *birds/wildlife* topics also increased over the analytic period and became significantly more prevalent in 2020 as compared with 2019, as did the topic about safely socializing outdoors (**Figure 2**).

We also observed topic prevalence to differ between years for all 10 topics, with 2020 seeing an increase in *Nature appreciation* (Mann–Whitney *U*-test, $W = 1.1537 + e^{11}$, $p < 0.00001$) and *Birds/wildlife* ($W = 1.2291 + e^{11}$, $p < 0.00001$) topics. We also observed *Socializing outdoors (safely)* ($W = 1.2146 + e^{11}$, $p < 0.00001$) to increase in discussion during 2020, in comparison with 2019. Activities described in tweets align with nature-based activities also varied among the two years, with *Gardening* increasing ($W = 1.2419 + e^{11}$, $p < 0.00001$) and

Hiking/camping/beach/vacation decreasing ($W = 1.1737 + e^{11}$, $p < 0.0001$).

Subjective Wellbeing

Plotting the overall PERMA index and individual subfactors identified differences in wellbeing between 2019 and 2020 (**Figure 3**). For all measures, values in 2019 were higher at the same point in time in 2020, and overall, values were consistently higher in 2019 than 2020. In 2019, the overall PERMA index was highest in April and May, whereas it was lowest in March and April in 2020 (between years comparison, Mann–Whitney *U*-test, $W = 1.2471 + e^{11}$, $p < 0.00001$). Individual subfactors vary somewhat over time between January and July for both years, with *Accomplishment* at a high during April and May in 2019 and relatively flat in 2020, with a slight increase in June and July (between years comparison, $W = 1.2424 + e^{11}$, $p < 0.00001$). Positive emotion was higher in 2019 than 2020, with February through April 2020 slightly lower than other months in 2020 (between years comparison, $W = 1.2499 + e^{11}$, $p < 0.00001$). Engagement was higher in 2019 than 2020, with 2020 seeing a slight increase after May 2020 and during this time period, *Engagement* was higher than other subfactors of PERMA (between years comparison, $W = 1.2171 + e^{11}$, $p < 0.00001$). *Positive relationships* and *Meaning* increased over time in 2019 before flattening out in May 2019 and they both saw a slight reduction after January 2020, remaining relatively even through

TABLE 3 | Topic prevalence and top 10 words for nature-themed topics.

Topics	Prevalence	Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	Word 7	Word 8	Word 9	Word 10
T13: Seasonal weather	9.83%	Outside	Summer	Winter	Spring	Like	Fall	Weather	Hot	Day	Cold
T7: Socializing outdoors (safely)	8.95%	Time	Outdoors	Outdoor	Summer	Fun	Great	Enjoy	Family	Kids	Day
T6: Nature appreciation	6.57%	Nature	Life	Love	Walk	World	Find	Walks	Things	Mother	God
T15: Urban ecology/climate change concern	5.97%	Natural	City	Nature	People	Water	Urban	Forest	Gas	Help	New
T12: Birds/wildlife	5.82%	Nature	Walk	Today	Day	Morning	Birds	Wildlife	Beautiful	Little	Trail
T1: Urban nature as amenity	5.52%	Park	City	New	Natural	River	Lake	Outdoor	Area	North	Home
T19: Hiking/camping/beach/vacation	4.66%	Nature	Outdoors	Hiking	Adventure	Hike	Travel	Lake	Ocean	Beach	Camping
T10: County/state/national park status	4.55%	Park	National	State	Recreation	Parks	Nature	Tree	Public	Closed	County
T11: Outdoor events	4.44%	Join	Outdoor	Pm	Summer	Free	Saturday	Park	Today	Day	June
T18: Gardening	3.92%	Garden	Spring	Nature	Flowers	Plants	Backyard	Flower	Gardening	Green	Plant

FIGURE 2 | Prevalence of nature-based topics within Twitter dataset in 2019 and 2020.

FIGURE 3 | Overall PERMA and individual subfactors during 2019 and 2020, as measured from Twitter dataset.
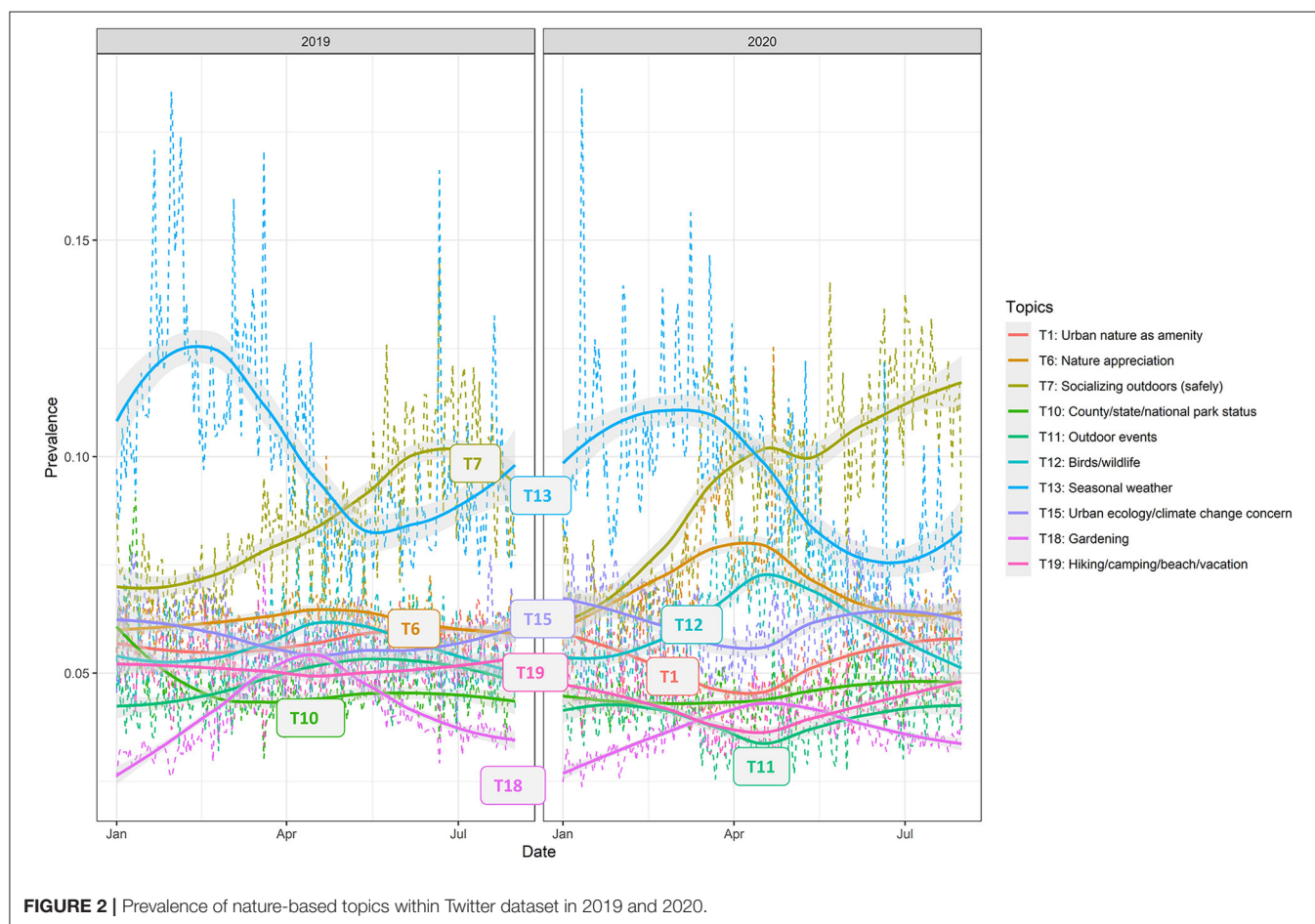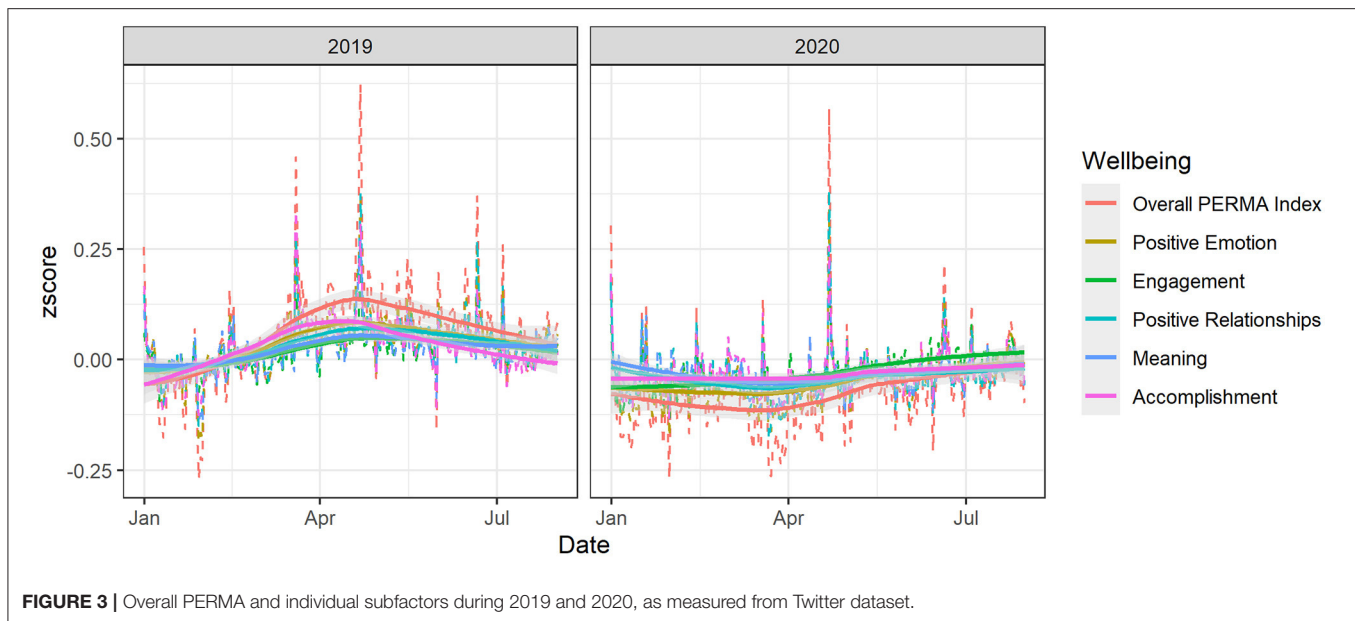
July 2020 (between years comparison, *Positive relationships*: $W = 1.2454 + e^{11}$, $p < 0.00001$; *Meaning*: $W = 1.2328 + e^{11}$, $p < 0.00001$).

County-Level Analysis

For our mixed-effects models, variance inflation factors were <3 for all independent variables across all models, indicating no presence of multicollinearity. Analyzing residuals for spatial correlation with Moran's I found no evidence of spatial autocorrelation. Model results are presented with unstandardized β coefficients; β coefficients for all topics are all on the same scale so effect size can be readily compared within and across models.

