Recreation Use and Human Valuation on the Nature Reserve of Orange County, California

Project Progress Report and Data Collection Summary

Recreation Ecology Lab at USU

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Mountain bikers at the Borrego Canyon Trail, Whiting Ranch Wilderness Park
Photo by Abigail Sisnero-Kidd

ON THE COVER
A busy day at Top of the World
Photo by Abigail Sisnero-Kidd

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Project Progress Report and Data Collection Summary

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Executive Summary

Outdoor recreation, in its many forms, provides a wide range of personal, societal and economic benefits. In an increasingly urban society, participation in some form of outdoor recreation is one of the primary ways people interact with and experience nature. These benefits and experiences are highly valued, and nearly 50% of the Americans participate in them on a regular basis. Providing these opportunities, and maintaining ecological integrity in parks and protected areas, is an ever-present management challenge, particularly in parks next to large urban populations.

This report summarizes the first phase of a multi-year visitor use and valuation study on the Nature Reserve of Orange County, California (Reserve). The project was initiated in 2017 after a scoping process with protected area managers documented numerous concerns about the visitor experience and ecological conditions in the Reserve. In response to these concerns, this study was developed to gain a fundamental understanding of the visitor experience, identify the spatial extent and location of visitor activities, measure the current status and future potential for ecological disturbance tied to recreation use, and assist managers in developing future monitoring and management strategies to better accommodate visitors and protect sensitive natural resources.

Our initial data collection in 2017 and 2018 employed a standard-design visitor-intercept questionnaire that measured basic demographics and visitor motivations; and included volunteer GPS tracking to understand spatial aspects of a visit. Data were collected across 10 park locations currently under high demand for recreation use. On the Reserve, visitors reported participating in a wide range of activities—with hiking/walking, mountain biking, running and nature appreciation most popular. Overall, visitors to areas in the Reserve were more likely to identify as white, and reported higher levels of education than the general population of Orange County—although some locations tended to attract a more diverse recreation population than others.

A detailed analysis of visitor motivations revealed that nature immersion/appreciation and exercise were primary reasons for visiting the Reserve, and that visitors were highly place attached, with a slightly stronger emotional connection (place identity) compared to a functional attachment (place dependence). Across all activity types, visitors report a high degree of satisfaction in their ability to realize the primary motives for their visit. The spatial extent of visitor use varied significantly by location, but most areas had focused sites with intense use, while some visitors traveled across several Reserve units in a single visit. In particular, mountain bike visitors exhibited the largest spatial extent of use across user groups. Bikers that used the Strava app to track and post their visit tended to travel at higher velocities, on average. Lastly, although approximately 35% of visitors did travel through coastal cactus wren and coastal California gnatcatcher habitat at some point during their visit, the total duration of this interaction was just 1.2% to 4% of their visit, with more visitor activity occurring in specific locations unoccupied by these species.

These research findings suggest that maintaining a natural setting is essential in the future provisioning of outdoor recreation on the Reserve, and that a suite of experience indicators developed during this study may be an effective tool for future monitoring. Several possible management challenges exist—for example, the high velocities of mountain bike activities and the spatial overlap of visitors and sensitive resources—but the significance of these issues, both biological and experiential, is still unclear. Future work will help us to understand the quality of ecological conditions in select locations, and the levels of acceptability for visitors to specific resource and social conditions.

Acknowledgements

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Introduction and Background

Nestled between the urban centers of Los Angeles and San Diego, Orange County, California is the third most populated county in the state, and the sixth most populated county within the entire country (United States Census Bureau, 2018). Orange County occupies 790 square miles and is home to approximately 3.2 million residents (United States Department of Commerce, 2018). Despite its high population density (approximately 4,036 people per square mile), Orange County also contains a highly interconnected network of open space lands, set aside for protection and conservation of wildlife and critical wildlife habitat—collectively referred to as the Nature Reserve of Orange County (Reserve)—(Natural Communities Coalition, 2018). Reserve lands in Orange County contain 13 major vegetation types, including coastal sage scrub, which provides habitat for the coastal California gnatcatcher, a species federally designated as "threatened" under the Endangered Species Act (R. J. Meade Consulting, 1996). Other dominant habitat types protected by the Reserve system include chaparral, grassland, riparian, oak woodland, cliff and rock, and Tecate cypress forest. In addition to the coastal California gnatcatcher, these areas provide habitat for species of concern, including coastal cactus wren and orange-throated whiptail, as well as several birds of prey, large mammals including coyote, gray fox, bobcat, and mountain lion, and various reptile, amphibian, and plant species (R. J. Meade Consulting, 1996). In addition to protecting and conserving these species and their habitats, these Reserve lands provide highly sought-after recreational opportunities for residents of and visitors to Orange County.

The management of nature-based recreation activities is an ongoing challenge. Recent reports suggest outdoor recreation continues to grow, with over 146 million people in the US participating in different forms annually, resulting in 10.9 billion recreational outings (Outdoor Industry Association, 2018; Cordell, 2012). Much of this activity occurs in urban-proximate wildland settings (Kyle & Graefe, 2007). These locations are often highly visited as people in an increasingly urban society seek opportunities to experience nature for exercise and renewal— often on a daily basis. Consequently, the demand for access and participation in a range of recreation activities is often exceptional in urban-proximate locations. These issues raise concerns as to whether other protected area goals are being compromised by recreation activities—such as the conservation of habitat for plant and wildlife species. Managers of urban-proximate wildland settings often must strike a careful balance between providing nature-based recreation experiences and the maintenance of ecological integrity.

A large body of research documents the social and ecological impacts of recreation in parks and protected areas (Hammitt, Cole & Monz, 2015; Manning, 2011; Monz et al., 2010). Activities such as hiking and mountain biking inevitably result in impacts to both biotic and abiotic components of protected areas—soil, vegetation, wildlife, water, air, and soundscapes. The degree of the impact (or environmental change) depends on the characteristics of the recreation use and associated behaviors, such as duration of a visit, season of visit, activity type, and frequency and distribution. While recreation results in ecological impacts, research has also documented numerous benefits to individuals, such as benefits to mental and physical health, personal growth, improved perception of quality of life, as well as society (Driver, 2008; Manning, 2011, Thomsen et al., 2018). On a societal level, outdoor recreation is associated with improved community satisfaction, economic development, and improved environmental conditions, including contribution to local and large-scale conservation efforts (Vagias, Powell, Moore, & Wright, 2014).

Understanding how to manage ecological impacts caused by recreationists requires understanding how visitors move through an area (their spatial patterns) their motivations, and how these motivations may be influencing behavior. Visitor motivations have been studied since as early as the 1950s. Much of the

research on visitor behaviors has focused on *why* visitors engage in outdoor recreation activities in particular settings (Manning, 2011). Results suggest that visitors often have multiple motivations for engaging in recreational endeavors, and these motivations tend to be influenced by the activity they are participating in, their location, and the potential benefits that might be derived from the experience (Driver & Brown, 1978; Haas et al., 1980). Research on visitors spatial behavior patterns shows that while most visitor behaviors tend to be concentrated at popular destinations (viewpoints, mountain summits, lakes) and along routes to these locations in a "node and linkage" pattern (Manning, 1979), dispersed visitor use (use outside designated destinations areas or trails) also occurs (e.g. D'Antonio et al., 2013). Dispersed use, in particular, can result in significant impacts to park and protected area resources (D'Antonio & Monz, 2016). Spatial patterns of recreation have historically been understood through the use of visitor observations, questionnaires and paper map diaries (Park et al., 2008; Hallo et al., 2012). More recently, improvements in technology have resulted in a shift to GPS-based methods, where researchers ask visitors to carry GPS units during their visit, and then aggregated and analyze patterns in visitor GPS "tracks" (Hallo et al., 2012; D'Antonio et al., 2010).

Given the widespread and varied participation in outdoor recreation in the U.S., managing use in a sustainable manner is often a significant challenge. Continuing increases in visitation have the potential to degrade the quality of the recreation experience through crowding, conflicting uses, and the aesthetic implications of resource impacts (Manning, 2011). Ultimately, outdoor recreation/tourism must be managed to ensure that it is sustainable, and managers must ask to what extent we can use protected areas before unacceptable impacts to natural resources and the quality of the visitor experience occur.

To begin answering this question as it relates to Reserve lands in Orange County, this project was initiated at the request of the Natural Communities Coalition (NCC). In fall 2015, we began the initial process to inform a potential long-term study of recreation use, impacts, and values on the collective lands of the Nature Reserve of Orange County. The goals of the study were to determine use levels, types, intensities, and spatial distributions of visitors, and to monitor these patterns over time. We wanted to understand various aspects of the visitor experience (including visitor perceptions, characteristics, and motivations for recreation), as well as assess the condition of biophysical resources on Reserve lands—including possible biodiversity responses to use—in order to provide a comprehensive picture of recreation impacts. This information could then be used to inform park planning and management efforts relative to providing opportunities for recreation without compromising conservation goals (Monz & D'Antonio, 2016).

This report provides a summary of ongoing research into the multiple aspects of outdoor recreation use on Reserve lands. Specifically what follows are key findings from data collection efforts in 2017 and 2018 that examined visitor use levels, spatial distributions of visitors and visitor experience dimensions. Detailed results and additional analysis not presented in the main body of this report are provided in a series of appendices.

Methods

Understanding how visitor use patterns and visitor motivations may be affecting conservation goals on Reserve lands requires the use of interdisciplinary research methods. This study utilized a combination of spatial analysis, social science, and recreation monitoring techniques, described in detail below (Table 1).

Table 1. *Data collection methodology, sampling approach, and year sampled for 2017-2018 data collection efforts*

Method Type	Information Need	Data Collection Method	Sampling Approach	Sampling Year
Visitor Use Estimation	Parking lot accumulation	Observational counts	Hourly counts during sampling period	2017
	Use levels on trails	Automatic trail counters	Continuous on sampling days*	2017 and 2018
Social Science	Visitor access, behavior, and movement	GPS-based tracking	Random sample of visitors on sampling days	2017 and 2018**
	Visitor experience	Quantitative post-experience surveys	Random sample of visitors on sampling days	2017 and 2018

*Sampling strategy differed slightly for each location in 2017 and 2018. In 2017 each Reserve unit was sampled on three different days throughout the sampling period, whereas in 2018, each Reserve unit studies was sampled for a continuous 4-5 day block.
**2018 GPS-based sampling only occurred with mountain bikers.

Study Sites

As an outcome of project scoping work, ten individual Reserve units were selected as a high priority for recreation assessment. The initial sampling of visitors occurred in May and October of 2017 (Table 2). Recreation opportunities within these Reserve lands range from beachfront ocean access with opportunities for surfing and other watersports, developed front-country and backcountry camping (Crystal Cove State Park only), to areas with multi-use double and single-track trails for pedestrian, equestrian, and mountain-bike use, paved trails, restroom facilities, and picnic areas. Additionally, these lands contain critical wildlife habitat. In 2018, we selected six units that had experienced the greatest diversity of user types and highest use levels throughout the 2017 study period for a second round of sampling.

Table 2. *Sampling Locations with Unit Abbreviations and Dates Sampled*

Sampling Location	Abbreviation	Dates Sampled 2017	Dates Sampled 2018
Peters Canyon Regional Park	PECA	May 3, 19, 21	May 5-8
Top of the World (Laguna Coast Wilderness Park)	TOWO	May 4, 25; Oct 7	May 24-29
Nix Nature Center/Willow Staging Area (LCWP)	NINA/WILL	May 5, 15, 20	Not Sampled
Irvine Ranch Open Space	IROS	May 6	Not Sampled
Aliso & Wood Canyon Wilderness Park	ALWO	May 9, 14, 26	May 24-29
Bommer Canyon	BOCA	May 10, 22, 27	Not Sampled
Whiting Ranch Wilderness Park*	WHRA	May 11[a], 17[b], 28[c]; Oct 8[a,b], 10[c], 12[a]	May 10-15
Pacific Ridge Park (Laguna Coast/Crystal Cove)	RIPA	May 12, 29; Oct 15	May 17-22
Black Star Canyon Gate	BLST	May 13	Not Sampled
Crystal Cove State Park—Moro Canyon	MORO	May 18, 23; Oct 14	May 17-22

* Multiple trailheads were sampled at Whiting Ranch Wilderness Park.
[a]Sampling location: Borrego Canyon Trail Entrance at Market Street.
[b]Sampling location: Serrano Creek Trail at Wahoo's Fish Tacos parking lot entrance.
[c]Sampling location: Glenn Ranch Road Entrance.

Data Collection and Analysis

Sampling strategy

Sampling for the 2017 data collection took place between May 3-29 and October 7-15, during periods of highest recreation visitation. Visitors to the Reserve units included in the study (Table 2, Fig. 1) were randomly sampled for participation on three separate sampling days, stratified to include both weekends and weekdays (Table 2). Groups were solicited for participation from park opening hours (which varied between each unit from 6am to 8am daily) to two hours before park close (which varied between each unit from 5pm to dusk) to allow for sufficient time for return of GPS units. During 2018, in order to understand visitor spatial behavior and recreation experiences in greater detail, visitors to six Reserve units with the highest visitation were randomly sampled on five separate sampling days, including both weekend and weekday days. Visitor use estimation and social science methods were conducted at all sampling locations.

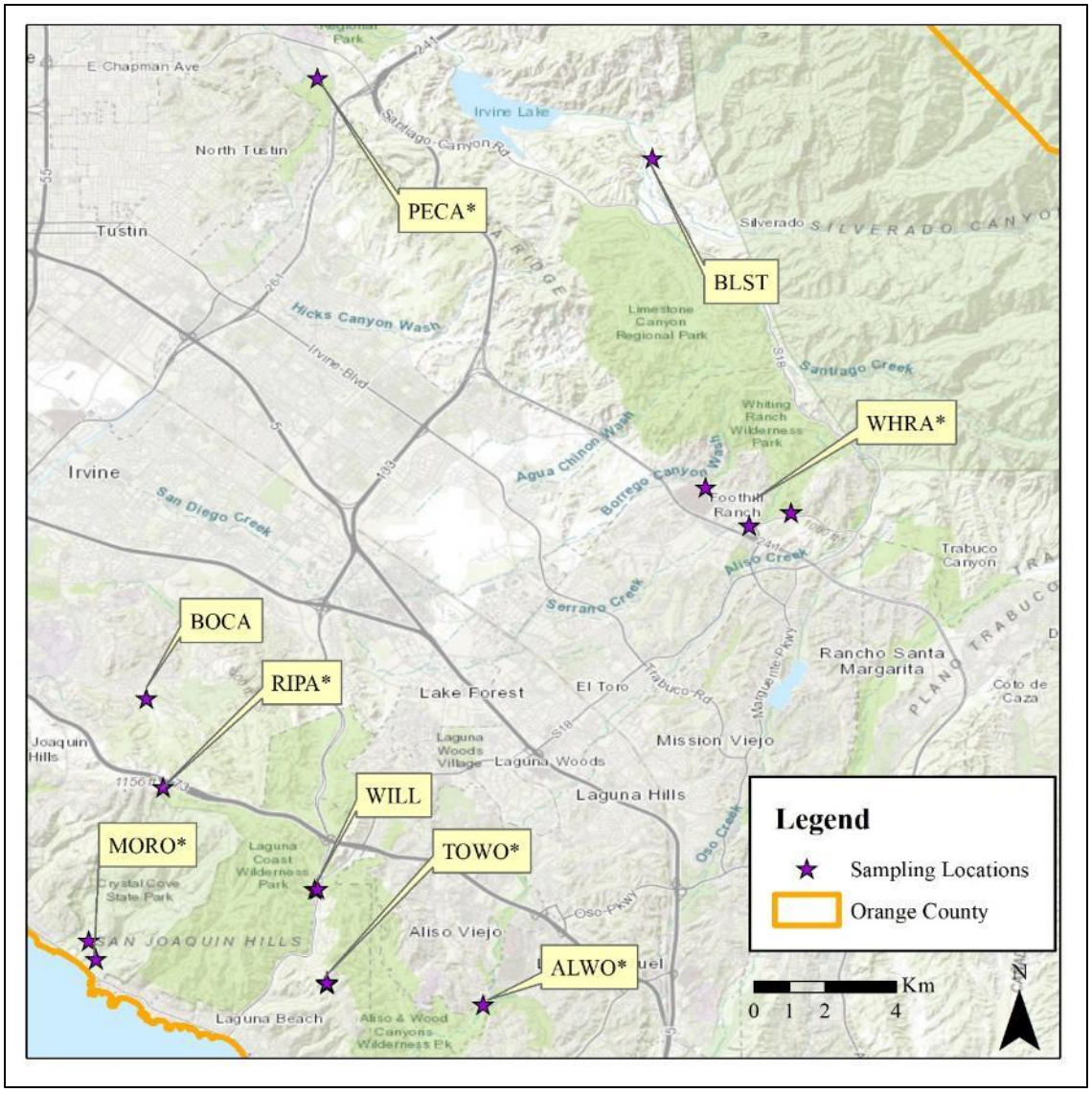

Figure 1. *Sampling locations with location abbreviations (refer to Table 2 for abbreviation descriptions). Locations with an asterisk were sampled in both 2017 and 2018.*

Visitor use estimation methods

During the sampling periods, visitor use levels at each trailhead were collected by installing TRAFx automated trail counters at each trailhead on sampling days. In 2017, parking lot use data was also collected for each location. This data consisted of hourly counts of the number of cars present in designated parking lots for each sampling location, as well as parking that occurred on adjacent city streets or other "undesignated" parking areas where applicable. Infrared automatic counters were used at trailhead locations to estimate total visitor use at that location. During data collection in both 2017 and 2018, at the start of each sampling period, a TRAFx brand automatic counter was placed at the trailhead of the study site for that day to estimate use during that sampling period (TRAFx Research Ltd., Canmore, Alberta, Canada). At the end of the sampling period, the automatic trail counter was removed. A high-accuracy Trimble GPS unit was used to map the location of each TRAFx counter. Counter data

from all the sampling periods at each study site were aggregated and average use across a day was calculated for each counter location (see results in Appendix A). Calibration techniques were utilized in the field to estimate counter error. Calibration involved a researcher taking manual counts of the number and travel direction of visitors passing the counter for four separate one-hour blocks where at least one visitor passed the counter every 15 minutes (Pettebone et al., 2010).

