CONSERVATION SCIENCE PARTNERS

FINAL REPORT
1 June 2023

For the project entitled:

Quantifying the recreation value of unprotected BLM lands in response to a proposed plan for balanced public land management

Submitted to:

The Center for American Progress

Recommended Citation: Conservation Science Partners. 2023. Quantifying the recreation value of unprotected BLM lands in response to a proposed plan for balanced public land management. Final Report. Truckee, CA

CALIFORNIA HEADQUARTERS
11050 PIONEER TRAIL, SUITE 202
TRUCKEE, CALIFORNIA 96161

(P) 1.530.214.8905
INFO@CSP-INC.ORG
WWW.CSP-INC.ORG

Table of Contents

1. Executive Summary

The Department of the Interior released a proposed planning rule in March 2023 to guide the management of U.S. public lands with the goals of (1) improving the resilience of public lands under climate change, (2) conserving valuable wildlife habitat and intact natural landscapes, (3) planning for development, and (4) recognizing public lands' unique cultural and natural resources (U.S. Department of the Interior, 2023). In response, the work presented here seeks to aid the BLM in their efforts to identify important areas for conservation and outdoor recreation, particularly in places where BLM lands may be capable of offsetting the impacts of high-volume recreation on national and state park lands and providing access to nature for underserved communities.

We quantified the total amounts of unprotected BLM land area within four buffer distances–10, 25, 50, and 100 miles–of national parks, state parks, and socially vulnerable and nature-deprived census tracts (for brevity, referred to as "SVDep census tracts") across the contiguous U.S. (CONUS). We also conducted a preliminary assessment of existing recreation capacity on these lands by quantifying non-motorized recreational trail density within each of these areas.

Key findings:

- Focusing protections on BLM lands in just four states–Arizona, California, Colorado, and Utah–could offset recreation demand for six of the ten most visited western national parks, which welcomed a combined total of nearly 23,000,000 guests in 2022.
- Among the top ten most visited western U.S. national parks, Joshua Tree NP (ranked 8th by visitation across all U.S. national parks), had the greatest amount of unprotected BLM land within a 10-mile radius. Grand Canyon NP (ranked 2nd by visitation) had the greatest amount of unprotected BLM land within a 25- and 50-mile radius.
- Nearly one-fifth of all unprotected BLM lands fall within 25 miles of a state park.
- In New Mexico alone, there are 10,369,500 acres of unprotected BLM land within 25 miles of a nationally-identified SVDep census tract. This equates to 5% of all unprotected BLM land across CONUS, and is one-third of the total area of unprotected BLM land within a 25-mile radius of all SVDep census tracts across all of CONUS.
- All but one of the ten SVDep census tracts with the greatest density of mapped trails are found within Montana, Oregon, or Washington. Among these states, 238,600 acres of unprotected BLM land with relatively high recreation capacity lies within 25 miles of a nationally identified SVDep census tract.

Table 1. Summary of key findings: The total amount of unprotected BLM land area within each buffer range of all national parks, all state parks, all parks combined, and all SVDep census tracts. The percentage of all unprotected BLM lands is provided in parentheses following each value.

	Total BLM land area (acres) within each buffer:			
Unit Type	**10 miles**	**25 miles**	**50 miles**	**100 miles**
National Parks (NP)	4,834,200 (2.3%)	14,348,100 (6.8%)	35,375,900 (16.7%)	81,001,400 (38.3%)
State Parks (SP)	10,100,200 (4.8%)	41,572,400 (19.6%)	93,608,100 (44.2%)	134,311,500 (63.5%)
All Parks (NP + SP)	14,442,700 (6.8%)	49,959,300 (23.6%)	99,352,600 (46.9%)	134,911,900 (63.7%)
All SVDep census tracts	20,023,500 (9.5%)	29,734,700 (14.0%)	46,735,000 (22.1%)	84,780,300 (40.1%)

2. Introduction

In March, 2023, the Department of the Interior released a proposed planning rule to guide the management of U.S. public lands with the goals of (1) improving the resilience of public lands under climate change, (2) conserving valuable wildlife habitat and intact natural landscapes, (3) planning for development, and (4) recognizing public lands' unique cultural and natural resources (U.S. Department of the Interior, 2023). The rule was proposed in response to the increasingly extreme climatic conditions that have led to more intense and frequent wildfires, droughts, and storms that severely impact communities, particularly in the western U.S. The rule also seeks to engage communities, states, and Tribes to promote responsible development and resource extraction on Bureau of Land Management (BLM) lands. The Department of the Interior states explicitly that this proposed rule "will increase access to outdoor recreation by putting conservation on equal footing with other uses, consistent with the BLM's multiple use and sustained yield mission" (U.S. Department of the Interior, 2023).

In response to this rule, the work presented here seeks to aid the BLM in their efforts to identify important areas for conservation and outdoor recreation, particularly in places where BLM lands may be capable of offsetting the impacts of high-volume recreation on national and state park lands. Thus, the goal of this analysis was to develop a quantitative justification for increasing protections of BLM lands and/or removing these lands from resource extraction activities based on their importance for recreation. To quantify BLM lands' importance for recreation, we focused on answering the following questions:

1. Which currently unprotected BLM lands are in close proximity to frequently used areas for public recreation–national and state parks–across the contiguous U.S. (CONUS)?
2. Which currently unprotected BLM lands are in close proximity to some of the most popular or over-visited national parks within CONUS?
3. Which currently unprotected BLM lands hold the greatest potential to serve underserved and/or vulnerable communities and fill the unequal gap in access to nature and its benefits for these marginalized groups (a concept otherwise referred to as the "nature gap"; Rowland-Shea et al., 2020)?

As an additional objective, we developed a preliminary estimate of recreation infrastructure (quantified as the relative density of mapped non-motorized trails) on unprotected BLM lands as an estimate of the existing capacity of these lands to support recreation.

3. Methods

3.1 Identifying unprotected BLM lands in close proximity to national and state parks

BLM lands were identified using the U.S. Department of the Interior's National Surface Management Agency Area Polygons dataset, which indicates the managing agency for federal lands across the U.S. (Bureau of Land Management, 2022). BLM lands were deemed "unprotected" if they held a GAP 3 or 4 status according to the Protected Areas Database of the U.S. (PADUS; U.S. Geological Survey (USGS) Gap Analysis Project (GAP), 2020). Any BLM lands outside of this domain were considered "protected", as they held a GAP 1 or 2 status. Each GAP status is defined as follows:

GAP 1: Areas managed for biodiversity (protected from natural land cover conversion) in which natural disturbance events are allowed to proceed or modeled through management

GAP 2: Areas managed for biodiversity (protected from natural land cover conversion) in which natural disturbance events are suppressed

GAP 3: Areas protected from natural land cover conversion but open to extractive uses of widespread, low intensity (e.g., logging, OHV recreation) or localized high intensity (e.g., mining)
GAP 4: Areas with no known mandates for protection (U.S. Geological Survey (USGS) Gap Analysis Project (GAP), 2021)

All national parks were identified by selecting polygons within CONUS with a 'designation type' or 'local designation type' of "national park" in PADUS. This resulted in a total of 51 national parks. All state parks were identified from PADUS in two steps: (1) all polygons within CONUS owned or managed by states were selected, then (2) from that selection all polygons with "state park" included in their 'unit name' or 'local name' were retained. Units with unique names but within the same state park system were each assessed separately. This resulted in a total of 2,344 individual state park units.

We used four, circular buffer distances when identifying unprotected BLM lands in close proximity to national and state parks and using radii of 10, 25, 50, and 100 miles. These buffers were run on the national and state parks layers, separately, using the *pairwise buffer* tool in ArcGIS Pro (v3.0.0), which calculates buffer distance out from the edge of a feature. The resulting buffers were then intersected with unprotected BLM lands using the *pairwise intersect* tool in ArcGIS Pro to identify areas that fell within each of the four buffer ranges.

All geodesic area calculations were conducted using the *calculate geometry* tool in ArcGIS Pro. These calculations were conducted in the 'USA Contiguous Albers Equal Area Conic USGS version' coordinate system, however potential boundary inaccuracies in the PADUS dataset lead us to recommend interpreting acreage estimates as approximate. We have rounded our estimates to the nearest 100 acres to reflect this uncertainty.

3.2 Identifying unprotected BLM lands with greatest potential to offset recreation demand on popular or over-visited parks

We identified the top ten most visited national parks in the western U.S.[1] based on National Park Service 2022 visitation counts in order to determine which BLM lands are in closest proximity to these well-loved, and as a result often over-visited, parks. These top ten most visited western national parks, listed in descending order of 2022 visitation counts, are (National Park Service, 2023):

1. Grand Canyon National Park
2. Zion National Park
3. Rocky Mountain National Park
4. Yosemite National Park
5. Yellowstone National Park
6. Joshua Tree National Park
7. Glacier National Park
8. Grand Teton National Park
9. Olympic National Park

[1] Here we focused exclusively on western U.S. national parks due to the majority of BLM lands being located in the West. We designated national parks as "western" if they were located in states within CONUS where the BLM has a state-specific office (i.e., all locations listed here except for the national and eastern states offices). There are three national parks that fall within the eastern U.S. that are among the top ten most visited parks across the entire U.S., yet all three have zero BLM lands within 100 miles or less of their boundaries. These parks are Great Smoky Mountains NP (ranked 1st by visitation across the U.S.), Acadia NP (ranked 5th), and Cuyahoga Valley NP (ranked 9th).

10. Bryce Canyon National Park

All four buffer distances (10, 25, 50, and 100 miles) were applied to these ten parks, which were then intersected with unprotected BLM lands following the workflow described above for all national and state parks (Fig. 1).

3.3 Identifying unprotected BLM lands that may serve to fill the "nature gap"

In order to identify unprotected BLM lands that may serve to increase nature access to underserved communities, we first identified socially vulnerable and nature-deprived U.S. census tracts by estimating the distance of each census tract to publicly accessible protected areas (defined as all land units with a GAP 1 or 2 status and "Open Access" public access status in PADUS) and developing an index of social vulnerability by U.S. census tract.

3.3.1 Nature deprivation

To understand community access (or lack thereof) to protected areas that may provide recreation opportunities, we first quantified the mean distance of each census tract to all GAP 1 and 2 areas within CONUS that are designated as having "Open Access" to the public. This was accomplished in three steps. We first selected all units in PADUS where 'GAP status' = "1" OR "2" and 'Public Access' = "Open Access". We then ran the *distance accumulation* tool in ArcGIS Pro to quantify the distance of each 90-m pixel across CONUS to any publicly accessible GAP 1 or 2 unit. We then used the *zonal statistics as table* tool to identify the mean distance of each census tract to these publicly accessible protected areas. The resulting nature deprivation dataset represented the mean distance (in meters) of each census tract to publicly accessible protected areas, which was then rasterized at 90-m resolution to be combined with the social vulnerability index.

3.3.2 Social vulnerability

We quantified the social vulnerability of each census tract using an index previously developed by CSP that incorporates factors such as income, education levels, prevalence of health issues, and other demographic characteristics. Generally speaking, social vulnerability describes a community or individual's lack of (or limited) access to political power, representation, physical and intellectual resources, social capital, physical health or ability, and infrastructure. Social vulnerability can also be defined based on one's beliefs and customs or age. While these overarching themes are generally agreed upon across the social science community, there exists variability in what component indicators are used to quantify social vulnerability within any given index (Cutter et al., 2003).

In compiling our index, we reviewed a total of 14 existing indices of social vulnerability (Table 2) to identify their component indicators and selected a final set of 22 indicators that describe a broad range of economic, demographic, and health characteristics while having minimal redundancy between indicators. For example, minority status was retained but partially redundant metrics contributing to this, such as the percent of the population identifying as Hispanic, Black, or Native American were not. This social vulnerability index was originally developed in the context of community capacity to respond to extreme events, specifically wildfire, but it is highly relevant in this context as well because it captures a set of variables that are considered good indicators of underserved communities in general.