Overall PERMA Index

Our mixed-effects model results that included all tweets for 2019 and 2020 show a decline in PERMA from 2019 to 2020 (**Table 4**). Across all models, percent conserved greenspace is positively associated with PERMA (**Table 4**) and subfactors of PERMA in 2020 (**Table 5**), supporting H1. Controlling for year, we also observe all nature-focused topics to be significant, with varying β coefficients between 2019 and 2020, supporting H2. We find positive relationships with the PERMA index for topics 1, 6, 7, 11, 12, 18, and 19 in both 2019 and 2020, supporting H2, with increases in the β coefficient in the 2020 model, particularly for topic 1: *Urban nature as amenity* (from 0.27 to 0.39), 6: *Nature appreciation* (from 0.49 to 0.64), topic 12: *Birds/wildlife* (from 0.43 to 0.64), topic 18: *Gardening* (from 0.20 to 0.49), and topic 19: *Hiking/camping/beach/vacation* (from 0.14 to 0.31). Topic 10: *County/state/national park status* was negatively associated with PERMA in 2019, but positively associated in 2020. Topic 13: *Seasonal weather* was negatively associated with the PERMA index in both 2019 and 2020 models, but to a lesser extent in 2020 (from −0.16 to −0.04). Social vulnerability and population density, included as control variables, were not associated with county-level subjective wellbeing in this dataset.

We also examined associations between wellbeing and stay-at-home orders, finding no relationship for the overall PERMA index during 2020.

Individual Subfactors of PERMA

In examining these same independent variables with the individual subfactors of PERMA for 2020, we find some further nuances and differences in these relationships that support H1b (**Table 5**). Associations between nature-focused topics and PERMA subfactors identify differences in how certain topics are associated with subjective wellbeing, through a comparison of β coefficients from identical, individual subfactor mixed-effects models with the overall PERMA mixed-effects model (**Figure 4**). For example, topic 12: *Birds/wildlife* has a higher β coefficient in the positive *Relationships* and *Positive* emotions subfactor models as compared with the overall index model (set as 0), with topic 12 having the smallest association with the *Engagement* aspect of PERMA.

Percent greenspace has a positive association with all subfactors of PERMA, supporting H1 (**Table 5**). In these subfactor models, we now find a negative effect of stay-at-home orders on subjective wellbeing, finding a negative association for *Positive emotion*, *Positive relationships*, and *Meaning*, but not *Engagement* or *Achievement*. Like the PERMA index models, we find no effect of SVI or population density on subfactors of PERMA.
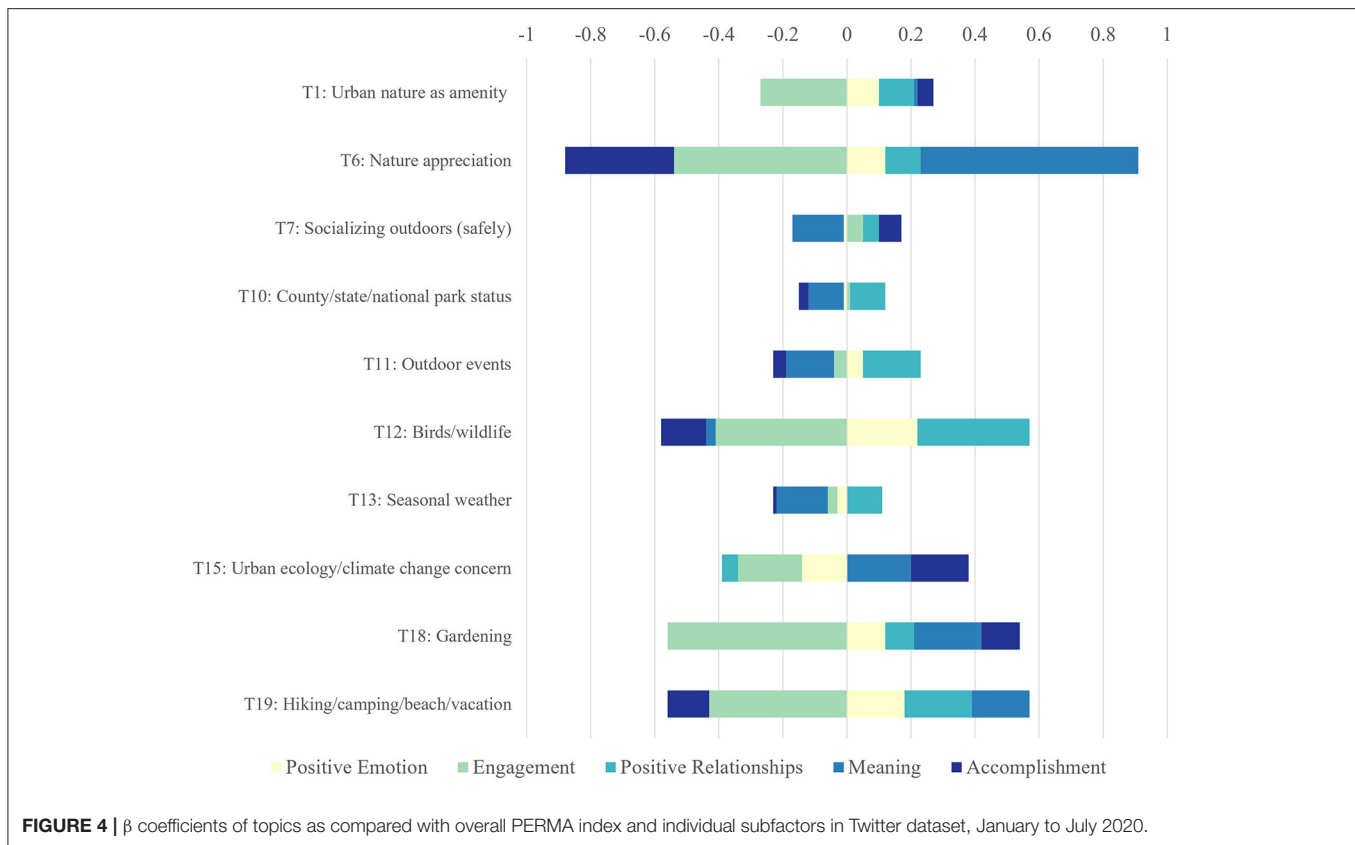
DISCUSSION

Our work contributes to the ongoing discussion of wellbeing and greenspace, finding nuanced relationships among nature-focused themes on social media in relation to wellbeing. Examining a multidimensional model of wellbeing, PERMA, enables us to examine multiple possible pathways for nature and greenspace

TABLE 4 | Mixed-effects model results for overall PERMA index for (a) 2019 and 2020 tweets, (b) 2019-only tweets, (c) 2020-only tweets, and (d) 2020-only tweets including stay-at-home orders, reporting 95% confidence intervals (CI).

Predictors	PERMA index (2019–2020)			PERMA index (2019)			PERMA index (2020)			PERMA index (2020 including stay-at-home)		
	β	95% CI	p	β	95% CI	p	β	95% CI	p	β	95% CI	p
(Intercept)	−0.15	−0.17 to −0.13	< 0.001	−0.11	−0.13 to −0.10	< 0.001	−0.24	−0.27 to −0.22	< 0.001	−0.24	−0.27 to −0.22	< 0.001
T1: Urban nature as amenity	0.33	0.32 to 0.34	< 0.001	0.27	0.25 to 0.29	< 0.001	0.39	0.37 to 0.41	< 0.001	0.39	0.37 to 0.41	< 0.001
T6: Nature appreciation	0.56	0.55 to 0.57	< 0.001	0.49	0.48 to 0.51	< 0.001	0.64	0.62 to 0.65	< 0.001	0.64	0.63 to 0.66	< 0.001
T7: Socializing outdoors (safely)	1.04	1.03 to 1.05	< 0.001	1.03	1.02 to 1.05	< 0.001	1.06	1.05 to 1.07	< 0.001	1.06	1.05 to 1.07	< 0.001
T10: County/state/national park status	−0.02	−0.04 to −0.01	0.004	−0.08	−0.10 to −0.06	< 0.001	0.06	0.03 to 0.08	< 0.001	0.06	0.03 to 0.08	< 0.001
T11: Outdoor events	0.48	0.46 to 0.49	< 0.001	0.45	0.43 to 0.47	< 0.001	0.48	0.45 to 0.50	< 0.001	0.48	0.45 to 0.51	< 0.001
T12: Birds/wildlife	0.54	0.52 to 0.55	< 0.001	0.43	0.41 to 0.45	< 0.001	0.64	0.62 to 0.66	< 0.001	0.64	0.62 to 0.66	< 0.001
T13: Seasonal weather	−0.10	−0.11 to −0.10	< 0.001	−0.16	−0.17 to −0.15	< 0.001	−0.04	−0.05 to −0.03	< 0.001	−0.04	−0.06 to −0.03	< 0.001
T15: Urban ecology/climate change concern	−0.29	−0.30 to −0.27	< 0.001	−0.37	−0.39 to −0.35	< 0.001	−0.20	−0.22 to −0.18	< 0.001	−0.20	−0.22 to −0.18	< 0.001
T18: Gardening	0.34	0.32 to 0.35	< 0.001	0.20	0.17 to 0.22	< 0.001	0.49	0.47 to 0.52	< 0.001	0.50	0.47 to 0.52	< 0.001
T19: Hiking/camping/beach/vacation	0.22	0.21 to 0.23	< 0.001	0.14	0.12 to 0.16	< 0.001	0.31	0.29 to 0.33	< 0.001	0.30	0.28 to 0.33	< 0.001
Social vulnerability (SVI–SES)	−0.02	−0.05 to 0.02	0.325	−0.02	−0.06 to 0.01	0.142	−0.02	−0.06 to 0.02	0.433	−0.01	−0.06 to 0.03	0.586
Population density (people/sq mi)	−0.00	−0.00 to 0.00	0.791	0.00	−0.00 to 0.00	0.942	−0.00	−0.00 to 0.00	0.505	−0.00	−0.00 to 0.00	0.569
% Conserved	0.00	0.00 to 0.00	< 0.001	0.00	0.00 to 0.00	< 0.001	0.00	0.00 to 0.00	< 0.001	0.00	0.00 to 0.00	< 0.001
Year (2020)	−0.06	−0.06 to −0.06	< 0.001									
Stay-at-home orders in effect (true)										−0.01	−0.01 to 0.00	0.066
Random effects												
σ^2		0.48			0.48			0.47			0.47	
τ_{00}		0.01 County.FIPS			0.01 County.FIPS			0.01 County.FIPS			0.01 County.FIPS	
		0.00 week			0.00 week			0.00 week			0.00 week	
ICC		0.02			0.01			0.02			0.02	
N		663 County.FIPS			654 County.FIPS			653 County.FIPS			554 County.FIPS	
		31 week			31 week			31 week			31 week	
Observations		971,968			505,166			466,802			431,582	
Marginal R^2/conditional R^2		0.074/0.090			0.070/0.082			0.079/0.101			0.079/0.101	

TABLE 5 | Mixed-effects model results for positive subfactors (P—positive emotion, E—engagement, R—positive relationships, M—meaning, and A—accomplishments/achievements) of PERMA for 2020-only tweets, reporting 95% confidence intervals (CI).

