



Understanding visitors' preferences for recreation sites during wildfire- and drought-induced displacements in the Southern California national forests

Bijan Gurung^{a,*}, Brian A. Peterson^a, José J. Sánchez^b, Alyssa Thomas^b, Elizabeth E. Perry^c, Jason Bergtold^d, Sarah Jackson^a

^a Department of Horticulture and Natural Resources, Kansas State University, USA

^b Pacific Southwest Research Station, United States Department of Agriculture Forest Service, USA

^c Department of Community Sustainability, Michigan State University, USA

^d Department of Agricultural Economics, Kansas State University, USA

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ABSTRACT

The four national forests in Southern California are dominated by the chaparral biome and are visited by millions of people annually. These forest ecosystems are impacted by wildfires and drought, which coincide with the peak outdoor recreation season. This study applied a discrete choice experiment to understand visitors' preferences for site and environmental attributes in wildfire- and drought-induced displacement scenarios. Two surveys were conducted: for a wildfire scenario and a drought scenario. Wildfires create disamenities for recreation through fire damage and smoke exposure, leading to the closure of forest areas due to safety concerns, whereas drought dries up water bodies, leading to the loss of water-based recreation opportunities. Regression model results for the wildfire survey indicate that park visitors preferred "wildland-urban" and "wildlands" views compared to "city" views in the alternative recreation sites. For the drought survey, preferences were for alternative recreation sites farther away from their homes ("1–2 h" and ">2 h" of travel time compared to "<1 h" travel time), and for "difficult" trails compared to "easy" trails. Models examining the influence of preferences for attributes across socio-demographic factors showed that visitors with "intermediate" and "committed" levels of outdoor recreation expertise preferred "moderate" and "difficult" trails in the wildfire survey, compared to "easy" trails, all relative to visitors with a "general or casual" level of outdoor expertise. In the drought survey, visitors in a group with kids preferred "wildlife" and "water" features compared to "mountain" features, relative to visitors in a group with only adults. The results can help forest managers develop effective recreation and resource management strategies by identifying key site attributes.

1. Introduction

Wildfires and droughts are ecological disturbances and environmental stressors in forest ecosystems. In forest management, a fire or wildland fire is a non-structure fire occurring in wildlands, including both prescribed fires and wildfires (National Wildfire Coordinating Group, 2012). Human factors contribute to modifying the underlying drivers of wildfire events in many landscapes (Pausas and Keeley, 2021). The number and extent of large fires increased across the western United States from 1984 to 2011, with a significant trend in the southern and mountain ecoregions, coinciding with increased drought severity (Dennison et al., 2014). The average warm-season burned area in the western United States from 2001 to 2020 was nearly double that of 1984

to 2000, and the area burned by 2020 warm-season wildfires was more than five times the average for the 1984–2000 record (Zhuang et al., 2021). In California, the annual burned area increased fivefold from 1972 to 2018, largely due to an eightfold increase in the extent of summer wildfires (Williams et al., 2019). Wind events and the delayed onset of winter precipitation are also contributing to the fall wildfires. In Southern California, the majority of large fires occur in the fall, driven by wind events, particularly Santa Ana windstorms (Keeley et al., 2009). The 2020 wildfire season was disastrous in California when nearly 10,000 fires burned over 4.2 million acres, or >4% of the state's roughly 100 million acres of land (CalFire, 2020).

Drought is a result of prolonged periods of precipitation levels below normal, leading to the loss of surface and groundwater (Richman and

* Corresponding author.

E-mail address: bijangrg@gmail.com (B. Gurung).

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Leslie, 2015). Drought is commonly categorized into four types: meteorological, hydrological, agricultural, and socioeconomic (Rasmussen et al., 1993). Temperature plays an important role in the water balance function and, thus, highlights the impact of a warming climate on drought occurrence and severity. Drought is not a new phenomenon in California, which has experienced prolonged multi-year droughts resulting in significant social and economic losses since the reliable instrumental record period starting in 1895 (Richman and Leslie, 2015). Severe droughts include the late 1920s–early 1930s (the ‘Dust Bowl’ drought), 1976–1977, the late 1980s–early 1990s, and 2012–2014. Drought events were often characterized by precipitation deficits in the past, but the latest significant drought event of 2012–2014 was unique, manifesting a combination of low precipitation and high temperatures. This led to a heat-based drought in California with one of the warmest years ever recorded since 1895 (Richman and Leslie, 2015). In addition to its evident impact on agriculture and ranching, droughts cause massive forest die-offs, significant water deficits in river basins, and contribute to severe wildfires (Flint et al., 2018).

Four national forests with chaparral-dominated landscapes surround the Los Angeles and San Diego metropolitan areas: Los Padres, Angeles, San Bernardino, and Cleveland national forests. These chaparral-dominated landscapes are popular for hiking, mountain biking, camping, and nature activities (Garnache et al., 2018). These landscapes have Mediterranean-type warm climate regions dominated by woody shrubland, with herbaceous understory and fire return intervals (FRIs) of 30 years or more (Van De Water and Safford, 2011). An analysis of wildfires between 2000 and 2020 showed that wildfires in California burned biodiverse areas critical to endemic species, in addition to impacting forest areas (Calhoun et al., 2022). Droughts have led to reduced streamflow, low lake and reservoir levels, impaired scenic resources (e. g., dried waterfalls), and drier soil and vegetation (Flint et al., 2018).

Wildfires and droughts pose challenges for outdoor recreation in the western United States because the peak outdoor recreation season coincides with wildfire and dry seasons (Gellman et al., 2022). Wildfires and the resulting smoke reduce the amenity value of recreation sites. Drought adversely affects recreation directly by limiting water-based recreation opportunities and indirectly by desiccating vegetation, disrupting wildlife habitats, and inducing wildfires (Jenkins et al., 2023). Research is being conducted to understand visitor behavior in response to ambient wildfire smoke in the American West and the associated risks to human health and welfare loss (Clark et al., 2023; Gellman et al., 2022). As more intense, prolonged, and larger fires, in tandem with severe drought, become more prevalent due to anthropogenic climate change (Balch et al., 2022), forest closures are becoming more frequent, restricting public access to recreation sites in the national forests of Southern California.