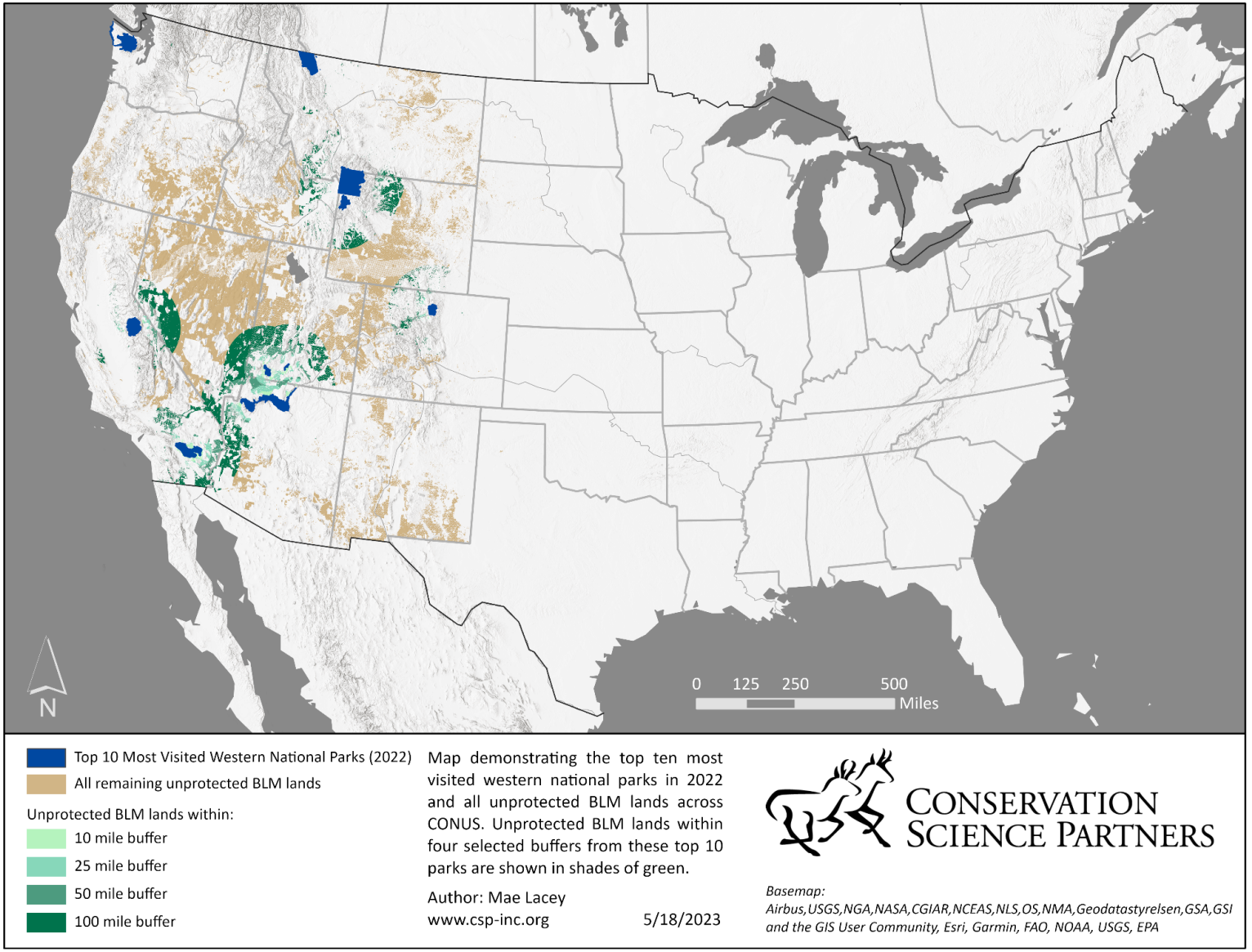

Figure 1. Unprotected BLM lands and the top ten most visited national parks across western states in the U.S.

Table 2. The fourteen indices of social vulnerability considered here. Each index used demographic and/or health-related datasets to quantify dimensions of social vulnerability or capacity that were reviewed for final indicator selection.

Vulnerability Index	Source
Adaptive capacity and sensitivity metrics	(D'Evelyn et al., 2022)
CDC/ATSDR Social Vulnerability Index	(Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program, n.d.)
Civic Capacity Index	(MacPhee, n.d.)
Community Health Vulnerability Index (CHVI)	(Rappold et al., 2017)
Community Vulnerability Index (San Mateo County, CA)	(County of San Mateo Executive's Office, n.d.)
COVID-19 Community Vulnerability Index (CCVI)	(Surgo Ventures, 2021)
EJScreen	(U.S. Environmental Protection Agency (EPA), 2022)
Social Vulnerability Index (SoVI)	(Cutter et al., 2003)
Social Vulnerability Index (SoVI update)	(Hazards Vulnerability & Resilience Institute, n.d.)
Social Vulnerability Index	(Wigtil et al., 2016)
The Neighborhood Atlas: The Area Deprivation Index (ADI)	(Kind & Buckingham, 2018)
The Rural Capacity Index	(Hernandez et al., 2022)
Vermont's Social Vulnerability Index	(Vermont Department of Health, 2015)
Wildfire Vulnerability Framework	(Davies et al., 2018)

The final set of indicators encompassed the following themes:

- **Education level** is represented by the percent of the total population (25+ years old) without a high school diploma (Manson et al., 2022).
- **Employment status** is represented by the total percent of the civilian labor force (16+ years old) currently unemployed (Manson et al., 2022).
- **Health** is represented by several metrics indicating overall health status (prevalence (%) of COPD, prevalence (%) of asthma, percent of the total population with a disability) as well as general access to healthcare (percent of the total population without health insurance, number of ICU beds available per 100k people) (Centers for Disease Control and Prevention, 2021; Schulte et al., 2020).
- **Living situation** is represented by metrics related to household composition and living quarters, including the percent of housing units that are mobile homes, the percent of the total population living in nursing and skilled nursing facilities, the percent of housing units with more than one occupant per room, the percent of households with children under 18 that are headed by a single parent, and the percent of the total population living within institutionalized group quarters (Department of Homeland Security, 2022; Manson et al., 2022).
- **Income** is represented by the percent of families whose income is below the poverty line and the median household income (Manson et al., 2022).

- **Cost of living** is represented by the median gross rent as a percentage of income, which can indicate overall property value within a given area (Manson et al., 2022).
- **Demographic characteristics** are represented by the percent of the total population (5+ years old) that speaks limited English as well as the percent of the total population with minority status (Manson et al., 2022).
- **Community engagement** is represented by voter turnout in 2020, which indicates civic engagement within a community during the most recent presidential election (Atlas of U.S. Presidential Elections, 2022)
- **Quality of life** is represented by several metrics related to common, though not universally available, household comforts including the percent of households with a broadband subscription, the percent of households with phone service, the percent of housing units without a vehicle, and the percent of households without complete plumbing (Manson et al., 2022).

To reduce the dimensionality of the data and simplify their interpretation, these 22 indicators were combined in a Principal Components Analysis (PCA) using the 'factoextra' package in R. In order to generate results for all 84,121 census tracts within CONUS, missing values for any of the above indicators at individual census tracts were imputed using a regularized iterative PCA algorithm in the R package 'missMDA'. This algorithm first replaces missing values with an initial value (here, the national mean for a particular metric), runs a PCA with this initial set of values, and then iteratively updates the imputed values and reruns the PCA until converging on a set of scores and loadings that minimize the least squares criterion for existing values in the dataset (Dray & Josse, 2015; *ImputePCA: Impute Dataset with PCA*, n.d.). The result is a complete dataset with imputed values for all census tracts. PCA scores for all census tracts with imputed values were then predicted from the original PCA run only on complete records.

The first principal component (PC1), which explained 26.7% of variance across all demographic and health datasets, was positively associated with factors such as income, broadband access, and voter turnout, while being negatively associated with, e.g., percent unemployment, minority status, and the prevalence of several health conditions. We therefore took the multiplicative inverse of PC1 and considered this our estimate of social vulnerability. This metric (-1 × PC1) was calculated for each census tract polygon, and tracts were then rasterized at 90-m for downstream analysis.

3.3.3 Combining datasets

We calculated quartiles of the nature deprivation dataset and the social vulnerability index, which were reclassified and then combined using *raster calculator* in ArcGIS Pro to identify areas where communities furthest from any publicly accessible protected area (top 25% of the nature deprivation layer) coincided with the most socially vulnerable communities (top 25% of the social vulnerability index). This process identified 1,600 census tracts within CONUS that fell within these top quartiles for both metrics (Fig. 2). Buffers were then created around these most socially vulnerable and nature-deprived census tracts (for brevity, referred to as “SVDep census tracts”) to identify unprotected BLM lands within a circular radius of 10, 25, 50, and 100 miles. Following the workflow described above, these buffers were then intersected with all unprotected BLM lands to identify areas where unprotected BLM lands were in close proximity to SVDep census tracts.

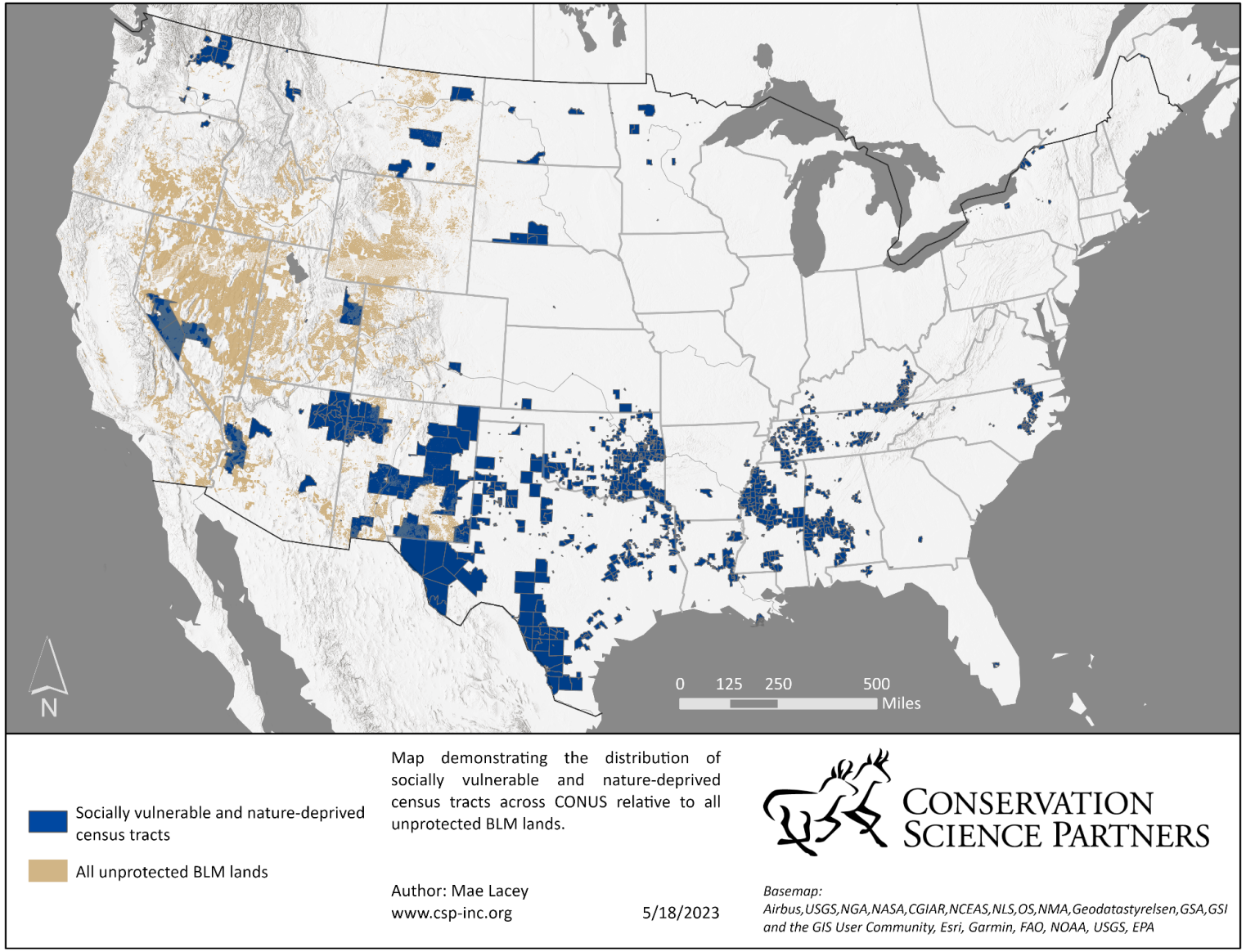

Figure 2. Distribution of socially vulnerable and nature-deprived census tracts across CONUS.