Predictors	P (z score)			E (z score)			R (z score)			M (z score)			A (z score)		
	β	95% CI	p	β	95% CI	p	β	95% CI	p	β	95% CI	p	β	95% CI	p
(Intercept)	−0.27	−0.31 to −0.23	< 0.001	−0.13	−0.15 to −0.10	< 0.001	−0.31	−0.34 to −0.28	< 0.001	−0.28	−0.31 to −0.26	< 0.001	−0.23	−0.26 to −0.21	< 0.001
T1: Urban nature as amenity	0.49	0.47 to 0.52	< 0.001	0.12	0.10 to 0.14	< 0.001	0.50	0.48 to 0.52	< 0.001	0.40	0.38 to 0.42	< 0.001	0.44	0.42 to 0.46	< 0.001
T6: Nature appreciation	0.76	0.74 to 0.78	< 0.001	0.10	0.09 to 0.12	< 0.001	0.75	0.73 to 0.77	< 0.001	1.32	1.30 to 1.33	< 0.001	0.30	0.28 to 0.31	< 0.001
T7: Socializing outdoors (safely)	1.05	1.03 to 1.07	< 0.001	1.11	1.10 to 1.12	< 0.001	1.11	1.09 to 1.12	< 0.001	0.90	0.89 to 0.92	< 0.001	1.13	1.11 to 1.14	< 0.001
T10: County/state/national park status	0.05	0.02 to 0.07	0.001	0.07	0.05 to 0.10	< 0.001	0.17	0.15 to 0.20	< 0.001	−0.05	−0.07 to −0.02	< 0.001	0.03	0.01 to 0.05	0.011
T11: Outdoor events	0.53	0.49 to 0.56	< 0.001	0.44	0.42 to 0.47	< 0.001	0.66	0.63 to 0.69	< 0.001	0.33	0.30 to 0.36	< 0.001	0.44	0.41 to 0.47	< 0.001
T12: Birds/wildlife	0.86	0.84 to 0.88	< 0.001	0.23	0.21 to 0.25	< 0.001	0.99	0.97 to 1.01	< 0.001	0.61	0.59 to 0.63	< 0.001	0.50	0.49 to 0.52	< 0.001
T13: Seasonal weather	−0.07	−0.08 to −0.05	< 0.001	−0.07	−0.09 to −0.06	< 0.001	0.07	0.06 to 0.09	< 0.001	−0.20	−0.21 to −0.18	< 0.001	0.05	0.03 to 0.06	< 0.001
T15: Urban ecology/climate change concern	−0.34	−0.36 to −0.31	< 0.001	−0.40	−0.41 to −0.38	< 0.001	−0.25	−0.27 to −0.23	< 0.001	−0.00	−0.02 to 0.02	0.668	−0.02	−0.04 to −0.00	0.045
T18: Gardening	0.62	0.59 to 0.65	< 0.001	−0.06	−0.08 to −0.03	< 0.001	0.59	0.57 to 0.62	< 0.001	0.71	0.68 to 0.74	< 0.001	0.62	0.59 to 0.64	< 0.001
T19: Hiking/camping/beach/vacation	0.48	0.45 to 0.51	< 0.001	−0.13	−0.15 to −0.11	< 0.001	0.51	0.49 to 0.54	< 0.001	0.48	0.46 to 0.51	< 0.001	0.17	0.15 to 0.19	< 0.001
Social vulnerability (SVI–SES)	−0.03	−0.09 to 0.04	0.406	0.01	−0.04 to 0.05	0.820	−0.04	−0.09 to 0.00	0.075	0.01	−0.04 to 0.05	0.843	−0.01	−0.05 to 0.03	0.741
Population density	−0.00	−0.00 to 0.00	0.655	−0.00	−0.00 to 0.00	0.986	−0.00	−0.00 to 0.00	0.472	−0.00	−0.00 to 0.00	0.538	−0.00	−0.00 to 0.00	0.336
% Conserved	0.00	0.00 to 0.00	0.001	0.00	0.00 to 0.00	0.008	0.00	0.00 to 0.00	< 0.001	0.00	0.00 to 0.00	< 0.001	0.00	0.00 to 0.00	0.007
Stay-at-home orders in effect (true)	−0.01	−0.02 to −0.01	0.002	−0.00	−0.01 to 0.00	0.359	−0.01	−0.02 to −0.00	0.010	−0.01	−0.02 to −0.00	0.032	0.00	−0.01 to 0.01	0.959
Random effects															
σ^2	0.73			0.50			0.63			0.58			0.57		
τ_{00}	0.02 County.FIPS			0.01 County.FIPS			0.01 County.FIPS			0.01 County.FIPS			0.01 County.FIPS		
	0.00 week			0.00 week			0.00 week			0.00 week			0.00 week		
ICC	0.03			0.02			0.02			0.02			0.01		
N	554 County.FIPS			554 County.FIPS			554 County.FIPS			554 County.FIPS			554 County.FIPS		
	31 week			31 week			31 week			31 week			31 week		
Observations	431,582			431,582			431,582			431,582			431,582		
Marginal R^2/conditional R^2	0.064/0.097			0.071/0.091			0.077/0.093			0.087/0.109			0.062/0.076		

FIGURE 4 | β coefficients of topics as compared with overall PERMA index and individual subfactors in Twitter dataset, January to July 2020.

to benefit wellbeing during the pandemic. In particular, we find a positive relationship between nature connection and wellbeing during a stressful, collective disturbance, and the ongoing COVID-19 pandemic, per two pathways identified by Cleary et al. (2017): nature appreciation fostering intrinsic value and non-human relationships. These relationships suggest Tidball's (2012) concept of urgent biophilia may be at work during the pandemic, as a way to cope with this large-scale, ongoing disturbance. Our findings also support recent literature (Morse et al., 2020; Ugolini et al., 2020) showing that wellbeing is affected by the COVID-19 pandemic, by empirically demonstrating how subjective wellbeing changed between 2019 and 2020. Because the COVID-19 pandemic offers a natural experiment, our work answers Hartig's et al. (2014) call for population-level experimental studies on health–nature relationships, demonstrating specific aspects of nature that are beneficial to wellbeing, in particular to subfactors of the PERMA wellbeing construct. Our results also highlight the need for maintaining and expanding access to urban greenspaces in the future, for the benefit of all city residents.

Nature-Based Topics

Our study synthesized observational data from tweets to find that nature matters during the pandemic, with changes in activities discussed by Twitter users occurring beyond expected seasonal shifts. Topics around nature/greenspace in US-based social media during the pandemic focused on greenspace conditions, activities, nature experiences, values, and concerns. We observed

topic prevalence to change year to year and across months; the *nature appreciation* and *birds/wildlife* topics seem to be the clearest depiction of people's increasing engagement with nature as a consequence of the pandemic. Activities described in tweets align with nature-based activities identified through surveys during the COVID-19 pandemic, including *Gardening* and *Hiking/camping/beach/vacation* (Morse et al., 2020; Ugolini et al., 2020). Rice et al. (2020) noted a decrease in camping and backpacking and an increase in hiking during the early months of the pandemic in the United States, but the coarseness of our topics does not enable us to separate hiking from the other activities in that topic.

Wellbeing and Nature-Based Topic Relationships

Our work provides further support for positive relationships between wellbeing and amount of greenspace in a county, but also goes further to examine how nature-based topics relate to wellbeing. Our mixed-effects models of county-level wellbeing from social media data support previous survey-based work that focused on city parks (Larson et al., 2016) and extend this work to all publicly available greenspace. Our work also examines which nature-based topics have larger relative effect sizes to other topics, comparable by β coefficients from our mixed-effects models. These effect sizes suggest the presence of multiple pathways for nature and greenspace to benefit wellbeing during the pandemic: providing opportunities to

socialize, strengthening nature connections through fostering intrinsic values and increasing non-human relationships, and providing activities such as gardening and hiking that can improve wellbeing through physical, mental, and emotional aspects. Below, we discuss the results of each nature-based topic in relation to wellbeing, aside from the *Seasonal weather* topic, which accounts for variation in weather year to year.

Socializing outdoors (safely) had a strong effect size in both 2019 and 2020, showing the enduring use of urban greenspaces for socializing. Strong social relationships are a known predictor of wellbeing (Kawachi and Berkman, 2001), and the act of socializing itself can reduce social isolation, a known predictor of poor health (Steptoe et al., 2013) that has deleterious effects on wellbeing during the pandemic (Clair et al., 2021). *Outdoor events* also had a strong effect size in both years, but with little variation between the 2 years in effect size. *County/state/national park status* was negatively correlated with wellbeing in 2019, but positively correlated with wellbeing in 2020, showing that discussion around park closings and openings relates to wellbeing differently during the pandemic.

Nature appreciation, the beginnings of nature connectedness, can foster intrinsic values (Weinstein et al., 2009), which in turn can lead to increased wellbeing (Ryan and Deci, 2000). Here, we find support for *Nature appreciation*'s positive association with wellbeing during the COVID-19 pandemic, with an increased effect size in 2020 as compared with 2019 and the second highest effect size of the nature-themed topics. Running a topic model on our tweet dataset does not enable us to examine the intricacies of these constructs' relationships, but the natural experiment of comparing before and during the pandemic offers strong support for this role of *Nature appreciation* in improving wellbeing during the pandemic across many cities in the United States. Further work could examine Tidball's urgent biophilia in relation to these constructs of nature appreciation, nature connectedness, intrinsic values, and wellbeing with methods that allow for stronger controls and within individual analyses, vs. our county-level analyses.

Birds/wildlife is a nature topic that is often viewed positively by the public. Bird-watching was observed in the media to increase during the pandemic, yet also was more likely to occur locally during the pandemic (Randler et al., 2020). Observing birds and wildlife offers the potential for non-human relationships to increase, another possible mechanism whereby nature connection affects wellbeing (Cleary et al., 2017). Non-human relationships also align with an increasing body of research on relational care (Jax et al., 2018) and biocultural stewardship (McMillen et al., 2020). Our mixed-effects models provide strong support for the role of non-human relationships in wellbeing. Lumber et al. (2017) five pathways for improving nature connectedness (contact, emotion, meaning, compassion, and beauty) align with positive emotion and meaning aspects of PERMA, and our subfactor models find support for positive emotion and meaning as they relate to both *Nature appreciation* and *Birds/wildlife*, among other nature-related topics.

Activities in greenspace also play a role in wellbeing. Here, our work identifies empirical differences in *Gardening* and *Hiking/camping/beach/vacation* as ways of experiencing nature;

to date, much work has focused on each of these activities separately. We observe gardening and hiking/walking in parks are both positively associated with wellbeing. The nature of these activities varies, where gardening involves transforming and directly interacting with a place, and is a type of care, or stewardship (Enqvist et al., 2018), while hiking involves more passively experiencing a place, aligning with ideas of nature experiences as a dose (Kondo et al., 2020). Both it also includes physical activity, which is also known to be associated with wellbeing. Future work could further examine these specific activities in relation to wellbeing during disturbances in relationship to demographic factors.

Urban nature as amenity was another nature-themed topic that showed a positive relationship with wellbeing. Parks and other greenspaces are known to increase adjacent property values, highlighting the revealed preferences for nearby nature in cities (Conway et al., 2010). During the height of the pandemic in 2020, migration patterns highlighted that individuals were moving out of cities, perhaps temporarily, as nearby communities experienced increased property values (Coven et al., 2020; Gupta et al., in press). Within cities, access to greenspace, both public and private, has been a critical aspect of managing the pandemic, as evidenced by other nature-based topics' relationships with wellbeing. This nature-based topic and related relationship with wellbeing further highlight how urban nature has been viewed as an amenity by renters and homeowners. We also observed concerns about urban ecology conditions and climate change (*Urban ecology/climate change concern*), while negatively related to wellbeing, to decline during the early months of the pandemic. Aspects of PERMA affected here in particular include *Meaning* and *Accomplishment*. One possible explanation for this is that there is a finite pool of worry that an individual can draw from Weber (2006). However, survey-based research in the United Kingdom found no decrease in climate change concern during the pandemic (Evensen et al., 2021).