Social science methods

GPS-based tracking

Multiple studies from recreation literature have demonstrated that GPS-based tracking techniques are an accurate measure of visitor behavior and use patterns in outdoor recreation settings. As part of this study, during each sampling period, a random selection of visitors was asked to voluntarily carry a GPS unit during their recreation visit. In 2017 all activity types (hikers, bikers, runners, etc.) were asked to participate in the GPS-tracking portion of the study. In 2018, only visitors on mountain bikes were asked to carry GPS units in order to better understand the spatial behavior patterns of this particular group.

Visitor groups were intercepted at the main trailhead access point for each Reserve unit by a graduate student researcher, and asked to voluntarily participate in the study by carrying a Garmin eTrex 10 GPS unit (Garmin International, Olathe, KS, USA) during their recreation experience to collect data on visitor spatial behaviors. Upon their return to the trailhead, visitors were asked to complete a survey administered via iPad tablet device to collect descriptive data on visitor demographics, motivations, experience use history, knowledge, and other variables (see details in survey section below). One visitor per group (the visitor with the next birthday who was 18 years of age or older) was asked to carry a GPS unit and complete the survey. Unique alphanumeric identifiers were generated for each visitor group and recorded along with the time the group left, group size, and any other pertinent information (such as if the group was walking a dog, or anticipated destination). No personal identifying information was collected as part of either GPS or survey administration. GPS units recorded visitor tracking points at 15 second intervals, standard for pedestrian use in parks and protected areas (D'Antonio et al., 2010; Kidd et al., 2015). Standard calibration techniques (see D'Antonio et al., 2010 and Kidd et al., 2015) were used to determine GPS unit positional error. All GPS units deployed were recovered, resulting in no loss of GPS units during the course of the study. The GPS tracks of the visitors were aggregated then brought into ArcGIS as point data, and densities of visitor use were calculated. These densities represent locations where more (darker areas on maps) or less (lighter areas on maps) GPS tracking points were located. Areas of high densities can represent locations where many visitors recreate, where visitors often slow down (such as very steep slopes) and also where a few visitors spend a very long time).

Visitor surveys

The questionnaire used during the 2017 sampling season was designed to understand basic visitor information such as type of activity visitors participated in, history and frequency of recreation use, visitor demographics (including age, gender, level of education and zip code or country of residence), as well as knowledge of reserve values, visitor place attachment, and motivations for visiting the Nature Reserve of Orange County lands. Visitor motivations were assessed using a suite of 37 questions derived from the Recreation Experience Preference scale commonly used to understand motivations of recreationists in parks and protected areas (Vaske, 2008; Manning, 2011). The survey instrument used during the 2018 sampling season was designed to understand elements of the visitor experience, including visitor satisfaction, visitor perception of resource conditions, and visitor perception of

recreation facilities. Survey questions for both surveys were derived from the National Park Service pool of vetted questions, and were based on key variables commonly assessed in recreation studies. Survey instruments for both 2017 and 2018 can be found in Appendix E.

A representative sample of visitors was solicited by randomly intercepting 4-6 visitors per hour at each sampling location trailhead during park hours of operation (which varied by location) on each sampling day. Upon completion of their recreation experience, visitors were asked to complete one survey per group, administered via iPad tablet device, using Qualtrics survey software (Qualtrics International, Inc., Provo, UT, USA). The unique alphanumeric identifier assigned to each visitor's GPS track was also recorded within the survey instrument. Prior to administering survey questions to each participating group, researchers recorded the GPS unit unique alphanumeric identifier as a response field within the survey. This pairing enabled descriptive spatial data about each group, including time spent during the recreation visit, velocity, and total time stopped, to be connected and analyzed relative to visitor survey responses to questions about visitor demographics, experience-use history, knowledge, motivations, and satisfaction.

Data from visitor surveys were summarized and analyzed using Qualtrics survey software and SPSS statistical software (v.25, SPSS INC., Chicago, IL, USA). Data analysis consisted of both descriptive analysis of survey variables, as well as comparative and multivariate analysis of specific variables of interest, most notably visitor motivations.

Results

Visitor Demographics

Visitor Demographics

Results in this section offer descriptive information of the recreation visitors on Reserve lands.

Important findings: Reserve visitors are more likely to identify as white and report higher levels of education than the population of Orange County.

Who are Reserve visitors?

The questionnaire administered in 2017 was designed to provide a better understanding of basic characteristics of visitors to Reserve Units in Orange County, as well as their motivations for participating in recreation. Variables included basic demographic questions (age, education, income, ethnicity, gender, etc.), experience use history, understanding of Reserve goals, place attachment, and visitor motivations, all assessed using a 37-item visitor experience scale. Response rates for the surveys ranged from 72-75%.

Across all Reserve units, the gender of visitors surveyed was 50% male and 50% female. Visitors surveyed were asked to report their age, as well as the age of all people participating in recreation in their group. The majority of visitors surveyed were between the ages of 21 and 60 (76%) with the most frequently reported age group as 21-30 (26%, Fig. 2). In general, visitors to Reserve units reported high levels of education, with the majority holding four-year college degrees or higher (63.6%, Fig. 3). Sixty percent of visitors to all Reserve units identified as White, with 20% identifying as Hispanic/Latino (Fig. 4). The vast majority of visitors (over 90%) primarily used English as their language of choice for communication (Fig. 5). Most visitors (83.5%) reported having a cell phone with them during their visit. Visitor length of stay, median number of visits, travel distance to the park, group size, and median income varied by reserve unit. A summary of these values can be found in Table 3.

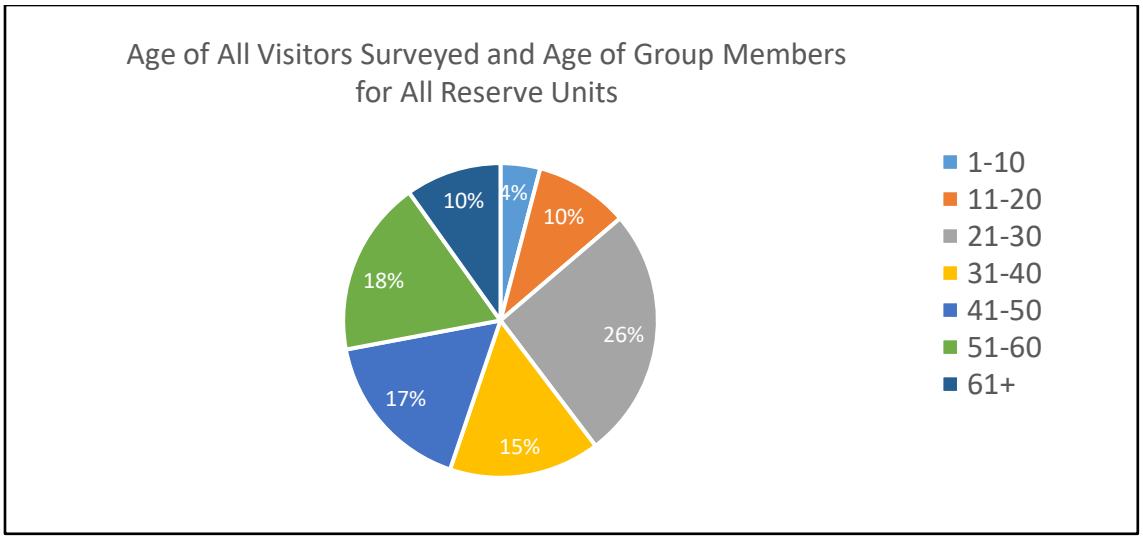

Figure 2. *Visitor age across all Reserve units.*

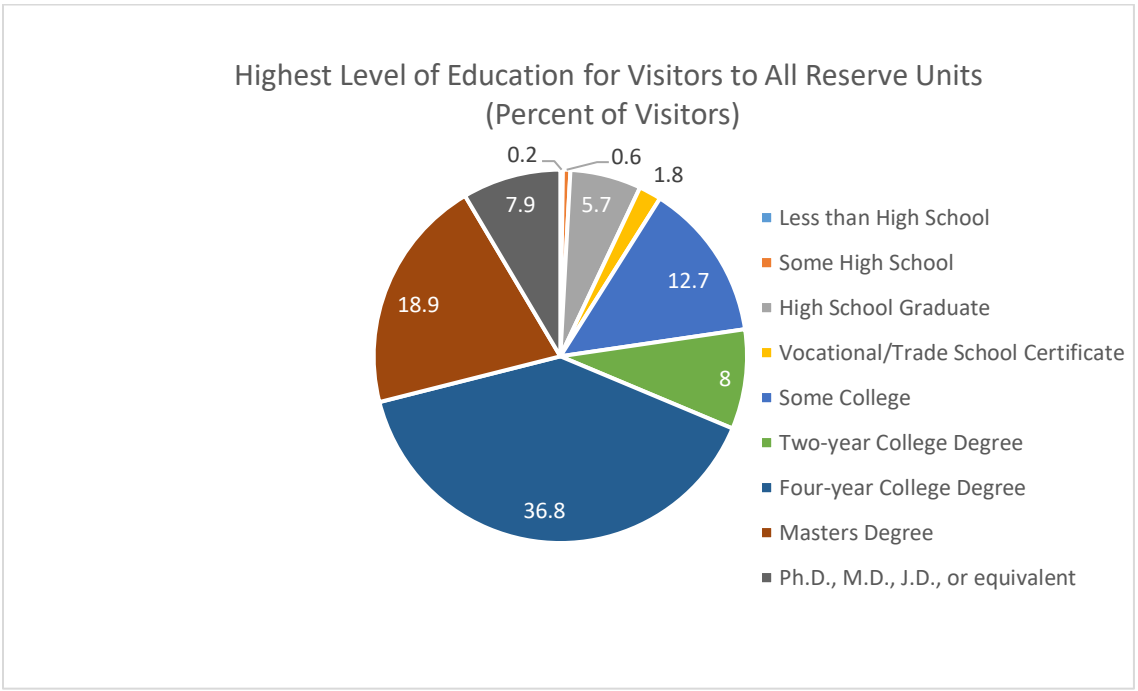

Figure 3. *Visitor education levels across all Reserve units.*

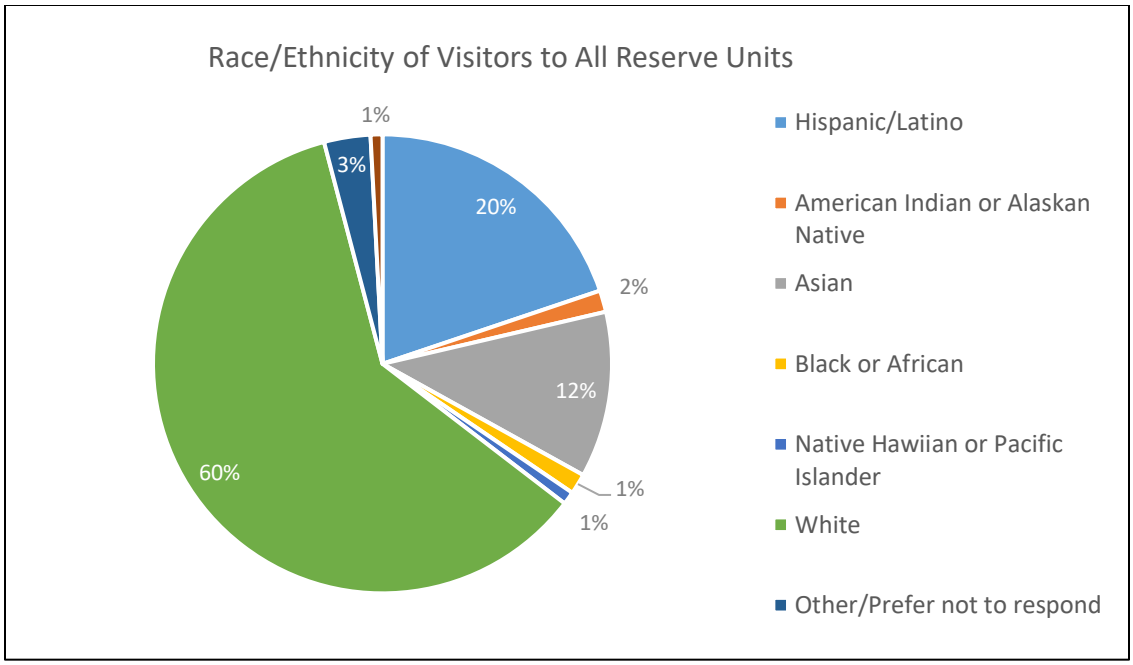

Figure 4. *Visitor race/ethnicity across all Reserve units.*

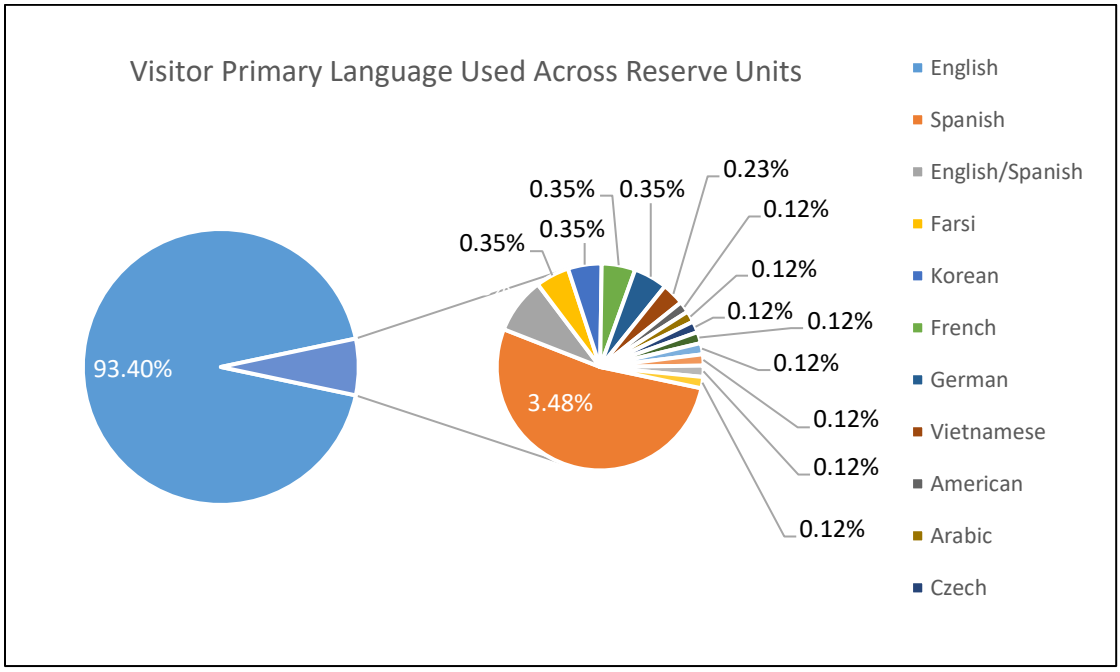

Figure 5. *Primary language used by visitors in each group across all Reserve units.*

Table 3. *Selected visitor summary statistics for all park units.*

	Statistic					
Reserve Unit	Average length of stay (hours)	Median number of visits (last 5 years)	Median number of visits (lifetime)	Median Travel distance to park (miles)	Average Group Size	Median Income Category
PECA	1.50	11	20	9	2.23	$50,000-$74,999
TOWO	1.43	6	30	10	2.62	$75,000-$99,999
NINA/WILL	1.90	6	20	10	2.30	$100,000-$149,999
IROS	2.75	9	3	10	4.57	$100,000-$149,999
ALWO	2.01	15	50	6	2.87	$100,000-$149,999
BOCA	1.53	20	30	3	2.30	$100,000-$149,999
WHRA	1.75	20	97	6	2.21	$100,000-$149,999
RIPA	2.16	24	50	9.5	2.50	$100,000-$149,999
BLST	3.20	2	2	17	3.06	$75,000-$99,999
MORO	1.89	10	30	12	2.09	$100,000-$149,999
All Units	1.84	20	30	9	2.33	$100,000-$149,999

Are parks serving the people of Orange County?