Limited research has focused on the recreational services provided by chaparral landscapes. Research on visitor displacement due to wildfire and drought is sparse, particularly in drought scenarios, because the drought effect is often estimated by its effect on agriculture (Thomas et al., 2013). Additional research is necessary to understand the impact of environmental stressors and site degradation on recreational benefits and their disproportionate effects on underrepresented groups (Garnache et al., 2018). Moreover, it remains unclear how visitors, including those engaged in water-based activities, adapt their use of recreational sites to increasing incidences of drought and wildfires, and changes in precipitation and temperature in Southern California (Garnache et al., 2018). This study contributes to addressing research gaps in recreational visitors’ responses to wildlife- and drought-induced displacement in the chaparral biome of Southern California. The study identifies the site attributes or environmental dimensions that influence visitors’ choice of recreation sites under such displacement scenarios in the four national forests of Southern California. The study also examines the differences in preference for site attributes or environmental dimensions across demographic groups. Understanding the effects of site attributes and spatial configuration of sites on ecosystem services—and

subsequently on public recreation preferences—can help decision-makers allocate resources to benefit the public (Garnache and Lupi, 2018).

The study aims to examine the displacement behavior of recreational users in the four national forests under negative resource conditions, such as wildfire and drought. The study examines heterogeneity in preferences among different visitor groups based on their socioeconomic characteristics. This analysis focuses on three key research questions.

RQ1: Which site attributes are significant in visitors’ recreation choices in the case of wildfire?

RQ2: Which site attributes are significant in visitors’ recreation choices in the case of drought?

RQ3: What are the preference heterogeneities based on the socioeconomic characteristics of the visitors?

2. Background

Forest recreation is commonly defined in terms of ecosystem services and their sustainability (Cviki, 2025). However, forest tourism is a broader concept that encompasses multiple theories, frameworks, and influencing factors. Accordingly, our study relates to the attribute theory and the transformative theory of forest tourism in the case of the four national forests (Wu et al., 2015). The natural attributes of these forests, including their scenic beauty, biodiversity, and diverse landscapes, make them unique destinations for millions of visitors from urban centers in Southern California and beyond. The attribute theory examines the relationships between visitors’ preferences and the attributes of forests, as well as the recreational opportunities and tourism products they offer. Transformative theory emphasizes the sociocultural values of these national forests, which promote visitors’ well-being, connection with nature, and sense of belonging (Cviki, 2025).

Public lands, including protected areas and national forests, provide space for outdoor recreation; however, these areas are increasingly confronted with undesirable conditions, such as crowding, conflicts in resource use, and poor resource conditions (Arnberger and Brandenburg, 2007). Crowding is the most common and visible phenomenon in popular recreation sites. Apart from crowding, researchers identified that park regulations (Hall and David, 2020) and wildfire-driven closures (Brown and Jenkins, 2023) can also influence the response and behavior of visitors. When there is an interference with their recreation experience, visitors will adopt a coping strategy to obtain a quality recreational experience (Fefer et al., 2024). Displacement is one of the coping mechanisms visitors adopt to reduce stress and avoid undesirable experiences (Richard S. and Susan, 1984). Displacement involves a process of moving away from places that have changed to an unacceptable level, rather than simply moving toward a more optimal one (Becker, 1981). Researchers have developed a typology to document and describe displacement behaviors, which include spatial displacement, temporal displacement, and activity substitutability (also known as product or activity displacement) (Hall and Shelby, 2000).

As a discrete situational factor in visitation dynamics, wildfire was found to significantly and negatively affect visitation in four of Utah’s five national parks, with an aggregate visitation loss or displacement of 0.5% to 1.5% in a typical fire year (Kim and Jakus, 2019). In an experiment involving two types of recreational users—bikers and hikers—demand decreased for both groups as the burned area increased, and the amount of burned area visible from the trail grew in four national forests in Montana (Hesseln et al., 2004). The impact of wildfires on the demand for forest recreation is complex because demand varies by time, type of recreation use, fire characteristics, landscape attributes, and availability of substitute sites (Garnache and Lupi, 2018). Wildfires and smoke led to campsite cancellations, with differential impacts on recreational activity across the 11 western continental U.S. states (Gellman et al., 2022).

The four national forests of Southern California attract millions of

visitors due to their proximity to major cities, but are also increasingly impacted by climate change effects (e.g., more frequent and severe wildfires and droughts) (Shaw et al., 2011). An estimated seven million recreational users visit the four national forests annually, the majority of whom are day trips by residents (Garnache and Lupi, 2018). The national forests are likely to be overused (exceeding their carrying capacity) by the growing population seeking wilderness, and are increasingly impacted by climate change (e.g., changes in precipitation, temperature, drought, and wildfire patterns) (Garnache et al., 2018).

There are few studies on visitors' responses to wildfires and drought in California's recreation areas. A study was conducted in the Angeles National Forest to understand visitor displacement and behavioral responses in wildfire conditions using a choice experiment survey. Four attributes—plants, lakes or streams, fire history, and driving distance—were considered for preference analysis (Tanner et al., 2022). The study revealed a preference for tree cover over shrubs, as well as a preference for water sites, but a dislike for forest fire damage. This highlighted preference heterogeneity for certain attributes, particularly the response of a minority group (Hispanic) to shrub fires. Another study estimated an access value of 23 dollars per trip for a typical site in the four national forests, incorporating the presence of past wildfires in the estimation (Garnache and Lupi, 2018). The travel cost term was statistically significant and negative in the nested logit model with the time-varying effects, indicating that higher travel costs reduce the indirect utility of the site.

Periodic surveys on recreation users are conducted in each national forest, and some studies have focused on the recreational behavior of Hispanic or Latino populations in these areas (Chavez and Olson, 2009). Another study examined the influence of drought on visitation at selected National Park Service units from mountain, arid, and coastal ecozones in California. The study found a decline in annual visitation at mountain parks during extreme drought years (Jenkins et al., 2023). A choice experiment covering the entire chaparral-dominated biome of Southern California has not yet been undertaken. This study represents an ambitious and novel effort to implement a discrete choice experiment across all four Southern California national forests under increasing wildfire and drought conditions.

3. Choice experiments and survey

Discrete choice experiments (DCEs) are a type of stated-preference valuation method that helps assess preferences or trade-offs between choices and attributes of choices in a hypothetical behavioral setting, such as users' selection of recreational sites (Holmes et al., 2017; Train, 2009). Stated choice modeling has been widely employed for recreational assessments. For example, a study at Bear Lake in Rocky Mountain National Park (RMNP) to evaluate alternative transportation systems (e.g., shuttle bus services) aimed at facilitating visitor access, reducing traffic congestion, improving visitor experiences, and protecting park resources (Pettebone et al., 2011). The study found that park visitors preferred private vehicles over shuttle bus services but were willing to make trade-offs to use shuttle buses to avoid crowding on trails and vehicle traffic. Another study on visitor use management considered transport-related attributes such as entrance wait time, parking availability, traffic speed, and traffic volume when analyzing visitor preferences and trade-offs in Grand Teton National Park, Wyoming. Parking was identified as the most important attribute for visitors, along with variations based on age groups (Newton et al., 2020).

