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### Authors

Jenkins, Jeffrey S  
Young, Terence G  
Petersen, Alexander M  
[et al.](#)

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## Article

# Climate Influences on Day and Overnight Use at California State Beaches and Coastal Parks

Jeffrey S. Jenkins <sup>1,\*</sup> , Terence G. Young <sup>2</sup>, Alexander M. Petersen <sup>1</sup>, Felber J. Arroyave <sup>1</sup>   
and Maria E. Medina-Chavarría <sup>3</sup> 

<sup>1</sup> Department of Management of Complex Systems, University of California, Merced, CA 95343, USA

<sup>2</sup> Department of Geography and Anthropology, California State Polytechnic University, Pomona, CA 91768, USA

<sup>3</sup> Department of Geography, Rovira i Virgili University, 43480 Vila-seca, Spain

\* Correspondence: [jjenkins8@ucmerced.edu](mailto:jjenkins8@ucmerced.edu)

**Abstract:** State beaches and parks provide access to coastal environments for recreational activities that rely on access to the ocean, coastal climate, and scenic amenities. Approximately 46 million people visit state beaches in California annually, and another 20 million people visit other types of state park units located in the Coastal Zone, which together constitute 72% of overall visitation to the state parks system. We utilized monthly attendance estimates available between 2001 and 2020 to assess the influence of extreme drought or wet conditions on visitation to state beaches and coastal parks for day use and overnight use. State beaches include direct access to the ocean for water-dependent recreation activities from swimming to scenery, while coastal park types range from coastal forests to historical sites and may include some ocean access but are not directly dependent on water. State park unit climate conditions were analyzed by coastal region according to seasonal variability between moderate and extreme drought and wet categories using the Palmer Drought Severity Index. We found that visitation to state beaches is more sensitive to climate than coastal parks, particularly during times of extreme drought, and that overall day use visitation is more sensitive to climate than overnight use.

**Keywords:** state parks; drought; hazards; recreation; coastal tourism



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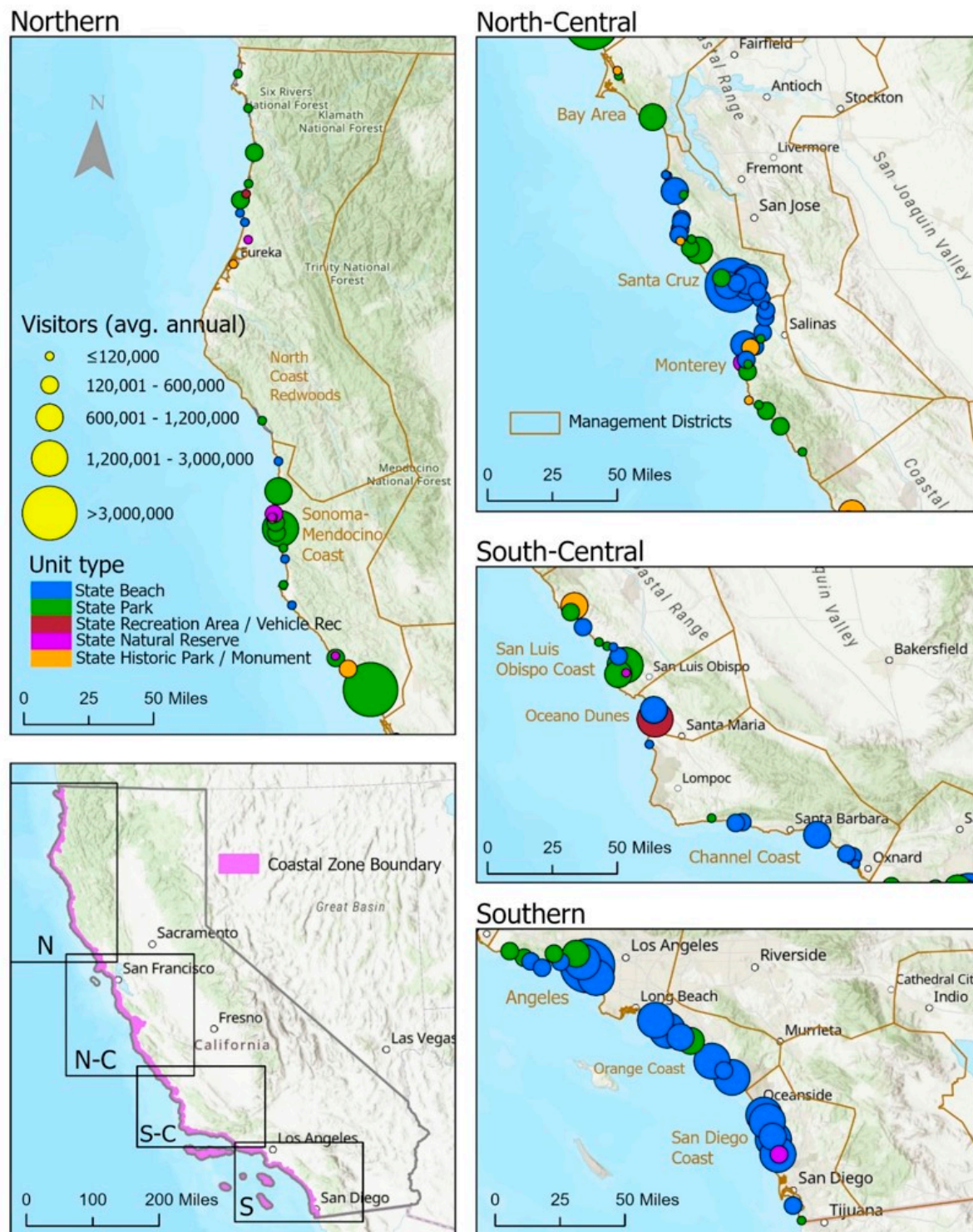
## 1. Introduction

### 1.1. Coastal Access and Climate

The California coast and its beaches are central to our collective imaginary, postcard images of what a beach is or ought to be: somewhere to find respite from the summer heat, a place of leisure and escape, and often sandy [1]. While much of the public beach use occurs on southern California's iconic beaches, like in Santa Monica, state beaches and coastal state park units provide access to 550 km of the approximately 1770 km, or one-third of the State's coastline, representing a geographically diverse assortment of coastal landscapes, recreational opportunities, and desired conditions available for public access. Generally wetter and cooler conditions can be expected in the north and warmer and drier conditions in the south, a difference driven by mixing of a wind-driven current of cooler water from the north and warmer tropical water from the south, a system known as the California Current [2].

The volume of visitors is distributed unevenly among different coastal regions, locations, and types of units (Figure 1). Some urban-proximate beaches have densely crowded conditions, especially throughout the peak summer months, while at more rural locations,

visitors tend to expect less crowded conditions amid stretches of undeveloped coastline [3,4]. Coastal units generally incur the largest proportion of their use during the peak summer visitation season, with 50% of average annual use occurring during June, July, and August [5]. During these typically hot and dry months, climate conditions drive visitors to the coast for recreational activities that are directly (e.g., swimming) or indirectly dependent (e.g., scenic resources) on access to the ocean or coastal climate.