When the race and ethnicity of visitors to all Reserve units surveyed is compared to race and ethnicity data for the county, it appears that visitors with races/ethnicities other than white are underrepresented in Reserve units compared to the demographic make-up of the county (Table 4). However, when the racial/ethnic make-up of individual Reserve units are compared, results indicate that some units (particularly Peters Canyon Regional Park) see a greater diversity of visitors than others (Fig. 6).

Table 4. *Ethnic make-up of Orange County, CA. Data compiled from 2017 American Community Survey data (U.S. Census Bureau, 2017).*

Race/ethnicity	***Percent of Orange County Population***	***Percent of Visitors from 2017 Survey***
Hispanic or Latino	34.2%	20%
White	41.4%	60%
Black or African American	1.6%	1%
American Indian or Alaska Native	0.2%	2%
Asian	19.5%	12%
Native Hawaiian or Pacific Islander	0.3%	1%
Other	0.2%	2%

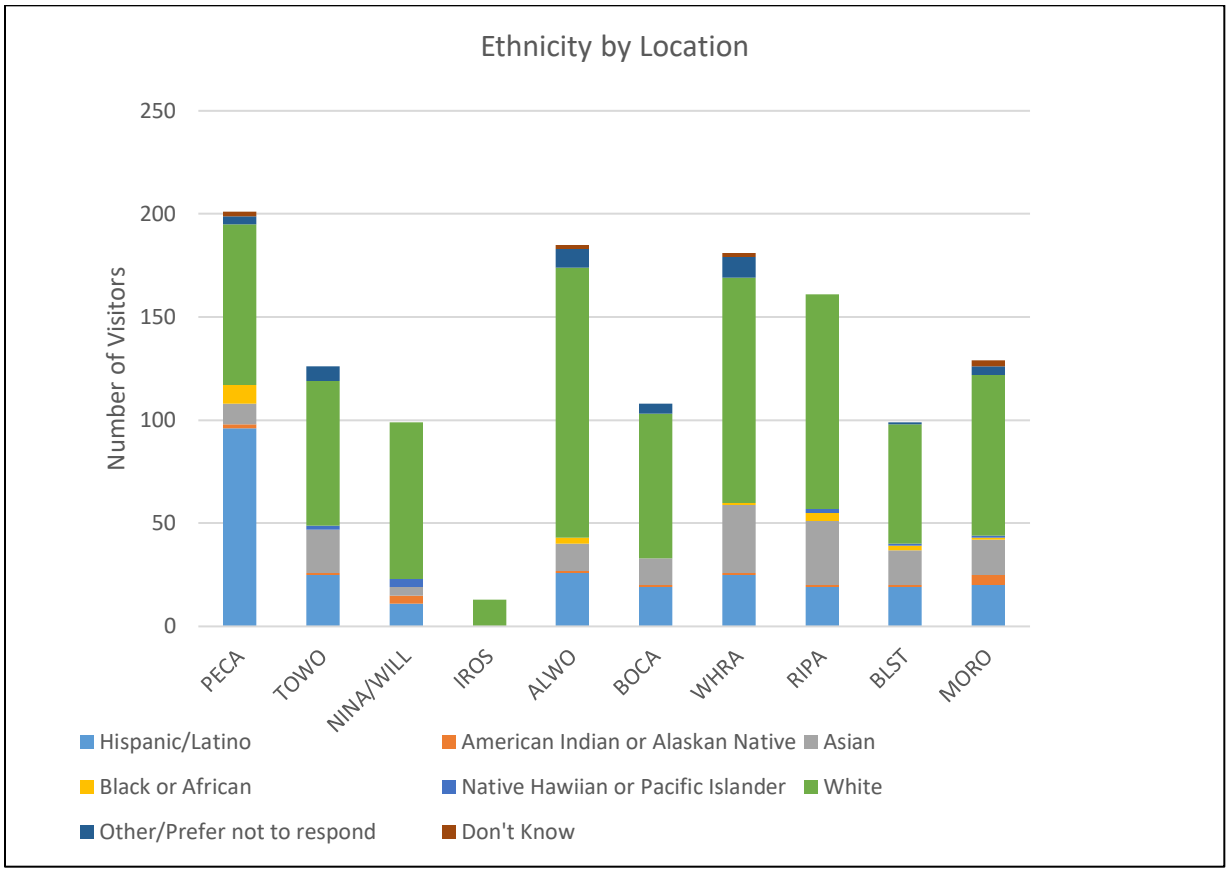

Figure 6. *Visitor ethnicity by sampling location.*

Visitor Motivations

Visitor Motivations

Results in this section offer information relative to the motivations and satisfaction of visitors on Reserve lands.

Important findings: Visitors are highly motivated by opportunities for nature immersion, but exercise is an important motivation as well. Visitors report a higher place identity than place dependence for Reserve units they visit.

What experiences do visitors seek?

A 37-question scale was used to assess visitor motivations for recreating in Reserve units of Orange County. This scale assessed components of solitude, learning, spiritual experience/connection, challenge, exercise/fitness, safety, and the social experience (see Table 5 for a complete list of scale items). Visitors were asked how important these experiences were to them using a five point Likert-style scale of importance (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree). Across all Reserve units, visitors found most motivations to be at least moderately important, with the exception of being alone (means score of 2.92), learning about the history/cultural significance of the area (mean 2.85), photographing wildlife (mean 2.63), learning about conservation/preservation values (mean 2.97), experiencing risk (mean 2.69), avoiding risky situations (mean 2.48), and being near others who could help if needed (mean 2.74, Table 5).

In order to understand the potential influence of visitor motivations on behavior, a multivariate statistical approach was used to examine 2017 survey data on visitor motivations, following recommendations and procedures used previously in the recreation literature (Leung & Marion, 1999; Monz & Twardock, 2010; Kidd et al., 2018). An exploratory factor analysis using principal component extraction and a Varimax rotation was conducted using SPSS statistical software to reduce the 37 question motivation scale into an interpretable group of factors, or domains, which represent general "themes" for visitor motivations. The factor scores for each domain were saved and used as inputs for a K-means cluster analysis. The cluster analysis was conducted in order to classify visitors into groups, or "types", based on similarities in their motivations for recreating. The cluster analysis was run with a two-cluster, three-cluster, and four-cluster solution in order to determine the most parsimonious cluster grouping. The cluster grouping for each individual survey was then paired to corresponding GPS-based tracking attribute data to enable analysis of visitor spatial behavior patterns as a function of visitor motivation type.

Table 5. *Results of factor analysis, reliability analysis and scale means*

Factor Analysis, Reliability Results, and Scale Mean Scores for Visitor Experience Scale				
Factors and Scale Items	Rotated Factor Loadings	Mean Scores	Item Total Correlation	Cronbach's Alpha
Solitude and Escape				**.919**
To experience solitude	.587	3.56	.57	
To experience natural quiet	.608	4.01	.67	
To be alone	.614	2.92	.63	
To get away from the demands of life	.721	3.89	.73	
To enjoy the sounds of nature	.567	4.05	.73	
To experience tranquility and contemplativeness	.568	3.97	.76	
To get out of the city	.579	4.01	.61	
To experience a sense of connection w/nature	.510	3.94	.72	
To be away from crowds	.721	3.71	.63	
To experience calmness or peace	.553	3.83	.73	
To get away from the usual demands of life	.610	3.80	.71	
Learning About and Experiencing Nature				**.867**
To view wildlife	.649	3.77	.57	
To learn about history/cultural significance	.694	2.85	.73	
To learn about plants and wildlife	.744	3.05	.78	
To photograph wildlife	.589	2.63	.50	
To learn about conservation/preservation values	.719	2.97	.76	
To experience the diversity of the natural world	.569	3.76	.66	
Spiritual Renewal				**.909**
To experience psychological renewal	.636	3.74	.70	
To grow spiritually	.824	3.26	.87	
To be in touch with my spiritual values	.755	3.13	.82	
To experience a spiritual connection with nature	.648	3.29	.80	
Challenge				**.815**
To experience risk	.713	2.69	.57	
To experience a sense of challenge	.729	3.78	.70	
To test my abilities	.787	3.61	.72	
Outdoor Exercise				**.833**
To improve physical health	.774	4.41	.65	
To view scenic beauty	.588	4.36	.69	
To be close to nature	.577	4.29	.71	
To get some exercise	.750	4.46	.61	
Safety				**.735**
To be where things are fairly safe	.751	3.36	.55	
To avoid risky situations	.786	2.48	.60	
To be near others who could help if you needed	.517	2.74	.53	
Social Experience				**.777**
To spend time with friends/family	.889	3.87	.64	
To share this space with friends/family	.755	3.73	.64	

The factor analysis reduced the 37-item scale into seven different "factors" or motivation categories, listed in Table 5. When factor mean scores were compared across sampling locations, only the factors of "challenge" and "safety" were significantly different between Reserve units, with visitors to Peters Canyon Regional Park more highly motivated by challenge than other visitors, while also placing a high importance on safety during their experience (refer to Table B.2 in Appendix B). These seven factors were then used as inputs for the cluster analysis. The cluster analysis resulted in two groups (types) of visitors—those motivated by nature and those motivated by exercise (Table 6). Fig. 7 illustrates the means for the seven main visitor motivation categories identified by the factor analysis, compared by visitor motivation type. Fig. 8 shows differences in visitor type by Reserve unit. Across all units, visitors tend to be highly motivated by experiencing nature immersion during their visit.

Table 6. *Cluster analysis of factor scores[a] from visitor experience scale*

Factor Name	Cluster (Visitor Type)[b]	
	1	**2**
N	*269*	*459*
Solitude and Escape	-.53	.31
Learning	-.11	.06
Spiritual Renewal	-.31	.18
Challenge	.28	-.16
Outdoor Exercise	.50	-.29
Safety	.18	-.11
Social Experience	-.50	.29

[a]Mean factor scores

[b]Cluster names: 1= Fitness-based recreation; 2= Nature immersion (N=728)

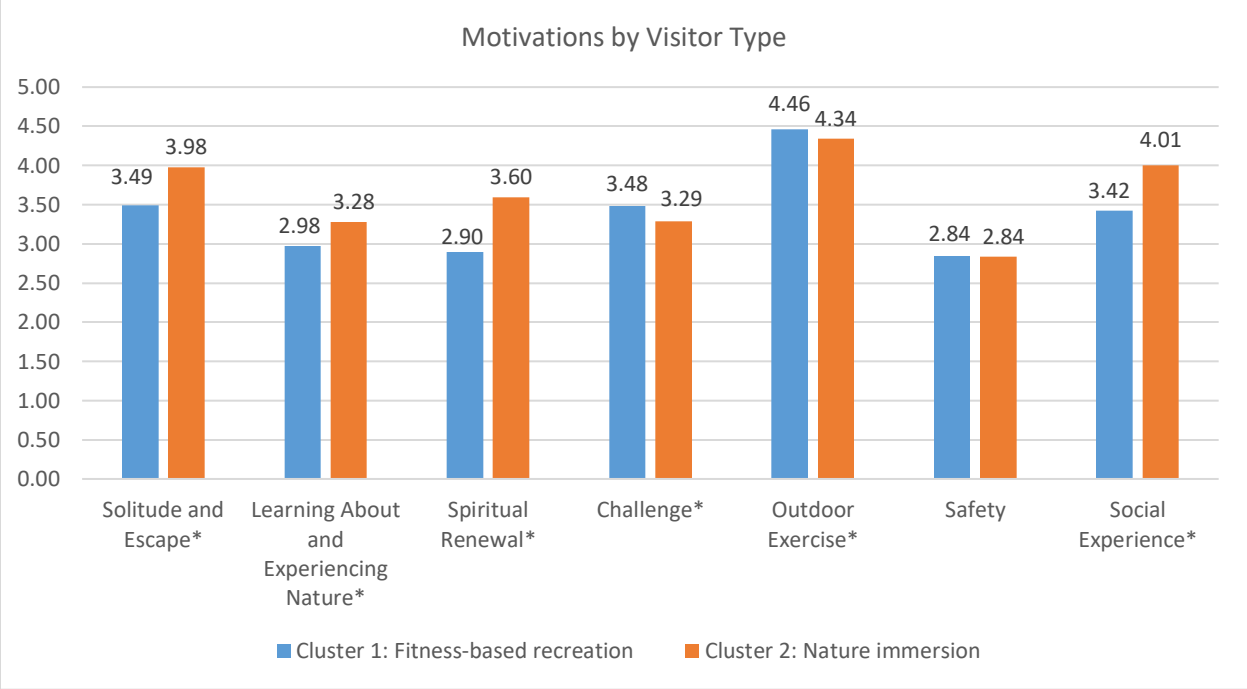

Figure 7. *Visitor motivation scores by visitor cluster type. * Indicates that means between groups are statistically significantly different at p<.05 in an Analysis of Variance (ANOVA*).

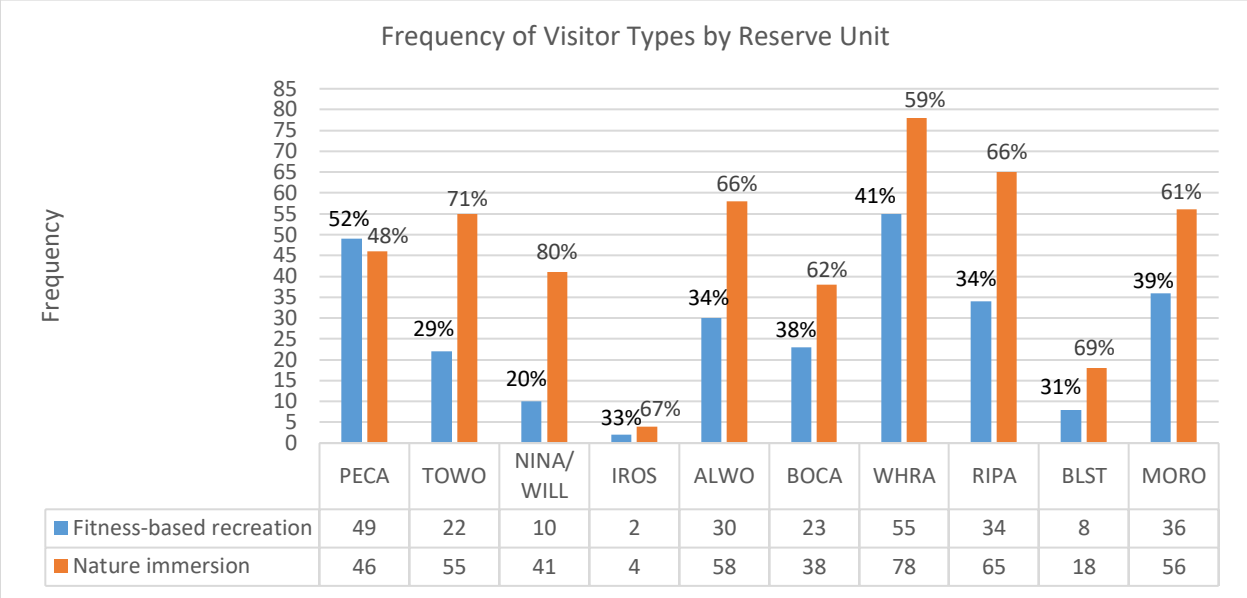

Figure 8. *Frequency of visitor types by Reserve unit.*

In 2017, visitors were also asked a suite of questions about their level of place attachment to Reserve units. Questions were asked using a five-point Likert-style scale where 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree. Across all Reserve units, visitors generally reported attachment to the places where they recreate. When place attachment was broken down into components of place identity (e.g. "This site means a lot to me", "I strongly identify with this place", "I feel this site is a part of me") and place dependence (e.g. "I enjoy recreating at this park more than any other park", "I wouldn't substitute any other location for the activity I do here", "no other place can compare to this park") visitors tended to rate components of place identity as slightly more important than place dependence (Fig. 9).