PERMA Subfactors and Nature-Based Topic Relationships

By examining wellbeing with a multidimensional construct, like PERMA, we are able to identify possible levers that could be used in therapeutic practice for enabling individuals to be resilient during stressful, ongoing collective disturbances. Previous work has examined resilience not only after individual events, but also in veterans (Pietrzak and Cook, 2013), where ongoing exposure to stressful events has resulted in PTSD and other mental health disorders. For many of the nature-based topics, positive emotions, meaning, and positive relationships were larger contributors to overall wellbeing than engagement and accomplishments during the 2020/COVID-19 time frame, suggesting these are the levers that may enable nature experiences to have a positive association with subjective wellbeing during the COVID-19 pandemic. Aspects of nature that have larger positive effect sizes with *Positive emotion*, *Positive relationships*, and *Meaning* include *Birds/wildlife*, *Socializing outdoors (safely)*, *Nature appreciation*, *Gardening*, and *Hiking/camping/beach/vacation*. During the

pandemic, our sense of accomplishment may be diminished, as many became housebound during "stay-at-home" orders, with Americans working from home for many, but not all job types. While attention restoration theory (Kaplan, 1995) identifies a positive relation between time in nature and attention, our dataset of tweets' engagement measures has small effect sizes. Because tweets are discussing nature rather than necessarily occurring while one is spending time in nature, it is possible the platform of social media could cause *Engagement* measures to be low. However, the effect size for *Socializing outdoors (safely)* in the *Engagement* mixed-effects model is equivalent to effect sizes for other PERMA subfactors, so it also could be that during the pandemic, time in nature may not be as absorbing. Levers that work for one individual, however, may not work for all. Here, we identify county-level, or community-level, relationships between conversations about aspects of nature and subjective wellbeing, but additional personal factors have the potential to mediate these relationships. Martínez-Martí et al. (2020) found character strengths to also play a role in wellbeing when monitoring individuals for one month during the COVID-19 pandemic.

Role of Stay-at-Home Orders

Our measures of county-level wellbeing demonstrate that wellbeing was lower in 2020 during the pandemic than at the same time the previous year. This supports ongoing weekly surveys measuring state-level anxiety and depression in the United States (Twenge and Joiner, 2020). Lockdown or "stay-at-home" orders are associated with decreased mental health (Le and Nguyen, 2021). By including the presence of stay-at-home orders in our models, we were also able to examine whether these orders affected wellbeing and, if so, through which pathways. We found negative associations between stay-at-home orders and wellbeing, but we speculate that the simultaneous positive relationships identified for nature may somewhat mitigate this effect. Other studies have shown access to nature during the pandemic has been uneven (Burnett et al., 2021; Jay et al., 2021), and our work further highlights the role that nature access can have on wellbeing.

Study Limitations

A few limitations apply to this research effort, many of which are inherent when working with social media datasets. Social media data can be biased, and because demographics data are not associated, this bias can be difficult to control for. We apply the PERMA-weighted lexicon, which has been validated in the literature against surveys, but in comparison to data-driven methods for measuring wellbeing in text datasets, associations with survey-based data are weaker (Jaidka et al., 2020). Survey-based methods with validated psychometric scales offer one of the best ways to measure wellbeing at present, yet they take time to implement and so are not as readily available as social media datasets. Surveys also offer the opportunity to identify differences in populations as to the role nature plays in coping during times of crisis (Morse et al., 2020). Social media datasets are also a measure of discussion about nature rather than self-reported measures or observed behavioral data. Yet, these types of data offer the opportunities for natural experiments during

disturbances and can serve as a triangulation method, providing further support for or as an avenue for exploratory analyses that can identify new avenues for future work. Finally, we recognize that our comparisons between 2019 and 2020 also include variations between the years beyond the COVID-19 pandemic, so some variation we observe in wellbeing or nature-based topics between the years may not be attributable to impacts from the pandemic itself.

CONCLUSIONS

Urban nature plays a critical role in individuals' wellbeing, particularly as a coping mechanism for exposure to stressful events such as the COVID-19 pandemic. Our social media topic-based research makes use of a natural experiment, finding support for multiple pathways for nature to improve wellbeing during the ongoing pandemic, including socializing outdoors, nature appreciation, non-human relationships, nature-based activities, and access to nearby nature as an amenity. By applying a multidimensional construct such as PERMA, we are able to identify *Positive emotion*, *Positive relationships*, and *Meaning* as subfactors of wellbeing that can potentially be increased by urban nature. We find support for changes in motivation—the intrinsic interest of nature—from the prevalence of nature-based topics and wellbeing/nature-based topic relationships. Future work with social media datasets could examine an expanded time frame and sustained impact and across nations and cultures, as the COVID-19 pandemic continues to impact the global population. Survey and laboratory-based studies can further unpack the relationships we identify here between PERMA, nature connectedness, non-human relationships, relational care, and nature-based activities, to explore the multifaceted role of urgent biophilia in resilient responses to maintaining a sense of wellbeing during the COVID-19 pandemic. Our findings about urban nature and wellbeing suggest an opportunity to re-envision the distribution and access of greenspace within cities and broader metropolitan regions, to assist in supporting individuals' resilience during times of disturbance.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

MJ co-developed both the research question and study design and led the regression model development, spatial and analysis,

introduction, literature review, and discussion. SS co-developed the research question, study design, led the tweet data collection, topic modeling efforts, led the results section, and edited other parts of the manuscript. Both authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2022.725870/full#supplementary-material

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Recruiting, paying, and evaluating the experiences of civic scientists studying urban park usage during the beginning of the COVID-19 pandemic

Bita Alizadehtazi, Sloane Woerdeman, Korin Tangtrakul,
Anna Gussenhoven, Nariman Mostafavi and
Franco A. Montalto*

Department of Civil, Architectural and Environmental Engineering, Drexel University, Philadelphia,
PA, United States

This paper describes an attempt to utilize paid citizen science in a research project that documented urban park usage during the early stages of the COVID-19 pandemic in two U.S. cities. Strategies used by the research team to recruit, pay, and evaluate the experiences of the 43 citizen scientists are discussed alongside key challenges in contemporary citizen science. A literature review suggests that successful citizen science projects foster diverse and inclusive participation; develop appropriate ways to compensate citizen scientists for their work; maximize opportunities for participant learning; and ensure high standards for data quality. In this case study, the selection process proved successful in employing economically vulnerable individuals, though the citizen scientist participants were disproportionately female, young, White, non-Hispanic, single, and college educated relative to the communities studied. The participants reported that the financial compensation provided by the study, similar in amount to the economic stimulus checks distributed simultaneously by the Federal government, were reasonable given the workload, and many used it to cover basic household needs. Though the study took place in a period of high economic risk, and more than 80% of the participants had never participated in a scientific study, the experience was rated overwhelmingly positive. Participants reported that the work provided stress relief, indicated they would consider participating in similar research in the future. Despite the vast majority never having engaged in most park stewardship activities, they expressed interest in learning more about park usage, mask usage in public spaces, and socio-economic trends in relation to COVID-19. Though there were some minor challenges in data collection, data quality was sufficient to publish the topical results in a peer-reviewed companion paper. Key insights on the logistical constraints faced by the research team are highlighted throughout the paper to advance the case for paid citizen science.

Introduction

Citizen science, *the collection and analysis of data relating to the natural world by members of the general public, typically as part of a collaborative project with professional scientists* (Oxford Dictionary), is broadly recognized as a strategy for expanding knowledge in a wide variety of scientific disciplines (Vohland et al., 2021). The practice can help increase distributed data collection while engaging the public in societal issues and enabling them to participate meaningfully in the scientific process (Turrini et al., 2018; Peter et al., 2019). The impact that citizen science has had on scientific discovery has been widely documented and discussed, with current research focusing on how to maximize the impact that these programs can have on the participants themselves (Jordan et al., 2012; Kieslinger et al., 2018; Phillips et al., 2018; Walker et al., 2021).

In citizen science projects, a key goal is to develop study designs and standards that maximize data accuracy and participant satisfaction (Walker et al., 2021). In-depth empirical documentation of the successes and failures of specific projects can be useful in achieving this goal, specifically by associating intended or unintended outcomes with specific aspects of the study design (Schaefer et al., 2021), thereby helping to inform the design of future studies (Conrad and Hilchey, 2011; Heiss and Matthes, 2017; Peter et al., 2019).

This paper focuses on the incorporation of citizen science in a research project that documented urban park usage during the early stages of the COVID-19 pandemic. Two overarching goals motivated the study. The first research goal was to study the potentially opposing roles that urban parks in residential neighborhoods of Philadelphia and New York City may play in mitigating the impacts of COVID-19, and/or facilitating its spread. We found no strong correlation between park visits and COVID cases and, as described in detail in Alizadehtazi et al. (2020), to the contrary saw evidence that park visits provided respite and relief during the early phase of the pandemic—an example of what Tidball (2012) calls "urgent biophilia." The second research goal, addressed in this paper, was to determine whether resident populations could be converted into paid officers of distributed data collection, promoting economic resilience in times of crisis. Specifically, we analyze the use of citizen science to achieve the project goals. To note, the term "civic scientist" (as opposed to "citizen scientist") was used by the research team so as not to exclude participants who are not citizens of the United States, with "citizen science" used in this paper only when describing the broader literature.

After a review of challenges to citizen science documented in the literature, the approaches taken for recruitment and financial compensation of study participants are described and critiqued, incorporating feedback provided by the civic scientists through a formal evaluation process. We also include descriptions of the experience as reported by the civic scientists, providing insights regarding execution of this study amidst a pandemic and lockdown, and recommendations for future studies.

Background literature review

A synthesis of relevant literature published between 2010 and 2021 was used to identify four "Key Challenges" in Citizen Science: Diversity and Inclusion, Financial Compensation, Participant Learning and Attitudes, and Data Quality.

Key Challenge #1: Achieving diversity and inclusion

A key goal of citizen science is to democratize science by fostering inclusivity in many dimensions (Bonney et al., 2014). However, in practice, individuals who participate in citizen science programs are often disproportionately middle-class, educated, and White (National Academies of Sciences, Engineering, and Medicine, 2018; Paleco et al., 2021; Walker et al., 2021). Challenges to diverse participation in citizen science projects include the tendency of the research team to rely on pre-existing networks for recruitment and the requirement for technological literacy among participants (Foster et al., 2017; Møller et al., 2019; Rall et al., 2019). Bela et al. (2016) reported that a lack of diversity in public data collection efforts can cause the views of certain groups to be overlooked, reinforcing social inequalities. Paleco et al. (2021) underscored the importance of tailoring recruitment strategies to the target study participants. Addressing Key Challenge #1 involves development of strategies that foster diverse and inclusive participation within the citizen science team.

Key Challenge #2: Financial compensation

There has been much debate about financially compensating citizen scientists. Informal interviews conducted over several years by the research team suggest that the architects of some stewardship programs assume that citizen scientists volunteer without the expectation of payment, and are motivated principally by a desire to learn, to contribute to a cause, and/or to experience personal enjoyment/leisure. From this perspective, the opportunity to participate is viewed as a privilege, a pleasure, and/or a civic duty for which financial rewards are inappropriate. Riesch and Potter (2014) related that some scientists justify the lack of financial payment as long as the participants are receiving free learning materials and an opportunity at scientific research. Non-payment for citizen science may also be simply because the research team neglects to budget funds explicitly for this purpose (Long et al., 2016).

However, critics of unpaid citizen science claim it is exploitative, especially when the rest of the research team is paid to participate in the study (Tauginiene et al., 2021). Others argued in favor of financial compensation because of a belief that it creates sustained motivation and work ethics leading to higher quality data (Alabri and Hunter, 2010; Resnik et al., 2015). Payments have also been described as important in attracting citizen scientists with economic needs and/or limited leisure time (Lave, 2015; Cieslik et al., 2019; Walker et al., 2021), advancing diversity. Key Challenge #2 thus focuses on the need to develop the right financial incentive structure that recognizes the monetary value of the work associated with data collection, attracts diverse participants, but which also recognize the highly varied entry points of individuals into citizen science projects.