This study applied a discrete choice model by asking individuals to select between recreational alternatives differing in attributes under wildfire and drought scenarios. The discrete choice experiment followed the seven key steps for designing and analyzing a choice experiment, suggested by Holmes et al. (2017) and Train (2009). The choice experiment was embedded in a larger survey that also collected recreational, perceptions, and demographic information from respondents. The research team identified the problem or the drivers of displacement,

developed the questionnaire, tested the surveys using Qualtrics, and rolled out in sites prioritized in consultation with forest managers.

3.1. Study area and survey sites

The four Southern California national forests are classified as Urban National Forests (UNFs) (Fig. 1). The four national forests span over 3.8 million acres, with Los Padres accounting for nearly two million acres, Angeles 655,387 acres, San Bernardino 675,000 acres, and Cleveland approximately 567,000 acres. The national forests include wilderness areas that protect some of Southern California's wildest and most pristine landscapes, with elevations ranging from sea level along Los Padres' Monterey coast to approximately 11,500 feet at the peak of San Geronio Mountain in the San Bernardino National Forest (USDA Forest Service, 2021). The chaparral vegetation type dominates all the national forests, except for San Bernardino, where coniferous vegetation prevails. The national forests span parts of ten counties, which collectively have a population of just over 24 million people (United States Census Bureau, 2023). An estimated eight million people live within a one-hour drive of these forests as of 2014 (Garnache et al., 2018). The forests offer a wide range of recreational opportunities, such as hiking, camping, OHV riding, watching wildlife, stream play, fishing, and so on, but these recreational opportunities face major threats from environmental stressors (Garnache et al., 2018).

In consultation with US Forest Service managers, survey sites were selected from a list of priority recreation sites—two from each national forest—based upon three factors: high usage, high fire risk, and potential drought conditions (Table 1). Each drought survey site contained a water feature (e.g., waterfall, water pools).

3.2. The discrete choice experiment

Six attributes and their levels were developed with forest managers based on the existing literature on recreation management in the four national forests and other comparable areas (Table 2). The two attributes, activity and travel time, were included to examine substitution behavior among visitors in the four national forests (Tanner et al., 2022; USDA Forest Service, 2025). Park facilities and recreation specialization were included as attributes in a stated preference choice experiment conducted in a park in Michigan (McCole et al., 2022), whereas site development and amenities were included in a study of Latino recreation visitors to national forests (Chavez and Olson, 2009). Environmental features, such as water bodies and vegetation cover, were selected based on a similar study conducted in the Angeles National Forest (Tanner et al., 2022). Trail condition has been used to assess visitor satisfaction and recreational experiences in forest settings (USDA Forest Service, 2025), whereas landscape openness and views were considered in a policy-making experiment conducted in the peri-urban environment of a European city (De Valck et al., 2017).

A collective full factorial design is represented as L^N , where L denotes the number of attribute levels, A the number of attributes, and N the number of alternatives. Given the number and levels of attributes, the full factorial design, if all possible combinations were considered, would result in 648 rows or combinations of attributes and their levels (L^A). The number of rows or combinations increased when the number of alternatives (N) for the experiment was included in the complete full factorial design. This approach generated an impractically large number of choice sets for respondents in the field. Consequently, a fractional factorial design with blocks was implemented to create a manageable subset of the complete factorial design while ensuring efficient estimation of the effects of interest. A D -efficient optimal orthogonal design (97.2659) was constructed in SAS 9.4 (SAS Institute Inc., 2023). This design optimized statistical efficiency by maximizing the amount of information gathered about the parameters of the attributes. The fractional factorial design produced eight blocks, each containing nine choice sets with distinct combinations of attributes and levels (SAS

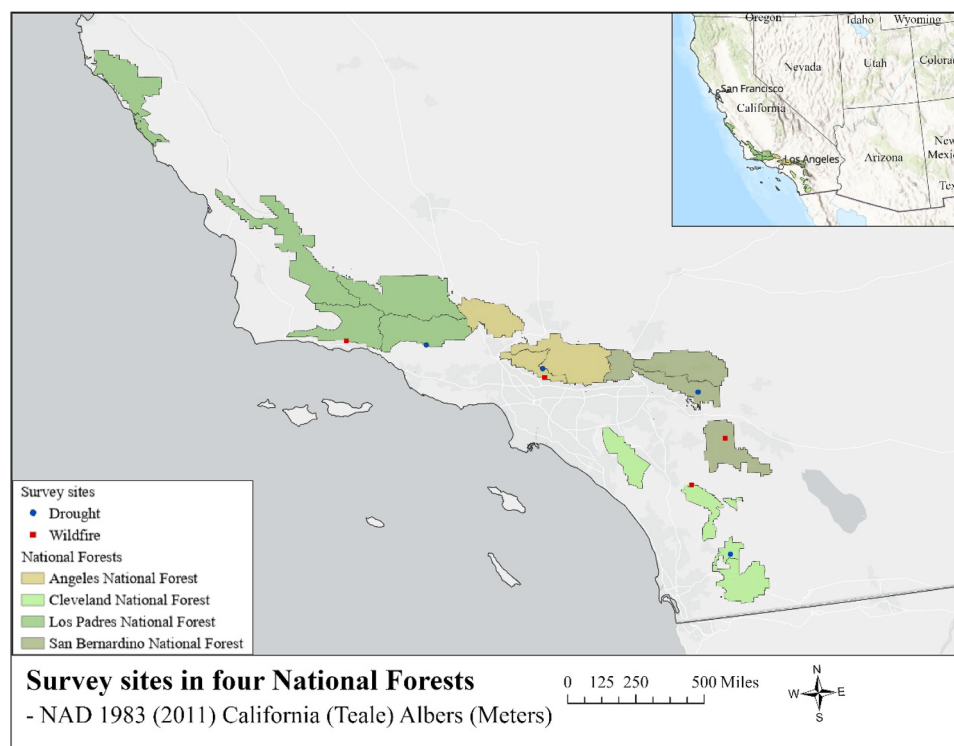


Fig. 1. Four National Forests and eight survey sites. The map was created using ArcGIS Pro (version 3.5.0; Esri Inc., Redlands, CA, USA).

Table 1

Survey sites for wildfire and drought surveys in the four Southern California national forests.