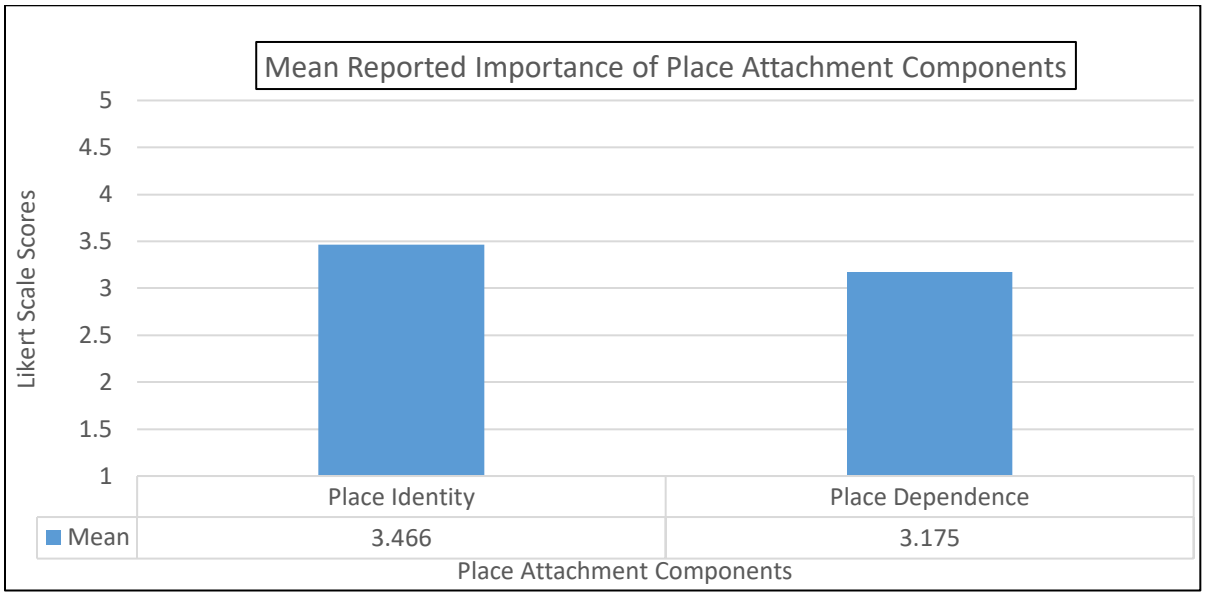

Figure 9. *Visitor self-reported place attachment scale component scores across all Reserve Units*.

In 2018, visitors were asked to self-classify their motivations into four possible categories (based on results from the 2018 visitor motivations scale): motivated by nature only, motivated by both nature and exercise but mostly nature, motivated by exercise only, and motivated by both exercise and nature but mostly exercise. Visitor motivations measured in 2017 with a highly sensitive 37-item scale reflected a strong nature orientation. Visitor self-reported motivations in 2018 reflected a stronger exercise orientation (Fig. 10), which was consistent across reserve units (see Appendix B, Fig. B.15). When visitor self-reported motivations were examined by activity type, visitors who were engaging in dog-walking, biking, and running tended to be more strongly exercise-motivated than those engaging in walking or other activities. However, only 18% of visitors in 2018 reported that they were motivated by "exercise only", suggesting that some degree of a nature-oriented experience was fundamental to 82% of visitors.

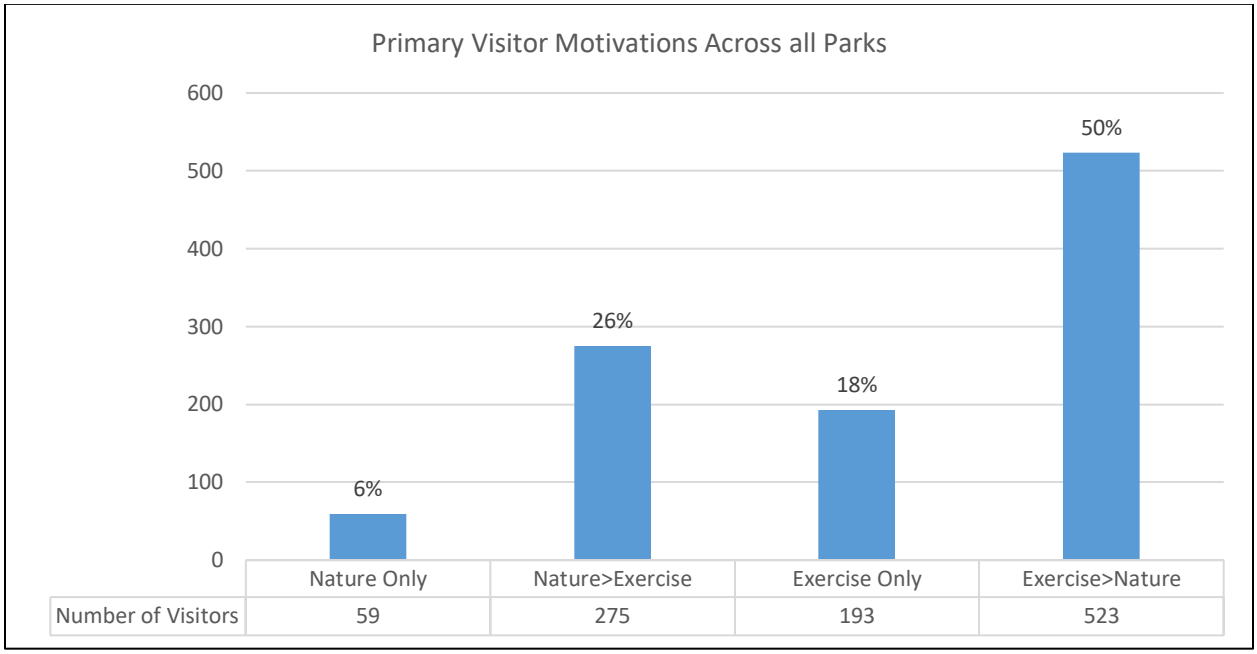

Figure 10. *Frequency of visitor motivations across all Reserve units.*

In 2018, visitors were also asked how satisfied they were with their visit (using the motivation categories identified in the 2017 survey analysis) using a Likert-style scale where 1=extremely dissatisfied, 2=somewhat dissatisfied, 3=neither satisfied nor dissatisfied, 4=somewhat satisfied, 5=extremely satisfied. Visitors in general expressed high levels of satisfaction with their experience, with the exception of "being in touch with spiritual values", where visitors tended to feel more neutral (Fig. 11). When visitor satisfaction was examined by motivation type (Table 7), Reserve unit (Table 8), and activity type (Table 9), several notable differences emerged. Visitors motivated by nature tended to be more satisfied with their ability to learn about plants and wildlife, be in touch with their spiritual values and spend time with family and friends, whereas visitors motivated by exercise tended to be more satisfied with being able to test their abilities and get some exercise (Table 7). Visitor satisfaction also varied by Reserve unit, with visitors feeling least crowded at Ridge Park (RIPA), visitors most satisfied with their ability to get exercise at RIPA and Moro Backcountry (MORO, Crystal Cove State Park), and visitors least satisfied with their ability to spend time with family and friends at Peters Canyon Regional Park (PECA, Table 8). However, it is important to note that these differences, though statistically significant, are quite subtle. Finally, when visitor satisfaction was examined by activity type, visitors engaging in biking and running were more satisfied with their ability to test their abilities and get some exercise (Table 9).

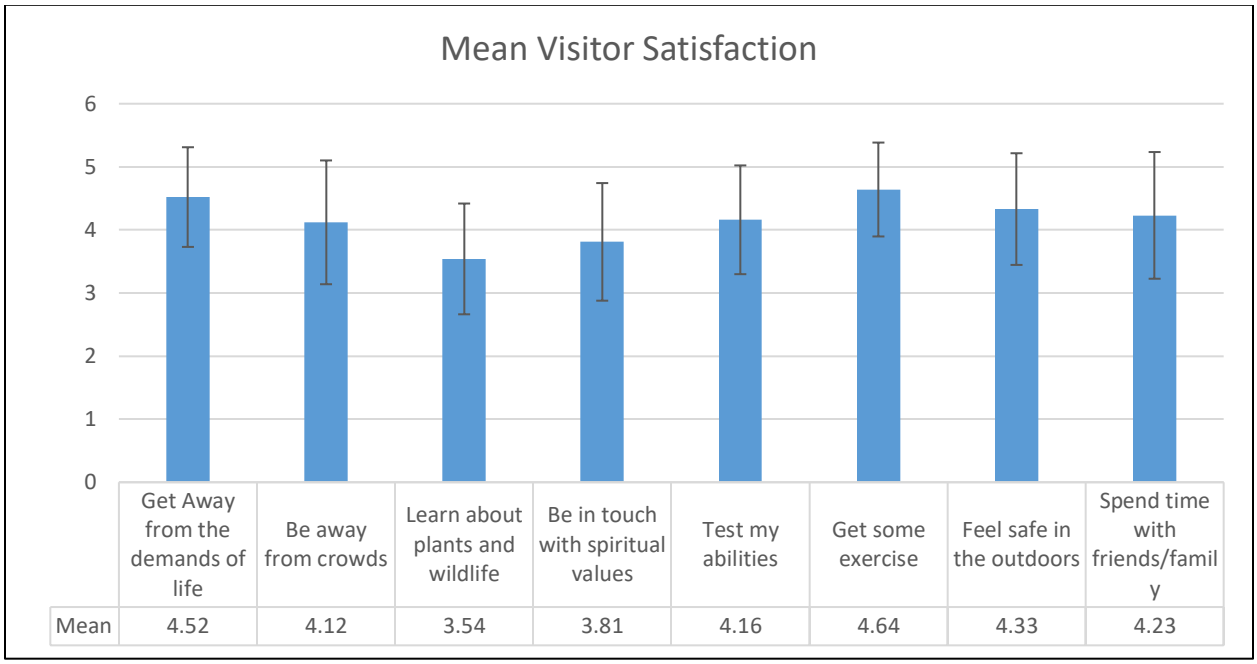

Figure 11. *Mean visitor satisfaction (from 2017 visitor motivations) across all Reserve units.*

Table 7. *Visitor satisfaction by visitor self-described motivation type. Nature and Exercise categories were collapsed from the four original categories such that Nature = visitors who responded that they were motivated by nature only or motivated by both nature and exercise but mostly nature, and Exercise = visitor who responded that they were motivated by exercise only, and motivated by both exercise and nature but mostly exercise. *Indicates statistical significant ANOVA results at P<.05.*

	Get Away from the demands of life	Be away from crowds	Learn about plants and wildlife*	Be in touch with spiritual values*	Test my abilities*	Get some exercise*	Feel safe in the outdoors	Spend time with friends/family*
Nature	4.5	4.13	3.72	3.96	4.04	4.55	4.36	4.35
Exercise	4.53	4.12	3.46	3.74	4.21	4.68	4.32	4.17

Table 8. *Visitor satisfaction by Reserve unit. *Indicates statistical significant ANOVA results at P<.05.*

	Get Away from the demands of life*	Be away from crowds*	Learn about plants and wildlife	Be in touch with spiritual values	Test my abilities*	Get some exercise*	Feel safe in the outdoors*	Spend time with friends/family*
ALWO	4.6	4.14	3.61	3.9	4.16	4.65	4.47	4.23
TOWO	4.41	3.87	3.48	3.76	3.98	4.49	4.17	4.35
RIPA	4.63	4.37	3.53	3.9	4.37	4.77	4.42	4.26
WHRA	4.51	4.14	3.65	3.82	4.08	4.58	4.26	4.16
PECA	4.42	4	3.41	3.74	4.14	4.61	4.31	4.08
MORO	4.56	4.19	3.56	3.68	4.18	4.75	4.41	4.45

Table 9. *Visitor satisfaction by activity type. *Indicates statistical significant ANOVA results at P<.05.*

	Get Away from the demands of life*	Be away from crowds	Learn about plants and wildlife*	Be in touch with spiritual values	Test my abilities*	Get some exercise*	Feel safe in the outdoors	Spend time with friends/family*
Walking	4.46	4.13	3.59	3.79	4.01	4.56	4.31	4.34
Running	4.57	4.21	3.56	3.95	4.5	4.8	4.41	3.93
Biking	4.65	4.1	3.43	3.8	4.35	4.74	4.32	4.12
Dog Walking	4.23	3.67	3	3.29	3.79	4.73	4.4	4
Other	4.62	4.23	3.85	3.92	4.08	4.31	4.69	4.08

Visitor Spatial Dynamics

Visitor Spatial Dynamics

Results in this section illustrate where visitors recreate across Reserve lands, including areas of high and low use, as well as other spatial and temporal characteristics of visits, including time spent on trails, distance traveled, and average speed.

Important findings: Though use densities vary by management unit, areas of high use can be identified in most locations. Overall use in each unit is broad in extent, with some visitors spanning multiple units in a single visit.

Where do visitors go?

A total of 841 visitor GPS-tracks were collected in 2017, representing several different activity types, including mountain bikers, hikers, and runners. A kernel density analysis was conducted for all of the GPS tracks of visitors at each Reserve units. This analysis illustrates spatial patterns in visitor behavior—particularly areas where visitor use is highest (most dense). Results for several Reserve units are presented in figures 12-14. For this analysis, areas of high density (greatest visitor use) are depicted in dark purple, while areas of lower density (lower visitor use) are depicted in light purple. Maps for the remaining Reserve units can be found in Appendix B.

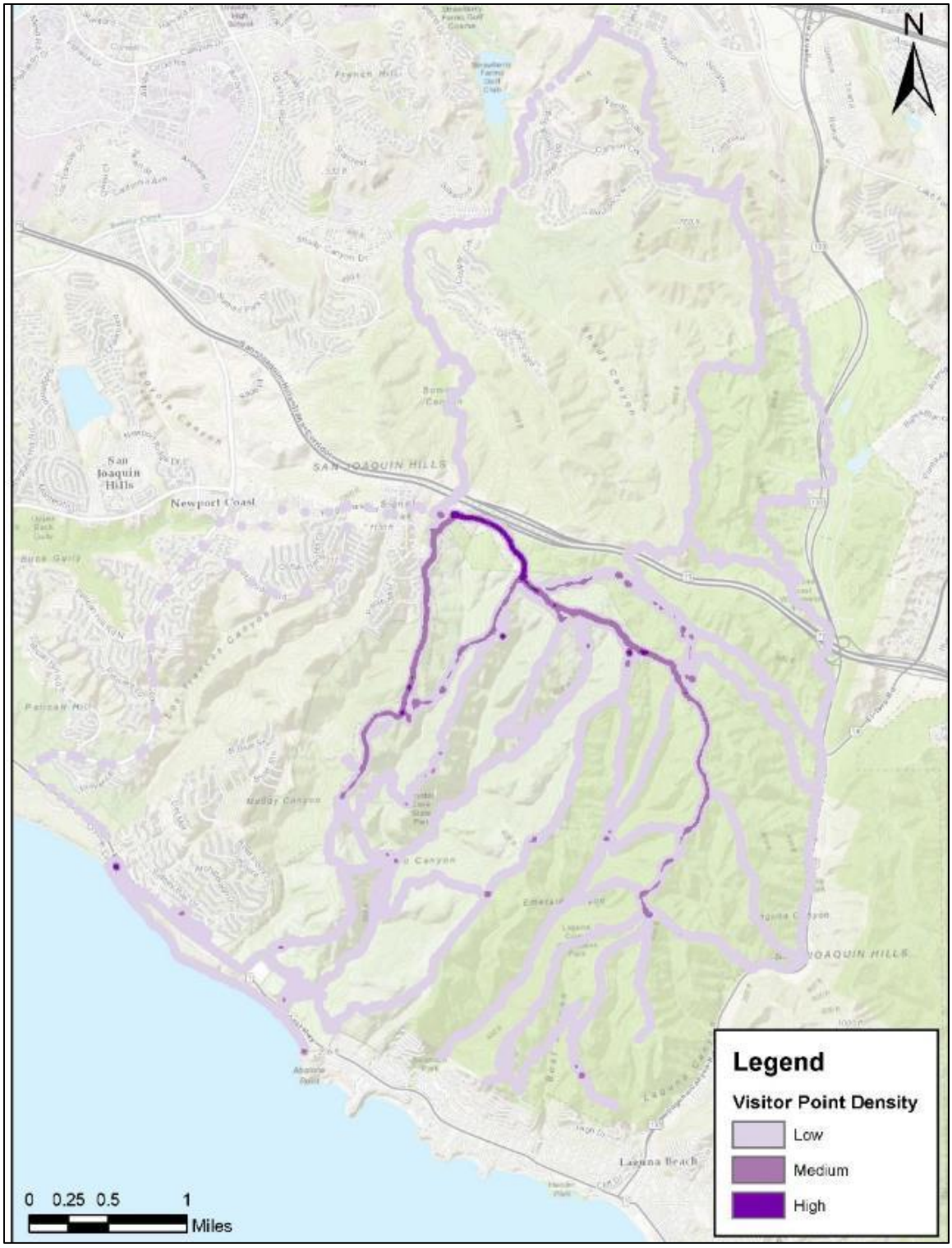

Figure 12: *Visitor use density at Pacific Ridge Trailhead. (Expected counts for density layers: low = 0 - 2 points/m^{2,} medium = 3 - 8 points/m^2, high = 9 - 36 points/m^2).*

