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The Impact of Forest Usage and Accessibility on the Perceptions of its Users and Surrounding Residents

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Abstract: Forests provide valuable ecosystem services to individuals that live near them and visit them. However, many forests, especially in highly developed areas, are specifically managed for resource conservation purposes. A common practice for conservation is restricting access to people to ensure minimal human-driven harm. While the restriction of human access to a forest increases its biological ecosystem services, it limits its cultural services and may reduce the public's perceived value of the forest. To investigate how access influences the perceived value of a forest, two forests in the state of New Jersey, USA, were compared. The forests, the Rutgers Ecological Preserve (RUEP) and Hutcheson Memorial Forest (HMF), represent accessible and inaccessible forests respectively. The study reported here evaluated the effects of visitation and accessibility on public perception of both sites. Residents near the RUEP and HMF, and visitors of both sites, were surveyed ($n = 48$). The results of the surveys demonstrated that the frequency of visitation and community location can have noticeable influences on a number of variables, including one's belief that forests provide important services and the thought that protected areas take away from an individual's freedom to use the area. A more positive view of the forests was present in those who visited the public forest most often.

Keywords: protected areas; conservation; public perceptions

1. Introduction

Urbanization is rapidly changing the global landscape with the continuing growth of cities separating people from nature [1,2]. With most of the world's population living in urban settings, there is a growing disconnect between people and their natural environment [3,4]. This separation of humans from the environment is a possible driver of poor human health outcomes [5]. These health outcomes may be further exacerbated in cities, given the frequently prominent legacy of cultural and socioeconomic histories that result in a disproportionate impact of environmental injustices on minority communities in urban areas [6,7]. Forests can provide a variety of benefits to individuals living near them, including improving air quality, reducing atmospheric carbon dioxide (CO₂), moderating local microclimates, lowering rainfall runoff and flooding and reducing noise pollution [8–10]. However, in many developed and developing areas, forests are targeted for conservation not for their benefits to human health but because of their importance in conserving biodiversity [11,12]. The difference in drivers behind forest conservation may cause potential conflicts as, often, protected areas and green spaces lose conservation value as they become more accessible to humans [13,14]

Sustainable management of forests has various definitions in the literature but broadly encompasses the core goal of maintaining ecological functionality (i.e., biodiversity, productivity) while promoting community benefits (i.e., economic, social) [15,16]. To maintain ecological functionality, some forests across the Northeast of the United States have been managed and classified as protected areas. Protected areas are clearly defined as those where development and human activity is limited in order to achieve long term conservation of nature and the associated ecosystem [17]. While the initial goal of protected areas was to preserve habitat and biodiversity, in recent years they have also been used to preserve spaces of cultural importance and to provide communities with access to nature [18]. Protected areas are classified into six categories according to their management objectives (see [17].org “Protected Areas Categories”). As a result of protected area classification, forests across the Northeast vary in their level of public access. Some classified protected forests entirely restrict public access, whereas others exist on a continuum of public access and use. Regardless of the accessibility or classification of a forests, the presence of these forests provides ecosystem services to the communities around them.

Prior research has found that physical engagement with the natural world increases understanding and knowledge of biodiversity and thus willingness to protect it [19]. Regular engagement in nature has been shown to be particularly important in childhood for promoting life-long appreciation and affinity for nature [20–25]. Additionally, urban green spaces have been shown to be an important source of social and psychological benefits for those communities surrounding them [26]. However, recent work has found that the accessibility of forests and green spaces may influence individuals’ valuation of these spaces. One study found that individuals were willing to pay larger amounts for homes near parks and that this behavior increased when parks were not heavily used [27]. Conversely, near parks where a lot of recreational activities were present, property values were lower. In less developed areas, property values were dependent on proximity to a forest or open area [27]. Other work has similarly found that house prices, and in turn property taxes, increased when in close proximity to protected forests [28]. From this work, it is clear that proximity to green space benefits those surrounding it, but this benefit is reduced with increased human use.