3.4 Quantifying trail density as a preliminary estimate of BLM land capacity to support recreation

To provide a preliminary assessment of the existing capacity of unprotected BLM lands to support outdoor recreation, we quantified relative mapped trail density through the presence of trails for non-motorized recreational activities. This analysis was dependent on publicly available nationwide trails data provided via The National Map (U.S. Geological Survey, 2023), the BLM Ground Transportation Linear Features dataset (Bureau of Land Management, 2021), the National Landscape Conservation System (NLCS) designated trails dataset (Bureau of Land Management & Conservation Biology Institute, 2009), and OpenStreetMap (OSM; OpenStreetMap contributors, 2023a).

We intend for the data and maps produced in our analyses to be used as evidence-based tools to inform recommendations regarding the management of public lands under the jurisdiction of the BLM. However, it is important to note that these freely available linear datasets are likely incomplete in their coverage across all of CONUS. Despite this, the datasets used in this analysis remain our best available open resources to represent recreation access and capacity across all of CONUS and care was taken to clean these data to the best of our ability.

3.4.1 The National Map

The 'Trans_TrailSegment' feature class within the national transportation geodatabase from the National Map was used to identify all nationally-documented trails designated for non-motorized uses. Trails were selected based on the following criteria:

'Hiker/Pedestrian' = "Yes" OR null ('null' records were accepted because these were often recreational trails that had incomplete entries, but in reality should be retained in the final dataset)
OR 'Bicycle' = "Yes"
OR 'Pack and Saddle' = "Yes"
OR 'Snowshoe' = "Yes"
OR 'Cross Country' = "Yes"
OR 'Dog Sled' = "Yes"
OR 'Non-Motorized Watercraft' = "Yes"
OR 'National Trail Designation' = not null (this ensured all national trails were included, regardless of information contained in other fields)

3.4.2 The BLM Ground Transportation Linear Features (GTLF) dataset

Four GTLF feature classes were included in our analysis: (1) public managed trails, (2) public non-motorized trails, (3) public non-mechanized trails, and (4) public "not assessed" trails. The "not assessed" trails feature class is intended to provide a comprehensive representation of all BLM trails with designated status (Bureau of Land Management National Operations Center, n.d.). Within the public managed trails and public unassessed trails datasets, only records in which the planned or observed mode of transportation equaled "Non-Motorized", "Non-Mechanized", or null were retained.

3.4.3 NLCS designated trails

All named trails within the NLCS designated trails dataset (where the 'Name' field = not null) were selected within this dataset, which represented the National Historic and Scenic Trails that the BLM has been tasked with managing.

3.4.4 OpenStreetMap

All linear features within OpenStreetMap where the 'highway' field = "bridleway" OR "cycleway" OR "footway" OR "path" OR "pedestrian" were selected. These classes were selected based on their relevance according to the provided descriptions:

> Bridleway: "For horse riders. Pedestrians are usually also permitted, cyclists may be permitted depending on local rules/laws. Motor vehicles are forbidden."
> Cycleway: "For designated cycleways."
> Footway: "For designated footpaths; i.e., mainly/exclusively for pedestrians. This includes walking tracks and gravel paths."
> Path: "A non-specific path."
> Pedestrian: "For roads used mainly/exclusively for pedestrians in shopping and some residential areas which may allow access by motorized vehicles only for very limited periods of the day."
> (OpenStreetMap contributors, 2023b)

3.4.5 Combining datasets

These trail datasets were then merged into a single layer (Fig. 3) that was rasterized to 30-m resolution. This rasterization was intended to address the considerable overlap between some trail datasets. Pixels with a value of 1 indicated that at *least* one trail was present within that 30 x 30 m pixel, and pixels with a value of 0 had no trails present. If a single 30 x 30 m pixel had more than one trail present, it would still only be assigned a value of 1. We quantified recreation capacity as the relative trail density based on a percentage of these pixels containing trails within unprotected BLM lands.

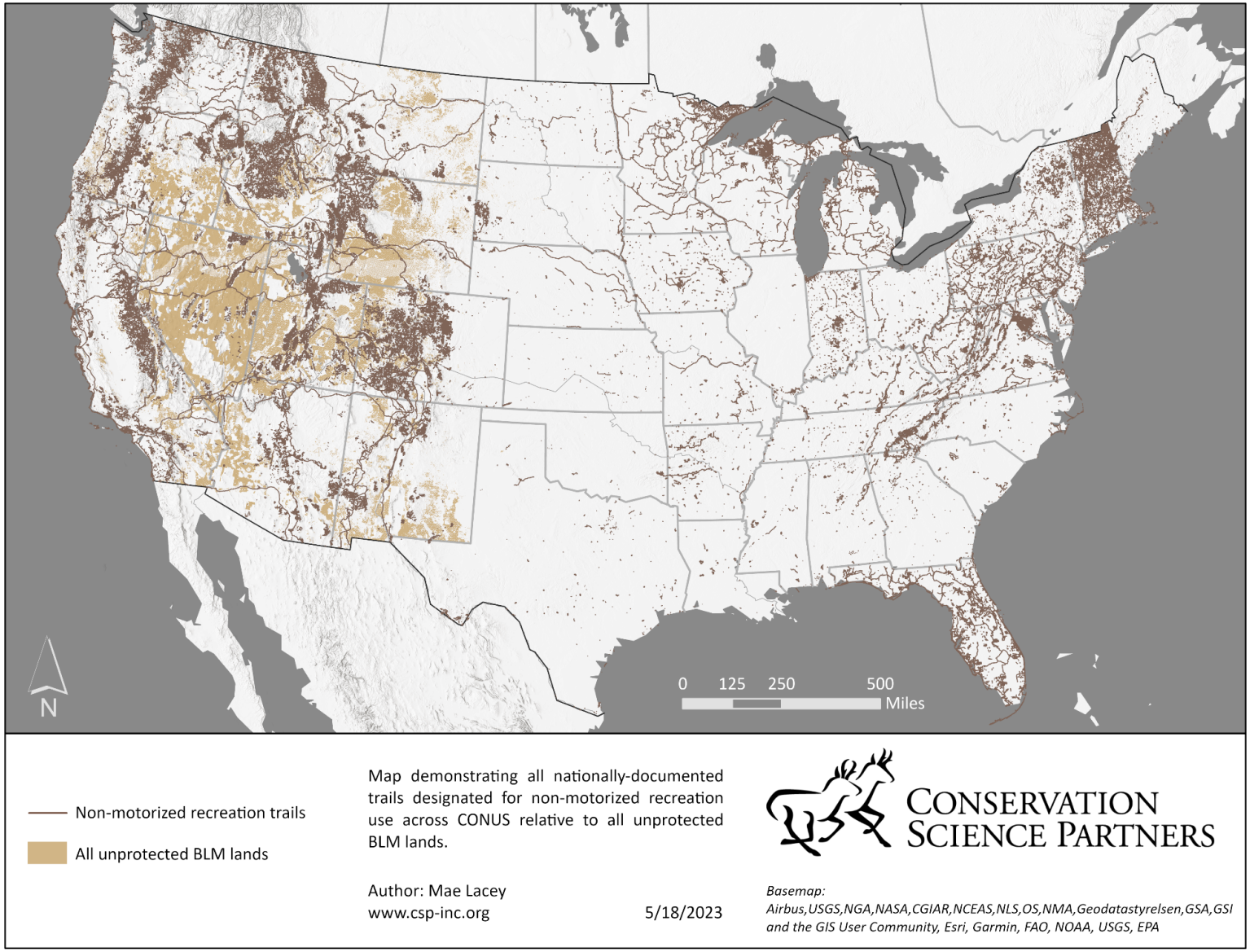

Figure 3. Distribution of mapped trails for non-motorized and non-mechanized recreation access across CONUS, overlaid on all unprotected BLM lands.

4. Results and Discussion

4.1 Unprotected BLM lands in close proximity to national and state parks: Opportunities to offset recreation demand

Recreation demand for national parks was quantified based on 2022 visitation rates, which provide a total count of visitors to each park throughout the year. Among the top ten most visited western national parks, Joshua Tree NP had the greatest amount of unprotected BLM land within a 10-mile radius (Table 3). Grand Canyon NP had the greatest amount of unprotected BLM land within a 25- and 50-mile radius, and Zion NP had the greatest amount within a 100-mile radius. Three eastern national parks that were among the top ten most visited across all of CONUS had no unprotected BLM land within even the maximum radius of 100 miles: Great Smoky Mountains NP, which is the number one most visited U.S. national park, as well as Acadia NP and Cuyahoga Valley NP.

Table 3. The total area of unprotected BLM lands within each buffer length of the top 10 most visited western national parks, listed in order of their 2022 total visitation count. The total area of unprotected BLM lands within each subsequent buffer distance is also provided.

			Total BLM land area (acres) within each buffer:			
National Park (NP)	State	2022 Visitation Count	10 miles	25 miles	50 miles	100 miles
Grand Canyon NP	AZ	4,732,101	335,000	1,270,800	3,405,800	9,616,500
Zion NP	UT	4,692,417	211,200	778,500	3,314,800	9,865,600
Rocky Mountain NP	CO	4,300,424	12,900	127,400	425,400	1,670,500
Yosemite NP	CA	3,667,550	27,900	240,300	857,800	5,581,600
Yellowstone NP	MT, ID, WY	3,290,242	2,200	35,000	709,800	4,404,500
Joshua Tree NP	CA	3,058,294	409,400	923,100	2,190,200	6,567,600
Glacier NP	MT	2,908,458	0	600	15,000	177,300
Grand Teton NP	WY	2,806,223	7,900	15,300	170,800	3,291,700
Olympic NP	WA	2,432,972	800	800	1,000	12,700
Bryce Canyon NP	UT	2,354,660	119,700	472,900	1,755,700	7,580,200

It is important to note when interpreting these results that the 25-, 50-, and 100-mile buffers fully encompass the lands identified in each preceding buffer. For example, the 3,405,800 acres of unprotected BLM land within a 50-mile buffer of Grand Canyon NP does include all lands contributing to the 1,270,800 acres identified within a 25-mile buffer of that same park. Due to the overall distribution of BLM lands, the U.S. national and state parks with the greatest amount of unprotected BLM lands within 100 miles or less were located entirely in the West.

We then assessed all unprotected BLM land within each buffer distance of all 51 national parks across CONUS and found that half of the ten national parks with the greatest amount of BLM land within a 10-mile radius were located in Utah (Table 4). While Death Valley NP has the greatest amount of nearby unprotected BLM land (a total of 1,280,000 acres), it ranks 25th in overall visitation in 2022 out of the 63 U.S. national parks.