**Figure 1.** Map of California state beach and coastal park units with administrative districts by climate region showing circles proportional to annual visitation and colored by unit type.

Our analysis depicts the climatic influence—particularly of abnormally dry or wet years—on visitation to California state beaches and coastal parks. In this regard, it builds on other studies that have examined other climatic influences on visitation, particularly warming weather, and corresponding resource changes [6,7]. Relative differences in seasonal visitation by drought or wet year category allow us to anticipate future shifts in level and timing of recreational use to assess the impact these changes may have on demand and access to coastal-dependent recreation. This work also directly addresses a noted lack of information between drought conditions and quantifiable tourism data [8,9], more studies of which are needed to inform management and coordinate adaptation strategies suited to the recreational opportunities and climatic context of each park and the system. In this study, we examined relationships between drought and visitation trends across state beaches and other state park units, with day and overnight use, that represent a latitudinal gradient of average climatic conditions along the state's coastline.

### *1.2. California State Park System*

The California Department of Parks and Recreation manages the State Parks system commonly known as California State Parks (CSP), which receives approximately 93 million visitors to state-owned recreation and conservation lands annually on average [10]. A total of 47 million people visit state beaches (or 50% of systemwide use), while 20 million people visit other coastal units (22% of systemwide use), and an additional 26 million people visit the remaining non-coastal CSP units throughout the state (28% of systemwide use). Together, public access at 58 state beaches and 60 other coastal units analyzed for this study accounts for a disproportionate amount of overall visitation to the CSP system, with 72% of overall visitors across 46% of the system's 280 units. The contribution of beach visitors as part of the overall CSP system use is effectively higher given that there are 65 state beaches, 7 of which do not have visitation data available.

California State Parks units are classified by different types according to a park's purpose and what recreational opportunities you can expect when you visit. The California State Parks General Planning Handbook provides guidelines for the park classification process, including definitions of each, which are useful for this study in understanding the spectrum of coastal use [11]. State beaches (SB) consist of areas with frontage on the ocean, or bays designed to provide swimming, boating, fishing, and other beach-oriented recreational activities. State parks (SP) consist of relatively spacious areas of outstanding scenic or natural character, oftentimes also containing significant historical, archaeological, ecological, geological, or other similar values. State recreation areas (SRA) and state vehicle recreation areas (SVRA) consist of areas selected and developed to provide multiple recreational opportunities to meet other than purely local needs, including vehicle use and boating. State historic parks (SHP) and state historic monuments (SHM) consist of nonmarine areas established primarily to preserve objects of historical, archaeological, and scientific interest, as well as sites and places commemorating important persons or historic events. State natural reserves (SNR) consist of areas embracing outstanding natural or scenic characteristics or areas containing outstanding cultural resources of statewide significance. SB, SP, SVRA, and SHP unit types include day use and overnight use opportunities (camping, recreational vehicle, cabins) with reservations available and campsites often booked months in advance.

SNR, SHM, and SRA unit types are available for day use only and often located within the vicinity of other coastal CSP units with overnight use options. Overnight reservations tend to fill up months ahead of the season given the popularity and limited supply of coastal overnight accommodations and camping opportunities, while day use entry at state beaches and coastal parks typically is not subject to reservations or need for lodging, which

allows visitors to be more sensitive to climatic conditions. Further, compared to coastal park unit visitors, visitors to state beaches may be more sensitive to climatic conditions given the nature of their visit typically involves water-dependent recreational activities.

### *1.3. Climate and Recreation*

California and the broader southwestern United States are prone to significant inter-annual variability in precipitation, with many ecosystems therefore considered drought adapted. Nonetheless, since 2000, much of the region is in the most extreme drought in the past thousand years [12], including the most extreme multi-year drought recorded in California (2012–2015) [13]. These droughts have resulted in numerous effects, including contributing to widespread drought-induced tree mortality and historic wildfire seasons. This includes both direct and indirect effects on visitation to coastal state parks and beaches, such as with the CZU Lightning Complex fires that burned much of Big Basin Redwoods SP and portions of other nearby units in 2020. The Complex destroyed nearly all infrastructure and amenities, which led to a public closure for nearly 2 years, displacing many would-be visitors, before reopening with restoration projects and temporary facilities to manage permitted day use [14].

Distinct from the direct role that daily temperatures and precipitation play on park visitation, protracted departures in hydroclimatic conditions, as realized through drought, can also affect outdoor recreation in variable ways by season and activity and may cause visitors to mitigate or adapt their recreation in response [15–17]. Some recreationists will continue to engage in coastal-dependent activities regardless of the conditions, while others will be displaced spatially to a different beach or coastal region, temporally to a different day or season altogether, topically to another activity not as dependent on coastal resources, or may choose to forgo the trip entirely [18,19].

Drought also indirectly affects outdoor recreation by impacting the vegetation, wildlife habitats, and scenic resources, as well as the likelihood of disturbances (e.g., wildfire) that may result in restrictions in certain activities, impacts to infrastructure, park closures, or degraded air quality [20,21]. The collective effects to scenery from ecological disturbance, such as that of tree mortality associated with drought, can also lead to visitor displacement [22].

As such, it is important to assess how visitation to CSP coastal units responds to drought (and wet) conditions across a hydroclimatic continuum, given the breadth of drought's impacts to landscapes and the recreational activities that rely on these places. The need for regional information over time has been emphasized as a need for visitor use management research [23]. The objective of this study was to assess across coastal regions how extreme drought or extreme wet conditions influence what types of parks people visit and whether day or overnight use is more effected. Our analysis depicts the influence of climate—particularly of abnormally dry or wet years—on visitation across a latitudinal gradient. We hypothesized that H1: visitation to state beaches is more sensitive to climate extremes than other coastal park units, and H2: that day use is more sensitive to climate extremes than overnight use.

## **2. Materials and Methods**

### *2.1. Selection of Coastal Units and Analysis by Type*

We assessed the impact of climate (drought and wet conditions) on the demand for recreational park visitation across a total of 123 units administered by CSP from 2001 to 2020. We first obtained the Monthly Visitor Attendance records from CSP, which contains estimates of day use and overnight visitation levels for units across the system based on entrance counts, reservation data, automated counters, and other methods [10]. Estimation techniques can vary considerably between beaches and coastal parks owing to

their different geographies and activity types, be it beaches, trail systems, parking lots, or campsites [24]. While previous studies have demonstrated the value of estimating use at the subunit level for regional park networks (e.g., Crystal Cove SP has six management units and is surrounded by other urban-proximate parks), we relied on data aggregated at the park level for comparability between units across the state [25].