Although limiting use of protected forests may have an ecological benefit, this benefit may not strongly influence individuals’ perceptions of protected forests. Instead, studies have found that visiting parks and natural areas and elements of individual identity may be more important in influencing perceptions of protected natural areas. A recent study of public views of parks found that there was a strong association between visitation frequency, age, gender and the perceived benefits of green spaces [29]. This work is supported by other studies, which found that parks and natural areas facilitate social interactions that establish a sense of community, pride, identity [30] and involvement [31]. As some protected forest areas are managed for public use, people may see more value in these forests for the social opportunities provided rather than the ecosystem service benefits, or be entirely unaware of the ecosystem services these protected forests provide. However, communities surrounding private-access protected forests may not receive the social benefits of public use forests and may be unaware of or not value the ecosystem service benefits provided by the forest. This lack of access may lead to decreased support for maintaining and protecting these forests, which play an important role in environmental health. Recent work has acknowledged that there is limited research that investigates the relationship between visitation/access to green spaces and perceptions of their personal and community-wide benefits [29]. It is, therefore, important to understand how access to protected forests influences people’s perceptions of them, particularly considering the role of the public in protected area conservation.

In this study, we asked what factors, including environmental orientation, perceptions and use of public green spaces and sociodemographics, influence how individuals perceive the value of a forest. Additionally, we asked if any of these factors impact whether people believe that “protecting” forests limits people’s “freedom to enjoy” the forests. Further, by comparing the responses of individuals who live near a protected forest with restricted access and those of individuals who live near a forest open to the public, we further investigated whether physical proximity to a protected forest shapes

perceptions of the value of the forest and the influence of protected status on use. This research sought to understand the relationship between visitation opportunities of protected forests and public attitudes towards these forests. Understanding these relationships can guide management strategies to increase public support for the creation and conservation of protected forests.

2. Materials and Methods

2.1. Study Location

The Northeast of the United States has experienced rapid urbanization over the last 100 years [32]. Although much of the region has been developed, in areas such as New Jersey, conservation efforts dating back to the 1950s have set aside many patches of forest and other natural landscapes and developed an extensive network of protected areas [33]. As such, the Middlesex and Somerset counties of New Jersey contain a mixture of developed landscapes and forested areas with 20% and 39% of the counties made up of forests, respectively. However, the management of the forests within the counties is not uniform, with some forests established as strict conservation areas, such as private easements which are inaccessible to the public, while other forests are open to the public and feature hiking trails and other amenities. For this study, we focus on two forests, Hutcheson Memorial Forest (HMF) in Somerset County and the Rutgers Ecological Preserve (RUEP) in Middlesex County. The two green spaces are about 10 miles apart (Figure 1) and while HMF is private (strict accessibility, in this context meaning only accessible to the public on select days with research staff-led tours), the RUEP is a multi-use forest open to the public, which also serves as a teaching area. This research was conducted during the summer months of 2017 in the neighborhoods surrounding the two forests.