Three parks among the top ten most visited–Joshua Tree NP, Grand Canyon NP, and Zion NP–also have some of the highest amounts of nearby unprotected BLM lands (Table 4).

Table 4. The ten national parks with the greatest amount of BLM land within a ten mile radius. The total 2022 visitation count for each park as well as the total area of unprotected BLM lands for each subsequent buffer distance is also listed. Visitation rankings relative to all 63 U.S. national parks are provided in parentheses. Any parks among the top ten most visited national parks in 2022 are indicated with an asterisk (*) and bold-faced font.

			Total BLM land area (acres) within each buffer:			
National Park	**State**	**2022 Visitation**	**10 miles**	**25 miles**	**50 miles**	**100 miles**
Death Valley NP	CA, NV	1,128,862 (25th)	1,280,100	2,824,600	5,357,400	12,489,300
Canyonlands NP	UT	779,147 (29th)	542,600	1,671,800	4,557,700	8,928,200
Capitol Reef NP	UT	1,227,608 (22nd)	510,300	1,329,800	3,177,000	8,991,200
Arches NP	UT	1,460,652 (20th)	412,900	1,228,000	3,085,700	9,432,500
Joshua Tree NP*	**CA**	**3,058,294 (8th)**	**409,400**	**923,100**	**2,190,200**	**6,567,600**
Great Basin NP	NV	142,115 (54th)	404,600	1,511,900	4,958,900	16,060,900
Grand Canyon NP*	**AZ**	**4,732,101 (2nd)**	**335,000**	**1,270,800**	**3,405,800**	**9,616,500**
Zion NP*	**UT**	**4,692,417 (3rd)**	**211,200**	**778,500**	**3,314,800**	**9,865,600**
Carlsbad Caverns NP	NM	390,932 (45th)	198,100	652,700	2,060,900	4,175,000
Bryce Canyon NP	UT	2,354,660 (15th)	119,700	472,900	1,755,700	7,580,200

Within Utah and Arizona alone, 2,426,400 acres of unprotected BLM land fall within 25 miles of either Grand Canyon NP, Bryce Canyon NP, or Zion NP. A focus on protecting a portion of these lands could serve to offset recreation demand on these three highly visited national parks while also creating a nearly continuous unit of protected BLM land connecting all three parks. Existing recreation capacity via trails could also be expanded in this region to connect neighboring park units via these BLM lands (Fig. 5). Similar opportunities for continuous protected, recreationally-accessible BLM lands between Arches NP, Canyonlands NP, and Capitol Reef NP (all also in Utah) exist if the BLM were to prioritize unprotected lands within a 25-mile buffer of those parks (Fig. 6).

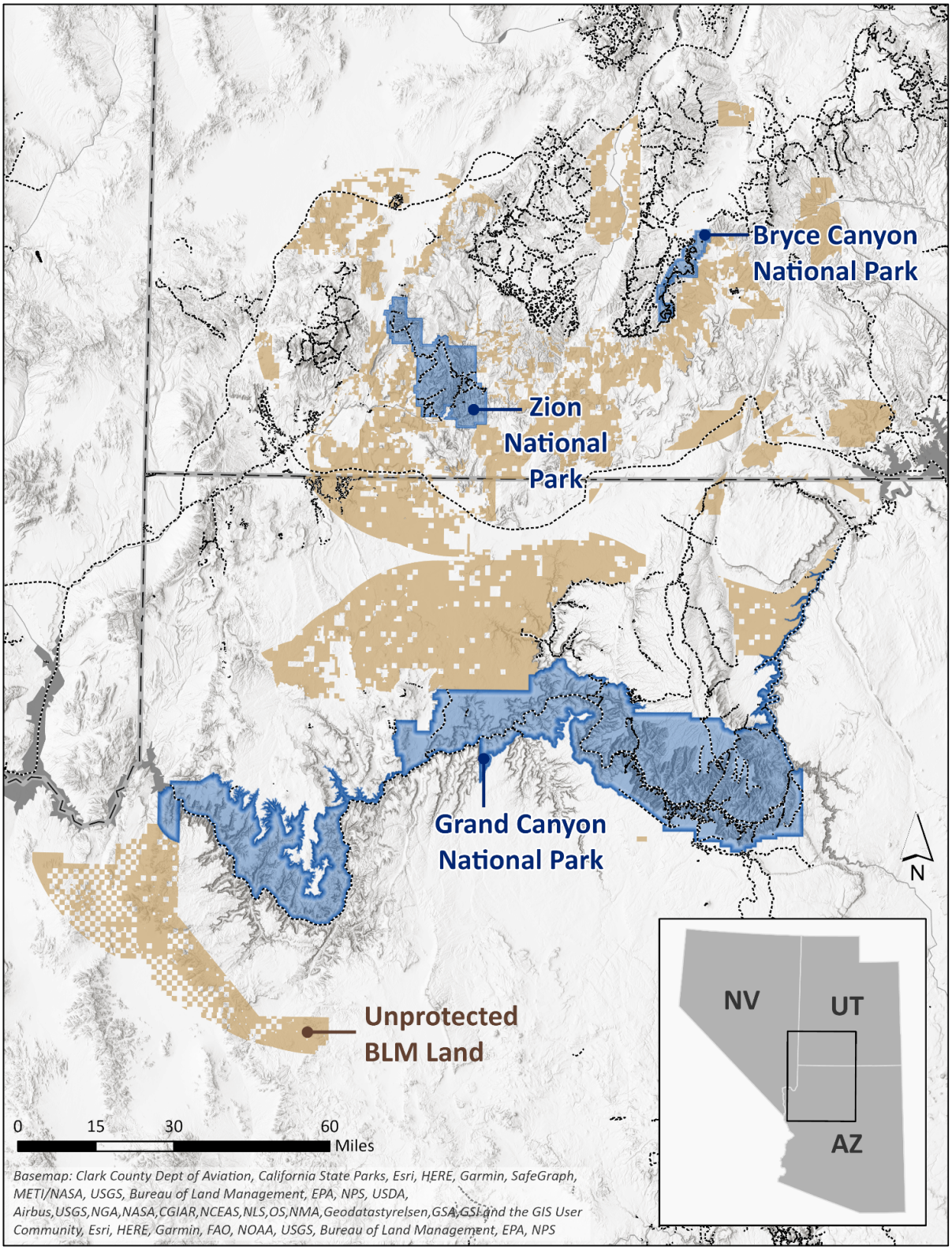

Figure 5. Unprotected BLM land within 25 miles of Grand Canyon National Park, Bryce Canyon National Park, or Zion National Park. Recreational trails are indicated with a black and white dashed line.

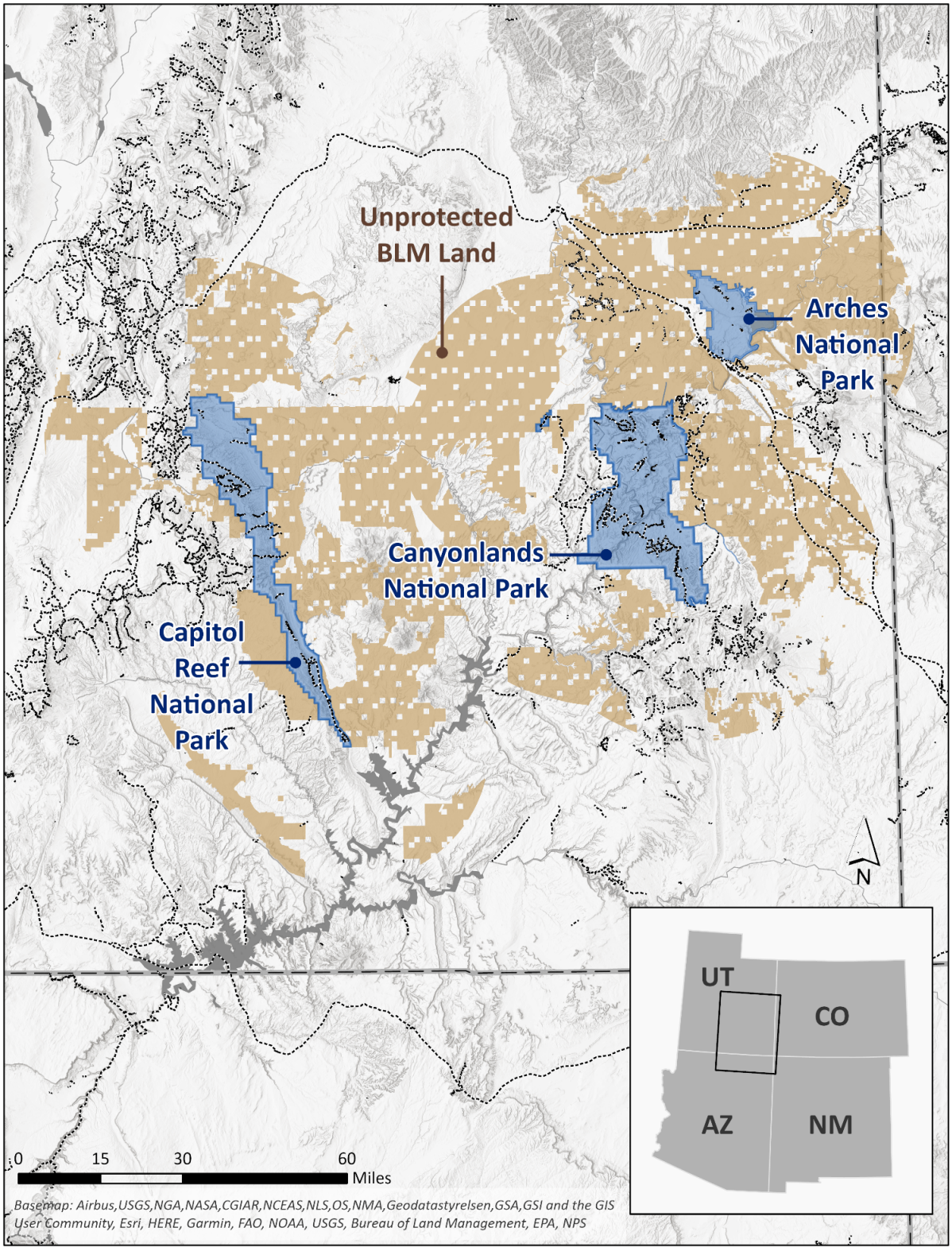

Figure 6. Unprotected BLM land within 25 miles of Capitol Reef National Park, Canyonlands National Park, or Arches National Park. Recreational trails are indicated with a black and white dashed line.

Even if the BLM were to limit their focus to a portion of the 1,270,800 acres of BLM land within 25 miles of the Grand Canyon NP alone, they would provide additional recreation access to offset the rapidly growing visitor population of nearly 5,000,000 people within the park itself. The Grand Canyon has long been a leader in park visitation, and following a widespread plummet in visitation across the majority of parks in 2020, it is now on a sharp rise back toward pre-pandemic levels (Fig. 7). Providing nearby recreation access in areas that share this iconic landscape can increase overall recreation capacity in the region without jeopardizing any visitor's experience due to crowding. Such efforts can ultimately reduce the concentrated use, and potential overuse, of these landscapes and resources.