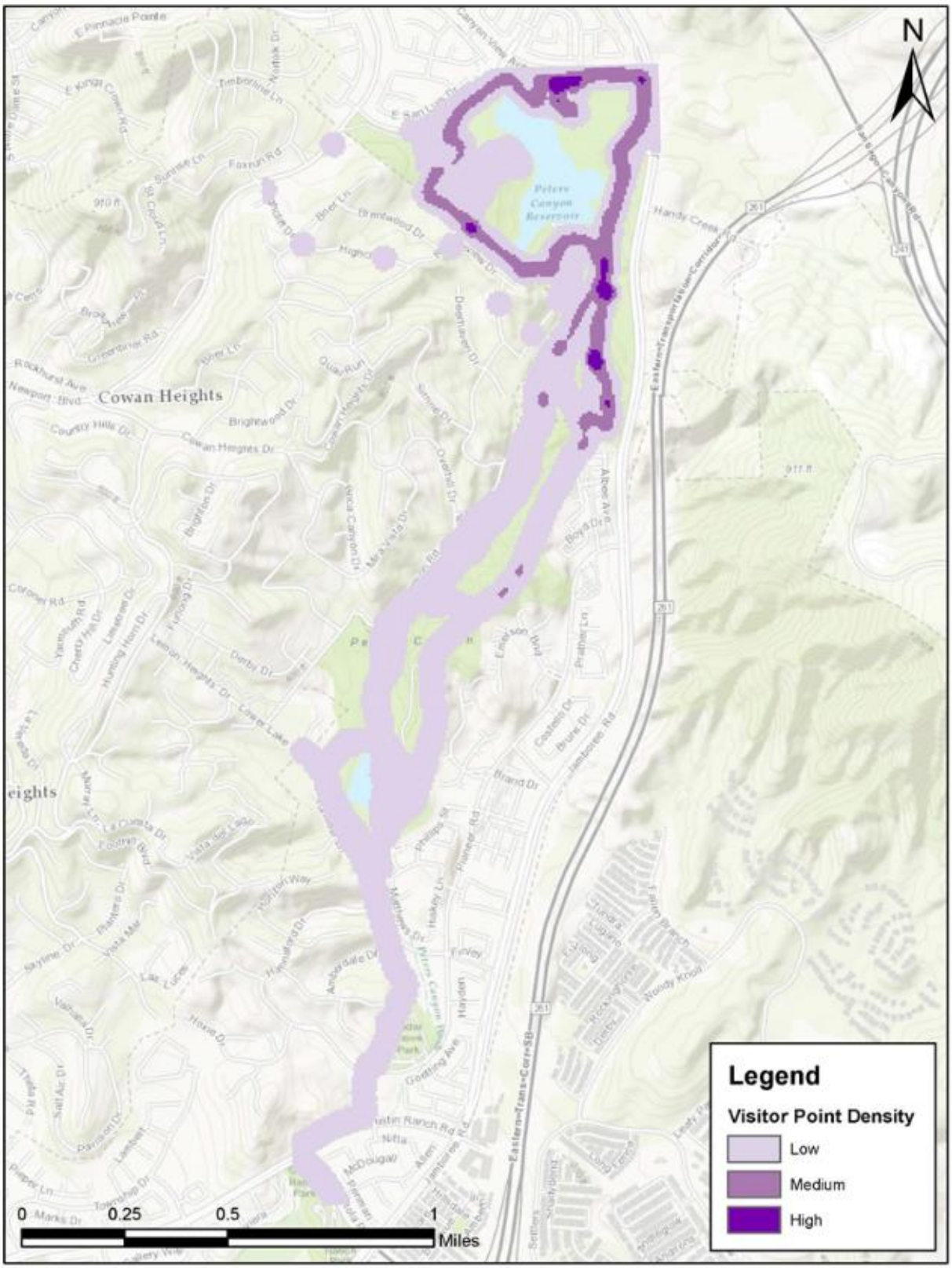

Figure 13: *Visitor use density at Peters Canyon Regional Park. (Expected counts for density layers: low = 0 - 6 points/m^2, medium = 7 - 17 points/m^2, high = 18 - 47 points/m^2).*

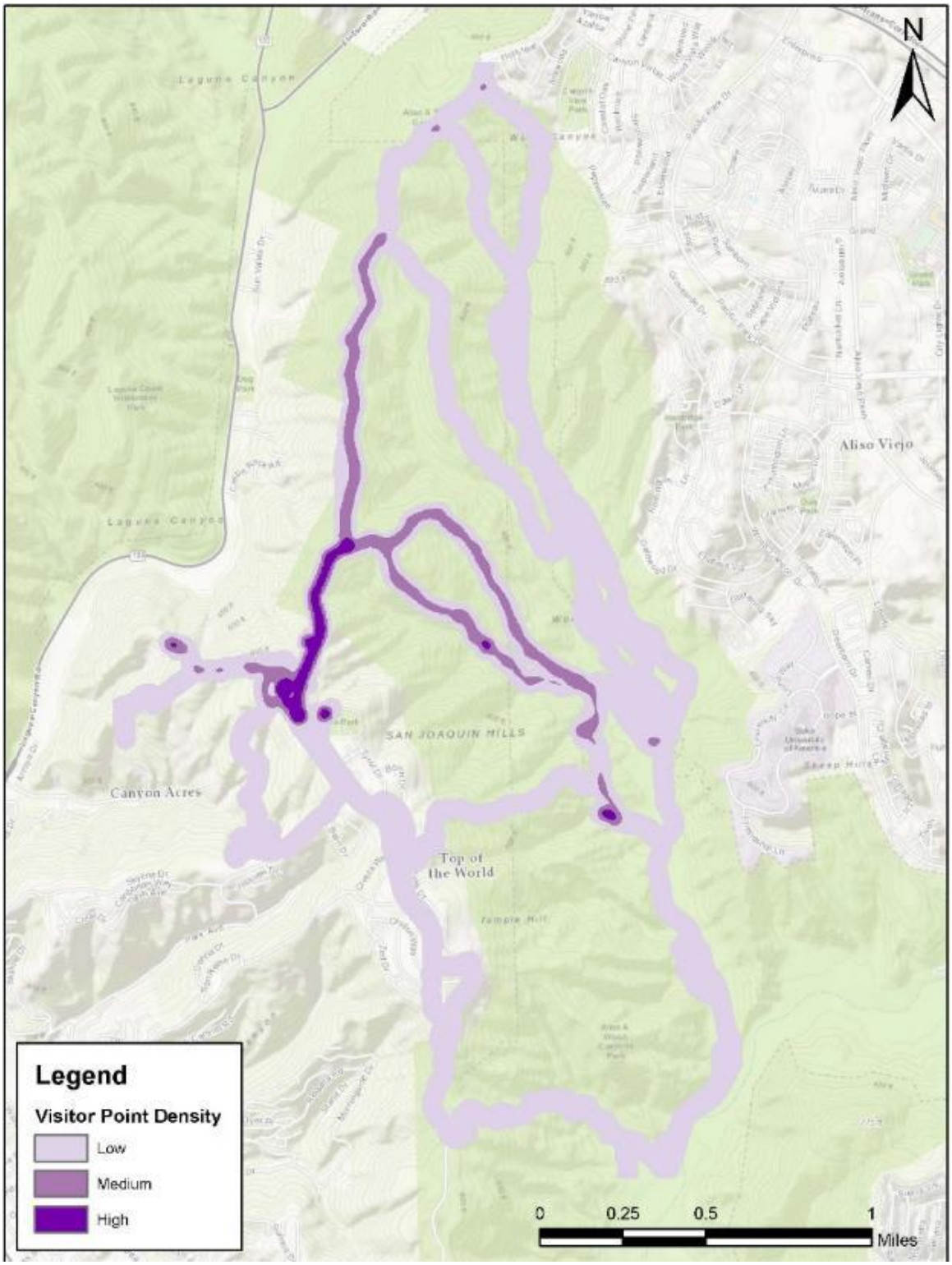

Figure 14: *Visitor use density at Top of the World. (Expected counts for density layers: low = 0-1 points/m^{2,} medium = 2 - 7 points/m^2, high = 8 - 32 points/m^2).*

A total of 252 visitor GPS-tracks were collected in 2018. Unlike in 2017 where all user types were sampled, GPS-based tracking was only conducted with visitors on mountain bikes in order to gain a better understanding of the spatial behavior patterns of these visitors. As with the 2017 data, a kernel density analysis was conducted for all of the GPS tracks of visitors at each Reserve site. In figures 15-18, areas of high density (greatest visitor use) are depicted as darker shades of blue, while areas of lower density are depicted in lighter shades of blue.

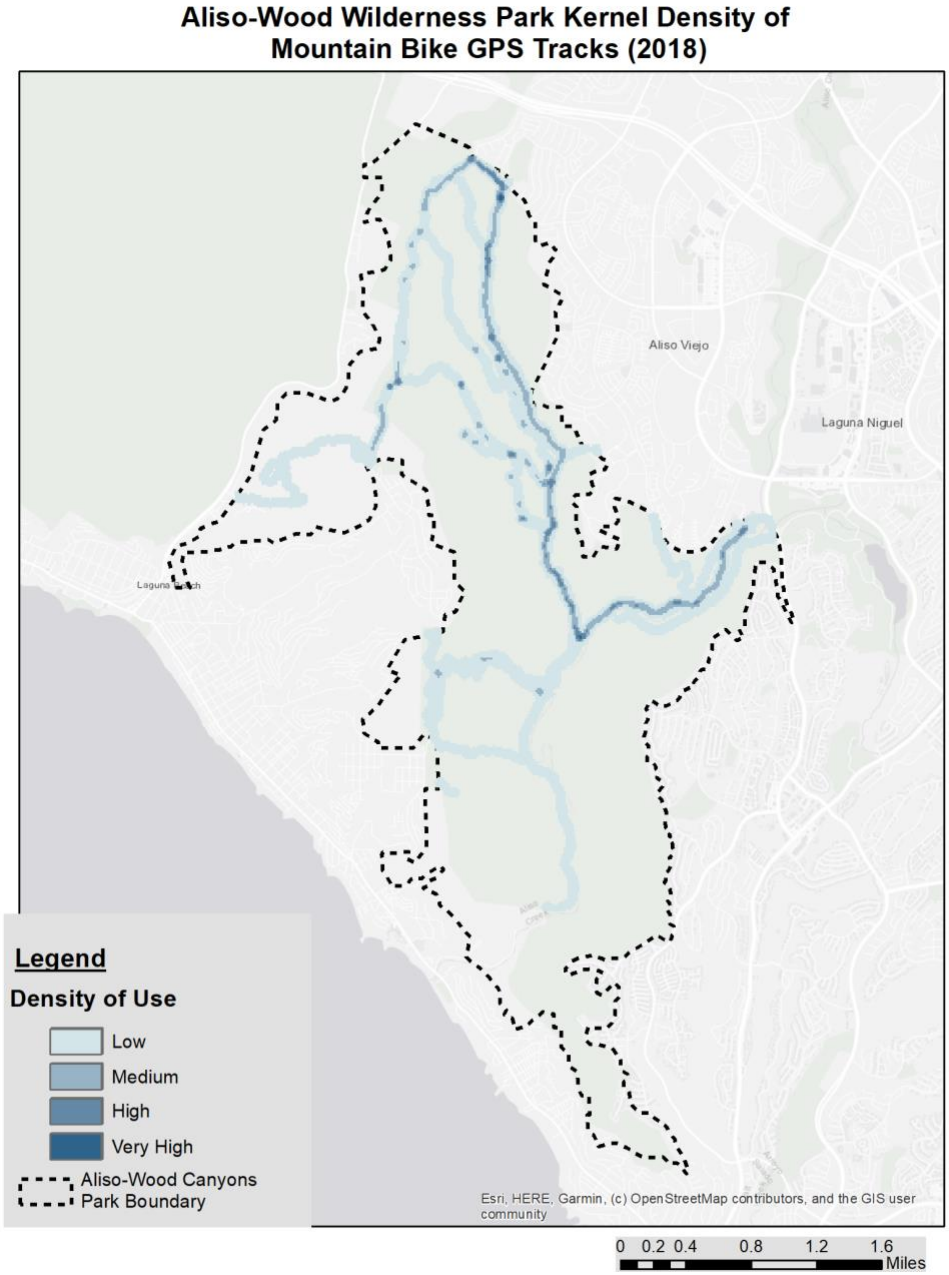

Figure 15. *Visitor use densities mountain bike users at Aliso and Wood Canyon Wilderness Park. (Expected counts for density layers: Low = 0-7 points/m^2, Medium =8-20 point/m^2, High= 20-66 point/m^2, Very High= 67-150 points/m^2)*

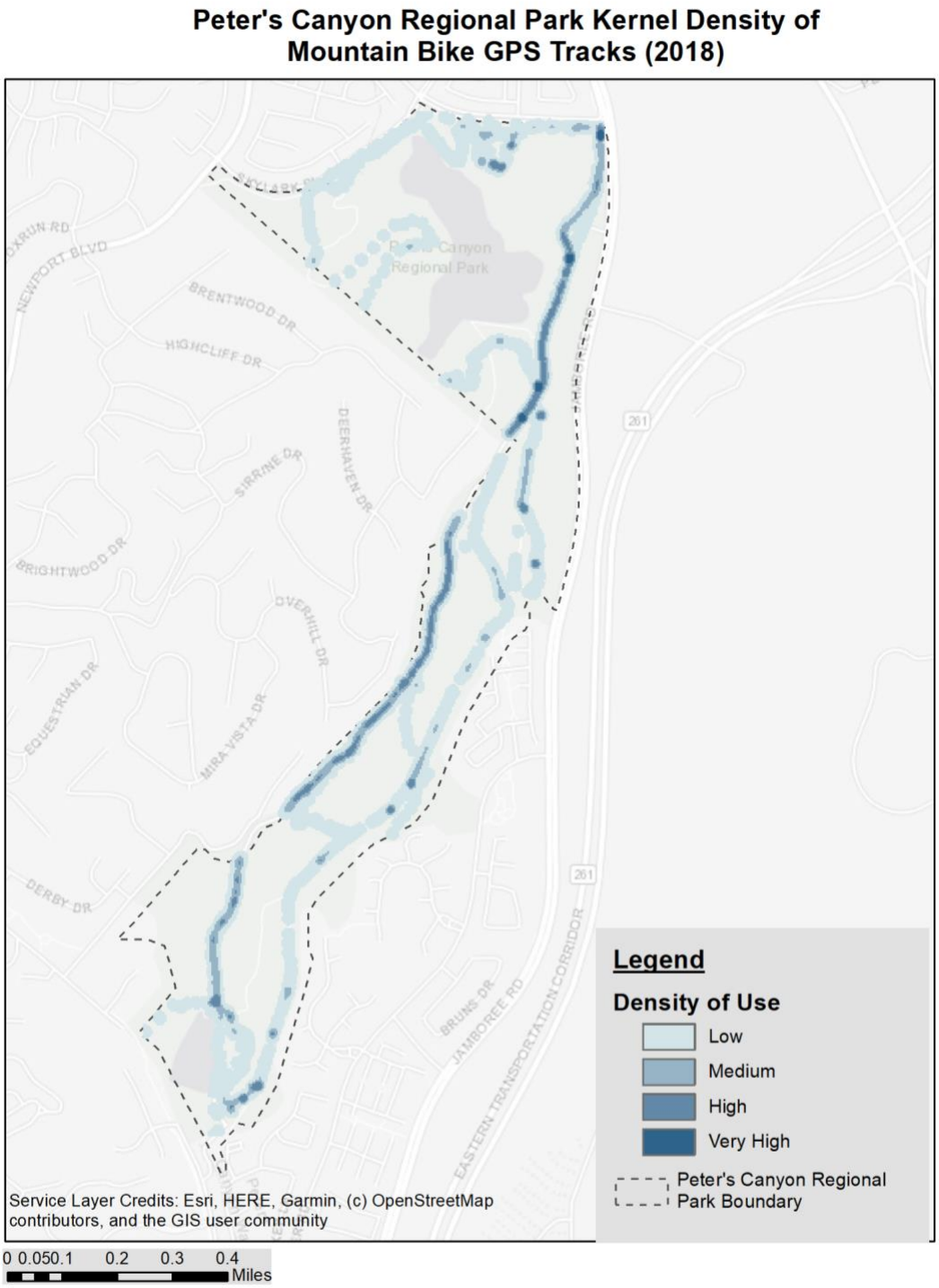

Figure 16. *Visitor use densities of mountain bike users at Peters Canyon Regional Park. (Expected counts for density layers: Low = 0-0.3 points/m², Medium =0.3-1 points/m², High= 2-3 points/m², Very High= 4-7 points/m²).*