Key Challenge #3: Participant learning and attitudes

Citizen science is often lauded for the numerous potential benefits it brings to participants, including improved research skills, increased content knowledge, and heightened incentive toward environmental stewardship (Krasny and Bonney, 2005; Jordan et al., 2012; Riesch and Potter, 2014; Bela et al., 2016; Peter et al., 2019). But as Phillips et al. (2018) and Walker et al. (2021) pointed out, actual participant outcomes are largely unstudied. Additionally, there can be a discrepancy between the goals of the researchers, on the one hand, and the experiences of the participants, on the other. A poorly executed project can cause participants to feel bored, overburdened, or unsafe, ultimately dissuading them from engaging in future projects (Resnik et al., 2015). To bolster participant satisfaction and avoid potential negative outcomes, researchers are urged to assess the motivations, learning outcomes, and general experiences of potential citizen scientists through surveys and interviews conducted before, during, and after the study (Jordan et al., 2012; Kieslinger et al., 2018). Participant feedback is also useful in adapting the structure of citizen science programs to better align intentions with outcomes (Phillips et al., 2018). Key Challenge #3 emphasizes the importance of developing study designs that maximize opportunities for participant learning while simultaneously achieving the research objectives.

Key Challenge #4: Data quality

Citizen science is a strategy for gathering data that might otherwise be difficult or impossible to obtain using traditional research methods. However, several concerns about data accuracy have been reported (Riesch and Potter, 2014; Theobald et al., 2015). Because citizen scientists lack the skills and incentives of trained professionals, the reliability and consistency of the data they collect has been called into question

(Resnik et al., 2015). While collection of high-quality data has been documented, some citizen scientist projects include non-standard sampling protocols, feature poor spatial or temporal representation, and/or small sample sizes (Anhalt-Depies et al., 2019; Balázs et al., 2021). Data quality is typically greatest when participants are properly trained, communication is maintained throughout the study, and random errors considered in data analysis (Resnik et al., 2015; Kosmala et al., 2016). Key Challenge #4 highlights the need to develop data quality standards that ensure high quality data is collected throughout the project.

Case study materials and methods

In 2020, a cohort of civic scientists was mobilized to gather data about park usage in Philadelphia, PA and New York City (NYC), NY—two East Coast cities in the United States that were, at the time, subject to stay-at-home orders (New York State, 2020; City of Philadelphia, 2020a). All non-essential businesses were closed, and residents were urged not to leave their homes unless necessary (including travel to universities). Despite these restrictions, people continued to use parks and other public spaces (Insider, 2020), and the research team became interested in whether communities with highly visited parks would ultimately present higher COVID-19 infection rates. Given the abrupt nature of the stay-at-home orders, the diffused locations of the parks of interest, the ephemeral nature of the solicited data, and other logistical constraints on research introduced by the university, the research team proposed a rapid-response citizen science project to the National Science Foundation (NSF).

A detailed description of the methodology and study findings are beyond the scope of this paper and are provided in a companion paper (Alizadehtazi et al., 2020). In brief, the team recruited and paid 43 civic scientists to document park usage patterns in 22 parks selected to represent low and high social vulnerability, and low, medium, and high population density in both cities. A strong correlation between the number of confirmed COVID-19 cases in adjacent zip codes and the number of park users was ultimately not found. Moreover, no significant differences in park usage were detected between parks in high and low vulnerability neighborhoods. The study found no evidence that park visits posed measurable risk of COVID-19 infection in the surrounding communities and, to the contrary, may actually have provided palliative value to residents during this early phase of the pandemic.

As a complement to Alizadehtazi et al. (2020), this paper focuses on the unique strategy for collecting data using civic scientists. The procedures used to recruit, select, hire, and survey the civic scientists are described, contrasting individuals who initially expressed interest in the project (i.e., applicants) with those who ultimately participated (i.e., participants). We also describe the civic scientists' experiences and discuss how each of

the four Key Challenges identified in the literature review were addressed by the study.

Civic scientist recruitment and selection

Separate plans were made for recruitment and selection of study participants. The research team initially sought to study 10 pre-selected parks in neighborhoods of varying population density and social vulnerability characteristics in each city, with the goal of hiring two civic scientists to enumerate different kinds of visitors in each park. The project budget included financial compensation for ∼40 civic scientists to make two data entries per day, at a rate of $10 per entry, over the 8-week study. The researchers were obliged to adhere to university and city guidance regarding park visits, and to devise a civic scientist recruitment strategy that satisfied Drexel University's Institutional Research Board (IRB). A snowball sampling strategy was adopted wherein initial potential study participants identified through outreach to community-based organizations (City of Philadelphia, 2020b) geographically situated near the candidate parks and other environmental networks were contacted by email and asked to identify potential study participants. All interactions between the research team, potential participants, applicants, and actual participants remained anonymous because the civic scientists were viewed by the university as research subjects.

A website was developed to introduce the study, with interactive maps highlighting the pre-selected parks. A Qualtrics application form was made available on the website, through which applicants could submit anonymized demographic information (e.g., gender, age, race and ethnicity, income, etc.) and an anonymous email address with no identifiable information for communication purposes (the anonymized email addresses were also used to pay the participants for their work using Paypal, as described in greater detail below). Through the Qualtrics form applicants were also invited to select one or more of the pre-selected parks they wished to research, or to propose another park, and then to answer specific descriptive questions about those parks. To characterize prior experience working in parks, the application form also included a series of questions about prior parks stewardship activities. The goal of these questions was to determine whether applicants had been previously (i.e., pre-COVID-19) involved in conservation, management, monitoring, education, advocacy, and transformation activities in their local park (Table 1).

Through the snowball sampling method, 300 applications were received for study of 85 different parks across the two cities. Applications were not received for all the pre-selected parks and more responses were received in Philadelphia than in New York City. To boost the response rate in New York City, the research team did more targeted outreach to "Friends of…" park groups and other organizations located near selected parks.

TABLE 1 Stewardship practices adapted from Landau et al. (2019).

Stewardship practice	Examples
Conservation	Preserving landmarks of cultural significance, protecting green space, defending endangered species
Management	Maintaining and operating parks, planting flower beds, hosting volunteer cleanups
Monitoring	Sharing data on water quality, tracking habitat metrics, surveying the public on park use
Education	Leading after school classes, public programming, preparing employees for green jobs
Advocacy	Community organizing, supporting environmental justice campaigns, voting for sustainable policies
Transformation	Making art from repurposed materials, collecting compost, installing solar panels

To maximize the economic benefits of the study amidst the layoffs and furloughs that occurred at the early phase of the pandemic, the research team developed a selection process that prioritized hiring unemployed applicants. Among applicants with the same employment status, the research team sought to diversify the participants based on gender, income, and/or race and ethnicity. No attempt was made in the selection process to diversify the entire cohort of civic scientists.

Applicants selected for participation in the study were sent an acceptance email, to which some did not ultimately respond. The research team learned later that some acceptance emails had been lost to the applicants' spam folders. Additionally, some applicants who initially agreed to participate in the study opted out. To fill these gaps, substitutions were made from the original pool of applicants. The total number of civic scientists who participated, including both those who opted out and those who were later selected as replacements, was 43.

Data about the civic scientists

In addition to the required park-specific observations (described in the companion paper), the civic scientists were asked to complete two surveys: (1) a personal conditions survey administered at three points during the study period; and (2) a post-study evaluation survey. Each of these surveys is described below.

Personal conditions survey

At three points during the project, roughly during Weeks 1, 4, and 8 of the study, civic scientists were asked to fill out the same survey that included personal conditions questions regarding their levels of stress, financial situation, and experiences around the COVID-19 pandemic. The intention of this survey was to demonstrate how/if the civic scientist's responses evolved over the course of the study. This survey is included in its entirety in Supplementary Section 2.

Post-study evaluation survey

At the end of the study, the civic scientists were asked to evaluate their overall experience in the study in a second survey (Supplementary Section 3). Specifically, this survey asked whether participation in the project increased their interest in this type of research and solicited feedback regarding communication with the research team and financial compensation provided by the project. Civic scientists were also invited to provide open-ended comments and recommendations for the research team regarding whether the project could have been implemented differently (Question 10) and whether they had other general feedback (Question 11).

Data analysis

Three different analyses of the survey responses were performed using R, version 3.6.3 (R Core Team, 2020). First, the 300 applicants were compared to the 43 participants to examine whether the selection process was successful in diversifying participation and prioritizing the economically vulnerable. The racial profiles of the applicants and participants were also compared to the racial profile of the population regarding in all zip codes within 400 m (1/4 mile) of each park, using American Community Survey for 2016–2020. Second, responses to the three personal surveys were analyzed to investigate trends over the course of the study. Finally, responses to the post-study evaluation were analyzed to profile the overall experience of the civic scientists.

Results

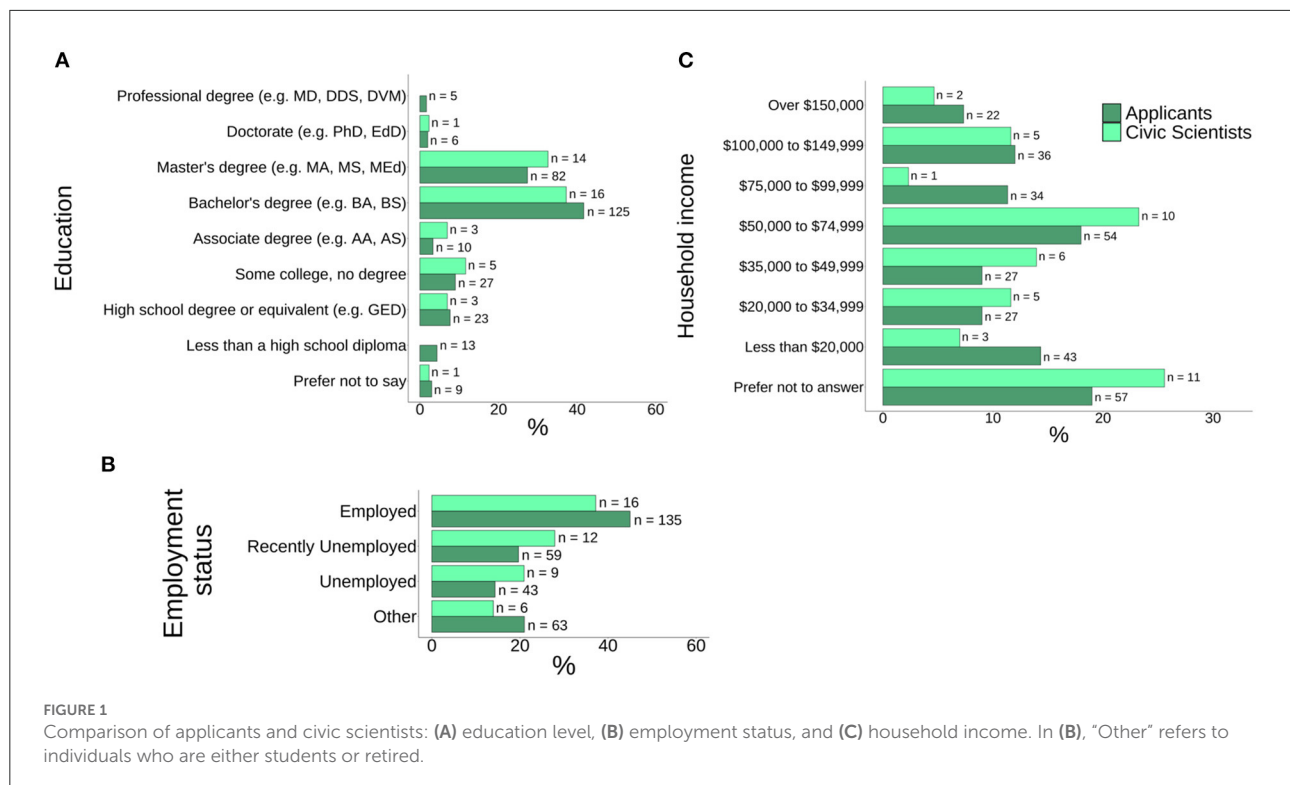### Comparison of applicants, participants and the population of the surrounding communities

The gender, age, race/ethnicity and marital status characteristics of the applicants and civic scientists are shown in Table 2. There were more female ($n = 174$, 58%) than male ($n = 118$, 39.4%) applicants for this study. The final cohort of civic scientists was comprised of 22 females (51.2%)

TABLE 2 Demographic characteristics of applicants and civic scientists.