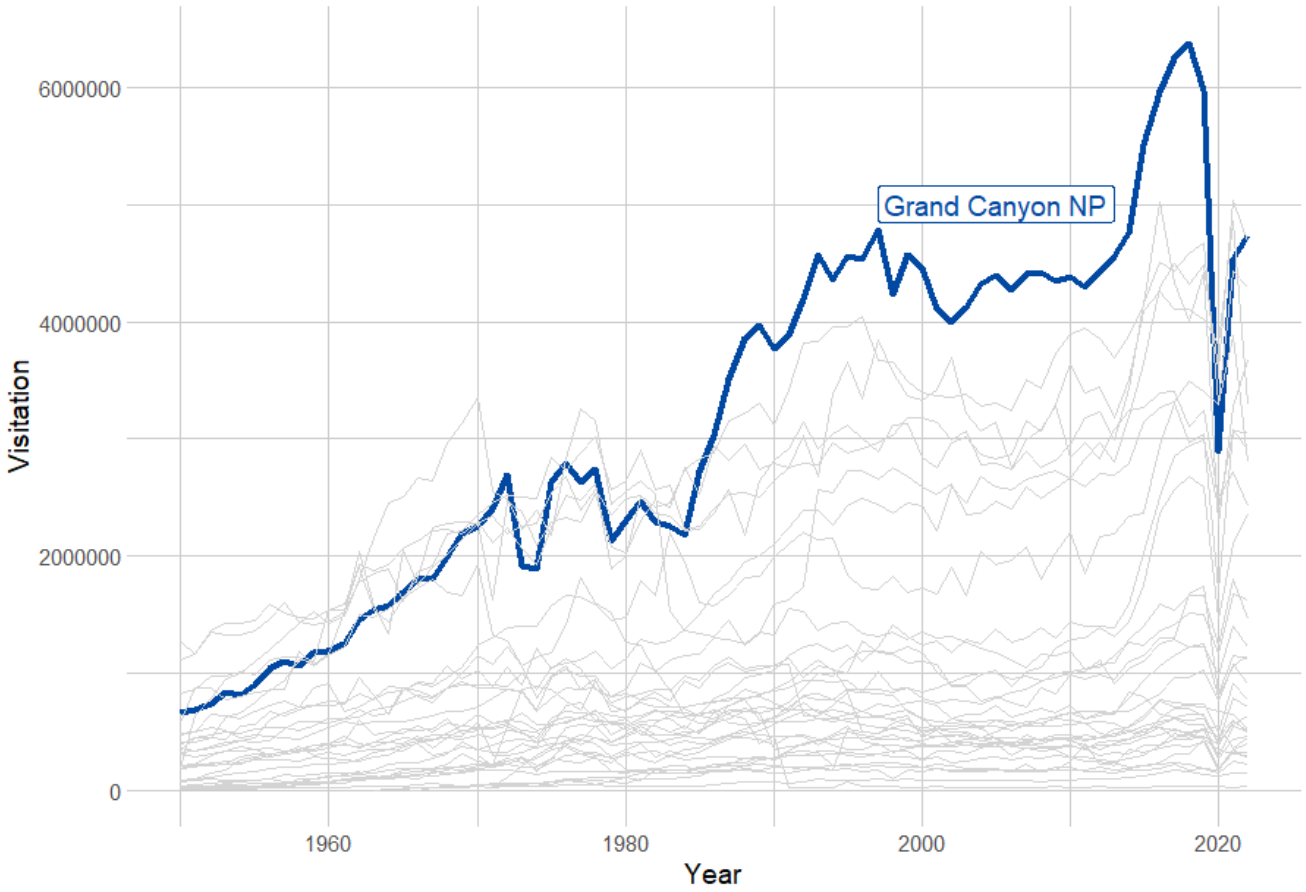

Figure 7. Visitation counts for all western U.S. national parks since the year 1950, with the trajectory for Grand Canyon National Park highlighted.

We were unable to assess recreation demand for state parks given a lack of standardized visitation count data across parks, and instead presented the top ten state parks with the greatest amount of BLM land within 10 miles. The majority of these state parks were found within Nevada, New Mexico, California, and Colorado (Table 5).

Table 5. The top ten state parks with the greatest amount of BLM land within a 10-mile radius, as well as the total area of unprotected BLM lands within each subsequent buffer distance.

		Total BLM land area (acres) within each buffer:			
State Park	State	10 miles	25 miles	50 miles	100 miles
Arkansas Headwaters SP	CO	285,300	527,700	1,100,100	2,649,200
Navajo Lake SP	NM	263,900	695,100	1,209,200	3,086,900
Valley of Fire SP	NV	248,200	801,700	2,043,400	8,683,300
Seminoe Reservoir SP	WY	239,600	913,500	2,753,800	8,158,300
Anza-Borrego Desert SP	CA	233,300	497,300	994,000	3,173,100
Caballo Lake SP	NM	231,900	724,500	1,334,600	4,432,600
Red Rock Canyon SP	CA	228,100	578,100	1,212,100	2,757,000
Colorado River	CO	222,900	957,100	2,917,500	8,730,900
Cathedral Gorge SP	NV	221,300	1,257,300	3,894,600	11,452,800
Echo Canyon SP	NV	215,800	1,115,500	3,912,900	11,815,500

One park ranked highly in Table 5, Valley of Fire SP, is a nearby favorite for many residents living in or near Las Vegas, NV and receives about 300,000 visitors per year (Borja, n.d.). If the BLM were to only focus on lands within a 10-mile radius of this park, they could ensure the preservation of 248,200 acres of natural habitat for biodiversity and recreational uses. Many of these BLM lands even share a border with Valley of Fire SP, presenting a unique opportunity for continuous recreation straight from the park onto BLM land and vice versa (Fig. 8).

Another park, Anza-Borrego Desert SP, falls within 25 miles of the eighth most-visited national park in the U.S. – Joshua Tree NP. Within a 25-mile radius of these two parks lies an overlapping area of unprotected BLM land that amounts to 83,800 acres (Fig. 9). Prioritizing new protected areas within these areas of overlap could serve a dual purpose and relieve recreation demand for both parks. This land area could offset some of the higher volume recreation impacts typically experienced within Joshua Tree NP, which is among the most heavily visited national parks in the country (Fig. 10).

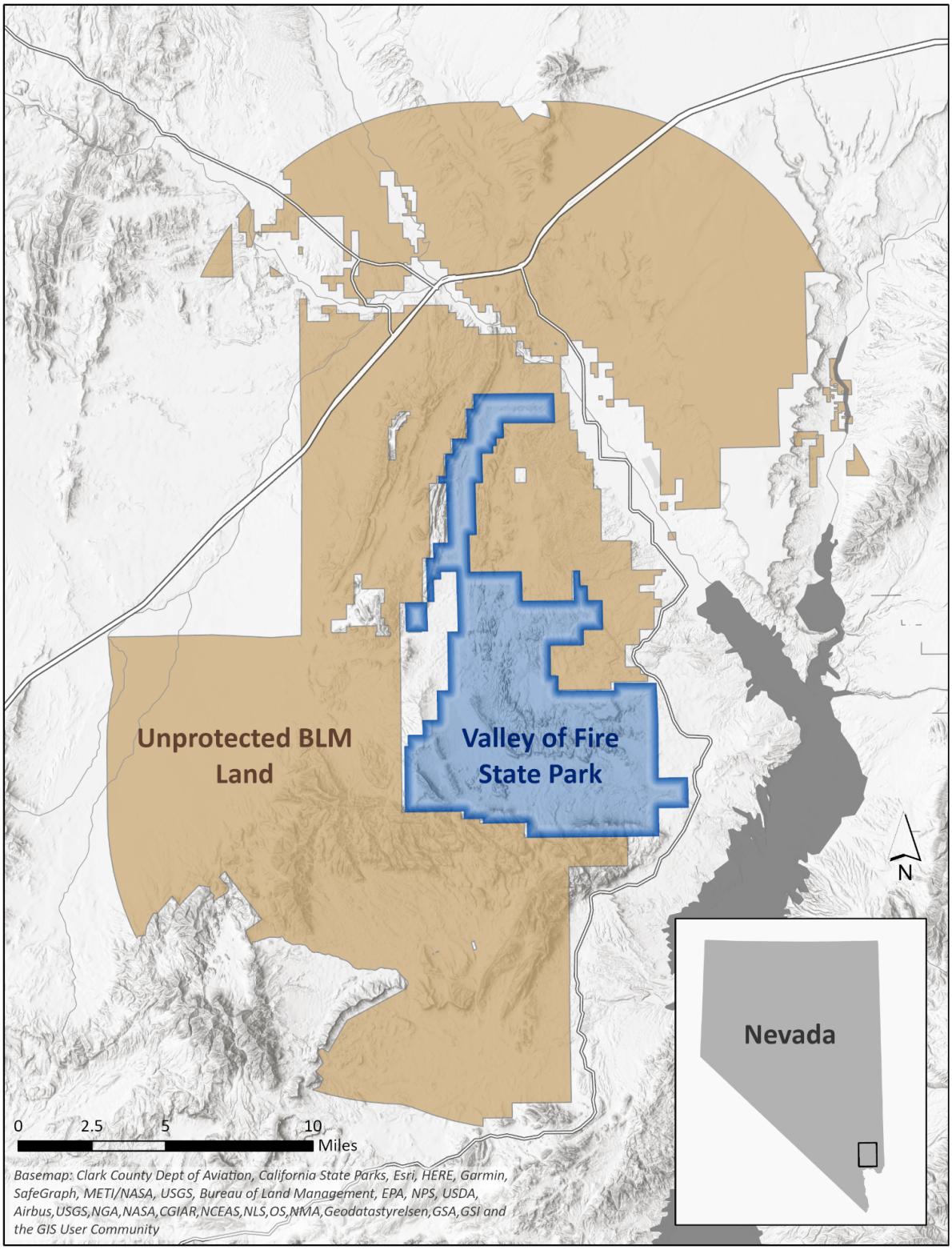

Figure 8. Valley of Fire State Park and the unprotected BLM land within a 10-mile buffer of the park's boundary.