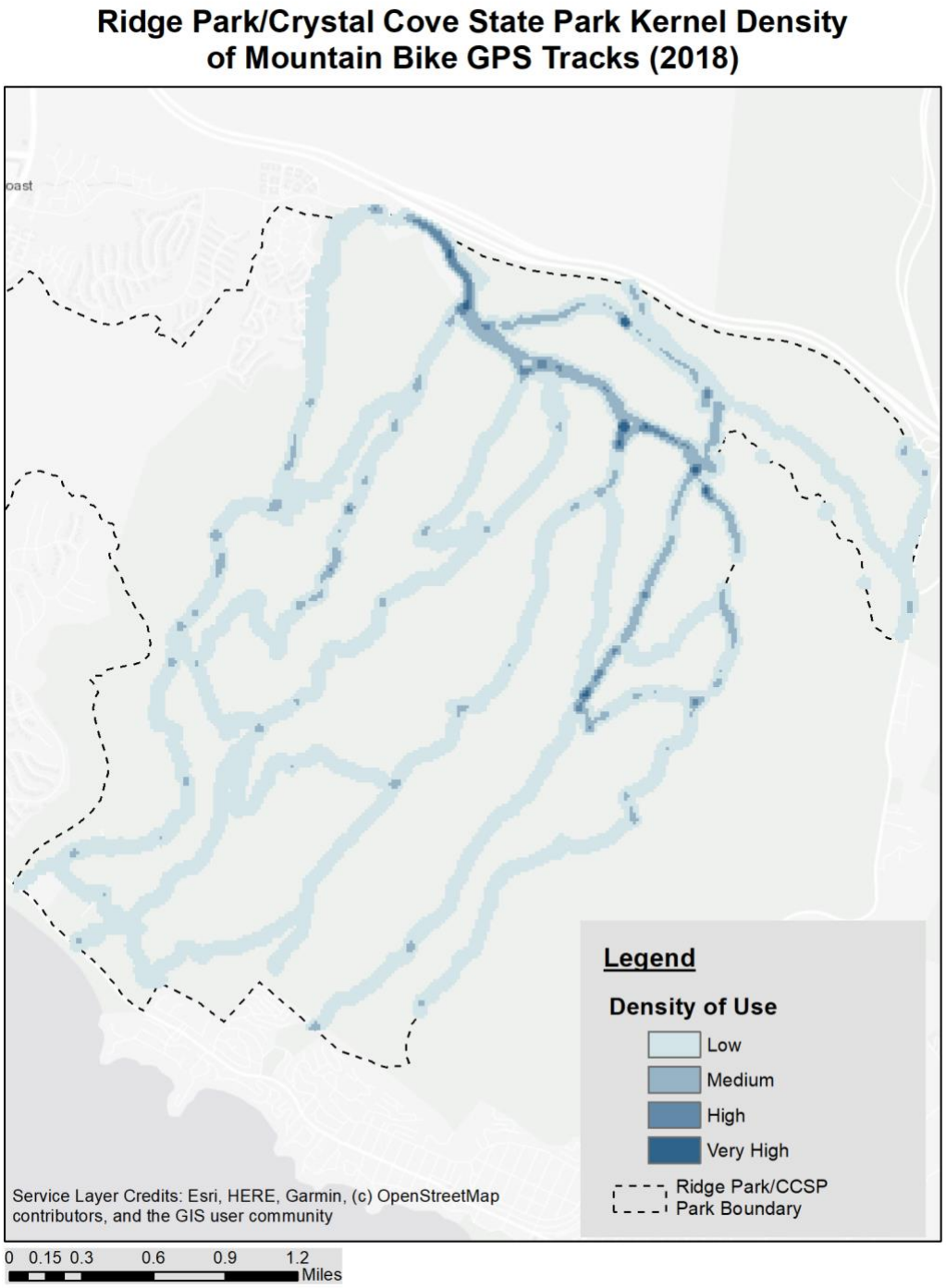

Figure 17. *Visitor use densities of mountain bike users at Ridge Park/Crystal Cove State Park. (Expected counts for density layers: Low=0.3-5 points/m², Medium=6-16 points/m², High=17-37 points/m², Very High=38-87 points/m²).*

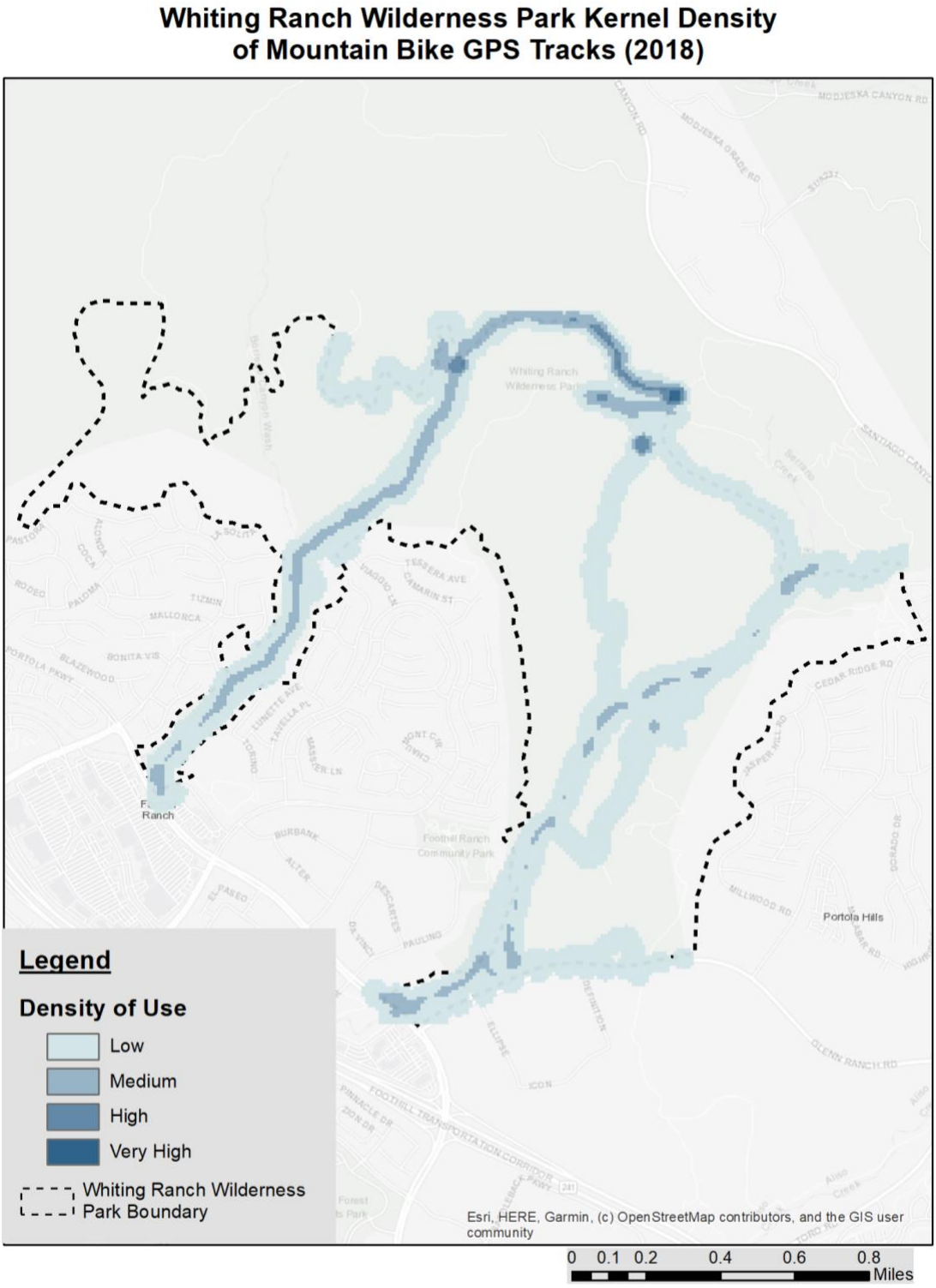

Figure 18. *Visitor use densities mountain bike users at Whiting Ranch Wilderness Park. (Expected counts for density layers: Low=0.5-6 points/m² , Medium= 7-19 points/m² ,High=20-67 points/m² , Very High= 67-135 points/m²).*

What are the spatial characteristics of a visit?

In order to better understand the spatial characteristics of visitors' behavior patterns, a suite of descriptive behavioral variables was populated for each visitor GPS track. These variables include total stoppage time for each visitor, total duration of visit, total distance traveled, and average speed.
A statistical analysis of descriptive spatial behaviors was conducted relative to visitor activity type, the distance that visitors traveled to arrive at the park for their visit ('Distance to park'), number of visits each visitor had made to the park in their lifetime ('Total lifetime visits'), visitor motivation type (derived from the factor and cluster analysis described in the Visitor Motivations section) and Reserve unit. Comparative analysis was conducted using individual t-tests or Analysis of Variance (ANOVA) with visitor descriptive spatial behaviors functioning as the dependent variables and visitor activity type, motivation type, and Reserve unit as the independent variables in the analyses.

Statistically significant differences in total distance traveled and average speed were observed for visitors with different motivations (Table 10). When visitor activity type (pedestrian vs. biker) was compared, statistically significant differences were observed for total distance traveled, average speed, and total time stopped (Table 11). An ANOVA comparing differences in visitor spatial behaviors relative to Reserve unit indicated statistically significant differences in all variables, with the exception of total lifetime visits. These analyses are preliminary, and further analysis will be conducted in the coming months.

Table 10. *Descriptive Statistics and T-test Results for Visitor Spatial Behavior Variables by Motivation Cluster.*

Variable	Cluster 1 (Fitness)		Cluster 2 (Nature)				
	Mean	SD	Mean	SD	*t*	*df*	*p*
Duration of visit (hours:minutes)	1:44	0:55	1:38	0:50	1.260	536	.208
Total distance traveled (km)	8.55	5.24	7.36	4.88	2.674	536	.008
Average speed (km/h)*	5.41	2.70	4.59	2.26	3.603	383.121	.000
Total time stopped (minutes)	10.58	15.84	13.64	19.92	-1.876	536	.061

* Equal variances not assumed. SD=Standard Deviation.

Table 11. *Descriptive Statistics and T-test Results for Visitor Spatial Behavior Variables by Activity Type.*

Variable	Pedestrian		Biker				
	Mean	SD	Mean	SD	*t*	*df*	*p*
Duration of visit (hours:minutes)	1:39	0:53	1:49	0:49	-1.344	535	.180
Total distance traveled (km)*	6.77	3.50	16.32	7.37	-9.870	60.25	.000
Average speed (km/h)*	4.35	1.80	9.42	2.63	-14.309	63.61	.000
Total time stopped (minutes)	11.59	18.64	19.16	15.57	-2.970	535	.003

* Equal variances not assumed. SD=Standard Deviation.

Spatial Dynamics of Mountain Bikers

Spatial Dynamics of Mountain Bikers

Results in this section explore the spatial patterns of use for mountain bikers on Reserve lands. In particular, differences in use characteristics of bikers using or not using the Strava app are examined.

Important findings: Visitors engaging in mountain biking have spatial use patterns that differ compared with other activity types. Many mountain bikers use the fitness and self-tracking app Strava. Use of the app is associated with higher velocities on some segments of trail.

What do we know about mountain biker use, behavior, and factors that influence use and behavior?

In 2018, 252 mountain bike GPS and survey responses from visitors in four parks (Whiting Ranch Wilderness Park, Aliso-Wood Canyons/Top of the World, Ridge Park/Crystal Cove State Park, and Peter's Canyon Regional Park) were collected. A kernel density analysis was conducted for all of the GPS tracks of visitors at each Reserve site, and broken down by those using the Strava app versus non Strava users. In figures 19-22, areas of high density (greatest visitor use) are depicted as darker areas (of orange or blue respectively), while areas of lower density are depicted in lighter areas of orange or blue.
The GPS tracks of mountain bikers were also analyzed to determine the zip codes these visitors were coming from to recreate. The majority of visitors to Aliso and Wood Wilderness Park and Peters Canyon Regional Park came from zip codes directly adjacent to the Reserve unit. However, more visitors to Ridge Park/Crystal Cove State Park and Whiting Ranch Wilderness Park came from zip codes further from the park. (For detailed analysis, see Appendix B, figures B.16-B.19).

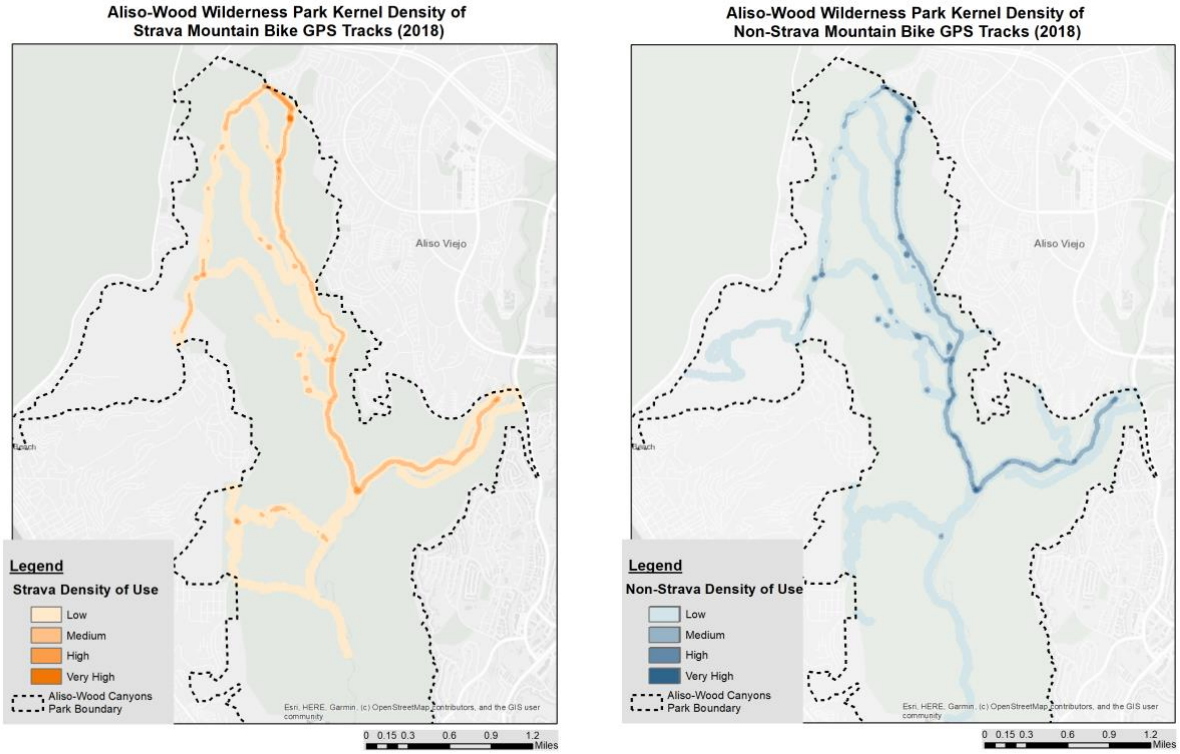

Figure 19. *Visitor use densities of Strava versus Non-Strava users at Aliso and Wood Canyon Wilderness Park.*

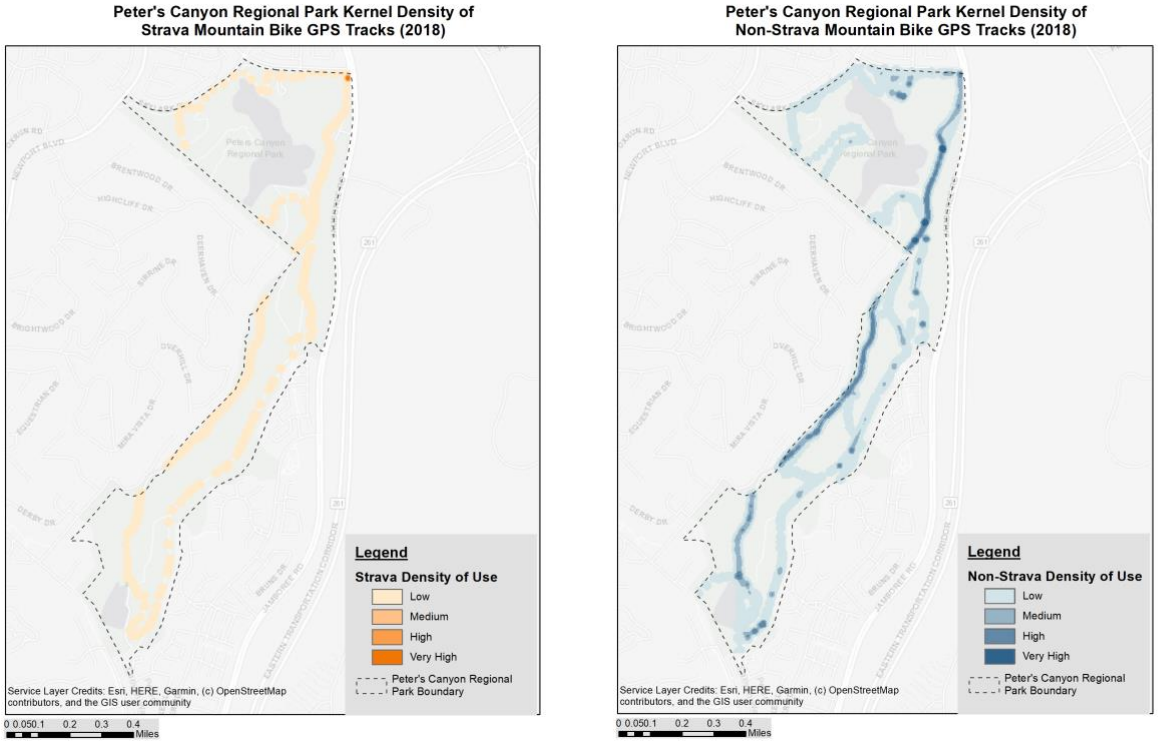

Figure 20. *Visitor use densities of Strava versus Non-Strava users at Peters Canyon Regional Park.*