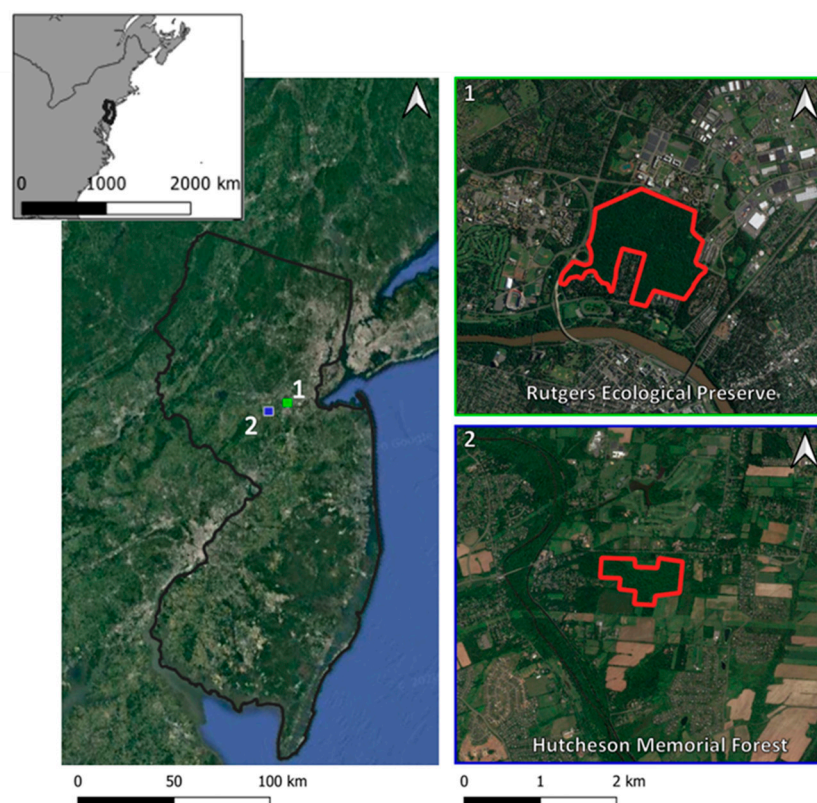


Figure 1. Location of the Rutgers University Ecological Preserve (RUEP, 1) and Hutcheson Memorial Forest (HMF, 2) within New Jersey on the East Coast of the United States. Imagery shows the differences in landscape surrounding these two areas, with the RUEP surrounded primarily by Rutgers University and residential land while HMF is surrounded primarily by agricultural and residential land. Images from Google Earth (2017).

2.2. Hutcheson Memorial Forest

Hutcheson Memorial Forest (HMF) is a 96-ha patchwork of abandoned agricultural fields and uncut old growth deciduous forest located in Somerset County, New Jersey, USA (40°29'55.7" N 74°33'46.6" W, Figure 1). The forest is surrounded primarily by undeveloped land (46%) with a mixture of developed land (28%) and agricultural land (24%). The core of HMF was established in 1711 by Dutch settlers and, as such, the 26-ha core is dominated by hickory and oak trees averaging 200 years of age [34]. Surrounding the old growth section of the forest, former agricultural fields have been undergoing succession over the past 60 years, resulting in young closed-canopy forest composed primarily of juniper. In 1955, Rutgers University acquired HMF and since then the forest has been a center for research. The forest is closed to the public and signs are posted around the forest perimeter declaring it private property and prohibiting trespassing. Additionally, in 2015, a 10-foot deer fence was built around the perimeter of the forest creating a physical barrier. For those interested in learning about the research done in the forest and the forest's history, tours are available one to two times a month during the spring and summer and once or twice during the winter. Tours are always guided by a researcher and range in size from 5–20 individuals. Generally, the audience of the tours tends to be older and the Hutcheson Memorial Research Center has paired with senior living centers to provide tours.

2.3. Rutgers University Ecological Preserve

The Rutgers University Ecological Preserve is a 128-ha tract of land that abuts Rutgers University's Livingston Campus in Piscataway, New Jersey (40°31'02.5" N 74°26'27.0" W, Figure 1) and is surrounded primarily by developed land (81%, Supplemental Figure S1). Almost all of the area has been used for agricultural purposes since the 1800s, with a few areas released from cultivation in the mid-1800s. All agricultural practices were stopped in the 1940s and Rutgers University acquired the land between 1945 and 1963. The Rutgers Ecological Preserve was officially established in 1976 [35]. The preserve is dominated by maple and oak trees with interspersed cherry and ash. There are six established trails through the Ecological Preserve and various events are hosted there to encourage people to use the area. The RUEP is also used by several courses at Rutgers as an outdoor classroom and many class projects revolve around creating signs and displays throughout the preserve to educate the public about the natural history of the area.

2.4. Survey Design and Implementation

We surveyed residences within a specified 300-m band area surrounding each of the study sites. The bordering residential areas were selected because individuals in these areas were more likely to be aware of and potentially use nearby forests. A sample of 100 residential households per neighborhood was selected using Google Maps. To the best of our ability, steps were taken to ensure that multihousehold residents were accounted for with the use of WhitePages. In the summer months (May through July) of 2017, two survey mail-outs were conducted about a month apart. When completed, participants received an Amazon gift card compensation with a monetary value of \$10.00.