Demographics	Applicants		Civic scientists	
Gender	$n = 300$	%	$n = 43$	%
Female	174	58.0	22	51.2
Male	118	39.4	19	44.2
Non-binary/third gender	7	2.3	1	2.3
Prefer not to say	1	0.3	1	2.3
Age	$n = 299$	%	$n = 43$	%
14–17	14	4.7	0	0.0
18–24	59	19.7	6	14.0
25–34	112	37.5	18	41.9
35–44	66	22.1	12	27.9
45–54	29	9.7	5	11.6
55–64	15	5.0	1	2.3
65–74	4	1.3	1	2.3
Hispanic, Latin, or of Spanish origin	$n = 299$	%	$n = 43$	%
No	246	82.3	37	86.0
Yes	53	17.7	6	14.0
Race	$n = 299$	%	$n = 43$	%
American Indian or Alaska Native	3	1.0	0	0.0
Black or African American	31	10.4	5	11.6
White	172	57.5	26	60.5
Asian	21	7.0	5	11.6
Mixed race	30	10.0	2	4.7
Some other race	42	14.1	5	11.6
Marital status	$n = 300$	%	$n = 43$	%
Divorced	11	3.7	4	9.3
Separated	1	0.3	0	0.0
Widowed	2	0.7	0	0.0
Married, or in a domestic partnership	88	29.3	13	30.2
Single (never married)	193	64.3	26	60.5
Prefer not to say	5	1.7	0	0.0

and 19 males (44.2%). Most applicants and civic scientists were between the age of 25–34, followed by individuals in the 35–44 age bracket. Most applicants and civic scientists were not of Hispanic, Latin, or Spanish origin (82.3 and 86%, respectively) and were White (57.5 and 60.5%, respectively). Both applicants and civic scientists were mostly single (64.3 and 60.5%, respectively).

The highest level of education, employment status, and household income of the applicants and civic scientists are displayed in Figure 1. Most of the applicants and civic scientists held bachelor's degrees (41.7 and 37.2%, respectively) and were employed (45 and 37.2%, respectively). There was a notable difference between applicants (19.7%) and civic scientists (27.9%) who were recently unemployed, a direct result of the selection process. After "prefer not to disclose" (19 and 25.6%,

FIGURE 1
Comparison of applicants and civic scientists: **(A)** education level, **(B)** employment status, and **(C)** household income. In **(B)**, "Other" refers to individuals who are either students or retired.

respectively), the next highest category of household income was $50,000–$75,000 (18 and 23.3%, respectively).

The racial makeup of the applicants and participants differs from the population of the communities surrounding the parks. While most applicants and civic scientists were White (57.5 and 60.5%, respectively), the racial makeup of the population surrounding the parks was predominantly non-White. In aggregate, the populations of the zip codes surrounding the parks were 38.6% White, 29.8% Black or African American, 8.2% Asian, 5.9% mixed race, 0.5% American Indian or Alaska Native, and 16.9% other race(s). The applicants and civic scientists were also more likely not to be of Hispanic, Latin, or Spanish origin (82.3 and 86%, respectively) compared to the surrounding population, 68.8% of which was not Hispanic/Latinx.

Figure 2 compares applicant and civic scientists' prior involvement in stewardship practices. More than 70% of the applicants and participants had never been involved in any forms of the stewardship practices mentioned above (with advocacy as an exception at >60% never having been involved).
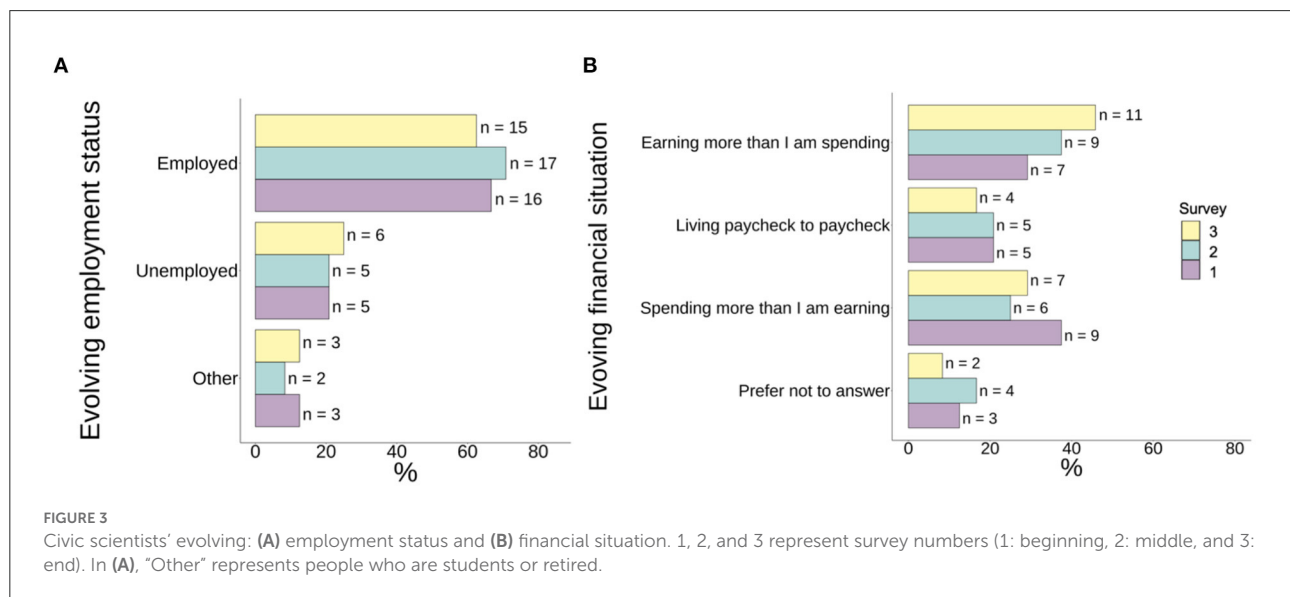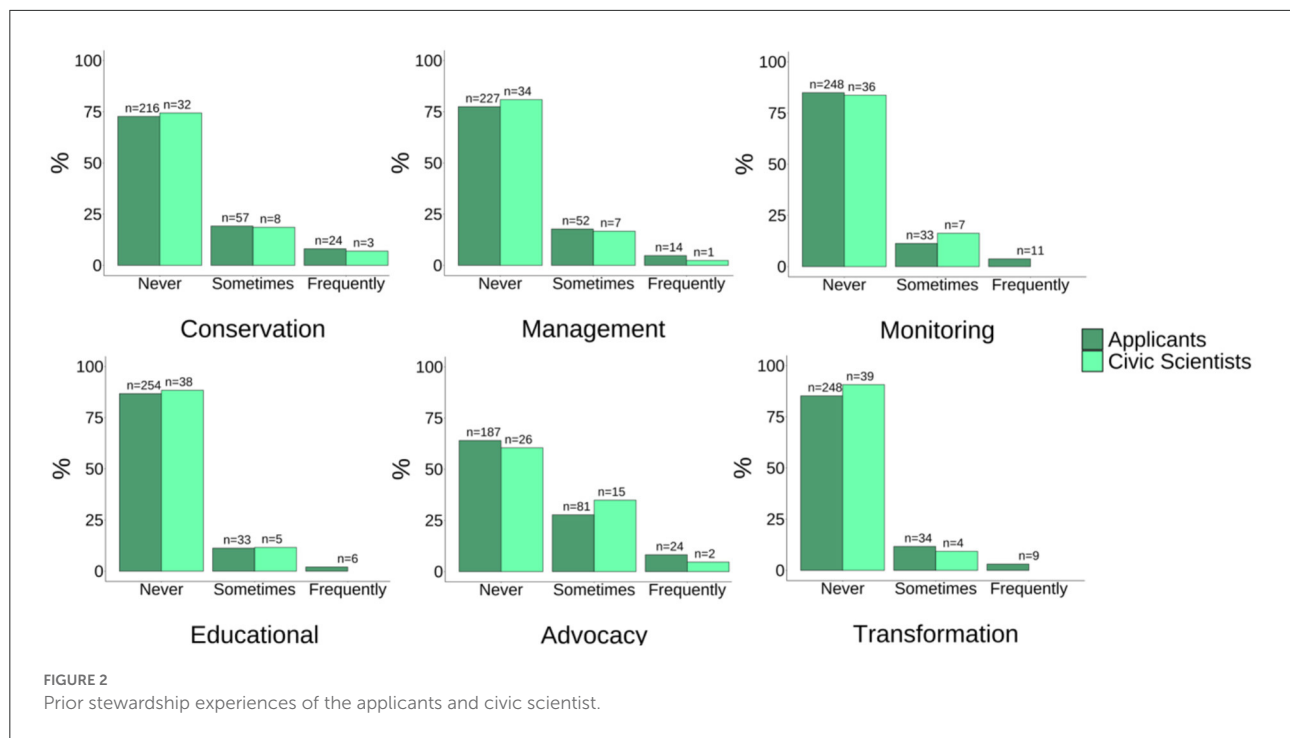
Overall, the pools of applicants and participants were similar in terms of age, race, marital status, educational level, and background experience in stewardship work. The applicants had a slightly higher percentage of females and were less likely to be unemployed than the participants, a direct result of the criteria underlying the selection process. The applicants and participants

were, however, more likely to be White and not Hispanic, Latin, or Spanish than the residents of the surrounding communities.

Responses to the personal surveys

Of the 43 civic scientists, 24 individuals completed all three personal surveys. Figures 3A,B display the evolving employment statuses and financial situations, respectively, of the participants throughout the study period. The results are color-coded by survey number (1: beginning, 2: middle, and 3: end, respectively). Most of the participants were employed, and only 20.8–25% remained unemployed throughout the study period (Figure 3A). A gradual increase in "earning more than I am spending" was noted over the study period. Between survey 1 and 3 there was a parallel decrease in "spending more than I am earning." During the first survey more participants reported the "spending more than I am earning," while during the third survey the opposite was true. By the end of the study, the number of participants who reported living paycheck to paycheck had dropped by one individual.

Figure 4 presents reported use of the financial compensation derived from the project. The most common response was for basic household needs and expenses, followed by paying off debt, with no clear temporal trends evident in the data.

FIGURE 2
Prior stewardship experiences of the applicants and civic scientist.

FIGURE 3
Civic scientists' evolving: **(A)** employment status and **(B)** financial situation. 1, 2, and 3 represent survey numbers (1: beginning, 2: middle, and 3: end). In **(A)**, "Other" represents people who are students or retired.

Figures 5A,B describe levels of financial and general stress. Over the study period, participants who reported "some" or "a lot" of financial and general stress outnumbered those with lower stress.