Survey	Survey sites	Forest
Wildfire	Cobb Estates	Angeles
	Dripping Springs Trailhead	Cleveland
	Humber Park	San Bernardino
	Jesusita Trail	Los Padres
Drought	Switzers Day Use Area	Angeles
	Three Sisters Trail	Cleveland
	Big Falls	San Bernardino
	Santa Paula Canyon	Los Padres

Table 2

Choice experiment site attributes and their levels.

Attributes	Levels
Activity	Same activity
	Different activity
Travel time	1 h
	1–2 h
	> 2 h
Facility	Primitive
	Semi-developed
	Developed
Trails	Easy
	Moderate
	Difficult
Views	City
	Wildland-urban
	Wildlands
Feature	Mountain
	Wildlife
	Wildflower
	Water

Institute Inc., 2014). Blocks were randomly assigned to respondents. The choice sets included two alternatives with generic labels (“Site 1” and

“Site 2”) and a status quo option (“Stay home” for the wildfire survey or “Continue with the same plan” for the drought survey). The blocks and choice sets were transferred into Qualtrics, which facilitated the random assignment of blocks to respondents. An example choice set within a block is presented below in Fig. 2, and each respondent received nine such choice sets in the survey.

3.3. Survey design and administration

A potential wildfire or drought scenario at the recreation site was presented to respondents at the beginning of the questionnaire. In the wildfire scenario, respondents were presented with a situation in which the recreation site was closed due to wildfire, and they either stayed at home or selected an alternative site based on a set of site-specific attributes. In the drought scenario, the water-based recreation site lacked available water, and respondents either chose to recreate at the dried site or sought an alternative based on a set of site-specific attributes. Additionally, the Qualtrics survey included questions about respondents’ socio-economic characteristics, such as race and ethnicity, level of expertise in outdoor recreation, income, age, gender, and visiting with or without kids.

The survey was distributed at eight sites during high-use periods (summer months) from 13 June to 3 August 2024. Two research technicians administered the survey, spending seven hours a day, five days a week (Thursday–Monday), at each site, and used a census approach when intercepting visitors with tablets. Each visitor leaving the recreation site was approached to participate in the survey, and in the case of a group, the individual with the most recent birthday was selected. A QR code was provided to visitors who did not have enough time to respond on-site to complete the survey on their device.

3.4. Recreational choice model

Consumers choose a product or service that maximizes their utility when faced with a range of alternatives in their daily decision-making, such as visiting a park, choosing a recreational activity, or a travel

Site #1	Site Attributes	Site #2
Participate in a different primary activity	Primary activity at new site	Participate in the same primary activity
1–2 hours (61–120 miles) one-way driving distance from home	One-way travel time/distance from home to new site	Up to an hour (up to 60 miles) one-way driving distance from home
Primitive (dirt parking lot, no toilet, no potable water)	Facility type at new site	Developed (paved parking area, flushable toilets, potable water, picnic tables)
Difficult—steep and rocky terrain	Trail type at new site	Difficult—steep and rocky terrain
View of wildland-urban interface where human development meets undeveloped wildland	Views from new site	View of city and lands developed by humans
Water feature (stream, waterfall, etc.)	Unique feature found at new site	Mountain peak
I prefer... (select only <u>one</u> below)		
☐ Site #1	☐ Site #2	☐ Neither. Stay Home

Fig. 2. A choice set from the questionnaire.

destination (McFadden, 1972). The nature of such decision processes is influenced by human choice behavior, which is shaped by factors that are difficult to control. Population choice behavior models, based on random utility models, are deduced and estimated based on the nature of decision processes and observed behavior. The choice behavior is assessed based on a set of alternatives available to decision-makers and alternative attributes.

For this study, we assume individual i receives utility, U_{ij} , from a given recreational activity j , which is influenced by activity attributes ($\mathbf{x}_j$) and individual characteristics ($\mathbf{s}_i$). That is:

$$U_{ij} = V_{ij}(\mathbf{s}_i, \mathbf{x}_j) + \varepsilon_{ij} \quad (1)$$

where $\mathbf{s}_i$ is a vector of individual characteristics (age, income, race, ethnicity, education level) of an individual i , $\mathbf{x}_j$ is a vector of attributes for recreational alternative j (travel time, facilities, recreational options, etc.), V_{ij} represents the systematic observed component of utility, while ε_{ij} represents the idiosyncratic or random (unobserved) component (McFadden, 1972).

We assume that individuals will maximize their utility. Thus, choosing the recreational activity that provides the greatest utility. Given that we only observe the choice, using a probabilistic approach, the probability that individual i chooses recreational alternative j over alternative k is given by:

$$P(\text{alternative } j \text{ is chosen}) = P(V_{ij}(\mathbf{s}_i, \mathbf{x}_j) + \varepsilon_{ij} > V_{ik}(\mathbf{s}_i, \mathbf{x}_k) + \varepsilon_{ik}) \forall j, k \in C. \quad (2)$$

We assume that $V_{ij}(\mathbf{s}_i, \mathbf{x}_j)$ is a linear function in the parameters and the attributes. That is:

$$V_{ij}(\mathbf{s}_i, \mathbf{x}_j) = \beta' \mathbf{x}_j + \varepsilon_{ij}, \text{ for all } j \in C \quad (3)$$

where β is a vector of parameters to be estimated. The vector $\mathbf{s}_i$ enters as a stratification variable both linearly in the regression and as an interaction term with the attributes, i.e., $V_{ij}(\mathbf{s}_i, \mathbf{x}_j) = \beta' \mathbf{x}_j + \gamma \mathbf{s}_{i,r} + \lambda' (\mathbf{s}_{i,r} \mathbf{x}_j) + \varepsilon_{ij}$, where γ and λ are additional coefficients to be estimated. An important property of this approach is the differences in utility between alternatives, which affect the choice probabilities, not the absolute level of utility. The choices are made based on the utility differences across alternatives, allowing us to only identify utility differences (Train, 2009).

We assume that respondents' or people's preferences vary randomly

across the population and are not completely observed, a common assumption in DCE. Given that preferences are captured by the marginal utilities (i.e., β) and randomly vary across the population, we assume that $\beta \sim \text{Normal}(\mathbf{b}, \Omega)$, where $\mathbf{b}$ is a vector of parameter means to be estimated and $\Omega = \sigma^2 \mathbf{I}$ where σ^2 is a vector of variances to be estimated for each parameter and $\mathbf{I}$ is an identity matrix of size equal to the number of parameters in the vector β (Train, 2009). Assuming the parameters are random allows for capturing potential dependence between choice questions answered for a given respondent (e.g., repeated measure data) (Train, 2009).