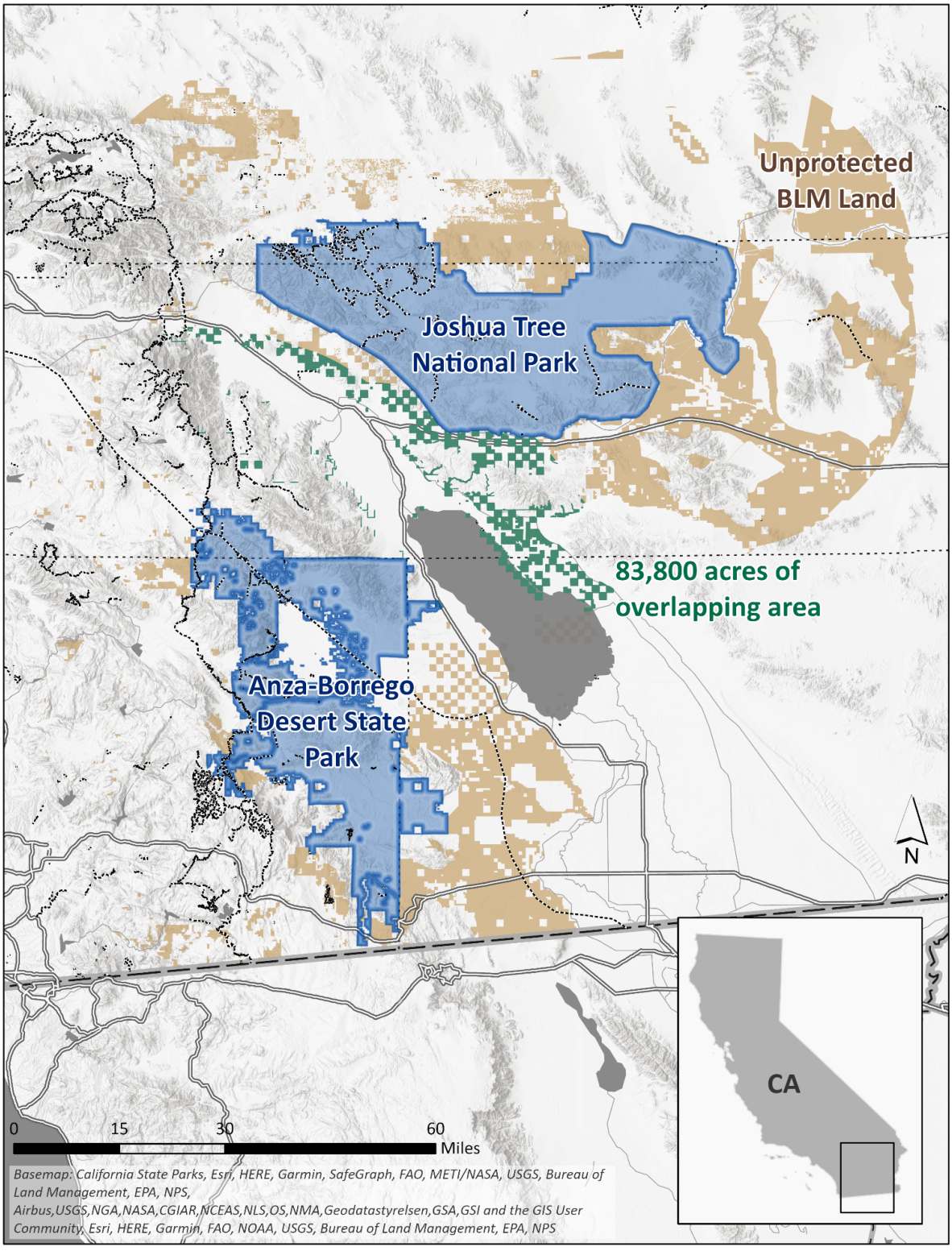

Figure 9. Unprotected BLM land within 25 miles of Anza-Borrego Desert State Park and Joshua Tree National Park. Overlapping BLM land, totaling 83,800 acres, is shown in green and recreational trails are indicated with a black and white dashed line.

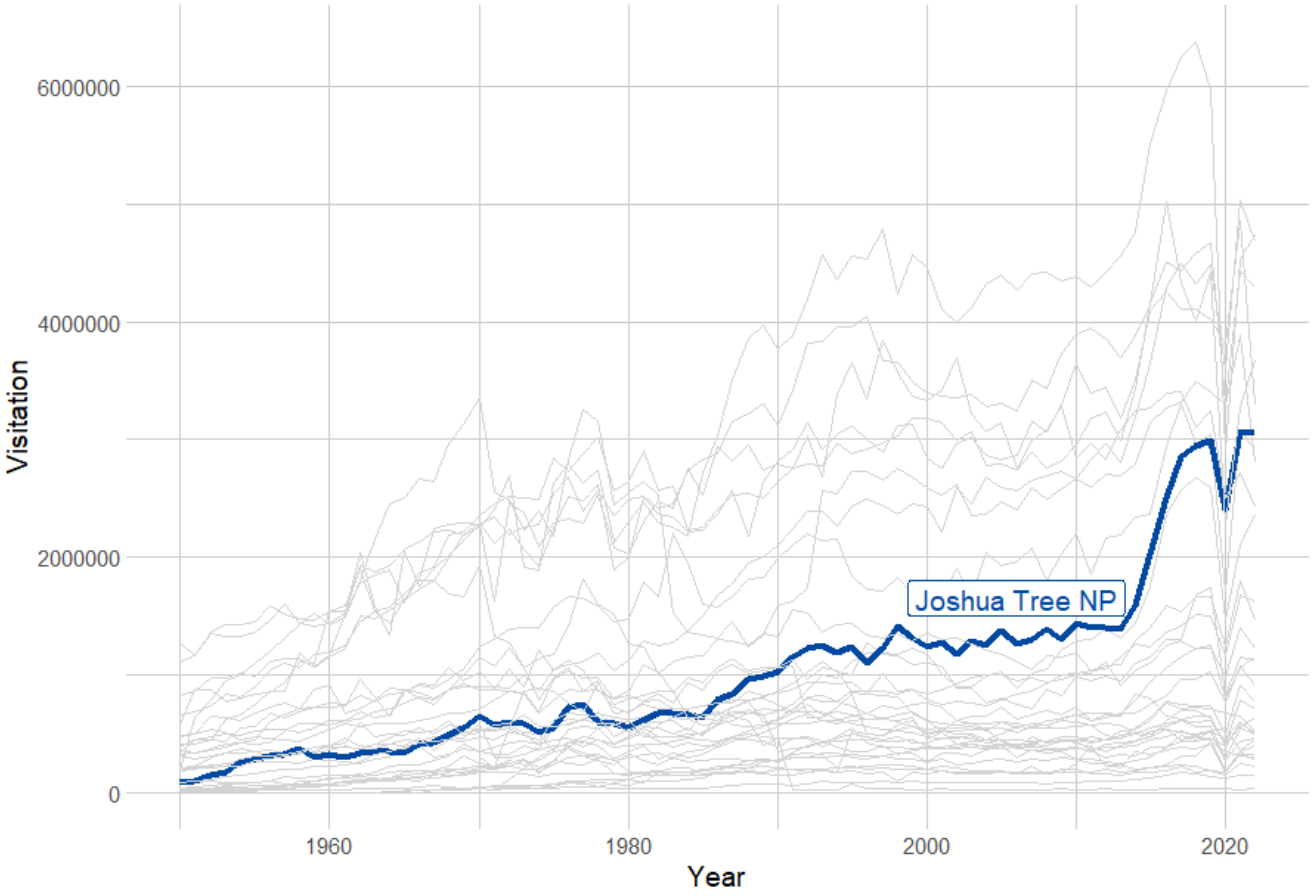

Figure 10. Visitation counts for all western U.S. national parks since the year 1950, with the trajectory for Joshua Tree National Park highlighted.

The harmful effects of increased and unchecked recreation in Joshua Tree NP became very apparent during both the government shutdown in early 2019 and the COVID-19 pandemic. The park is home to a fragile ecosystem that is sensitive to intense or unregulated use. During the government shutdown, news outlets such as the New York Times were recommending recreators find alternatives to the iconic national park, such as nearby Anza-Borrego Desert SP, to prevent damage from high volume, unmonitored recreation (Cowan, 2019). Likewise, the droves of new residents that left urban areas for the solitude of California's deserts during the COVID-19 pandemic also meant there were many new recreationists seeking respite in the outdoors (Sahagún, 2020). If kept in a natural state and made available for recreation, nearby BLM lands could help to ensure the sustainable use and preservation of wildlife and landscapes in areas that have become increasingly popular.

In addition, the area in and surrounding Anza-Borrego Desert SP is often most popular in late winter and early spring when wildflowers paint the desert floor. It is during this season that the park receives roughly 80% of its annual visitation (which totals ~150,000 for the year; Winkler & Brooks, 2020). This visitation may be pushed to extremes during super bloom events, however protecting a portion of the 497,300 acres of BLM land within 25 miles of the park's boundary may also offset some of the recreation impacts this sensitive ecosystem can face during those specific high visitation periods. This BLM land area would also provide additional access to outdoor spaces for urban populations in and around San Diego as well as communities further inland along the U.S.-Mexico border, such as El Centro, CA.

In total, 6.8% and 23.6% of all unprotected BLM lands fall within ten and 25 miles, respectively, of a national or state park (Table 6). A much larger portion of unprotected BLM lands, 63.7%, falls within 100 miles of a national or state park. These results suggest that there exists an ample opportunity for establishing additional protections on BLM lands that can increase recreation opportunities. These recreation opportunities can offset heavy visitation to national and state parks, primarily across the western U.S. An exhaustive list of all 51 national parks and 2,344 state parks within CONUS and the total amount of unprotected BLM land within each buffer assessed may be found in an accompanying spreadsheet.

Table 6. The total amount of unprotected BLM land area within each buffer range of *any* state or national park, as well as all national and state parks combined. The percentage of all unprotected BLM lands is provided in parentheses below each value.

	Total BLM land area (acres) within each buffer:			
Park Type	**10 miles**	**25 miles**	**50 miles**	**100 miles**
National Parks	4,834,200 (2.3%)	14,348,100 (6.8%)	35,375,900 (16.7%)	81,001,400 (38.3%)
State Parks	10,100,200 (4.8%)	41,572,400 (19.6%)	93,608,100 (44.2%)	134,311,500 (63.5%)
All Parks (NP + SP)	14,442,700 (6.8%)	49,959,300 (23.6%)	99,352,600 (46.9%)	134,911,900 (63.7%)

4.2 The role of unprotected BLM lands in equitable nature access

Socially vulnerable census tracts were classified as the 25% of census tracts with the highest values of the social vulnerability index based on metrics describing socioeconomic status, demographic characteristics, health and quality of life, community engagement, and education. Nature-deprived census tracts were classified as the 25% of census tracts with the greatest mean distance to any publicly accessible protected area. The census tracts falling within this top 25% were between 27 and 125 miles from any publicly accessible protected area. The intersection of these two datasets then determined which census tracts were among the most socially vulnerable *and* the most nature-deprived.

New Mexico and Nevada hold the greatest potential for leveraging unprotected BLM lands to provide additional recreational opportunities and outdoor access to SVDep census tracts (Table 7). Arizona and Utah also contain a notable amount of unprotected BLM lands within close proximity of these communities. There is then a noticeable drop off in the total acreage within a 10-mile buffer of SVDep census tracts within all remaining states.

Table 7. The ten states with the greatest amount of BLM land within a 10-mile radius of all nationally identified socially vulnerable and nature-deprived census tracts, as well as the total area of unprotected BLM lands within each subsequent buffer distance.

	Total BLM land area (acres) within each buffer:			
State	10 miles	25 miles	50 miles	100 miles
New Mexico	7,284,500	10,369,500	11,568,000	11,722,900
Nevada	6,895,700	8,877,600	12,545,800	25,019,800
Arizona	3,111,700	4,276,300	6,607,900	8,960,900
Utah	1,444,200	2,272,600	5,392,500	12,415,900
Montana	455,700	1,235,800	3,309,000	6,361,600
Colorado	325,700	1,044,100	2,782,700	5,956,900
California	240,300	792,600	1,819,100	4,587,600
Washington	172,800	319,200	405,800	435,400
Wyoming	87,900	504,000	2,159,300	8,076,500
Oregon	2,600	10,600	78,700	807,700

Within New Mexico alone, there are 10,369,500 acres of unprotected BLM land within 25 miles of a nationally-identified SVDep census tract. This equates to 5% of all unprotected BLM land across CONUS, and is roughly one-third of the total area of unprotected BLM land within a 25-mile radius of any SVDep census tract across all of CONUS (Table 8).

Table 8. The total amount of unprotected BLM land area within each buffer range of all nationally identified socially vulnerable and nature-deprived census tracts. The percentage of all unprotected BLM lands is provided in parentheses below each value.

	Total BLM land area (acres) within each buffer:			
Unit	10 miles	25 miles	50 miles	100 miles
All SVDep census tracts	20,023,500 (9.5%)	29,734,700 (14.0%)	46,735,000 (22.1%)	84,780,300 (40.1%)

The three SVDep census tracts with the greatest amount of BLM land within a 10-mile radius are all clustered in western Nevada (Table 9; Fig. 11). These three tracts maintain this ranking primarily because they contain a large amount of BLM land within their boundaries, as well as beyond in the 10-mile buffer. Much of the unprotected BLM lands within close proximity to SVDep census tracts in Nevada and New Mexico are also close to national or state parks. If these lands were to be managed as publicly accessible GAP 1 or 2 areas, they could significantly offset recreation pressure on nearby national and state parks as well as increase recreation access for marginalized communities lacking access to nature.

Table 9. The ten census tracts with the greatest amount of BLM land within a ten mile radius of all nationally identified socially vulnerable and nature-deprived census tracts, as well as the total area of unprotected BLM lands within each subsequent buffer distance.