Our next step was to analyze each year of the data compared with average monthly trends for different state beach and coastal park unit types, which helped us to reveal and remove anomalous years that were not due to extreme climatic conditions. In 2009 at the height of the great recession, Governor Schwarzenegger proposed full closures to 75% of parks across the system, though no parks were fully closed, and weekday closures of many parks resulted after much pushback. And in 2011, CSP faced a fiscal crisis embroiling the director for handling of the budget that resulted in full closures to 25% of CSP units, 12 of which were coastal. In spring of 2020, COVID-19 public health advisements led to the decision by Governor Newsom to fully close all state beaches and parks, including parking lots to prevent access and reduce the likelihood of super-spreading conditions. Use resurged with reopening of state beaches and parks in summer 2020, making it the highest use year on record. In the climate analysis that follows, we excluded these data to focus on the relationship between climate variability and visitation.

We then obtained publicly available GIS files showing boundaries for units of the CSP system [26] as well as the Coastal Zone Boundary for the State of California [27]. The Coastal Zone delineates the inland area from the shoreline that is subject to the laws and regulations associated with the California Coastal Act of 1976, which was passed to limit housing development and conserve the environmental resources and scenic integrity of coastline, as well as to preserve the public's right to coastal access [28]. The Coastal Zone Boundary is not a uniform distance inland from the shoreline given topographic and jurisdictional differences. Thus, when an overlay of the park units and the boundary were conducted, some parks that were near to the coast but not at all within the Coastal Zone were excluded from the analysis, while other parks that were contained in whole or in part of the coastal zone and provided coast access were included. Also, while there are CSP units in the San Francisco Bay, the area is excluded from the Coastal Zone Boundary, and therefore those units were not part of the analysis. The Coastal Zone is used as a proxy to assess coastal influence for direct beach access and ocean-dependent recreational activities, coastal scenery and viewing opportunities, dependency on coastal climate (e.g., endemic coastal flora), or a historical coastal-dependent location (e.g., fort, lighthouse).

## 2.2. Drought Analysis and Coastal Climate Regions

Drought remains challenging to quantify given the varied influences of precipitation amount, phase, timing, and evaporative demand, as well as the varied means through which these climatic factors influence resources [29].

We constrained the bulk of our analysis to the summer (June–August) Palmer Drought Severity Index (PDSI), given its widespread usage in the drought literature, ability to incorporate both supply and demand aspects of drought, lack of multi-scalar nature that lends to ease in use, and operational use in drought monitoring for longer duration droughts [30]. The PDSI is a standardized index based on water balance models of supply and demand that represents the severity of departure from normal soil moisture conditions. Negative values indicate dry conditions, and positive values represent wet conditions. Furthermore, many recent analyses of drought in California have focused on summer PDSI as a surrogate for capturing overall annual drought intensity in California, as PDSI contains information about precipitation supply over the previous 9–12 months (encapsulating the wet season) while also incorporating evaporative demand during the warm season [31,32].

Coastal climate regions were derived from the regional combination of CSP management district boundaries [33]. These district boundaries were compared with bioclimatic patterns derived from drought mapping analyses using monthly data collected at a network of meteorological stations throughout the state [34], along with traditional Climate Divisions used to measure PDSI [35], and ultimately reconciled with the variables the Coastal Commission uses to map coastal climatic patterns, including average high temperature, average low temperature, average annual precipitation, and the Köppen climate classification system [36]. PDSI for each coastal climate region was obtained from gridded climate data on a 4 km horizontal resolution grid [37]. We further sorted years into drought condition classes grouped by standard PDSI classification categories: extreme drought:  $\text{PDSI} \leq -3$ , moderate drought:  $-3 < \text{PDSI} \leq -1$ , near normal:  $-1 < \text{PDSI} < 1$ , moderate wet:  $1 \leq \text{PDSI} < 3$ , and extreme wet:  $\text{PDSI} \geq 3$ .

We used a composite analysis of monthly park visitation among the five drought categories to identify differences that reflect the resource conditions and managerial decisions across the geographies and structures of park units [9]. For each region and across the drought categories, we assessed the volume and timing of visitation and the percent departure in use from the annual mean to determine relative differences in use levels for (1) state beaches—day use, (2) state beaches—overnight use, (3) other coastal units—day use, and (4) other coastal units—overnight use.

### 2.3. Statistical Analysis

In order to test the hypotheses proposed (i.e., H1: visitation at beaches is more sensitive to climate extremes than coastal parks; H2: day use is more sensitive to climate extremes than overnight use), we conducted an inferential analysis consisting of a collection of linear models in which we evaluated the statistical deviations in visitation (either day use or overnight use) attributable to climate extremes, across different type of recreation units (i.e., state parks and state beaches). Our models followed the structure:

$$y = \beta_0 + \beta_1 C + \beta_2 R + \beta_3 M + \varepsilon$$

where the independent variable  $y$  corresponds to the reported number of visitors for each month/year/park. The dependent variables included in the model are  $C$ , which identifies the PDSI 5 category calculate for each year;  $R$  which denotes the region (Northern, North-Central, South-Central, Southern) where the park is located; and  $M$ , which indicates the month. The term  $\varepsilon$  represents the model error term, and  $\beta_0$  is the constant term. Our models were designed to evaluate the correlation between  $C$  and  $y$ , while controlling for regional and temporal differences via  $R$  and  $M$ .

Acknowledging the differences in the magnitude of visitation across recreation units and types of visitations, we normalized monthly visitation values such that they can be compared across recreation units and types of visitations. As such, for instance, the day use number of visitors to state parks follows  $\mu = 0$  and  $\sigma = 1$ . This is to say, for all models, the dependent variable has a mean equal to 0 and a standard deviation of 1. Overall, model 1 evaluates day use in state parks, model 2 day use in state beaches, model 3 overnight use in state parks, and model 4 overnight use in state beaches. Results are presented as the estimated mean effect of climate extremes on the normalized visitation. We estimated the model coefficients using the R 4.2 package ‘ggeffects’, and assign statistical significance to estimates featuring a  $p$ -value less than 0.1.