2.5. Questionnaire Design

The questionnaire focused on assessing individuals' knowledge and perception of the local forest, as well as their environmental orientation and demographic information.

2.6. Forest Perception Variables

Eight questions investigated individuals' perceptions and knowledge of the forest. There were five Likert-type scale questions (1. "The quality of the forest is excellent", 2. "The forest is valuable to the community and the environment", 3. "The forest has a diverse number of species", 4. "The forest has a variety of birds" and 5. "Most people in the community are not aware of this forest"),

with 1 representing strong disagreement and 5 representing strong agreement. A sixth question asked if respondents were aware of the forest's history (note: this was coded as yes or no). A seventh question asked how long the respondent lived adjacent to the forest and was scored between 1–4 with 1 representing 1–5 years, 2 representing 6–10 years, 3 representing 11–15 years and 4 representing 15 years or more. The final question asked how often a respondent visited the forest.

2.7. Environmental Orientation

Three questions assessed individual's attitudes toward protected areas. These five-point Likert-type questions were "People in my community believe that a sense of community is important", "I consider myself an environmentalist" and "Protecting lands take away from our freedom to enjoy them."

2.8. Sociodemographic Variables

Three questions investigated sociodemographic factors of the respondents. Age was clustered on a scale from 1 to 5 including the categories: 18–24, 25–32, 33–40, 40–50 and 50+. Individuals were only given two options for gender, so it was used as a binary variable. Ethnicity was treated as a binary variable so that it could be included in the analysis and due to the lack of non-white respondents. Individuals were categorized as either white or non-white.

2.9. Analysis

We investigated whether people's perceptions of protected forests differed between individuals who lived near a strictly protected forest (HMF) and those who lived near a more openly protected forest (RUEP) by comparing the average responses to the questions "Protecting lands take away from our freedom to enjoy them" and "The forest is valuable to the community and the environment". Comparisons between the responses for the two groups were conducted via a two-tailed t-test with uneven variance, as the sample size between the two groups were different.

We also ran a generalized linear mixed model to investigate whether other factors led to differences in perceptions of how protecting lands may limit individuals "freedom to enjoy them". In this model, the dependent variable was respondents' responses to the question above while independent variables included the three sociodemographic variables, the eight forest perception variables and the two additional environmental orientation variables as fixed effects and the location where the respondents lived (near the RUEP or HMF) as a random effect. We also investigated what factors influenced the perceived value of a forest to the community. For this analysis, we followed the same methods as the previous model, except that we used the response to the question "The forest is valuable to the community and the environment" as the dependent variable. Before running our models, a Pearson's correlation analysis was conducted on all independent variables. The questions "The forest has a diverse number of species" and "The forest has a variety of birds" were correlated above 0.7 so the second question was dropped from our models. No other variables were correlated at a level above 0.7. All analysis was run in R version 3.6.1.

3. Results

A total of 54 surveys were received from participants, providing a 27% response rate. For our analysis, 48 participants responded to the survey fully enough to be included in the analysis, as incomplete surveys were removed from the data. Of the 48 responses included, 13 responses were from the area surrounding HMF and 35 were from the RUEP (see the supplementary materials for full survey).

3.1. Demographics

Overall demographics were similar between the respondents from around HMF versus those from around the RUEP (Table 1). A total of 68% of respondents to the survey sample were in the 40–50 and 50+ age intervals, with no significant difference between groups ($p = 0.19$). Twenty-two of the twenty-seven respondents who provided racial identification identified as white, with no significant difference between the two groups, although the number of non-white respondents was higher among those from the Rutgers University Ecological Preserve ($p = 0.09$), with more individuals identifying as non-white. There was an equal representation at a proportion of 50:50 for those that identified as male or female, with no difference between groups ($p = 0.71$). Overall, the survey population was generally older white individuals but nonsignificant differences in demographics implied that differing opinions on forests were not a result of differences between sample populations around HMF versus the RUEP. The majority (75%) of locals had lived at their residences for more than 15 years, 15% for 1–5 years, 10% for 6–10 years and 2% for 11–15 years. Participation in the survey varied by forest, with 73% of survey respondents living near the RUEP.