We estimated two primary regression models for the DCE for each scenario: a conditional logistic regression model and a mixed logit model, to assess if the mixed logit model was a proper choice (i.e., that there was unobserved preference heterogeneity). NLOGIT 6 was used to estimate all regression models. For the mixed logit models, we set the number of Halton Draws to 100 and used the BFGS algorithm (Econometric Software, Inc., 2024). Nonlinear effects of variables or attributes were estimated using dummy variables coded as 0 or 1, representing $L - 1$ levels for an attribute. Each attribute included a reference level or category. The reference categories for each variable or attribute are "same activity," "1 hour," "primitive," "easy," "city," and "mountain." The main effects of site attributes were analyzed separately for wildfire and drought scenarios using separate regression models.

There are intergroup differences in participation, preferences, and perceptions related to outdoor recreation, driven by cultural diversity and other visitor characteristics (Chavez et al., 2008). In Southern California, a study found that minority recreation visitors disproportionately engaged in water-based activities (Garnache et al., 2018). Furthermore, cultural practices of recreating in large groups remain important for certain demographic groups (Flores and Sánchez, 2020). Wildfire risk perceptions were influenced by demographic factors, such as education and income, in a survey conducted in California (Sánchez et al., 2022), whereas preferences for park facilities varied according to respondents' levels of recreation specialization (McCole et al., 2022). As participation in outdoor recreation among minority groups has increased in the United States, the number of Latino and Hispanic visitors to the Southern California National Forests has increased, prompting forest managers to adopt strategies that promote inclusion and cultural responsiveness for minority and underserved communities (Thomas et al., 2022). Visitation to wilderness areas also varied across age groups, between genders, and among ethnic groups (USDA Forest

Service, 2025).

Respondent-specific variables (or socio-economic characteristics) cannot be directly examined in the model; thus, we used a stratification approach as discussed earlier. We estimated logistic regression models that included interactions with alternative-specific attributes to identify differences in attribute parameters based on individual characteristics. Socio-economic characteristics can help capture variation (heterogeneity) in respondents' observed preferences. Most socio-economic variables were categorical, except for income and age. Income and age were converted into categorical variables: income was divided into low- and high-income groups based on the median income of the ten counties, and age was grouped into three intervals. The median income (USD 109,200) was calculated as the average of the median household incomes across the ten counties (Department of Housing and Community Development, 2023).

Dummy variables were generated for the other socio-economic variables to incorporate them into the regression models. Models incorporating interaction terms of dummy variables for socio-economic characteristics—such as race and ethnicity, level of recreation expertise, income, gender, age, and group type—with site attributes were used to assess factors contributing to preference heterogeneity. For race and ethnicity, dummy variables for Hispanic or Latino and Asian were interacted with site attributes. For the level of recreation expertise, dummy variables for intermediate and committed levels of expertise were interacted with site attributes. For income, the dummy variable for the high-income group was interacted with site attributes. For gender, the dummy variable for male respondents was interacted with site attributes. For age, two age categories—46–65 and >65—were interacted with site attributes. For group type, the dummy variable for groups with children was interacted with site attributes. All the interactions were assessed using one regression for the wildfire datasets and another for the drought dataset.

4. Results

4.1. Exploratory data analysis (EDA)

Table 3 presents the socio-economic characteristics of respondents, displaying only the levels with the highest values. The detailed table is provided in the Appendix. Hiking and walking were the primary activities for most respondents in both surveys. Picnicking was a notable activity among some respondents in the drought survey. Regarding visit frequency, most respondents reported visiting “a few times a year,” accounting for 32% of wildfire survey respondents and 29% of drought survey respondents. In terms of time spent at the sites, 26% of respondents spent 1–2 h, and another 26% spent 2–3 h in the wildfire survey, whereas 27% spent 2–3 h in the drought survey. Group size also differed between the surveys: 50% of respondents traveled in groups of 2–5 people in the wildfire survey, while 45% were solo travelers. In contrast, 74% of respondents in the drought survey traveled in groups of 2–5 people. Outdoor recreation expertise levels also differed: 44% of respondents in the wildfire survey identified as committed, and another 44% as intermediate-level experts. In the drought survey, 41% identified as intermediate-level experts.

Respondents' priorities for attributes varied. In the wildfire survey, 42% ranked “activity” as the top priority attribute, followed by 28% ranking “travel time.” In the drought survey, 29% ranked “activity” as the top priority, followed by 21% for “travel time” and 20% for “views.” Most respondents in both surveys identified as White, followed by Hispanic, Asian, and other minorities. In the wildfire survey, 66% of respondents identified as White, 32% as Hispanic or Latino, 6% as Asian, and 13% as other minorities, whereas in the drought survey, 38% identified as White, 30% as Hispanic or Latino, 14% as Asian, and 14% as other minorities. Income classification revealed that 54% of respondents in the wildfire survey belonged to the high-income group, while 30% in the drought survey were in the high-income group. Many respondents belonged to the 18–45 age group, with 46% in the wildfire survey and 71% in the drought survey. Seventeen percent of respondents in the wildfire survey were over 65, compared to a mere 2% in the

Table 3

Summary statistics of selected characteristic variables of respondents. Bold numbers indicate the highest percentage in each category or variable. A complete table is provided in the Appendix.

Variables	Levels	Wildfire	Wildfire %	Drought	Drought %
Primary activity	Hiking/Walking	203	82%	127	78%
	Picnicking	2	1%	9	6%
Frequency of visit	A few times a year	79	32%	48	29%
	This is my first time	29	12%	48	29%
Time spent	1–2 h	65	26%	30	18%
	2–3 h	64	26%	44	27%
	4–6 h	47	19%	38	23%
	1 or solo	111	45%	21	13%
How many people are in the group?	2 to 5	124	50%	121	74%
Checking site conditions	Always	80	32%	67	41%
Outdoor recreation expertise	Intermediate	109	44%	67	41%
	Committed	108	44%	46	28%
Ranking attributes (Most important = 1)	Activity	103	42%	48	29%
	Travel time	70	28%	35	21%
	Views	25	10%	33	20%
Ethnicity	White	163	66%	62	38%
	Hispanic or Latino	32	13%	49	30%
	Asian	14	6%	23	14%
Gender	Male	134	54%	73	45%
	Female	106	43%	81	50%
Income (Median=\$105,990) (Avg. median of 10 counties)	Above median	134	54%	49	30%
	Prefer not to say	41	17%	30	18%
Age	Age 18–45	115	46%	116	71%
	Age 66 and above	43	17%	4	2%
With kids	With kids	25	10%	32	20%
Number of unique ZIP codes		110		129	
Distance traveled (miles) (median value)		9.9		35.8	

drought survey. Finally, 10% of respondents in the wildfire survey visited in a group with kids, compared to 20% in the drought survey. The distance traveled by respondents to each site was estimated in miles using the centroid of their home ZIP codes in Google Maps. The wildfire survey included 110 unique ZIP codes, compared to 129 in the drought survey. The overall median distance traveled was 9.9 miles for the wildfire survey and 35.8 miles for the drought survey.