### 3. Results

#### 3.1. Visitation Trends

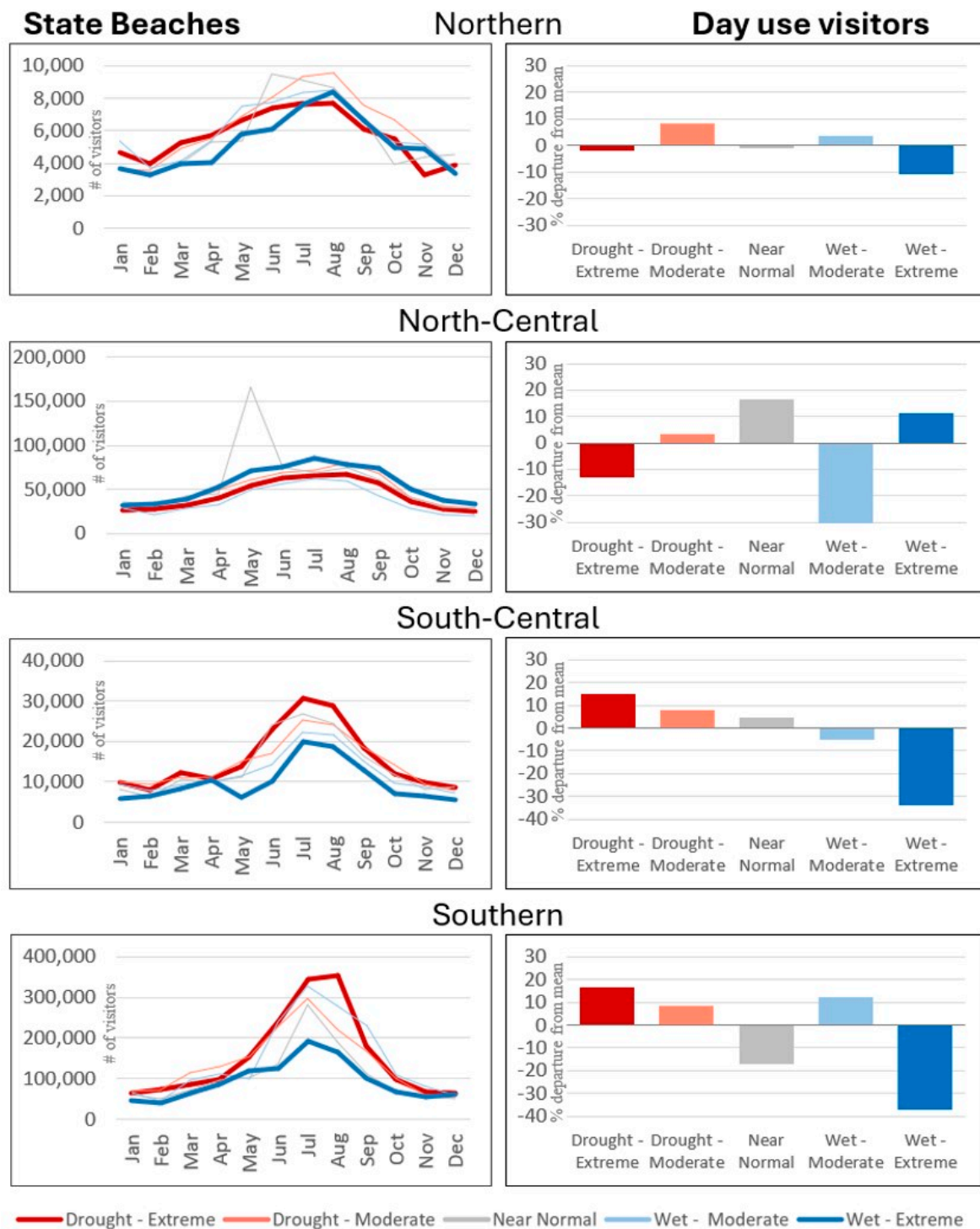
The Southern coast region incurs the most overall visits with 33.5 million people or 50.7% of overall coastal visitation annually. The region contains the Angeles, Orange Coast, and San Diego Coast administrative districts, with the Angeles incurring the most use of any CSP coastal district with 17.7 million people or 26.8% annual coastal visitors. Most of this use takes place on state beaches, many of which are in high demand from the surrounding metropolitan region and relatively few other non-coastal water access opportunities for the population in the region. The South-Central coast region has 7.8 million visitors or 11.9% of visitation along the coast annually. The San Luis Obispo Coast, Oceano Dunes, and Channel Coast administrative districts comprise this zone. Use at state beaches and coastal parks in this region is a mix between local beachgoers, those coming in from Bakersfield and the southern San Joaquin Valley, and pass-through tourism from travelers along the route between Southern and Northern California. Use in the North-Central region is predominately along the Santa Cruz and Monterey coasts and contains a slice of the Bay Area, that together receives 17.3 million visitors annually or 26.2% of coastal visits annually. The Northern region is the most rural coastal region with 7.3 million people visiting annually or 11.1% of coastal CSP use. This region includes the North Coast Redwoods and Sonoma–Mendocino Coast administrative districts.

The peak visitation season to state beaches and other coastal parks generally begins to ramp up in May, reaching high levels from June through August, and winds down through September. While these CSP coastal units are visited throughout the year, the expected higher temperatures and lower precipitation during the late spring, summer, and early fall months are most ideal for visiting the beach and other outdoor recreational activities at the coast.

There is generally a greater difference in visitation between extreme drought and wet years for state beaches than for other coastal units, indicating a greater sensitivity to conditions associated with beach use given exposure to environmental conditions when at the ocean. Overall, day use is relatively more sensitive to extreme drought and wet conditions than overnight use, given that day users can adapt their plans in real time, while the latter often requires trip pre-planning and reservations that max out available capacity months before conditions can be known.