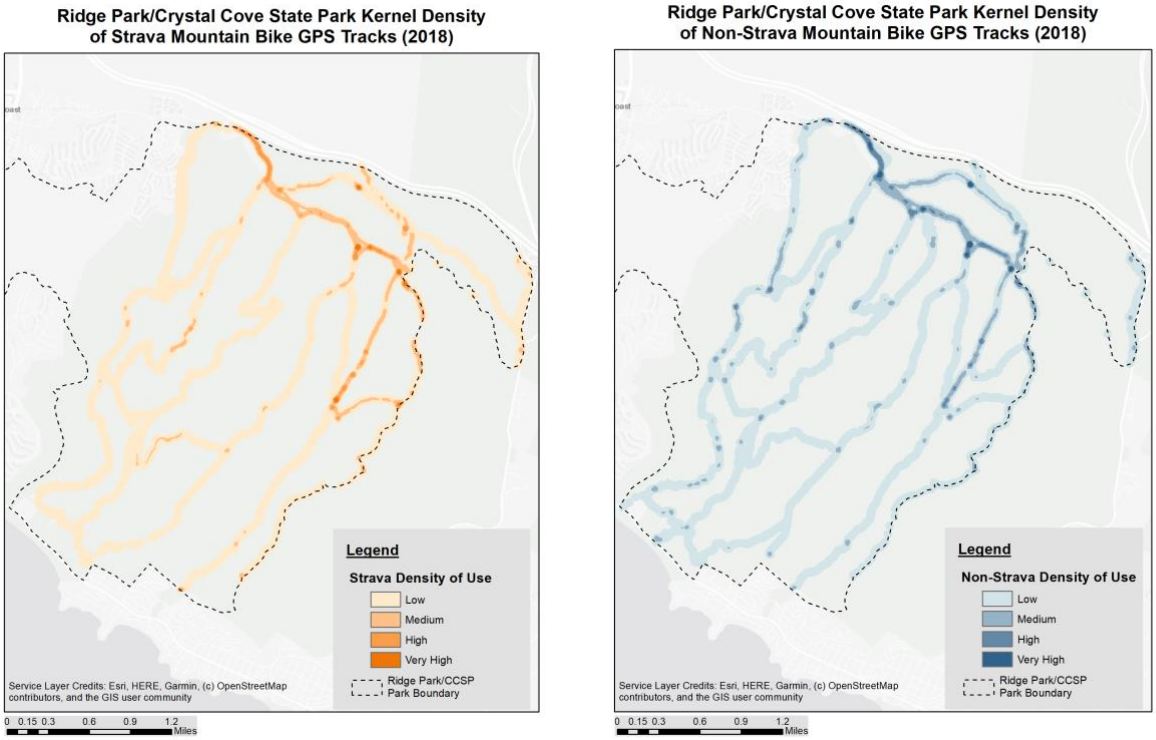

Figure 21. *Visitor use densities of Strava versus Non-Strava users at Ridge Park/Crystal Cove State Park.*

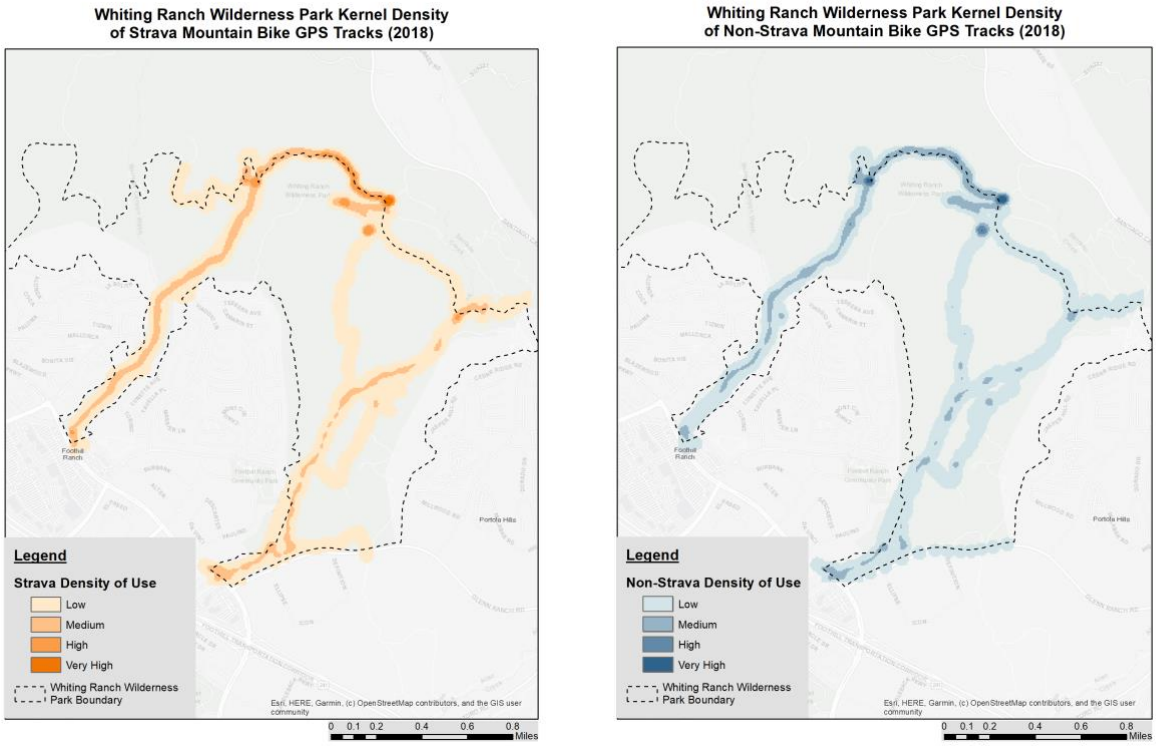

Figure 22. *Visitor use densities of Strava versus Non-Strava users at Whiting Ranch Wilderness Park.*

Mountain Biking Behavior and Strava Use

Early in the scoping of this project, Strava, a fitness tracking app frequently used by runners and cyclists was identified as a possible mediator of recreation behavior. A central feature of the app is a leaderboard, which is a game-design element used by app developers to provide motivation or encourage a behavioral outcome. The Leaderboard adds a challenge to a ride to compete against other Strava users for the fastest time on trail sections or "Segments" crowning the fastest man or woman King-of-the-Mountain or Queen-of-the-Mountain (KOM/QOM).

Mountain bike visitor GPS tracks and paired survey responses were used to analyze visitor spatial behavior and better understand how the Strava app may be mediating the experience of those using the app while they recreate. (Fig. 23) shows the trail segment in Lower Serrano Creek in Whiting Ranch Wilderness Park with velocities (meters/second) illustrated with a graduated color ramp. This section of trail has a sign indicating the maximum speed of travel at 10 mph (4.47 m/s). Fig. 24 shows the range and mean of these velocities between Non-Strava and Strava using mountain bikers for this trail section. The average velocity for Strava users is approximately 1 m/s faster and the range of velocities is greater for Strava users than non-Strava users.

Additionally, Strava hosts a trail-map that allows users to explore these trail segments in a park but does not indicate whether the trail is designated or non-designated. Consequently, Strava presents managers of PPAs with a host of new challenges, including communicating to visitors behaviors consistent with the habitat conservation goals of PPAs within Orange County, despite Strava serving as a mediator of the recreation experience and diffusing information to users inconsistent with those goals. Finally, managers

may need to consider visitor safety on multi-use trails while mountain bikers are competing in a race for the fastest time on trails.

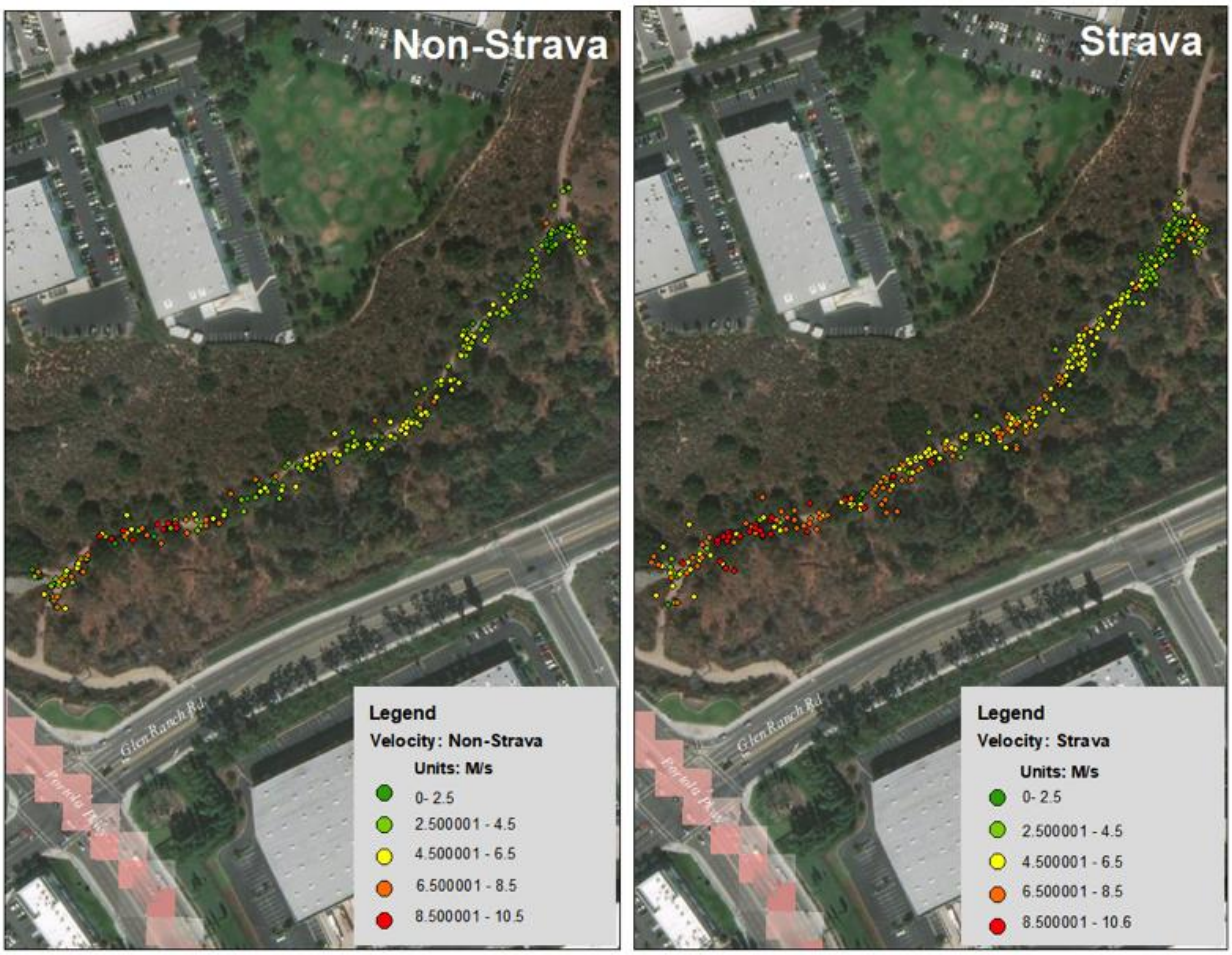

Figure 23: *Comparison of velocities of Strava vs. Non-Strava using mountain bikers at Lower Serrano Creek* Trail, *Whiting Ranch Wilderness Park.*

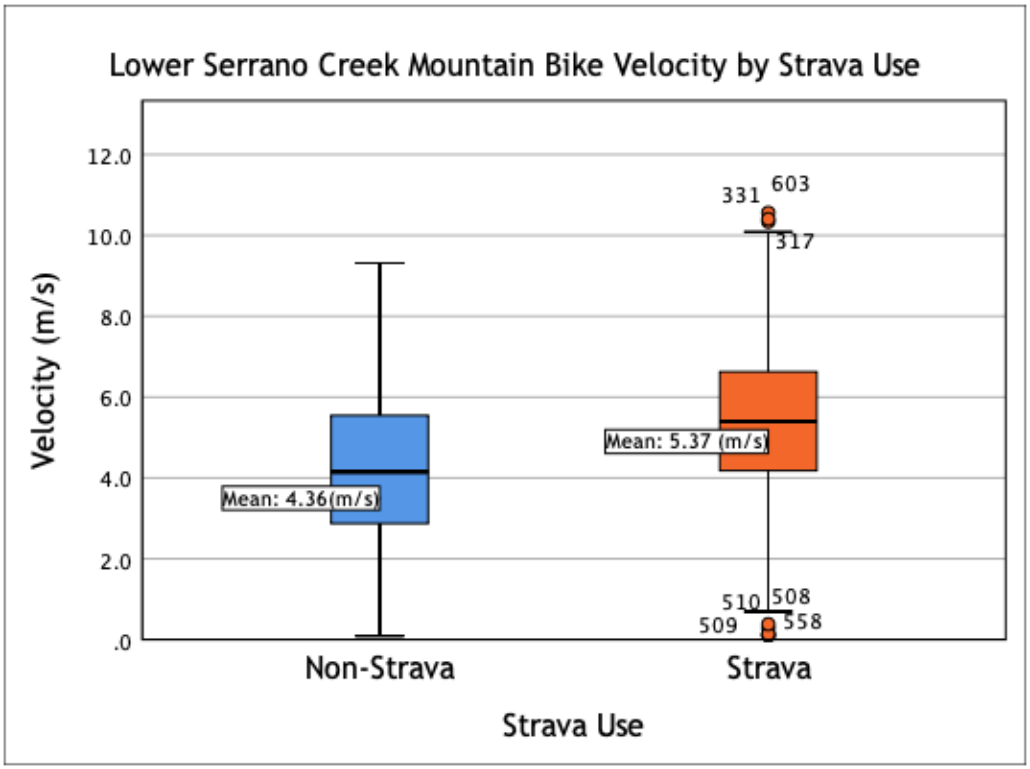

Figure 24: *Strava vs. Non Strava Velocities Boxplot: This figure shows the mean and range of velocity for Strava and Non-Strava mountain-bikers on the Lower Serrano Creek Trail in Whiting Ranch Wilderness Park. Strava users, on average, are traveling approximately 1 m/s faster than Non-Strava using mountain bikers (9.7 mph vs 11.2 mph)). This section of trail has signage indicating the maximum speed mountain bikers should travel is 10 mph.*

Visitor Use Patterns and Sensitive Resources

Visitor Use Patterns and Sensitive Resources

Results in this section investigate how the spatial distribution and behavior of visitors to the Reserve relates to the location of sensitive habitat (Coastal Sage Scrub) and locations where the Coastal Cactus Wren and Coastal California Gnatcatcher were found to be present or absent on the landscape.

Important findings: A substantial proportion (34.5%) of visitor use intersects with critical habitat, but for a very brief duration (2 ½ minutes) and consequently a limited spatial extent. More visitor activity occurred around locations that were classified as unoccupied by previous bird surveys.

What are the implications of the spatial extent of visitor use to sensitive resources, such as wildlife habitat?

In Southern California, urban development has resulted in the destruction of approximately 90% of previously extant coastal sage scrub (CSS) habitat (Jensen, Torn, & Harte, as cited in Crooks, Suarez, Bolger, & Soulé, 2001). Two species that remain dependent on fragments of CSS habitat in the Reserve are the coastal cactus wren (CACW) (*Campylorhynchus brunneicapillus)* and coastal California gnatcatcher (CAGN) (*Polioptila californica californica*) (Crooks et al., 2001). The CACW is listed as a California State Species of Special Concern by the California Department of Fish and Wildlife (Solek & Szijj, 2004) due to loss of habitat and declining population levels (Cooper et al., 2014). The CAGN is a threatened species under U.S. Endangered Species Act (U.S. Fish and Wildlife Service, n.d.). This species has been extirpated from many urban fragments of CSS, though it still occurs in larger habitat fragments that are also thought to have high levels of recreation use (Crooks et al., 2001; Larson et al., 2018).

The purpose of this analysis is to better understand how the patterns of recreation use observed on the Reserve interact with habitat important to these two species (especially Coastal Sage Scrub habitat) and the locations of the species themselves. Overall, managing for both recreation use and conservation requires an understanding of the interaction of both the social and ecological environment in the Reserve.

Methodological Approach:

This analysis combines four different data types collected at the same spatial scale in the Reserve to understand how recreation use interacts with the ecological components of the system. The four data types combined in a spatial overlap analysis were: GPS tracking points of visitors collected in this study, vegetation, and two occupancy surveys for the bird species in the Reserve (CACW and CAGN). See Appendix D for flow charts explaining how these GIS analyses were conducted. Approaches for the bird species overlay analysis are based on methods used in Gutzwiller et al. (2017). A goal of this analysis was to combined social and ecological measures from the Reserve.