4.2. Baseline conditional logistic regression results – wildfire and drought scenarios

Estimation results for the conditional logistic regression models for the wildfire and drought scenarios are presented in Table 4. In the wildfire scenario, findings suggest a strong preference for “views” or viewscapes, specifically for “wildland-urban” views and “wildlands” views, relative to “city” views. All other attribute coefficients in the wildfire scenario were not statistically significant, indicating no difference in preference between the baseline category and other levels of that attribute.

Under the drought scenario, the attributes “travel time” and “trails” were statistically significant (Table 4). For the attribute “travel time,” the dummy variables for “1–2 h” and “>2 h” of travel time were preferred relative to the reference level (“less than one hour” of travel time). This indicates a preference for getting farther away from a person’s present location, which was likely to be urban. For the attribute “trails,” the dummy variable for “difficult” trails was statistically significant, suggesting a preference for “difficult” trails relative to the reference group (“easy” trails). All other attribute coefficients were not statistically significant.

4.3. Preference heterogeneity – considering differences across demographic groups

Tables 5 and 6 present the conditional logistic regression models with interaction terms between socio-economic characteristics and site attributes for the wildfire and drought scenarios. Only the statistically significant interaction variables are presented in the tables for brevity; the complete models are provided in the Appendix.

Under wildfire scenario (Table 5), the interaction terms for Hispanic and Asian (characteristic “ethnicity”) with the attributes for “moderate”

Table 4

Conditional logit model with main effects. Bold values indicate statistically significant parameters.

Attribute	Level	Wildfire coefficient (p-value)	Drought coefficient (p-value)
Activity	Different activity	0.01368 (0.8248)	0.03828 (0.6225)
Travel time	1–2 h	–0.09960 (0.1830)	0.15913* (0.0794)
	> 2 h	0.02644 (0.7257)	0.15666* (0.0968)
Facility	Semi-developed	–0.04892 (0.5190)	–0.15045 (0.1032)
	Developed	–0.00401 (0.9577)	–0.08648 (0.3556)
Trails	Moderate	–0.01060 (0.8863)	0.02183 (0.8068)
	Difficult	0.03424 (0.6509)	0.20926** (0.0226)
Views	Wildland-urban	0.12971* (0.0817)	0.05834 (0.527)
	Wildlands	0.14118* (0.0633)	–0.07752 (0.4016)
Feature	Wildlife	0.00428 (0.9606)	0.09212 (0.387)
	Wildflowers	0.05796 (0.5024)	0.15616 (0.1365)
	Water	0.04406 (0.6025)	0.06153 (0.5543)
Sample size		248	163
No. of observations		2232	1467
AIC		4619.6	2945.4
Log Likelihood		–2295.78785	–1458.69094

Note: P-values in parentheses: *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$.

Table 5

Logit model with interaction effects for wildfire survey.

Variable (Interaction term)	Level	Wildfire coefficient (p-value)
Hispanic × Trails	Moderate	0.72876* (0.0708)
	Difficult	0.85644* (0.0556)
Hispanic × Views	Wildlands	0.89011** (0.0292)
	Moderate	1.36638* (0.0607)
Asian × Trails	Difficult	0.96814* (0.0867)
	Developed	–0.68801* (0.0843)
Intermediate × Facility	Moderate	0.89718** (0.0351)
Intermediate × Trails	Difficult	0.89056* (0.05)
	Wildland-urban	–1.54839*** (0.0002)
Intermediate × Views	Moderate	0.89249** (0.0477)
	Difficult	1.01345** (0.0322)
Committed × Trails	Wildland-urban	–0.97941** (0.0256)
Committed × Views	Moderate	0.70700*** (0.0048)
	Difficult	0.48678* (0.0632)
Male × Trails	Semi-developed	0.53001* (0.094)
Group with kids × Facility		
Sample size		248
No. of observations		2232
AIC		2087.8
Log Likelihood		–921.92403

Note: P-values in parentheses: *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$.

Table 6

Logit model with interaction effects for drought survey.

Variable (Interaction term)	Level	Drought coefficient (p-value)
Asian × Facility	Developed	–1.08214** (0.0148)
Asian × Feature	Wildflower	1.02597** (0.0339)
Committed × Trails	Difficult	–0.69799** (0.0336)
High-income × Feature	Water	–0.88222*** (0.0059)
Age 46–65 × Activity	Different activity	–0.70070*** (0.0072)
Age 46–65 × Views	Wildland-urban	–0.65480** (0.0279)
Age 46–65 × Feature	Wildlife	0.62577* (0.077)
Age > 65 × Feature	Wildflower	2.01238* (0.0943)
Group with kids × Feature	Wildlife	0.79593** (0.0155)
	Water	0.53492* (0.0942)
Sample size		163
No. of observations		1467
AIC		1969.5
Log Likelihood		–862.77084

Note: P-values in parentheses: *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$.

and “difficult” trails were positive and statistically significant, indicating Hispanics or Latinos and Asian respondents’ preference for “moderate” and “difficult” trails compared to “easy” trail types, relative to White respondents. Additionally, the interaction term for Hispanics or Latinos with the attribute for “wildlands” views relative to “city” views indicated Hispanics or Latino respondents preferred “wildlands” views over “city” views, relative to white respondents. Regarding the level of outdoor recreation expertise, respondents with intermediate and committed groups preferred “moderate” and “difficult” trails over “easy” trails, relative to the general or casual recreation group. However, respondents from both groups disliked “wildland-urban” views compared to “city” views, relative to the general or casual group. Respondents from the intermediate group disliked “developed” facilities compared to “primitive” facilities, relative to the general or casual group. Male respondents preferred “moderate” and “difficult” trails compared to “easy” trails, relative to female respondents. The visitors traveling with children preferred “semi-developed” facilities over “primitive” facilities, relative to groups composed solely of adults.