			Total BLM land area (acres) within each buffer:			
Census Tract	County	State	10 miles	25 miles	50 miles	100 miles
Census Tract 9501	Esmeralda County	NV	2,999,900	4,381,900	6,722,200	13,981,100
Census Tract 9708	Mineral County	NV	2,805,000	4,614,700	7,498,200	15,292,400
Census Tract 9602	Nye County	NV	2,408,600	4,220,600	8,399,300	19,923,300
Census Tract 9402.01	Uintah County	UT	1,696,800	3,036,800	6,673,900	14,575,000
Census Tract 9548.02	Mohave County	AZ	1,688,800	2,619,900	4,981,200	8,931,200
Census Tract 9.04	Otero County	NM	1,654,500	2,238,900	3,547,900	7,433,600
Census Tract 201.01	La Paz County	AZ	1,233,900	2,570,100	4,731,500	7,796,300
Census Tract 9432.01	San Juan County	NM	863,700	1,339,500	1,777,600	3,335,900
Census Tract 5	Luna County	NM	852,200	1,579,800	3,013,300	5,400,700
Census Tract 205.01	La Paz County	AZ	755,100	1,580,200	4,057,800	7,322,800

These results suggest that if the BLM were to prioritize protections for lands that may provide outdoor recreation access to disadvantaged or marginalized communities, they could largely focus on just four states: New Mexico, Nevada, Arizona, and Utah (Fig. 11). Including these communities as a consideration in BLM's planning will be crucial, particularly on the heels of the COVID-19 pandemic, as studies indicate that park visitation behavior has shifted for marginalized groups since 2020. For example, national park visitation increased among non-white communities during the pandemic if those communities lived close to a national park. However, if those communities had to travel further distances to visit a given national park (specifically, 215 miles or more), their visitation rates decreased (Alba et al., 2022). Likewise, individuals in other marginalized groups, such as members of low-income households, reported greater overall impacts to their outdoor recreation experience as a result of the COVID-19 pandemic, citing factors such as crowding, conflict, access, closures, and ecological impacts such as vegetation damage (Ferguson et al., 2023). Increasing the total amount of publicly available protected areas for recreational use could serve to improve both community access to the outdoors as well as the overall enjoyment of one's recreational experience.

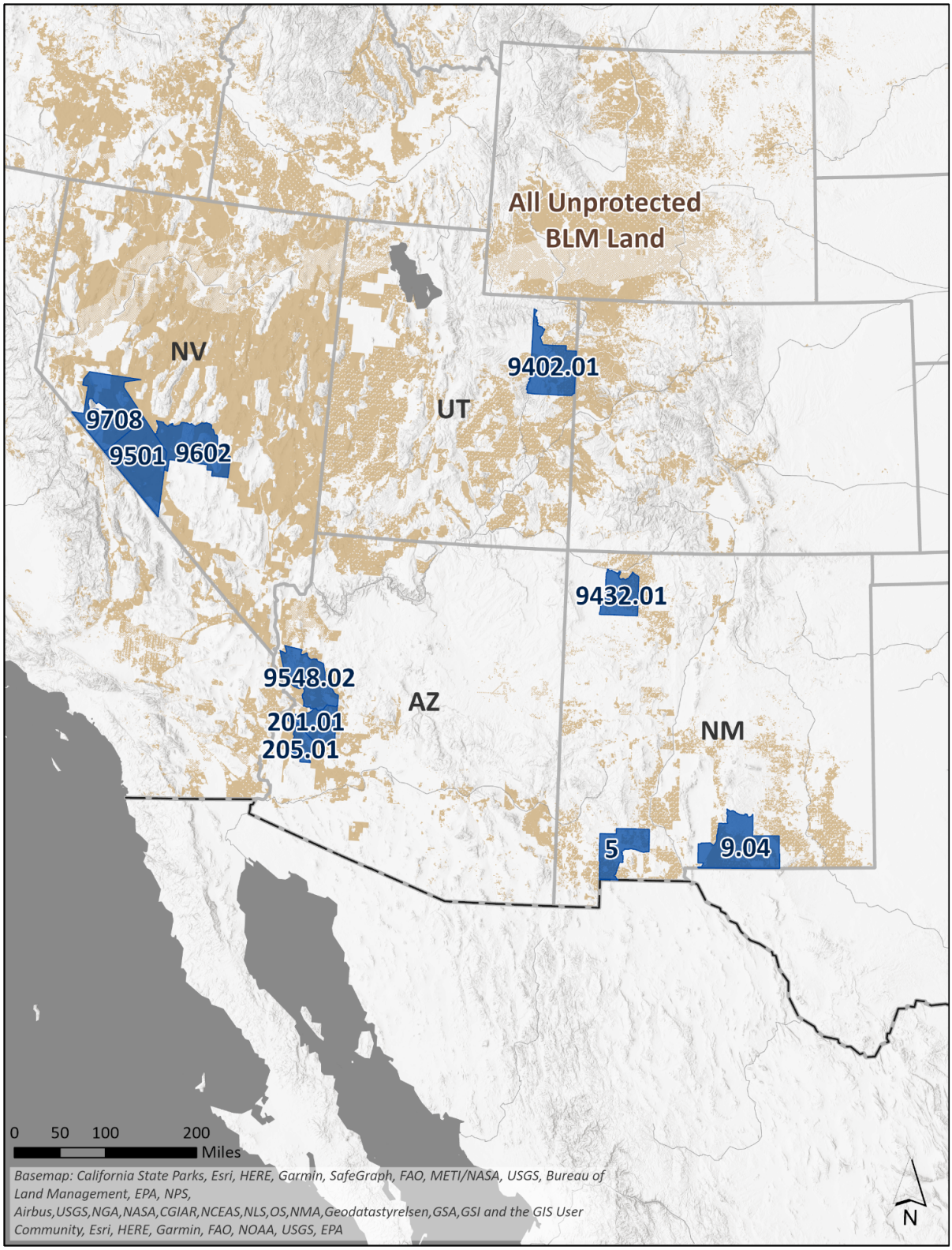

Figure 11. A map depicting the ten census tracts with the greatest amount of BLM land within a 10-mile radius of all nationally identified socially vulnerable and nature-deprived census tracts. Labels indicate the census tract number.

4.3 The capacity of unprotected BLM lands to support outdoor recreation

To provide a preliminary assessment of the existing capacity of unprotected BLM lands to support outdoor recreation, relative mapped trail density was calculated within each buffer distance of national parks, state parks, and SVDep census tracts. The CONUS-wide trails data were typically sparse on BLM land, thus the resulting density estimates tended to be low.

Only two of the ten most visited western national parks also had some of the highest trail density estimates: Yellowstone NP and Rocky Mountain NP (Table 10). Prioritizing BLM lands in close proximity to these parks would be advantageous–and likely the most efficient use of resources–because such efforts could offset recreation impacts within these well-loved national parks by protecting lands that already have existing capacity and infrastructure for recreational use. In addition, this approach would be focused on a relatively small total area, with only 2,200 acres and 12,900 acres of unprotected BLM land within 10 miles of Yellowstone NP and Rocky Mountain NP, respectively.

Table 10. The ten national parks with the greatest estimated density of trails on unprotected BLM lands within a ten mile radius, quantified as a percentage of the total number of 30-m pixels of BLM land with at least one trail in them. The total 2022 visitation count for each park as well as the trail density for each subsequent buffer distance is also listed. Visitation rankings relative to all 63 U.S. national parks are provided in parentheses. Any parks among the top ten most visited national parks in 2022 are indicated with an asterisk (*) and bold-faced font.

			Trail density (%) on unprotected BLM lands within each buffer:			
National Park	**State**	**2022 Visitation**	**10 miles**	**25 miles**	**50 miles**	**100 miles**
Mesa Verde NP	CO	499,790 (40th)	2.636	1.028	0.240	0.277
Great Sand Dunes NP	CO	493,428 (41st)	1.383	0.464	0.624	0.603
Crater Lake NP	OR	527,259 (37th)	1.056	0.427	0.248	0.339
Mount Rainier NP	WA	1,622,395 (16th)	0.917	0.198	0.935	0.435
Black Canyon of the Gunnison NP	CO	297,257 (48th)	0.680	0.876	0.720	0.599
Yellowstone NP*	**MT, ID, WY**	**3,290,242 (7th)**	**0.329**	**0.088**	**0.276**	**0.196**
Sequoia NP	CA	1,153,198 (24th)	0.274	0.234	0.396	0.165
Rocky Mountain NP*	**CO**	**4,300,424 (4th)**	**0.242**	**0.787**	**0.408**	**0.689**
White Sands NP	NM	705,127 (30th)	0.231	0.332	0.120	0.047
Canyonlands NP	UT	779,147 (29th)	0.210	0.210	0.148	0.206

Mesa Verde NP, which had the greatest trail density within a 10-mile radius, also has a smaller total unprotected BLM land area (28,400 acres) relative to many other western national parks. However, those BLM lands contain a fairly extensive trail network that could make it an excellent candidate for protection while leveraging (and potentially expanding) existing recreation capacity.

Four of the ten state parks with the greatest amount of unprotected BLM land within a 10-mile radius were found in Oregon (Table 11). These parks, as well as several others, maintained relatively high trail density on BLM lands within the smallest radius of 10 miles, but as that radius increased, density values notably

decreased. This would suggest that in the case of these ten parks, the greatest amount of trails on BLM land tends to already be in the areas closest to state parks.

Table 11. The ten western U.S. state parks[2] with the greatest estimated density of trails on unprotected BLM lands within a 10-mile radius, as well as the trail density for each subsequent buffer distance.

		Trail density (%) on unprotected BLM lands within each buffer:			
State Park	State	10 miles	25 miles	50 miles	100 miles
Fort Ord Dunes SP	CA	18.750	0.026	0.020	0.010
Bullards Beach SP	OR	12.278	0.584	0.177	0.262
Pictograph Cave SP	MT	11.344	4.458	2.709	0.466
Cape Arago SP	OR	10.609	0.745	0.140	0.262
Sunset Bay SP	OR	9.536	0.647	0.131	0.272
Border Field SP	CA	9.524	1.017	1.015	0.235
Shore Acres SP	OR	9.338	0.690	0.134	0.268
Lake Elmo SP	MT	8.745	3.676	2.280	0.507
Antelope Island SP	UT	6.593	0.244	0.113	0.115
Sylvan Lake/Brush Creek/East and West Brush Creek	CO	4.785	2.576	1.931	0.722

It is important to note that some of the density estimates listed in Table 11 may be artifacts of small BLM land units that are bisected by trails. In the case of Fort Ord Dunes SP, the surrounding unprotected BLM lands are just a small sliver, totaling roughly 4 acres, that traces along the boundary of the neighboring Fort Ord National Monument. Several trails are located in this region, and given this small BLM land area, just a few sections of overlap could equate to relatively high trail density estimates. Similar cases also apply to Border Field SP and Antelope Island SP, thus these density estimates should be interpreted with caution.

Lastly, all but one of the ten SVDep census tracts with the greatest estimated trail density are found within Montana, Oregon, or Washington (Table 12). Among these northwestern states, 238,600 acres of unprotected BLM land with relatively high recreation capacity lies within 25 miles of a nationally identified SVDep census tract.

[2] Here we focused exclusively on western U.S. state parks due to the majority of BLM lands being located in the West. We designated state parks as "western" if they were located in states within CONUS where the BLM has a state-specific office (i.e., all locations listed here except for the national and eastern states offices). A small number of eastern U.S. state parks, such as John A. Latsch SP, have relatively high trail densities, but these are the result of small parcels of BLM land in the east with a single trail or two bisecting them as a part of a larger trail network.