#### 3.2. State Beaches—Day Use Visitation

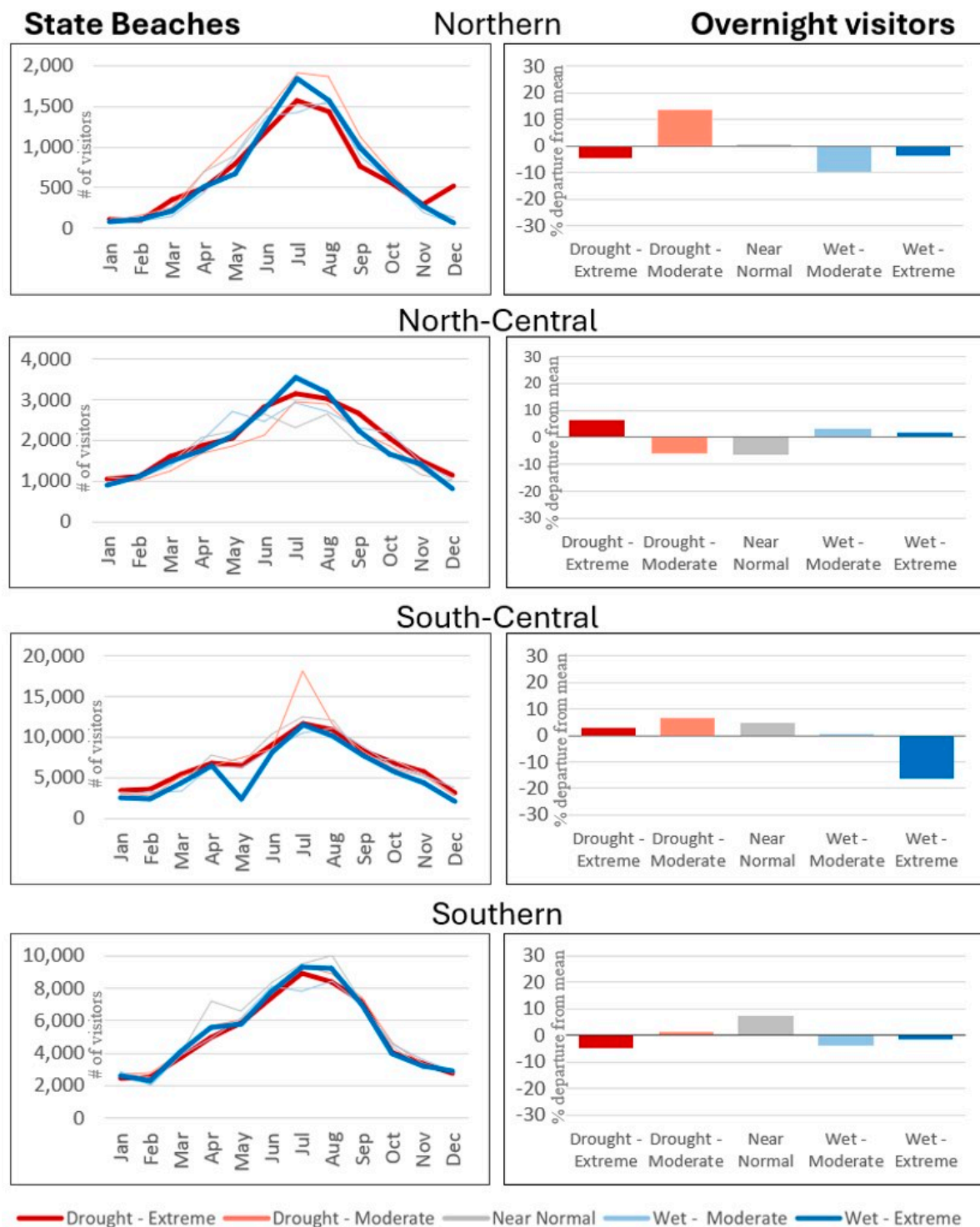
Extreme drought conditions are associated with an increase in the number of day use visitors to state beaches during the peak visitor season and throughout much of the year in Southern and South-Central coastal regions, leading to 16.2% and 14.7% more visitors compared to the annual mean for each region (Figure 2). Day use drastically decreases during extreme wet conditions, with −36.7% less visitors in Southern and −33.6% less visitors in South-Central regions. And in the North-Central region, day use at state beaches is less in drought years than in extreme wet years, which is due in part to coastal fires that have limited some access during drought years. In the North-Central coastal region, there are −30.4% less visitors during moderate wet years, the storm events of which can be hazardous when following years of drought, leading to flash floods and erosion of sections of highway and beach. Drought conditions are also associated with more day use visitors in the Northern coast region during winter and spring when compared to extreme wet conditions, though the relative difference is marginal given low use levels compared to other regions.



**Figure 2.** State beach day use visitation by region: mean monthly volume and timing (**Left**); percent annual departure from the mean by climate condition (**Right**).

### 3.3. State Beaches—Overnight Visitation

Extreme drought conditions showed relatively little influence on overnight use at state beaches (Figure 3). There was slightly more overnight use in the peak months of summer during extreme wet years. In the Northern coastal region, moderate drought is associated with a 13.4% increase in visitors throughout spring and summer. In the South-Central region, extreme wet conditions result in −16.0% less visitors on average annually, which is largely due to inaccessibility following spring storms when landslides can take out sections of the coast highway.

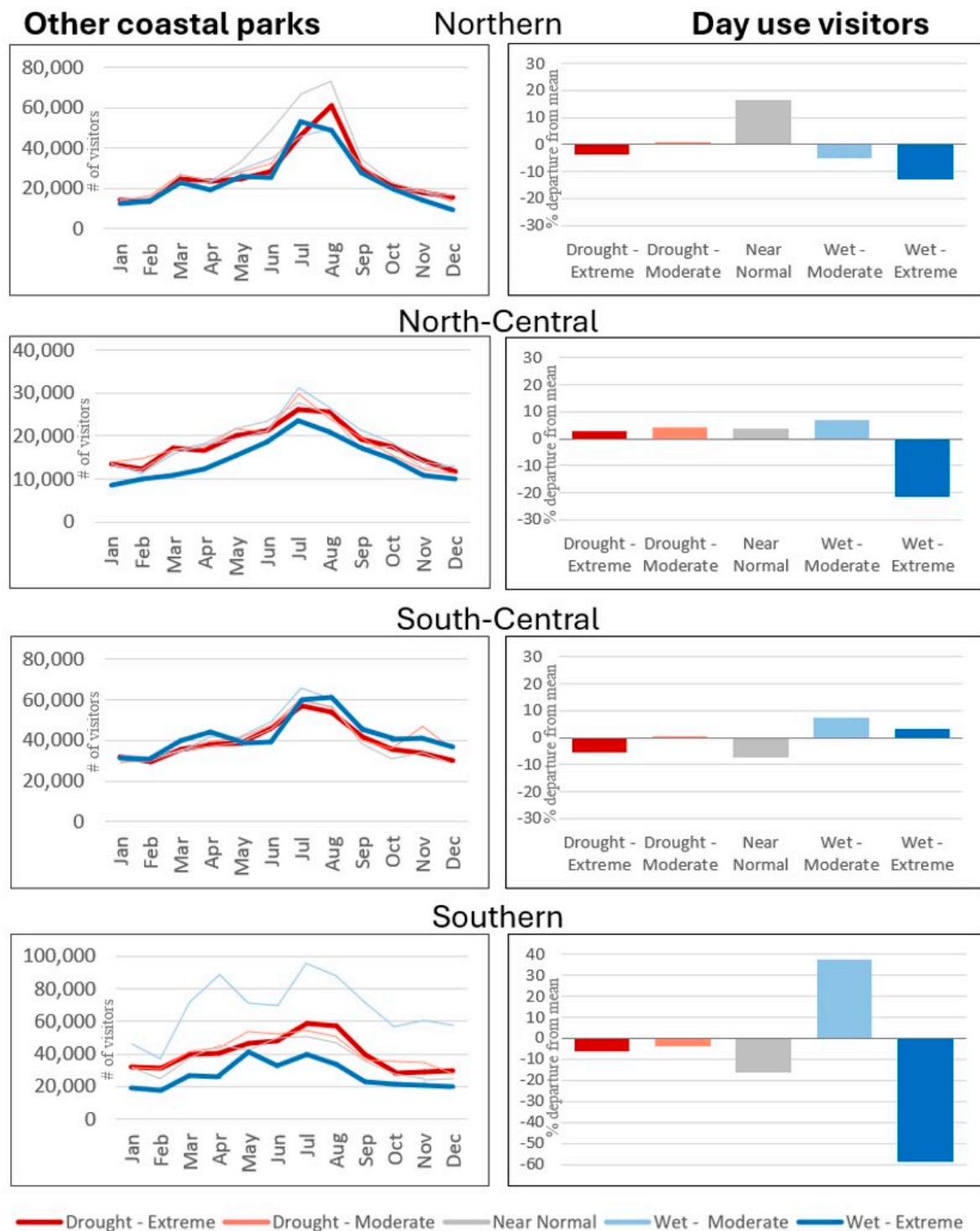


**Figure 3.** State beach overnight visitation by region: mean monthly volume and timing (Left); percent annual departure from the mean by climate condition (Right).