Table 1. Sociodemographic information for participants displayed by overall composition, as well as separated for those who lived near HMF and those near the RUEP. Average values are shown along with standard deviation in parenthesis.

Variable	Combine	RUEP	HMF
Age	3.81 (1.48)	3.66 (1.47)	4.23 (1.48)
Caucasian (1 = yes, 2 = no)	1.31 (0.47)	1.36 (0.49)	1.17 (0.39)
Gender (male = 1, female = 2)	1.5 (0.51)	1.49 (0.51)	1.53 (0.51)
Length of time in neighborhood	3.33 (1.15)	3.31 (1.16)	3.38 (1.19)

3.2. Perceptions of Protected Status and Freedom to Use Land

Results from the t-tests showed that the responses for the HMF versus RUEP residents did not differ with regard to how individuals perceived the protected status influencing the freedom of individuals to use the land ($p = 0.41$). Both groups disagreed with the statement that, in general, protecting forests limits individuals' freedom to enjoy these lands, with RUEP average response of 1.66 and the HMF average response of 1.74 (Table 2).

Table 2. Average responses for those who lived near HMF vs. those who lived near the RUEP to the questions "Protecting lands take away from our freedom to enjoy them" and "The forest is valuable to the community and the environment". Average value and standard deviation are shown in parentheses. For responses, 1 indicated strong disagreement and 5 indicated strong agreement.

Variable	RUEP	HMF
"Protecting lands take away from our freedom to enjoy them"	1.66 (1.25)	1.74 (1.41)
"The forest is valuable to the community and the environment"	4.91 (0.28)	4.62 (0.77)

Our mixed model investigating perceptions of whether protected status limited individuals' freedom to use forests had an R^2 of 0.41. The model revealed that only two significant variables—an individual's perceived sense of community and their self-identification as environmentalist—influenced respondents' perceptions of protected status. The more an individual agreed that a sense of community was important, the more likely they were to also think that protecting forests removes people's freedom to enjoy the forests ($\beta = 0.59$, $p = 0.04$; Figure 1, Table 3). Additionally, individuals who identified as environmentalists were less likely to see protected status as removing the freedom of individuals using forests ($\beta = -0.95$, $p = 0.02$; Figure 1, Table 3). No other variables were significant in our model (Table 3).

Table 3. Results from the linear mixed models. Beta estimates for each variable, as well as the p -value for each variable (in parentheses), are shown for our model investigating whether people perceived protected status as limiting freedom to use the forest, as well as for our model investigating how people perceived the value of the forest. Significant beta values are marked with *. R^2 for each model is displayed in parentheses after the question the model investigated as a dependent variable.

Variable	“Protecting Lands Take Away from Our Freedom to Enjoy Them” (R^2 0.41)	“The Forest Is Valuable to the Community and the Environment” (R^2 0.39)
Age	−0.05 (0.84)	−0.05 (0.63)
Caucasian (1 = yes, 2 = no)	−0.23 (0.67)	−0.08 (0.72)
Gender (male = 1, female = 2)	−0.09 (0.85)	0.41 (0.05) *
Length of time in neighborhood	0.47 (0.15)	−0.08 (0.50)
“The quality of the forest is excellent”	0.40 (0.11)	−0.10 (0.33)
“The forest has a diverse number of species”	0.19 (0.56)	0.37 (0.01) *
“Most people in the community are not aware of this forest”	0.34 (0.11)	−0.15 (0.49)
Awareness of forest’s history	−0.66 (0.24)	0.08 (0.31)
Frequency of visitation	−0.39 (0.19)	0.03 (0.80)
“People in my community believe that a sense of community is important”	0.58 (0.05) *	0.14 (0.20)
“I consider myself an environmentalist”	−0.94 (0.02) *	0.00 (0.98)