Table 12. The ten socially vulnerable and nature-deprived census tracts with the greatest estimated density of trails on unprotected BLM lands within a 10-mile radius, as well as the trail density for each subsequent buffer distance.

			Trail density (%) on unprotected BLM lands within each buffer:			
Census Tract	**County**	**State**	**10 miles**	**25 miles**	**50 miles**	**100 miles**
Census Tract 9405	Big Horn County	MT	1.564	0.974	0.514	0.226
Census Tract 9400	Umatilla County	OR	1.507	0.857	0.681	0.465
Census Tract 9410	Stevens County	WA	0.986	1.161	1.436	0.822
Census Tract 21	Cascade County	MT	0.878	0.084	0.139	0.133
Census Tract 9502.02	Umatilla County	OR	0.803	1.291	1.295	0.661
Census Tract 208.02	Franklin County	WA	0.755	0.612	1.117	0.865
Census Tract 9400	Ferry County	WA	0.690	1.189	1.110	0.812
Census Tract 9800	Toole County	MT	0.630	0.283	0.204	0.104
Census Tract 9501.02	Douglas County	WA	0.563	0.565	0.886	0.878
Census Tract 9606	Huerfano County	CO	0.551	0.203	0.495	0.604

Ultimately, through this analysis we quantified the total amount of unprotected BLM lands and their estimated recreation capacity within four radii from national parks, state parks, and SVDep census tracts across CONUS. Protecting BLM lands in the intermountain west holds the greatest potential to offset recreation demand within some of the country's most popular parks while also providing additional recreation opportunities to communities that have been historically disadvantaged or marginalized. Many unprotected BLM land units do fall within buffers of national *and* state parks, or they may fall within buffers of these parks *and* SVDep census tracts, making them excellent candidates for protection in an effort to meet multiple goals simultaneously.

5. Acknowledgements

This analysis was supported by the Center for American Progress. Analyses were conceived and performed by Mae Lacey and Justin Suraci, with substantial input from colleagues at CAP. Valuable feedback was provided by Caitlin Littlefield and Brett Dickson.

6. References cited

Alba, C., Pan, B., Yin, J., Rice, W. L., Mitra, P., Lin, M. S., & Liang, Y. (2022). COVID-19's impact on visitation behavior to US national parks from communities of color: Evidence from mobile phone data. *Scientific Reports*, *12*(1), 13398. https://doi.org/10.1038/s41598-022-16330-z

Atlas of U.S. Presidential Elections. (2022). *Voter Registration & Turnout Data by County* [Data set]. https://uselectionatlas.org/

Borja, R. (n.d.). 7 Burning Reasons to Visit the Valley of Fire. *Canyon Tours*. https://www.canyontours.com/guides/7-burning-reasons-visit-valley-of-fire/

Bureau of Land Management. (2021). *BLM Ground Transportation Linear Features* [Data set]. https://databasin.org/datasets/f367c5d945e44f52b47907084b9bfa38/

Bureau of Land Management. (2022). *BLM National Surface Management Agency Area Polygons—National Geospatial Data Asset (NGDA)* [Data set]. https://catalog.data.gov/dataset/blm-national-surface-management-agency-area-polygons-national-geospatial-data-asset-ngda

Bureau of Land Management, & Conservation Biology Institute. (2009). *National Landscape Conservation System (NLCS) designated trails and rivers of the Western US* [Data set]. https://databasin.org/datasets/6df06e8872ea42368a386e448b8d5d59/

Bureau of Land Management National Operations Center. (n.d.). *BLM National Ground Transportation Linear Features Public Display* [Data set]. https://gis.blm.gov/arcgis/rest/services/transportation/BLM_Natl_GTLF_Public_Display/MapServer

Centers for Disease Control and Prevention. (2021). *PLACES: Local Data for Better Health, Census Tract Data 2021 release* [Data set]. https://chronicdata.cdc.gov/500-Cities-Places/PLACES-Local-Data-for-Better-Health-Census-Tract-D/cwsq-ngmh

Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. (n.d.). *CDC/ATSDR Social Vulnerability Index 2020 Database US* [Data set]. https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html

County of San Mateo Executive's Office. (n.d.). *Community Vulnerability Index*. County of San Mateo. https://www.smcgov.org/ceo/community-vulnerability-index

Cowan, J. (2019, January 10). The Shutdown's Lasting Damage to Joshua Tree. *The New York Times*. https://www.nytimes.com/2019/01/10/us/california-today-shutdown-joshua-tree.html

Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social Vulnerability to Environmental Hazards [*]: Social Vulnerability to Environmental Hazards. *Social Science Quarterly*, *84*(2), 242–261. https://doi.org/10.1111/1540-6237.8402002

Davies, I. P., Haugo, R. D., Robertson, J. C., & Levin, P. S. (2018). The unequal vulnerability of communities of color to wildfire. *PLOS ONE*, *13*(11), e0205825. https://doi.org/10.1371/journal.pone.0205825

Department of Homeland Security. (2022). *Homeland Infrastructure Foundation-Level Data (HIFLD): Nursing Homes* [Data set]. https://hifld-geoplatform.opendata.arcgis.com/datasets/geoplatform::nursing-homes/about

D'Evelyn, S. M., Jung, J., Alvarado, E., Baumgartner, J., Caligiuri, P., Hagmann, R. K., Henderson, S. B., Hessburg, P. F., Hopkins, S., Kasner, E. J., Krawchuk, M. A., Krenz, J. E., Lydersen, J. M., Marlier, M. E., Masuda, Y. J.,

Metlen, K., Mittelstaedt, G., Prichard, S. J., Schollaert, C. L., … Spector, J. T. (2022). Wildfire, Smoke Exposure, Human Health, and Environmental Justice Need to be Integrated into Forest Restoration and Management. *Current Environmental Health Reports*, *9*(3), 366–385. https://doi.org/10.1007/s40572-022-00355-7

Dray, S., & Josse, J. (2015). Principal component analysis with missing values: A comparative survey of methods. *Plant Ecology*, *216*(5), 657–667. https://doi.org/10.1007/s11258-014-0406-z

Ferguson, M. D., Lynch, M. L., Evensen, D., Ferguson, L. A., Barcelona, R., Giles, G., & Leberman, M. (2023). The nature of the pandemic: Exploring the negative impacts of the COVID-19 pandemic upon recreation visitor behaviors and experiences in parks and protected areas. *Journal of Outdoor Recreation and Tourism*, *41*, 100498. https://doi.org/10.1016/j.jort.2022.100498

Hazards Vulnerability & Resilience Institute. (n.d.). *SoVI® Social Vulnerability Index for the United States—2010–14*. University of South Carolina. https://www.sc.edu/study/colleges_schools/artsandsciences/centers_and_institutes/hvri/data_and_resources/sovi/index.php

Hernandez, P., Daigle, B., Preston, T., Pohl, K., Smith, K., Powell, B., Story, S., Cahail, J., McGlone, D., & Hassan, A. (2022). *A Rural Capacity Map*. Headwaters Economics. https://headwaterseconomics.org/equity/rural-capacity-map/

ImputePCA: Impute dataset with PCA (missMDA (version 1.18)). (n.d.). https://www.rdocumentation.org/packages/missMDA/versions/1.18/topics/imputePCA

Kind, A. J. H., & Buckingham, W. R. (2018). Making Neighborhood-Disadvantage Metrics Accessible—The Neighborhood Atlas. *New England Journal of Medicine*, *378*(26), 2456–2458. https://doi.org/10.1056/NEJMp1802313

MacPhee, D. (n.d.). *Civic Capacity Index: Assessing Community Driven Change*. Colorado State University. https://engagement.colostate.edu/civic-capacity-index/

Manson, S., Schroeder, J., Van Riper, D., Kugler, T., & Ruggles, S. (2022). *IPUMS National Historical Geographic Information System: Version 17.0 [2020 American Community Survey: 5-Year Data]. Minneapolis, MN: IPUMS* [Data set]. https://doi.org/10.18128/D050.V17.0

National Park Service. (2023). *Annual Visitation and Record Year by Park (1904—Last Calendar Year)* [Data set]. https://irma.nps.gov/Stats/Reports/National

OpenStreetMap contributors. (2023a). *North America Regional Downloads* [Data set]. https://download.geofabrik.de/north-america.html

OpenStreetMap contributors. (2023b). *OpenStreetMap Wiki—Key:highway*. https://wiki.openstreetmap.org/wiki/Key:highway

Rappold, A. G., Reyes, J., Pouliot, G., Cascio, W. E., & Diaz-Sanchez, D. (2017). Community Vulnerability to Health Impacts of Wildland Fire Smoke Exposure. *Environmental Science & Technology*, *51*(12), 6674–6682. https://doi.org/10.1021/acs.est.6b06200

Rowland-Shea, J., Doshi, S., Edberg, S., & Fanger, R. (2020). *The Nature Gap: Confronting Racial and Economic Disparities in the Destruction and Protection of Nature in America*. The Center for American Progress. https://www.americanprogress.org/article/the-nature-gap/

Sahagún, L. (2020, March 22). Hoping to escape coronavirus, city dwellers are fleeing to California's deserts and mountains. *Los Angeles Times*. https://www.latimes.com/california/story/2020-03-22/californians-flee-cities-as-coronavirus-pandemic

-spreads

Schulte, F., Lucas, E., Rau, J., Szabo, L., & Hancock, J. (2020). Millions Of Older Americans Live In Counties With No ICU Beds As Pandemic Intensifies. Kaiser Health News. *KFF Health News*. https://kffhealthnews.org/news/as-coronavirus-spreads-widely-millions-of-older-americans-live-in-counties-with-no-icu-beds/

Surgo Ventures. (2021). *Vulnerable Communities and COVID-19: The Damage Done, and the Way Forward*. https://surgoventures.org/resource-library/report-vulnerable-communities-and-covid-19

U.S. Department of the Interior. (2023, March 30). Interior Department Releases Proposed Plan to Guide the Balanced Management of Public Lands. *Press Releases*. https://www.doi.gov/pressreleases/interior-department-releases-proposed-plan-guide-balanced-management-public-lands

U.S. Environmental Protection Agency (EPA). (2022). *EJScreen*. U.S. Environmental Protection Agency (EPA). www.epa.gov/ejscreen

U.S. Geological Survey. (2023). *National Transportation Dataset (NTD)* [Data set]. https://prd-tnm.s3.amazonaws.com/index.html?prefix=StagedProducts/Tran/National/GDB/

U.S. Geological Survey (USGS) Gap Analysis Project (GAP). (2020). *Protected Areas Database of the United States (PAD-US) 2.1: U.S. Geological Survey data release*. https://doi.org/10.5066/P92QM3NT

U.S. Geological Survey (USGS) Gap Analysis Project (GAP). (2021). *GAP Status Code Assignment: Assumptions, Criteria, and Methods*. https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/s3fs-public/atoms/files/GAP%20Status%20Code%20Assignment_2021.pdf

Vermont Department of Health. (2015). *Social Vulnerability Index: A User's Guide*. https://www.healthvermont.gov/sites/default/files/documents/2016/12/ENV_EPHT_SocialVulnerabilityIndex.pdf

Wigtil, G., Hammer, R. B., Kline, J. D., Mockrin, M. H., Stewart, S. I., Roper, D., & Radeloff, V. C. (2016). Places where wildfire potential and social vulnerability coincide in the coterminous United States. *International Journal of Wildland Fire*, *25*(8), 896. https://doi.org/10.1071/WF15109

Winkler, D. E., & Brooks, E. (2020). Tracing Extremes across Iconic Desert Landscapes: Socio-Ecological and Cultural Responses to Climate Change, Water Scarcity, and Wildflower Superblooms. *Human Ecology*, *48*(2), 211–223. https://doi.org/10.1007/s10745-020-00145-5