### 3.4. Coastal Parks—Day Use Visitation

Drought conditions, both extreme and moderate, had a minimal correlation with visitation to coastal state park units across all regions (Figure 4). Extreme wet conditions substantially decrease annual visitation by −58.5% less visitors to the Southern region and −21.4% less visitors to the North-Central region, and −12.8% to the Northern region. This is the result of access limitations following winter rain and flood events, which can cause landslides and tree falls and destroy infrastructure, posing risks for use in coastal areas

and upland forests. Additionally, in the Southern region, moderate wet conditions are associated with a 37.4% increase in annual use. This is directly tied to record visitation levels during super bloom years, which occur after several years of drought when conditions are not too wet for parks to be accessible.

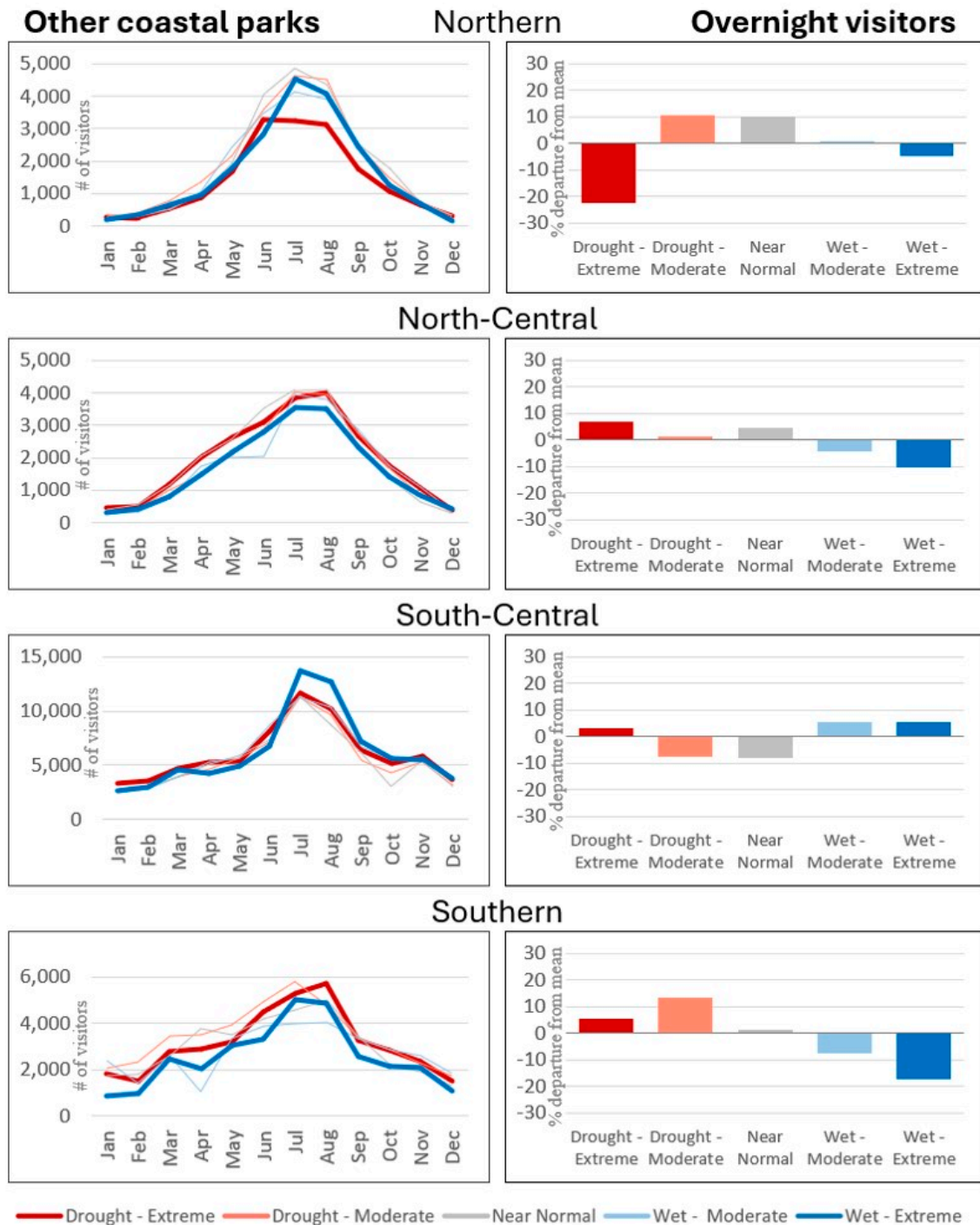


**Figure 4.** Other coastal state park day use visitation by region: mean monthly volume and timing (Left); percent annual departure from the mean by climate condition (Right).

### 3.5. Coastal Parks—Overnight Visitation

Extreme drought conditions substantially limit overnight use at coastal parks in the Northern region during peak season, reducing annual visitation by  $-22.4\%$  from the mean

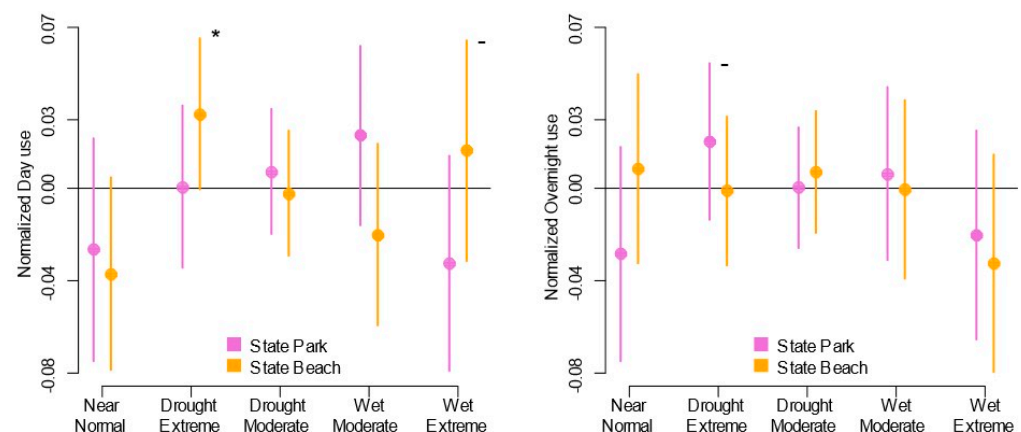
(Figure 5). This is counter-intuitive for an area typically very wet that would ostensibly be more accessible if drier but can be attributed to displaced use due to the coincidence of wildfires and resulting smoke along the north coast during these drought years. Also notable is  $-17.2\%$  less overnight use of coastal parks during extreme wet years, and this is due to access restrictions associated with winter storms, flooding, and hazards that have a disproportionate effect on overnight use with damage to campground infrastructure and amenities requiring further resources than opening parks to day use.