Because the goal was to determine whether paid participation in the study could reduce economic stress, the participants were asked questions regarding the risk level that COVID-19 poses to the local economy, and their assessment of the Federal government's response to the

pandemic (which because of the timing of the study included distribution of the stimulus checks). The results, shown in Figure 6, indicate that throughout the study the participants rated the economic risks to their community as "high" and "extremely high," while rating the governmental response as resoundingly "poor."

Overall, the pandemic appears to have presented significant perceived risks to the civic scientists and to their communities. However, the financial compensation provided by the project
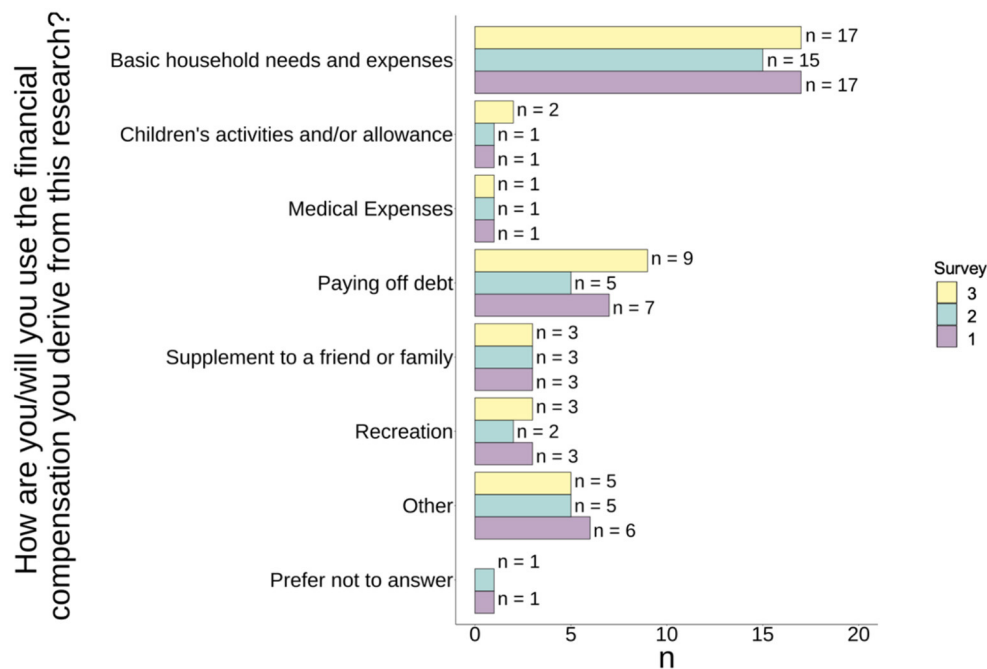
FIGURE 4
Civic scientists' evolving spending of financial compensation derived from the study, where "n" represents the amount of time that the answer was selected.
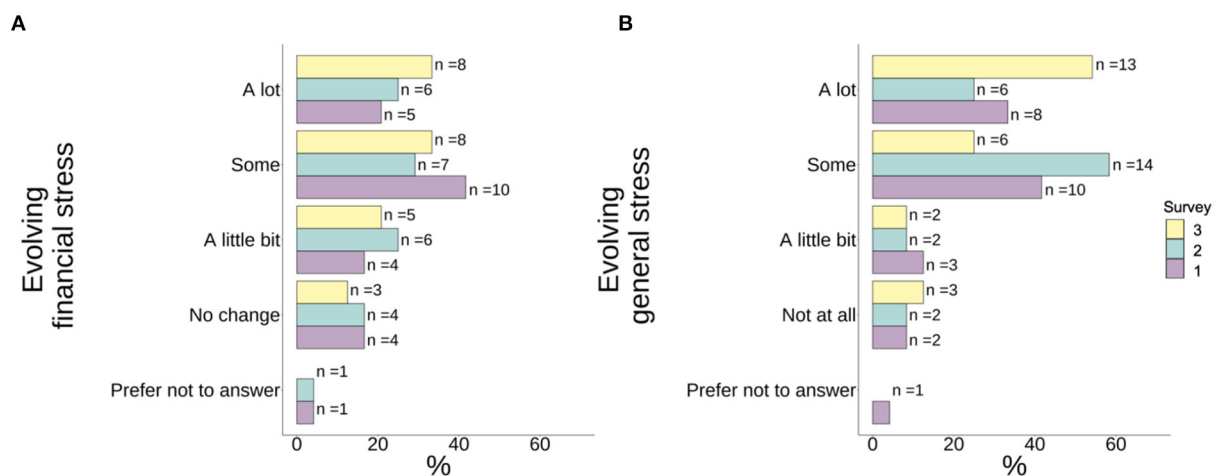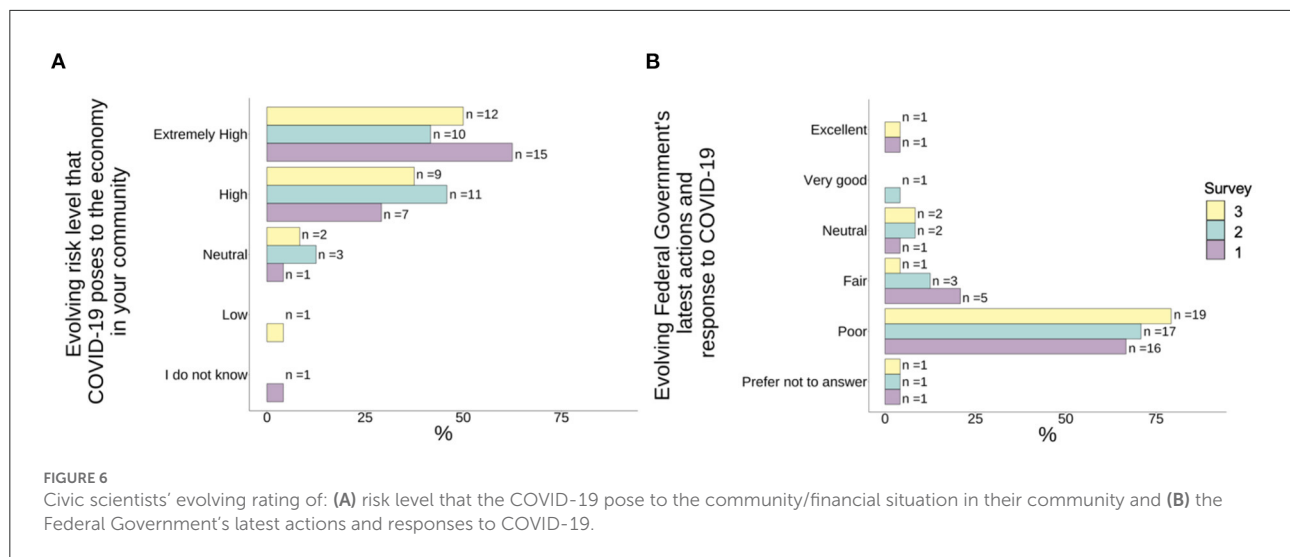

FIGURE 5
Civic scientists' evolving: **(A)** financial and **(B)** general stress.

appears to have been helpful in covering basic household— and other-expenses.

Post-study evaluation

A portion of the results of the post-study evaluation are presented in Table 3 (complete results are provided in Supplementary Table 1). Of the 43 civic scientists, 24 individuals completed the post-study evaluation (though some did not answer all questions). Although 83.3% of study participants reported that they had not previously participated in a scientific study, all respondents indicated that after this experience they would consider participating in other scientific studies. A total of 54.2% of the civic scientists reported that their views on scientific studies had changed for the better (i.e., "yes, positively"); and

FIGURE 6
Civic scientists' evolving rating of: **(A)** risk level that the COVID-19 pose to the community/financial situation in their community and **(B)** the Federal Government's latest actions and responses to COVID-19.

none reported less favorable views (i.e., "yes, negatively"). When asked whether involvement in this study increased their interest in related research, 12.5% respondents answered "yes, very much so," 50% said "yes, a little," 4.2% stated "yes," and 33.3% said "maybe in the future." Additionally, 45.8% of respondents reported that the compensation provided by this study "very much" impacted their financial situation during this time of economic crisis, and a total of 95.8% indicated that the tasks asked of them were reasonable given the compensation. Finally, about 67% of the civic scientists found the application process, data regimen, and communication with the research team to be "easy" (see Supplementary Table 1).

Besides general expressions of "thanks," only five open-ended responses were submitted: two responses regarding how the study could have been conducted differently (Question 10), and three responses to the general feedback inquiry (Question 11). As presented in greater detail in the Discussion, the civic scientists reported that it was "nice being out every day and having the sun" and that the project had a "great impact" on family and that it made them feel "useful" and "anchored" in a difficult time. They also acknowledged "racial and social tension" between the park users and the civic scientists and recommended potentially providing future civic scientists with an "official pin/insignia" to clarify their role as a researcher. The full quotes are integrated in the Discussion.

Discussion

The discussion analyzes lessons learned from the application process, personal survey responses, and the post-study evaluations in terms of their relevance to the four Key Challenges revealed during the literature review.

Diversity and inclusion

The snowball sampling method was effective in attracting a large pool of 300 applicants spanning the two cities. The number of applicants accumulated more quickly in Philadelphia, possibly due to institutional name recognition (Drexel University is in Philadelphia) and fewer COVID-19 cases at the time of the study, relative to NYC. In Philadelphia, 135 applications received within a few days of publicizing the study, and in NYC 165 applications were received over a 2-week period.

White people made up a higher percentage of both the applicants and civic scientists than found in the population of the surrounding zip codes. This discrepancy is noteworthy given the intention of the research team to diversify the two civic scientists servicing each park in each density/vulnerability category. In part, the shortcoming was due to the goal of assigning exactly two civic scientists to each park. Parks receiving only one applicant were removed from the study, reducing the overall pool of applicants (and potentially some non-White applicants). If a particular park had exactly two applicants, both applicants were automatically included in the study, independent of demographic profile. It was only when multiple applicants applied to study the same park that the research team had any ability to diversify participation, and in those cases, priority went first to unemployed applicants. In such instances, once the research team made a selection both accepted applicants needed to respond to the acceptance email in a timely manner and agree to accept the position. If those conditions were not met, other individuals were selected from the pool of applicants.

If diverse participation was hindered by the limited pools of applicants to each park, the study's rigid schedule and privacy considerations may have also been partly to blame. With more

TABLE 3 Post-study evaluation.

Post-study inquiries	Civic scientists	
Have you ever participated in a scientific study prior to this one?	n = 24	%
Yes	4	16.7
No	20	83.3
After this one, would you consider participating in other scientific studies?	n = 24	%
Yes	24	100.0
No	0	0.0
Not sure	0	0.0
Has your view on scientific studies changed after your participation?	n = 24	%
Yes, positively	13	54.2
Yes, negatively	0	0.0
No	11	45.8
Has your participation in this study encouraged you to look more into topics of research related to this study?	n = 24	%
Yes, very much so	3	12.5
Yes, a little	12	50.0
Yes	1	4.2
Maybe in the future	8	33.3
Not at all	0	0.0
No	0	0.0
Did the compensation provided by this study positively impact your financial situation during this time of economic crisis?	n = 24	%
Very much	11	45.8
A little	13	54.2
Not at all	0	0.0
It had negative impact	0	0.0

time, the research team could have extended and broadened the recruitment process until a more diverse team of civic scientists were assembled. However, the scientific goals driving the research effort required collection of ephemeral data at this unique, early phase of the pandemic when stay-at-home orders were in effect. This urgency created pressure on the research team to expedite the recruitment process.