3.3. Perception of Forest’s Value to the Community

Between the two groups of individuals surveyed, there was a small but statistically significant difference in how individuals perceived the value of the forest to the community and the environment ($p = 0.05$); however, both groups agreed or strongly agreed that the forest was valuable, with those living near the RUEP averaging a response of 4.91 and those near HMF averaging 4.61 (Table 2). Our mixed model investigating perceptions of the value of the forest had an R^2 of 0.39. The model revealed two significant variables which influenced respondents’ perceptions of the value of the forest. The more an individual agreed that the forest contained a diverse number of species, the more likely they were to think that the forest was valuable to the community and the environment (beta = 0.37, $p < 0.01$). Additionally, one demographic factor, gender, influenced the perceived value of the forest, with females more likely to agree that the forest was valuable to the community and the environment (beta = 0.41, $p = 0.04$; Table 3).

4. Discussion

These data suggest that, in general, people may not believe that protected status limits the ability of individuals to enjoy forests. However, this view may be held more strongly by those that are ecologically oriented, as those that identified as environmentalists were less likely to think that protected forests limited the freedom of individuals to enjoy forests. Those that are more anthropocentrically oriented may in fact disagree, as increased emphasis on a sense of community correlated with increased agreement that protecting forests could be limiting to forest use. This may be the case because those with an anthropocentric orientation may feel that resources exist solely for human use.

We also acknowledge that the results of this study might not be universal. Given that HMF is surrounded by a large amount of undeveloped and natural land, its restricted status may not limit community members from accessing nature. However, if the surrounding landscape were more developed, like the land surrounding the RUEP, people might have felt more negatively about HMF's limited access. Additionally, with the RUEP's recent housing development, the community is newer and may be less aware of the access points.

This work aligns with previous literature about perceptions of the value of protected areas and green spaces. In conservation, land is often deemed valuable because of high levels of biodiversity [36]. The respondents in this study also seemed to agree that biodiversity may drive the perceived value of a forest, as perceived increased species diversity was correlated with increased forest value. Although biodiversity was not measured in this study, other work has found a connection between biodiversity, or perceived biodiversity, and increased human wellbeing [37]. Thus, individuals who perceive an area to have higher biodiversity may, in fact, benefit from proximity to these areas. The role of gender and perception of the environment has also been seen in other studies in which females more positively perceived protected areas and their associated ecosystem services [38,39].

This study has some limitations because of the difference in the response rates of HMF participants. It is reasonable to believe that those individuals who have taken time to participate in a tour of HMF would hold different perceptions of the forest than those that never visited HMF. We also considered the implications of using Likert questions, as these questions are ideal for initial exploration but not in-depth analysis. Therefore, more work is needed to explore public perceptions of open-use versus protected forests.

Other scholars have highlighted the need to further explore the value of protected areas for people living outside of them [40]. Prior work has characterized the values derived from protected areas [41], indicating that these spaces influence the lives and wellbeing of visitors and residents. In-depth interviews with a subset of the users of and residents nearby the forests from this study would be particularly useful to help tease apart the relationships between the perceived and real value of protected areas, user-ship and personal identity.

While the restricted access of HMF serves an important purpose for scientific research, our work suggests that there may be broader consequences of these restrictions in terms of community support for maintenance of the forest. However, additional educational and community outreach programming may bolster community awareness and support of the forest. As protected areas are increasingly becoming the main mode by which people can experience nature [40], it is important to maintain these areas for future generations. Perhaps those who might be less ecologically oriented might be affected by appeals to community, which may be a motivation to support protected area preservation. Regardless, this work highlights, in conjunction with prior research, that it is important to prioritize management strategies of protected areas that directly involve the local community, with the explicit goal of generating community interest and buy-in to support these spaces.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2413-8851/4/4/79/s1>, Figure S1: Map of surrounding development composition of HMF and EP, Item 2: Full Survey.

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