**Figure 5.** Other coastal state parks' overnight visitation by region: mean monthly volume and timing (Left); percent annual departure from the mean by climate condition (Right).

### 3.6. Statistical Tests

The results, shown in Figure 6, indicate (1) climate extremes on state beaches tend to be associated with higher day use with respect to ‘near normal’ years; however, such a difference is significant only during extreme drought ( $p$ -value = 0.010) and barely significant during extreme wet years ( $p$ -value = 0.098). (2) Climate extremes also tend to be associated with slightly higher day use in state parks (except for wet extremes); nevertheless, in any case, such differences are significant. These two results indicate that, although climate extremes show higher levels of day use, only state beaches manifest a significant effect of extremes on day use visitation. As such, these two results provide statistical evidence in support of H1: that visitation to state beaches is more sensitive to climate extremes than other coastal park units. In contrast, overnight use in state beaches tends to be lower than what is expected during ‘near normal’ years, especially in extreme wet years. Notwithstanding, the effect of climate extremes on overnight use in state beaches is not significant. For state parks, overnight use is frequently higher during extremes than ‘near normal’ years but is not significant, except for extreme drought years that are barely significant ( $p$ -value = 0.095). These last two results indicate that overnight use is in general not affected by climate extremes. Overall, the results indicate that there are some significant effects of climate extremes on day use, but strong differences are not found on overnight use. Further to this, while we observe a significant correlation with respect to climate extremes and state beaches (particularly during drought extremes), for state parks, we do not observe strong evidence of shifts in visitation attributable to climate extremes. This supports H2: that day use is more sensitive to climate extremes than overnight use.



**Figure 6.** Estimated mean shifts in visitation to state parks and state beaches attributable to mean climate extremes. **Left panel** shows estimated coefficients for normalized day use, and **right panel** shows estimated coefficients for normalized overnight use. Note that the 0 horizontal line corresponds to the mean normalized visitation; as such, coefficients are measured in units of 1 standard deviation from the mean normalized visitation. Circles indicate the mean effect, and vertical bars the 95% confidence interval of estimation. Each climate extreme estimation is measured relative to a baseline level corresponding to ‘near normal’. Significant differences in the comparisons are displayed to the right of each bar with  $p$ -value < 0.05 shown as ‘\*’, and 0.1 shown as ‘-’.

## 4. Discussion

This research shows that the effect of extreme drought and wet years on beach and coastal park visitation varies by coastal region, season, and type of use—day or overnight. California drought corroborates this variability, noting that droughts and associated hazards have the potential to affect recreational values of landscapes year-round, but in context-specific ways, which may be perceived differently by those pursuing different activities or with varying experience [38,39]. Yet, among the different contexts of parks and beaches

with varying use levels, geography, and climate, some patterns emerged from our investigation that are useful for further research and managerial consideration. These points are important as more people access the coast and as the climate continues to fluctuate in ways further deviating from the current average, toward years of more extreme drought, years of more extreme wet conditions, and with volatile swings between hydroclimatic regimes that can create hazard-prone coastal landscapes (e.g., as seen with the Los Angeles area fires in January 2025 when wet years that lead to fuels build up are followed by extreme dry year with increased risk of fire) [40].

Variability in climate between one year and the next can result in unanticipated effects and novel tourism patterns, particularly in drought-adapted and sensitive ecosystems [41]. One such case is with the November 2018 Woolsey Fire that burned more than 150,000 of the Santa Monica Mountains through several coastal state parks and led to highway and beach closures. The fire had occurred during drought conditions, but the nutrient-rich soils it left along with moderate winter precipitation (importantly on the heels of the drought-stressed environmental conditions) resulted in a superbloom the following spring in 2019 [42]. While the opening of the state park and the superbloom were celebrated as a sign of nature's recovery, the high volume of people that visited during the ecological-sensitive conditions that year was particularly concerning given the potential for soil compaction and vegetation loss in a recovering post-fire landscape. Environmental hazards such as wildfires, flooding, and landslides can partially or fully impede park access by closing off highway access and restricting movement within park boundaries and have the potential to pose safety risks that managers must anticipate [20].

The issues related to climate variability require adaptive management of the coastline. Drought conditions can lead to 'socio-economic droughts', triggered by severe water supply shortages in destinations and the unequal distribution of water resources between rural and urban users, leading to unequal exposure between residents and tourism interests [43]. In terms of environmental exposure, heavy precipitation and storms can exacerbate the regression of shorelines. The sea level rise and beach erosion can significantly decrease the capacity of coastal areas to accommodate the potential tourism demand, as demonstrated in the case of the Catalan Coast in the Mediterranean region [44]. In response to such challenges, studies on adaptation and the carrying capacity of beaches and coastal protected areas should consider various climate scenarios. Additionally, it is crucial to consider that, at a longer term, climate variability can encourage a redistribution of tourism flows to destinations with more favorable climate conditions as would-be visitors self-displace over time [45]. This is especially relevant in destinations affected by heat waves, which can reduce environmental quality and attractiveness due to unbearable heat and humidity [46].

Studies generally show that warmer temperatures expand the seasonal range for warm weather recreation opportunities in cooler climates, as well as increase demand for water-based recreation, especially on hot days [47–49]. Previous studies also have found that daily or monthly precipitation affects patterns of visitation, with visitation generally declining with more precipitation [50,51]. Visitors can be discouraged by rain, or the conditions can create hazards that cause damage and limit park access. One such event was the winter rain and windstorms that occurred throughout northern and central California in 2017. These conditions contributed to landslides along the Pacific Coast Highway and erosion of coastal roads, perhaps most famously with the collapse of the Pfeiffer Canyon Bridge, making it not possible to access much of the North-Central coast of Big Sur. The visitor infrastructure like parking lots and coastal walkways were destroyed, which limited people's ability to access the coast and led to maintenance backlogs at the park units [52]. There was also below-average visitation in 2017 following intense winter storms that caused great damage

to beach and park infrastructure and led to landslides and eroded sections of the Pacific Coast Highway.