Overlap between recreation use & sensitive habitat:

The kernel density map for all GPS tracking data collected for this study in 2017 was overlaid with maps of Coastal Sage Scrub (CSS) habitat for the entire Reserve system (see Appendix B for kernel density maps). Overall, small percentages of use density layers intersected with this sensitive habitat for the CAGN and CACW (see Appendix D, Table D.1). Approximately 4% of the density layer for all GPS tracked visitors sampled overlapped with sensitive habitat in the Reserve. Of the 4%, 1.1% was low-density use, 1.2% was made up of medium density use, and 1.4% of the high-density use areas overlapped with sensitive habitat. To determine if differences existed between how "nature motivated visitors" used these sensitive habitat areas compared to "exercise motivated visitors," (see earlier section in this report on "Visitor Motivations"), visitor use densities of these two groups were also overlaid on the CSS habitat layers. Slightly more of the low-density use area for the nature group overlapped with the sensitive habitat compared to the exercise motivated group. Yet, for the medium and high-density use categories, the exercise group's kernel density layer overlapped more with the sensitive habitat. However, these differences were relatively small (see Table D.2 in Appendix D).

To further explore the behavior of visitors in these sensitive habitats, in addition to looking at the different densities of visitors, individual points from the GPS tracking data was also examined. Only 1.2% of all of GPS tracking points collected in 2017 were located within sensitive habitat for the CAGN and CACW (Table 12); this percentage represents about 35% of all visitors entering sensitive habitat at some point during their trip. The exercise group had a statistically higher proportion of GPS tracking points that intersected with sensitive habitat compared to the nature group (although this difference is relatively small; 0.3%). Approximately 43% of exercise motivated visitors recreated in sensitive habitat at some point during their trip compared to only 29% of nature motivated visitors. On average, visitors who recreated in sensitive habitat at some point during their visit spent 2 minutes and 23 seconds inside those sensitive habitats (Table 12). There was no statistically significant difference (α=.05) between the exercise and nature motivated groups in average time spent in sensitive habitats.

Table 12. *Intersect between avian sensitive habitat for the entire Reserve and GPS data of visitor to the Reserve.*

	% individuals that intersected with sensitive habitat	% of points that intersected with sensitive habitat	Average time spent (mm:ss)	+/- SD (mm:ss)
All GPS Tracked Visitors	34.5%	1.2%	02:23	02:41
Exercise Group	42.8%	1.4%	02:14	02:40
Nature Group	29.3%	1.1%	02:32	02:45

Overlap between recreation use & occupancy survey results for CAGN and CACW

Buffers were placed around the sampling locations for bird surveys conducted in the Reserve for CAGN and CACW to begin to understand the spatial relationship between recreation and these bird species. These results are presented for all GPS-based tracking data and all bird survey locations. A relatively small amount of the GPS point data intersected with buffers surrounding the occupied CAGN locations (Table 13). For all buffers less than 25m, less than 1% of the GPS data intersected with the buffers, and for the 75m buffer, about 2% of the GPS data intersected with the buffer. Putting these percentages in the context of individual visitors, 35% of individual visitors entered the 50m buffers and 48% individual visitors entered the 75m buffers. Statistically more visitors entered the buffers surrounding the unoccupied CAGN locations (Table 13). For all buffer sizes, the percentage of intersecting GPS points was statistically significantly higher in the unoccupied areas compared to the occupied areas. For the 2m and 10m buffers, less than 1% of the GPS data intersected with the unoccupied location buffers. For the remaining unoccupied location buffers, 3% in the 50m buffer, and nearly 5% in the 75m buffer. Again, seeing how these percentages translate to individual visitors 72% of visitors entered a 75m buffer.

Table 13: *Percentage of GPS points intersected with occupied/incidental and unoccupied CAGN location buffers in the Reserve for all GPS tracked visitors. CAGN location sample sizes are 102 occupied/incidental and 182 unoccupied.*

All GPS Tracked Visitors & CAGN Sampling Locations						
	Occupied & Incidental			**Unoccupied**		
Buffer Size	**# of points overlap** N = 337,259	**% points overlap**	**# individuals overlap** N= 827	**# of points overlap** N = 337,259	**% points overlap**	**# individuals overlap** N= 827
2m *	7	0.002	6	117	0.035	94
10m *	175	0.052	97	2473	0.733	367
25m *	1292	0.383	211	4911	1.456	437
50m *	3538	1.049	292	10175	3.017	498
75m *	6962	2.064	398	16468	4.883	597
*Statistically significant difference between occupied and unoccupied locations (*p-value*<.001)						

For the occupied CACW locations in the Reserve, less than 1% of the GPS data for all GPS tracked visitors was located within the 2m, 10m, and 25m buffers (Table 14). About 1.3% of the GPS data was located within the 50m buffer and 2.4% of the GPS data was located within the 75m buffer. This translates to 46% of visitors intersecting with the 75m buffer. In comparison, statistically more of the GPS data intersected with the buffers surrounding the unoccupied CACW locations (Table 14). For all buffer sizes larger than 2m, there were statistically significant differences between the occupied and unoccupied locations in the percentage of intersecting GPS points. For all buffers smaller than 25m, less than 1% of the GPS data intersected with the buffers. For the 50m buffer, this percentage increased to 2.5%, and for the 75m buffer, this percentage increased to 4.8%. Again, this translates to 58% of individual visitors intersecting with the 50m buffer and 61% individual visitors intersecting with the 75m buffer.

Table 14. *Percentage of GPS points intersected with occupied and unoccupied CACW location buffers in the Reserve for all GPS tracked visitors. CACW location sample sizes are 72 occupied and 275 unoccupied.*

All GPS Tracked Visitors & CACW Sampling Locations						
	Occupied & Incidental			**Unoccupied**		
Buffer Size	**# of points overlap** N = 337,259	**% points overlap**	**# individuals overlap** N= 827	**# of points overlap** N = 337,259	**% points overlap**	**# individuals overlap** N= 827
2m	21	0.006	20	33	0.010	30
10m *	495	0.147	250	662	0.196	244
25m *	1523	0.452	313	2742	0.813	404
50m *	4397	1.304	363	8351	2.476	481
75m *	8171	2.423	381	16090	4.771	503
*Statistically significant difference between occupied and unoccupied locations (*p-value*<.001)						

When examining the average time visitors spent inside the buffers around the occupied CAGN locations, visitors overall spent up to three minutes inside the largest 75-meter buffer (Table 15). In contrast, visitors spent 1.5-3.5 times more on average inside the buffers surrounding the unoccupied CAGN locations. These differences between the occupied and unoccupied locations were statistically significant for all buffer sizes except the 2m buffer. Considering travel speed, we found that visitors traveled between 1.08-1.49 meters/second through the buffers surrounding the occupied CAGN locations (Table 15). Of the GPS points that occurred within the buffers, stopping behavior ranged from 4% to 14% of the total number of GPS points in the buffers, with each stop representing a visitor standing still for 10 seconds. When we examined travel inside the buffers surrounding the unoccupied CAGN locations, we found that overall, visitors traveled a little faster—between 1.24-1.36 meters/ second through the buffers (Table 15). Of the GPS points that occurred within the buffers, 5-6% represented stopping behavior. The differences in speed between the occupied and unoccupied locations were statistically different for only the 50m and 75m buffers.

In the occupied CACW locations, visitors spent up to about 3.5 minutes inside the 75m buffer (Table 16). They spent more time around the unoccupied CACW locations (Table 16)—up to an average of about 5.5 minutes inside the 75m buffer. For every buffer except the 2m buffer, visitors spent statistically more time in the buffers surrounding the unoccupied CACW locations. In the buffers surrounding the occupied CACW locations, visitors traveled between 1.06-1.30 meters/second, depending on the buffer (Table 16) and 5-6% of the points represented visitors stopping for 10 seconds. Visitors traveled at similar speeds within the buffers surrounding the unoccupied CACW locations, with speeds ranging from 1.23-1.34 meters/second (Table 16). Additionally, stopping behavior characterized between 0-7% of all GPS points occurring within the buffers surrounding unoccupied locations.

Table 15. *Average time spent, average speed, and number of stops made in buffers around occupied/incidental & unoccupied CAGN locations for all GPS tracked visitors. CAGN location sample sizes are 102 occupied/incidental and 182 unoccupied.*

	Occupied/Incidental					Unoccupied				
Buffer Size	**Average time spent** (mm:ss)	**SD** (mm:ss)	**Average speed** (m/sec)	**SD**	**#/ (%) stops made**	**Average time spent** (mm:ss)	**SD** (mm:ss)	**Average speed** (m/sec)	**SD**	**#/ (%) stops made**
2m	00:12	00:04	1.08	0.58	1 (14%)	00:12	00:05	1.34	1.16	6 (5%)
10m*	00:18	00:14	1.25	0.97	10 (6%)	01:07	01:47	1.24	0.98	153 (6%)
25m*	01:01	00:54	1.27	0.94	61 (5%)	01:52	02:14	1.26	1.02	280 (6%)
50m*^	02:01	01:48	1.35	1.17	169 (5%)	03:24	03:07	1.26	1.02	569 (6%)
75m*^	02:55	02:35	1.34	1.16	385 (6%)	04:36	04:09	1.27	1.05	931 (6%)

Average time spent:
*Statistically significant difference between occupied and unoccupied locations (*p-value*<.001)
Average speed:
^Statistically significant difference between occupied and unoccupied locations (*p-value*<.001)

Table 16. *Average time spent, average speed, and number of stops made in buffers around occupied & unoccupied CACW locations for all GPS tracked visitors. CACW location sample sizes are 72 occupied and 275 unoccupied.*

	Occupied					Unoccupied				
Buffer Size	**Average time spent** (mm:ss)	**SD** (mm:ss)	**Average speed** (m/sec)	**SD**	**#/ (%) stops made**	**Average time spent** (mm:ss)	**SD** (mm:ss)	**Average speed** (m/sec)	**SD**	**#/ (%) stops made**
2m	00:11	00:02	1.06	0.74	1 (5%)	00:11	00:03	1.34	0.68	0 (0%)
10m*	00:20	00:12	1.27	1.00	29 (6%)	00:27	00:23	1.28	1.03	38 (6%)
25m*	00:49	00:30	1.30	1.07	92 (6%)	01:08	01:07	1.30	1.19	151 (6%)
50m*	02:01	01:27	1.28	1.09	271 (6%)	02:54	02:53	1.26	1.10	490 (6%)
75m*^	03:34	02:35	1.29	1.13	523 (6%)	05:20	05:25	1.23	1.06	962 (6%)

Average time spent:
*Statistically significant difference between occupied and unoccupied locations (*p-value*<.001, 5m: *p-value*=0.003)
Average speed:
^Statistically significant difference between occupied and unoccupied locations (*p-value*<.001)

Distance between recreation use and occupancy survey results for CAGN and CACW:

The distances between every GPS tracking point and the sampling locations for the two bird species were calculated and summarized. The results were heavily skewed (see figures D.6 and D.7 in Appendix D), thus median distances are reported. The median distance between GPS tracking points and occupied CAGN locations was 76 meters compared to 38 meters for unoccupied CAGN locations (Table 17). The mean distance between GPS tracking points and occupied CACW locations was 131 meters compared to a median of 104 for unoccupied CACW location (Table 17). This indicates that recreation activity was closer to the unoccupied locations than the occupied locations for both species.

Table 17. *Median closest distance between occupied/incidental and unoccupied CAGN and CACW locations for all GPS tracked visitors. CAGN location sample sizes are 101 occupied/incidental and 176 unoccupied. CACW location sample sizes are 72 occupied/incidental and 267 unoccupied.*

	Median closest distance (meters)	Max (meters)	Min (meters)
CAGN			
Occupied/incidental	75.71	4089.08	0.71
Unoccupied	38.07	4244.50	0.00
CACW			
Occupied/incidental	131.63	3795.88	0.50
Unoccupied	104.91	5276.84	0.50

In summary, key findings include:

- Approximately 96% of recreation activities occurred outside of sensitive, Coastal Sage Scrub habitat, but over a third of all visitor tracks entered sensitive habitat at some point during their visit to the Reserve.
- A small percentage (5% or less, depending on the species) of GPS tracking points overlapped with areas surrounding the CAGN and CACW documented locations. There was more overlap between the unoccupied locations compared to the occupied locations, but this could be due to a larger sample size of unoccupied locations for both species.
- Visitors spent more time on average recreating, and moved more slowly around unoccupied locations for CAGN and CACW compared to occupied locations.
- Results show that recreation activity occurred closer to the unoccupied CAGN and CACW locations in comparison to the occupied locations.

Summary of Findings and Management Implications (Implications, Future Research, and Monitoring)

An analysis of basic demographic information of visitors revealed that male and female visitors tend to recreate with near equal frequency. In general, visitors to the Reserve are more likely to be white and highly educated than the general population in Orange County. While the overall ethnicity of visitors varies by recreation site, it appears that the population of the Reserve is not representative of the population of the surrounding county. This lack of diversity in outdoor recreation participation is not unique to Orange County (Outdoor Industry Association, 2018). These findings indicate that there may be constraints to visitation to Reserve lands for certain demographics. These could include lack of information, lack of transportation, or any number of factors (safety, lack of a sense of belonging, etc.). Additional studies of non-visitors would need to be conducted to determine why individuals of certain demographics are not recreating on Reserve sites. It is also important to consider that the racial and ethnic makeup of visitors to *these* Reserve units studied does not reflect the racial and ethnic makeup of visitors to *all* Reserve units in Orange County. Other units, such as Irvine Regional Park (not examined in this analysis), may better serve the diverse population of recreators in Orange County.

The most common activities that visitors participate in, how far they travel to recreate, and how long visitor recreate at a given location varies by management unit. However, perceptions of crowding, level of satisfaction and visitor motivations appear to be similar across the Reserve. This indicates that cross-jurisdictional management could focus on managing the quality of the visitor experience across management units and the Reserve as a whole.

Visitors to Reserve units in Orange County are highly motivated by nature and exercise. The strength of the nature dimension as revealed in the 2017 visitor motivation scale was quite surprising. Interestingly, in 2018, when visitors were asked to self-categorize their motivations into exercise or nature-oriented categories, visitors tended to describe their motivations as exercise based—though 82% of visitors indicated some or a strong motivation for a nature-oriented experience. These results indicate that having a nature-based experience, even if a visitors' primary motivation is exercise, is important to the vast majority of Reserve visitors. This holds true even when visitors were asked about their motivations for visiting in two very different ways (i.e. the long-format motivations scale administered in 2017 and the short-form question administered in 2018).

Visitor use densities vary by management unit, but overall use in each unit is broad in extent (some visitors travel throughout the trail system). High use areas are easily identified at most locations. In terms of visitor use levels, while use levels vary by site, most locations experience pulses of use before and after work on weekdays and generally higher levels of use on the weekends (see detailed results for each Reserve unit studied in Appendix A). While visitors to the Reserve generally do not feel crowded, are satisfied with their visit, and tend to be repeat visitors, some visitors indicate adjusting the timing of their recreation experience to avoid these predictable and consistent times of high use. Thus, visitors who may feel crowding or have unsatisfactory experiences may be making decisions to allow them to cope with use levels they may find undesirable (not coming before or after work).

Visitors whose primary activity is mountain biking have distinct behavior and spatial use patterns when compared with other primary activity types. A high proportion of mountain bikers' use of the fitness and self-tracking app Strava provided opportunities to analyze behavior of app users compared to the

general population of mountain bikers. Use of the app is associated with higher velocities on segments of trail—and patterns of directional trail use may be influenced by the start-finish orientation of trail segments users race for the fastest times.

Visitor use does overlap with some sensitive areas of wildlife habitat. However, analysis of the overlap between recreationists and sensitive wildlife habitat revealed the spatial behavior of visitors to the Reserve did not overlap to a great extent with the Coastal Sage Scrub habitat or occupied/unoccupied locations of the California gnatcatcher (CAGN) and cactus wren (CACW). Yet, a key finding of this study was that more recreation activity occurred around unoccupied locations for these birds species in comparison to areas where the birds where actually found when surveyed. Thus, these results imply outdoor recreationists may not be a current significant threat to these species, and managers should focus more on preventing habitat loss and fragmentation, a well-documented cause of the decline of these species' populations (Crooks et al., 2001). Additionally, managers could utilize the habitat data and location data for the two species when planning new trail development, as to avoid building new trails or buildings around where these species are found. Further research could also be warranted into the response of these species to outdoor recreation as specifics related to these species sensitivity to recreation use is not well understood. Despite the lack of literature specifically related to the CAGN and CACW and recreation, recent studies have indicated that recreation use itself has greater impacts on bird species compared to the impacts related to trail development (Botsch et al., 2018) and that subtle differences in recreation activity type (running vs. walking) results in more substantial differences in the level of disturbance experienced by a variety of bird species (Lethlean et al., 2017).

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Appendices

Appendix A: Visitor Use Estimation

Appendix B: Additional Visitor GPS-Based Tracking and Survey Results

Appendix C: Additional Resource Impact Analyses

Appendix D: Additional Visitor Use Patterns and Sensitive Resources Methods, Flowcharts, and Results

Appendix E: Visitor Survey Instruments