Table 6 presents the interaction variables of socio-economic characteristics with site attributes for the drought scenario. The interaction term for the Asian group with a dummy variable for a “developed” facility was negative and statistically significant, indicating that Asian respondents disliked “developed” facilities compared to “primitive”

facilities, relative to White respondents. Additionally, the interaction term for Asian respondents with a dummy variable for a “wildflower” feature was positive and statistically significant, indicating Asian respondents preferred the “wildflower” feature over the “mountain” feature, relative to White respondents. Respondents from the committed group disliked “difficult” trails compared to “easy” trails, relative to the general or casual group. The high-income group respondents disliked the “water” feature compared to the “mountain” feature, relative to the low-income group.

The 46–65 age group respondents disliked engaging in a “different activity” compared to the “same activity,” relative to the 18–45 age group. The same 46–65 age group respondents disliked “wildland-urban” views than “city” views, relative to the 18–45 age group. However, the 46–65 age group respondents preferred a “wildlife” feature over a “mountain” feature, relative to the 18–45 age group. The >65 age group respondents preferred the “wildflower” feature over the “mountain” feature, relative to the 18–45 age group; however, the >65 age group constituted a mere 2% of the total sample. The visitors with children preferred the “wildlife” and “water” features compared to the “mountain” feature, relative to groups composed solely of adults.

5. Discussion

This study was part of a larger project assessing environmental stressors like wildfires and droughts and their impact on visitor displacement in the four national forests of Southern California. The present study applied a discrete choice experiment to evaluate visitor preferences for site and environmental attributes in recreation sites during displacement. As shown in the descriptive statistics, the sociodemographic characteristics of the respondents are consistent with those reported in previous studies and surveys conducted in these forests, including those of the U.S. Forest Service (USDA Forest Service, 2025). The majority of respondents in both surveys listed “hiking/walking” as their primary recreation activity, which aligns with findings from the USDA National Visitor Use Monitoring (NVUM) program in Southern California's four national forests (Garnache et al., 2018). Respondents identified as White constituted the largest proportion of visitors in both surveys. Notably, the percentage of Hispanic respondents was comparatively higher (30%) in the drought survey, nearly equal to white respondents (38%), and picnicking was another primary activity in the drought survey. This finding relates to previous research, in which Hispanics largely preferred sites for picnicking or barbecuing, with some also participating in stream play for recreation (Chavez and Olson, 2009; Flores and Sánchez, 2020). The higher percentage of Hispanics in the drought survey potentially indicates an increasing trend of Hispanic participation in outdoor recreation sites with water features. Visitors came from a wide range of locations (identified by home ZIP codes) and traveled longer distances, as evidenced by the median distance traveled from the centroid of their ZIP code to drought survey sites (sites with a water feature) compared to wildfire survey sites. This finding is supported by the conditional logit model with main effects (Table 4), which revealed that visitors in the drought survey preferred longer “travel time” in their substitution behavior. It is worth noting that distance to recreation sites and transportation have been identified as barriers to outdoor recreation among minority populations (Yen Le et al., 2013). Therefore, future research should examine Hispanic or Latino visitors' preferences regarding travel time, with a particular focus on water-based recreation sites and other large public lands, while accounting for the growth of the Latino population and generational differences in recreation preferences. The findings also underscore the need to provide informational resources and outreach materials in Spanish to improve accessibility and engagement at recreation sites. We reported the median travel distance to the recreation sites, estimated from respondents' ZIP codes. These estimates may be used to approximate visitors' travel costs to recreation sites. However, previous studies have examined the economic aspects of recreation services in these forests

(Garnache and Lupi, 2018).

In the wildfire survey, the preference for “wildland-urban” and “wildlands” views over “city” views indicated a stronger valuation of naturalness in the viewscape compared to urban, semi-natural, or city views. A similar preference for natural landscapes was observed in a study conducted in urban-proximate recreation settings in the province of Antwerp, Belgium (De Valck et al., 2017). In the drought survey, respondents preferred “difficult” trails over “easy” ones at recreation sites during drought-induced displacement, suggesting a preference for day hiking as another recreation activity (substitution behavior) around the water sites.

The interactions of attributes with sociodemographic factors provided a detailed picture of preferences within the population, illustrating how these factors influence the preferences of individuals and subgroups for site attributes. In the wildfire scenario (Table 5), under the ethnicity category, Hispanic respondents preferred “moderate” and “difficult” trails as well as “wildlands” views. This finding suggests that Hispanic preferences extend beyond the water-based activities, facilities, and amenities identified in earlier studies (Chavez and Olson, 2009; Flores and Sánchez, 2020; Garnache et al., 2018), indicating a preference for hiking and wildland viewscape. Under the expertise category, respondents in the intermediate and committed groups disliked “wildland-urban” views compared to “city” views, relative to the casual or general group, a somewhat unexpected outcome. Additionally, the intermediate group expressed a dislike for “developed” facilities. This tendency aligns with findings from a study on committed users in off-road vehicle parks, who also showed lower preferences for developed facilities (McCole et al., 2022). Gender and group composition (visiting with kids) also influenced preferences. In periodic visitor monitoring, the male subgroup exhibited higher visitation rates to wilderness areas than the female subgroup (USDA Forest Service, 2025), whereas in this survey, they expressed a preference for moderate and difficult trail types. Visitors with children preferred “semi-developed” facilities over “primitive” facilities. This finding is important for forest managers, as children under 16 constitute a substantial percentage of visitors, ranging from 8.8% in the Angeles National Forest to 19.5% in the San Bernardino National Forest (USDA Forest Service, 2025).

The variation in preferences among respondents from different sociodemographic groups under the drought scenario differed slightly from those observed under the wildfire scenario. One notable result was that respondents from high-income groups disliked the “water” feature compared to the “mountain” feature, relative to the low-income group under the drought scenario (Table 6). Income or socioeconomic status determines an individual's position in society and influences outdoor recreation behavior, including their ability to adapt recreation patterns during a crisis, with lower mean visitation rates observed among low-income residents (Beasley et al., 2024). This study revealed differences in preferences for landscape features at recreation sites between high-income and low-income groups. There were also differences in preferences for site attributes by age group. Respondents aged 46–65 disliked adopting a “different activity” compared to the “same activity,” relative to the age group 18–45 in the drought-induced displacement. The majority of visitors tend to prefer the “same activity” in their substitution behavior across the four national forests (USDA Forest Service, 2025). This study clearly differentiated the preferences of different age groups regarding their choice of substitute activities. Future studies should examine the substitution behavior and substitute activity choices of visitors aged 18–45 in response to drought-induced displacement, as this age group constitutes a substantial proportion of visitors across all four forests. Previous studies have shown that age is also associated with visitation rates to recreation sites during crisis scenarios, with lower mean visitation rates observed among adults aged over 55 (Beasley et al., 2024).