The rigid conditions imposed by the study's IRB protocol may also have worked against the research team's goal of reflecting the community demographics in the participant pool. Had in-person recruitment through flyers and tabling at the parks of interest not been prohibited, it is possible that recruitment strategy could have been better tailored to recruit individuals residing in the vicinity of each park over those

identified through the network of NGOs known by the research team. Recent research suggests that greater diversity can be achieved by expanding networks beyond direct institutional affiliation, offering multiple ways to participate at different levels (Paleco et al., 2021), and relating project goals to potential participant values and interests (Whitmarsh et al., 2013; Merenlender et al., 2016).

In summary, the selection process did achieve the goal of creating jobs for economically vulnerable, i.e., unemployed individuals. However, by extending and diversifying the recruitment period and process, a larger pool of applicants to study each park could have been generated. This larger pool could have presented the research team with more options for diversifying study participation. Such changes to the recruitment duration and process would perhaps be more feasible on citizen science projects that do not require anonymous participation and does not seek to collect ephemeral data at a time when direct interpersonal contact is discouraged for public health reasons.

Financial compensation

The project appears to have been successful in providing some meaningful financial relief to the participants. At a rate of $10 per entry, with two entries possible per day, civic scientists who completed all of the requested activities would have earned a total of $1,120 over the course of the 8-week study, approximately the amount of the government-sponsored stimulus checks being distributed at the time (Clifford Colby, 2021). The personal surveys revealed that although the employment status of the civic scientists did not change significantly throughout the study (i.e., most of them remained employed throughout), there was an increase in the number of participants who reported earning more than they were spending, perhaps due somewhat to the payments provided by the study.

The timing and scale of financial compensation also appear to have been appropriate. Positive feedback regarding the study's financial compensation is not surprising. Izraeli and Murphy (2003) suggest that in post-disaster periods, the creation of new employment opportunities that leverage the skills and availability of the local labor force can foster a positive community response to disruptions. COVID-19 was both an economic and public health crisis, and the civic scientist feedback suggests that the compensation provided by the study helped to alleviate some of the background financial burden.

Though the payments appear to have been appreciated and impactful, the process of delivering them to the civic scientists was onerous and plagued with institutional barriers. Distribution of gift cards, often a default strategy for universities to financially reward study participants, was not logistically feasible in this case, both because the payment amount needed to be scaled to the number of observations made by each

civic scientist (i.e., more observations, more payment), and because the research team promised to compensate the civic scientists on a weekly basis. The possibility of formally hiring the civic scientists as temporary employees of the university was initially explored but ultimately abandoned because of the need to hide participant identities from the research team. The delivery mechanism ultimately implemented involved the use of an online money transfer application (PayPal). Each civic scientists linked their PayPal accounts to an email address that did not reveal their identity (the same email address they used to interact with the research team). Funds were disbursed weekly from a university account after verifying data submissions made by each civic scientist.

Although the PayPal approach was ultimately successful, several challenges emerged as the study proceeded. Administering payments to 43 civic scientists every Friday afternoon required a non-trivial level of collaboration between the university accounting office and the research team. Additionally, at the outset of the study, it appeared to the research team that the burden of collecting tax forms (W-9s) for participants earning over $600 (the threshold for which payments are taxable) would fall on PayPal. Ultimately, the university determined that it was responsible for collecting W-9s and issuing 1099s. Because the civic scientists needed to remain anonymous to the research team, these fiduciary responsibilities also had to be managed by the university's accounting office, adding significant complexity to the process. When it was revealed that the civic scientists needed to pay taxes on the compensation, several individuals became concerned that their participation would render them ineligible for unemployment or other forms of public assistance. Through additional consultation with the accounting office, it was, however, ultimately determined that while they did indeed need to pay taxes, the civic scientists were not required to report the compensation as income since it was for participation in a research study.

This case study demonstrates the significant logistical complexity faced by one university seeking to provide financial compensation to citizen scientists. This project suggests that if such barriers can be overcome, financial compensation for this type of work is appreciated, can be scaled to work completed, and can reduce economic hardship in times of crisis, a key finding of the study.

Participant learnings and attitudes

The post-study evaluation yielded mostly positive feedback. Most civic scientists had never participated in a scientific study before, yet all respondents indicated they would consider participating in similar efforts in the future. Similarly, more than half of the participants confirmed that the study encouraged them to investigate topics of research related

to the study. This observation is critical, considering that the public perception on science has grown increasingly partisan (Kirchner, 2017). Civic scientists shared that they were specifically interested in learning about park usage, mask usage in public spaces, and socio-economic trends in relation to COVID-19.

Although most civic scientists reported "some" or "a lot" of stress throughout the duration of the study, comments submitted through the post-study evaluation form suggested that the data gathering activity provided some relief. In general, the pandemic triggered feelings of helplessness and loss of control (BBC, 2020; The New York Times, 2021). Yet, one civic scientist stated in their post-study evaluation:

> "This was actually a great impact to my family. I was able to get my kids out and walk with me every day. I did all the pictures and note taking, but they helped and were paid. I think we all look back fondly on participating in the study."

In a similar response, another participant reported:

> "I felt somehow 'useful' during a time when I am actually quite powerless to change the course of events, in several ways: I could help further knowledge; it 'anchored' my day during a time when my regular schedule has been disrupted; it encouraged me to walk from 3-5 miles a day; and the money has been used for charitable donations, something that makes me feel good."

During this unique time when daily life changed abruptly and dramatically, this study provided participants with structure to their days. Other researchers (Pocock et al., 2019) have shown that participation in research aimed at understanding the crisis at hand can help to combat feelings of uselessness and provide a sense of belonging. This crucial affirmation of one's value at a difficult time is key in helping individuals adapt and respond. The project created linkages between the urban environment, individual behavior, and social information, creating a social-ecological feedback loop that has been shown to build resilience in disaster contexts (Tidball and Aktipis, 2018).

It is worth noting that the reported stress relief is not surprising given the nature of the specific work required of these civic scientists. The data collection regimen for this study had the participants visit their local park two times a day for the duration of May–July 2020. Visits to urban parks have been shown to improve physical and psychological health (Jennings and Bamkole, 2019; Ma et al., 2019; Zuniga-Teran et al., 2020). More specifically, advocates have emphasized the important role urban parks have had on morale boosting and stress relief amidst societal disruption throughout the pandemic (Kleinschroth and Kowarik, 2020; Uchiyama and Kohsaka, 2020; Ugolini et al., 2020).

Although most civic scientists reported positive experiences with the observation process, such as getting exercise and getting to know their park better, one civic scientist had concerns with awkward encounters while collecting data and suggested:

> *"…possibly providing the surveyors with an official pin/insignia so that if they are approached during such an observation, they can refer to that title."*

Another described this discomfort further, stating:

> *"There is a racial and social tension that I felt. White male walking around in a very ethnic/African American/and Mexican neighborhood with a lot of homeless. I usually had my kids and I was raised in NYC otherwise I dunno, it would not be pleasant. Several times people approached me too close and started a convo and wanted to see if I was fascist or something, but I am a true NYer and that is never the case… but I felt more uncomfortable with the social distance factor… but it was nice being out every day and having the sun, fresh air, and in the middle of the study I was reading most cases were from long island people who have been quarantined in their home, so I dunno. I hope this study sheds some light to the virus and homeless and so on…"*

The comment illustrates the relationship between participant diversity and experiences. It could be that there would have been fewer feelings of "racial and social tension" had the racial and ethnic identities of the participants better represented the surrounding community.

Data quality

Research, like many other activities, was complicated in the early phases of the COVID-19 pandemic. Although most civic scientists reported no problems navigating the instructions and communicating with the research team in their post-study evaluations, of the 43 civic scientists, only 24 completed the personal survey all three times, and completed the post-study evaluation. However, as described in our companion paper, the data gathered by the civic scientists in this study was more than adequate to publish the study findings in a peer-reviewed academic journal (Alizadehtazi et al., 2020).

This said, the requirement of anonymity posed some challenges in training and supervising the civic scientists, specifically with respect to describing the required activities. In retrospect, though the civic scientists were provided a digital memo on Drexel University letterhead indicating that they were part of a research study, interactions with the public might have been smoother if they could have been provided with a more formal badge, though mailing these out was not possible, again because of the requirement of anonymity. The application form requested that applicants demonstrate that they take photographs with a mobile phone and blur out any faces, since the actual study required this task. Instructions were provided on the application form but inability to complete this task may have inadvertently reduced the pool of applicants.

Roughly 20% of the participants reported difficulty with the initial application process and problems comprehending the tasks requested of them. Referring to one of the enumeration duties of counting the number of people wearing masks and the number of homeless people, one civic scientist elaborated in their post study evaluation,

> *"I think it should have been clearer what proper use of the mask is. Additionally, I would have liked more clarification on the definition of those 'seeking refuge' in the park."*

Because of the abrupt nature of the stay-at-home orders, the diffuse locations of the parks of interest, the ephemeral nature of the solicited data, and other logistical constraints on research introduced by the university, the participation of citizen scientists in this research project was essential to its successful completion. Indeed, this data could not have easily been collected any other way.

Conclusion

This paper analyzes the incorporation of civic scientists into a research study conducted at a unique, early stage of the COVID-19 pandemic. In-depth scrutiny of the recruitment, payment, and evaluation processes undertaken by the research team yielded useful insights into some of the key contemporary challenges associated with citizen science. It also helped to develop recommendations for how to maximize the benefits of these projects on the participants, while achieving the intended scientific outcomes (Bonney et al., 2016; Schaefer et al., 2021).

Citizen scientists collected data of sufficient quality to produce at least one article for publication in a peer-reviewed journal (besides this one), and the study's policy-relevant conclusions were picked up by the media (Philly Voice, 2021). Through their data gathering activities, the civic scientists became more interested in the specific focus of the study, and in research in general. They also reported that the research itself helped to relieve general and economic stress they were experiencing at this early phase of the pandemic.

Though administration of weekly payments by the university to the citizen scientists was logistically cumbersome, financial compensation provided by the project was used by the citizen scientists to cover household, and other expenses in this time of high economic risk.

In these ways, the study represents what Riesch and Potter (2014) describe as a win-win. However, while the research team was successful in recruiting economically vulnerable

(i.e., unemployed) participants, the pool of participants did not racially and ethnically reflect the communities surrounding the parks of interest. Notably, the participants were disproportionately female, young, White, non-Hispanic, single, and college educated. In this way, the diversity outcomes were similar to many other citizen science projects in which participants are often found to be disproportionately middle-class, educated, and White (National Academies of Sciences, Engineering, and Medicine, 2018; Paleco et al., 2021; Walker et al., 2021).

The IRB protocol requirement that the civic scientists remain anonymous to the research team introduced a wide range of logistical obstacles for the research team, from diverse recruitment, to communication, to training, to administration of payments. The requirement of anonymity was driven by the desire of the research team to evaluate the experiences of the civic scientists themselves. Ironically, if the team had not sought to survey the civic scientists' experiences, it might have been easier to recruit a diverse cohort, train, communicate, and pay the citizen scientists for their work. One possible solution could have been to hire two cohorts of civic scientists, only one of which would have been personally surveyed.

The co-production of knowledge in the midst or aftermath of a crisis is essential in gaining different perspectives from a wide range of those affected, and can increase the legitimacy of the study findings while providing more evidence for decision making and solution implementation. The case study illustrates that paid civic science can be successful and efficient, even in a time of crisis and stress.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Drexel Institutional Research Board (IRB). The patients/participants provided their written informed consent to participate in this study.

Author contributions

BA, KT, NM, and FM: conception and design. BA, SW, KT, NM, and FM: methodology. BA, SW, KT, and AG: data curation. BA: software, analysis, and visualization. BA and SW: manuscript drafting with the contributions from all other authors. KT and FM: project administration. FM: principal investigator and supervision. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2022.709968/full#supplementary-material

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