The emergency closures associated with hazards pose challenges for visitor movement—including ingress and egress, as well as communication with current and upcoming visitors. Hazard closures have an economic impact on gateway communities that are dependent on seasonal tourism to keep lodging, restaurants, and other businesses open [53]. The timing of closures—weekdays vs. weekends—have different impacts on visitation that may affect revenue unevenly given that half of all visits (48%) to California beaches occur on weekends [5]. Further, weekend closures may have a greater impact on those living farther away from coastal destinations, who rely on weekends for further drives [54] and are more likely to rely on overnight accommodations. Moreover, the impacts that arise from administrative closures and displaced use—e.g., relative crowding levels, maintenance backlogs, local business shortfalls—may be perceived differently among stakeholder groups, both for locals who experience the impacts more routinely and for longer durations, and for out-of-towners who may not be aware of new reservation systems or encounter unexpected conditions [55]. The economic value of public beach access is expected to grow as the share of the population that can afford to go on vacation increases and visitor capacity limitations to scarce coastal resources results in greater demand for visitation than available supply [56]. This is especially the case in urban-proximate and already high-use coastal destinations, and as changing climatic conditions of more extreme but fewer winter precipitation events and prolonged drought conditions drive demand for water-dependent recreation and coastal access in summer months [47].

Beaches and coastal parks are job-creators and revenue-generators for local economies with more than 850,000 jobs created directly or indirectly and USD 14 billion generated from overall beach use across the state (USD 26.5 billion in 2024 dollars) [57,58]. Beyond the market value generated by concession stands, paid parking lots, and waterfront restaurants, an additional USD 2 billion in non-market value (e.g., the value of different uses, like surfing, swimming, or sunbathing) is generated through access to state beaches and coastal parks in California [59]. The market value for what beachgoers would spend if California's beaches were not available for public access is estimated to be USD 3.1 billion with travel to other states (USD 5.8 billion in 2024) and USD 2.4 billion with travel outside the United States (USD 4.5 billion in 2024) [58,60]. Closures have a disproportionate economic impact during all days of the peak summer season and on weekends when coastal destinations receive the most out-of-town tourism and generate revenue for local improvements through transient occupancy taxes, while weekday closures can be most impactful to local access.

Beach closures also pose challenges for maintaining equitable access. In general, wealthy, white, and older residents of California live closer to the coast than other groups [61]. These coastal residents may be able to more easily adapt to beach closures by finding an alternative than those living inland who must drive farther to any beach and might not be aware of closures. However, sea level rise is expected to accelerate erosion wherever hard structures are built along the coastline, and this passive erosion threatens to not only limit access but to reduce the extent of beach available for recreation and ecological use [62,63]. The disparities between coastal residents and those who visit the beach from inland could be further stressed by shoreline management practices that prioritize protection of existing structures (infrastructure and private property) over preservation of natural beaches with public access [64].

Results showed that day use was generally more responsive to the influence of climate than overnight use, especially for state beaches that include water-dependent recreational activities. The availability of infrastructure and facilities for overnight use is much more limited in capacity than day use, and in hedging for this limited availability most overnight

users book their overnight state beach and park reservations many months in advance. This poses challenges for managers when would-be visitors do not show up and fail to cancel their reservation thereby limiting availability for other potential users. The California Legislature has attempted to remedy this with the passage of AB 618 (2023) that permits CSP to impose penalties for no-shows, including fines and revoking reservation access after multiple failures to cancel [65]. The availability of affordable public overnight use (e.g., camping, cabin, and RV) at state beaches and parks is increasingly important as hotel rates at coastal destinations increase and put overnight stays near the shoreline out of reach. This issue has begun to be addressed with AB 250 (2017), pursuant with Coastal Act Section 30213 that requires lower cost visitor and recreational facilities, through bonds authorized for the CSP system to expand and build new campgrounds and other accommodations [66]. However, lower cost coastal lodging remains a vexing issue in California, with high housing prices, lack of investment in affordable accommodations or new housing typologies (e.g., portable cabins and modular container housing, floating houses and campgrounds), and the transportation costs and accessibility issues (e.g., expensive parking rates, limited park spaces, insufficient public transit) that need to be addressed to facilitate equitable public coastal access [67].

Climate and policy have implications not only for the timing and volume of use of state beaches and coastal parks but also for how the benefits of that use are valued and change over time [56], be it with business income, tax revenue, non-market value, or personal well-being, and even non-use existence value [68]. Most Californians (77%) see the condition of beaches and the ocean as very important to the quality of life and future economy of California, while 71% of the state's residents are very or somewhat concerned about the effects of climate change on coast access (i.e., sea level rise) [69]. These beliefs are underpinned by psychological understandings of the value of beaches that are situated in previous experience [70] and that are linked to environmental conditions, be it weather, environmental quality, or perceived restorativeness of the ocean [71]. While some state beaches and coastal parks have comparable settings and activities with other units, people have a great affinity for specific beaches or coastal parks, making it difficult to substitute the value of experiences between different units or regions that have varying levels of use, resource conditions, in-park amenities, and local community context [72]. These insights build upon those of Bombana et al., 2023 [73], who recognized varying degrees of sensitivity to changing climate conditions between locals and foreign visitors. In their study, local visitors showed a higher tolerance for temperature increases likely due to their familiarity with the local climate, compared to foreign visitors, who were more selective about their preferred temperature ranges. As drought conditions and associated disturbances become more common and as wet extremes and sea-level rise continue to threaten infrastructure and access, so too will the value that people derive from use of beaches and coastal parks change in highly contextual ways.

## 5. Conclusions

The results show that visitors to state beaches are overall more sensitive to differences in extreme drought and wet conditions than those to other coastal state park units, and that day users are generally more responsive to differences in climate than overnight users.

The number of visitors to state beaches and other coastal park units differs by coastal region and over time by unit type. Yet in addition to beach-specific factors that directly influence demand and capacity, it is also important to appreciate the contingency relations between state beaches and coastal parks (e.g., impact associated with climate conditions and hazards, including ecological and scenic effects, infrastructure repair costs, and closures at a small number of high-use units that have a disproportionate effect on system-wide

attendance). Hence, even local interventions can have system-level effects that are immediate and moreover can become long-lasting as their impacts become codified within individuals' experiences and memories in such a way that they impact future expectations and decisions. As drought and more extreme conditions become more common, so too will visitors become more familiar with the potential effects of hazards on recreational access for their preferred activities.

Managers must be prepared to adapt to changing and variable conditions to mitigate future climatic impacts on visitation to state beaches and coastal parks. Restoration projects, infrastructural improvements, and management strategies that address differences in visitor behaviors and provide equitable access to recreational areas are imperative to addressing user capacity and avoiding impacts to beach and coastal landscapes. Since many beachgoers carry their own expectations of seasonality and preferences for crowding, effective communication approaches must be developed that allow those planning trips to anticipate potential conditions that they will meet, thereby allowing them to choose their own adaptation strategies or alternative experiences.

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