Recreation studies have primarily used ranking methods and Likert scales to assess respondents' preferences and satisfaction (Chavez and Olson, 2009; USDA Forest Service, 2025) and have seen the

application of the discrete choice experiment as a stated preference method lately. A discrete choice experiment is widely used in natural resources and agricultural economics. Recreation studies can use logistic regression models (binary or multinomial) to examine visitor preferences and their underlying determinants, including interaction effects; however, this approach requires a discrete analysis of a dependent variable over a set of explanatory variables. A discrete choice experiment narrates a set of environmental attributes and their levels and estimates respondents' relative preferences for alternative attribute levels in a multivariate setting. This study built on the findings of previous surveys by incorporating additional attributes of recreation services or products and examining the influence of sociodemographic factors on visitor preferences. The USDA NVUM program reported visitation across age groups to the wilderness areas, whereas the discrete choice experiment characterized wilderness areas by their attributes and attribute levels and estimated relative preferences for specific attribute levels across age and income groups. The monitoring report summarized preferred travel distances as a substitution behavior using descriptive statistics but did not estimate visitors' choice probabilities. In contrast, the discrete choice experiment estimated the relative preference for different travel times compared with the baseline attribute level.

Some of the findings from this study may be generalizable to similar contexts characterized by urban-proximate forest recreation sites, ecoregion type, similar environmental stressors, and comparable sociodemographic compositions. For example, preferences for wildland views have been reported consistently across similar studies, as have the preferences of visitors with different levels of recreation expertise. Other findings should be generalized with caution, as additional contextual factors may influence their applicability. This includes findings related to the preferences of high- and low-income groups and different age groups, as well as defining the levels of site attributes.

Limitations of the study

There was insufficient evidence to establish the statistical significance of many variables, especially parameter estimates with "borderline" *p*-values. Given the large geographic extent of the four national forests and the high volume of visitors they receive, the number of completed survey responses (i.e., the sample size) was relatively small. Increasing the sample size in future surveys that are organized around thematic issues (e.g., wildfires and drought), rather than spatial considerations, would improve the statistical power to detect significant effects and associations. Additionally, the closure of the Three Sisters Falls during the drought survey period further limited data collection efforts at that location.

Management considerations

Our findings can help forest managers identify and prioritize attributes that visitors value most during displacements, enabling targeted investments to enhance recreation experience. Minority groups and low-income groups, in particular, are disproportionately affected by these changes and face unique socio-economic and cultural barriers to outdoor recreation (Johnson et al., 2007; Thomas et al., 2022). For instance, the Angeles National Forest receives a comparatively higher percentage of Hispanic visitors, along with a growing number of Asian visitors, in its forest recreation activities. This study reiterates the need to use ethnic media and provide written materials in ethnic languages to effectively communicate the recreation services and explore the growing interest of Hispanic visitors in hiking and landscape views. With a growing number of Asians participating in forest recreation, the heterogeneity in terms of culture and recreation participation among Asian subgroups (such as Chinese, Japanese, Korean, and Filipino) will become more visible in the future. Regarding site facilities, visitors with an intermediate level of recreation expertise and visitors with children showed contrasting preferences. Forest managers may need to tailor site improvement plans

by providing semi-developed facilities in areas frequently visited by families with children, while maintaining primitive (basic) facilities in areas commonly used by visitors with intermediate or advanced levels of recreation expertise. This strategy may be complemented by maintaining trail conditions that match the skill and fitness levels of these visitors (expert) groups, which represented the majority of the respondents in both surveys. Therefore, forest- or site-specific analyses (or rapid assessments) could be conducted to support targeted recreation planning that addresses the needs and preferences of specific demographic groups.

6. Conclusion

Regarding the key sociodemographic characteristics, the white subgroup constituted a majority of respondents, followed by Hispanics or Latinos and an increasing number of Asian respondents, especially in drought survey sites (water-based recreation sites). The age group 18–45 was the majority of respondents, and most of the respondents retained a higher level of recreation expertise in both surveys. Respondents in the drought survey were drawn from a broader geographic area and traveled longer distances, as estimated from their home ZIP codes. In the conditional logit model, respondents preferred wildland views over "city" views in the wildfire survey, whereas longer travel times compared to the baseline category of "less than one hour" and a "difficult" trail in the drought survey. In the case of the mixed logit model for the wildfire survey, Hispanic respondents preferred "moderate" and "difficult" trails over "easy" trails, relative to White respondents, and similar preferences of intermediate and committed recreation groups over "easy" trails, relative to the general or casual recreation group. The latter groups also preferred "wildland-urban" views over "city" views, relative to the general or casual recreation group. In the case of the drought survey, Asian respondents disliked "developed" facilities over "primitive" facilities, relative to White respondents, but they preferred the "wildflower" feature over the "mountain" feature, relative to White respondents. The high-income groups disliked the "water" feature over the "mountain" feature, relative to the low-income groups. The age group 46–65 respondents preferred "wildlife" over "mountain" feature, relative to the age group 18–45, but disliked switching to a "different activity," relative to the age group 18–45. This study provides a greater understanding of substitution behavior and preferences during the wildfire and drought events in the chaparral ecosystem. As the environmental stressors are increasing in frequency and intensity in that region, identifying suitable alternative recreation sites with appropriate environmental attributes, together with broader communication and outreach efforts, can help address these challenges in those urban-proximate forest recreation areas. Future research should focus more on the types of substitution activity across different sociodemographic groups, in particular, ethnicity, age groups, levels of recreation expertise, and income levels. Additionally, the estimation of travel distances using visitors' home ZIP codes can be extended to assess travel costs and willingness to pay (WTP) for the recreation site attributes in these forests.

CRedit authorship contribution statement

Bijan Gurung: Data curation, Formal analysis, Visualization, Writing – review & editing. **Brian A. Peterson:** Conceptualization, Methodology, Software, Writing – review & editing. **José J. Sánchez:** Conceptualization, Formal analysis, Funding acquisition, Methodology, Writing – review & editing. **Alyssa Thomas:** Conceptualization, Methodology, Project administration, Resources, Writing – review & editing. **Elizabeth E. Perry:** Conceptualization, Methodology, Writing – review & editing. **Jason Bergtold:** Formal analysis, Writing – review & editing. **Sarah Jackson:** Methodology, Writing – review & editing.

Declaration of competing interest

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

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Supplementary materials

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Appendix A. Supplementary materials

The supplementary materials to this article are attached to Appendix A.

Data availability

Data will be made available on request.

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