SIERRA CLUB
SAN DIEGO CHAPTER

March 11, 2021

Mayor Mary Casillas Salas
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Maria V. Kachadoorian, City Manager
Tiffany Allen, Director of Development Services
Kerry K. Bigelow, City Clerk

City of Chula Vista
276 Fourth Avenue
Chula Vista, CA 91910

msalas@chulavistaca.gov
jmccann@chulavistaca.gov
jmgalvez@chulavistaca.gov
spadilla@chulavistaca.gov
acardenas@chulavistaca.gov
mkachadoorian@chulavistaca.gov
kbroughton@chulavistaca.gov
cityclerk@chulavistaca.gov

Subject: Sierra Club comments on pilot program to open Rice and Snake canyon trails to mountain biking in the Rancho Del Rey Community

Dear Mayor Salas and City of Chula Vista leaders:

On behalf of our more than 15,000 members, the Sierra Club San Diego Chapter opposes the City of Chula Vista's (City) proposal for a pilot program to open Rice and Snake canyon trails to mountain biking in the Rancho Del Rey Community (mountain bike pilot project).

Sierra Club San Diego supports mountain biking as an outdoor recreational activity but the mountain bike pilot project does not appear to include a detailed plan and necessary resources for successful implementation as currently proposed.

The mission of the Sierra Club is "To explore, enjoy, and protect the wild places of the earth; To practice and promote the responsible use of the earth's ecosystems and resources; To educate and enlist humanity to protect and restore the quality of the natural and human environment; and to use all lawful means to carry out these objectives." Mountain biking has the potential to support our mission but also has a well-documented history of abuse. As such, City decisionmakers should be aware of the significant planning, environmental review, resources, and funding necessary to adequately manage responsible mountain biking and ensure that such resources are available prior to authorizing new mountain biking in the City.

One important consideration for the mountain bike pilot project is the primary purpose of natural open space like Rice and Snakes canyons for preservation of endangered species and habitat as mitigation for resources lost to development elsewhere in Chula Vista. Mountain biking and other recreational trail use is allowable only to the extent it remains compatible with the leading priority of species and habitat preservation. As such, a pure balance between habitat preservation and recreation is neither desirable nor appropriate when the habitat values for which the land was originally preserved must be prioritized above all other demands and uses.

With regard to the decision-making process, the mountain bike pilot project must comply with the City of Chula Vista [Multiple Species Conservation Plan] Subarea Plan (MSCP Subarea Plan). Under the MSCP Subarea Plan, mountain biking is allowed as a permitted use on trails located in the least sensitive areas of the City's MSCP preserve in specified locations identified in area-specific management plans.

> Limited public access and passive recreation are permitted uses within the Preserve.[1] … Passive recreation includes hiking, bird watching and, <u>under specified locations identified in approved projects and/or area-specific management plans</u>, mountain biking… Equestrian use, hiking and bicycles may be allowed when in accordance with this Subarea Plan, as determined by the Appropriate Managing Entity.[2] Locate trails, view overlooks, and staging areas in the least sensitive areas of the Preserve.[3]

In this case, the City of Chula Vista would be the "Appropriate Managing Entity" and the mountain bike pilot project would necessarily require a detailed project description, implementation plan and schedule, budget, and public review and analysis under the California Environmental Quality Act to serve as an "area-specific management plan". But there is no such qualifying plan as required by the Subarea Plan. Outdated plans for the Rancho Del Rey community that identify trails in this area do not satisfy the requirements of an area-specific management plan because they pre-date the MSCP Subarea Plan and do not include important specific measures and resources necessary to manage mountain bike use or protect species and

[1] Chula Vista MSCP Subarea Plan Section 6.2.1.1.
[2] Chula Vista MSCP Subarea Plan Section 6.2.1.3 (emphasis added).
[3] Chula Vista MSCP Subarea Plan Section 7.5.3.3.

habitats covered under the MSCP Subarea Plan. Nor is the award of the SANDAG grant funding for this proposal a legitimate area specific management plan.

The popularity of mountain biking is rapidly increasing with many riders expressing a strong sense of entitlement and rationalizations for riding wherever and however they desire. Construction and use of unauthorized trails are serious problems at nature preserves where mountain biking is authorized on legitimate trails such as the Del Mar Mesa Preserve and Mission Trails Regional Park in the City of San Diego. Dozens of miles of unauthorized trails have been constructed by mountain bikers on the Del Mar Mesa Preserve alone (see attached maps of Del Mar Mesa Preserve unauthorized trails). And some mountain bikers have actively vandalized fencing and signs and even stolen security cameras installed by City of San Diego rangers and volunteers to close and block unauthorized trails (see attached photographs of Del Mar Mesa Preserve unauthorized trails and vandalism). Many more mountain bikers regularly use closed trails out of sometimes legitimate but more often feigned ignorance. Speeding, failure to yield to other trail users, amplified music, construction of tracks with jumps and embankments, and nighttime trail use are other common problems with mountain bike use.

The conclusion that mountain bikers are responsible for construction and use of so many unauthorized trails and vandalism on local preserves is grounded in science. According to a study of enforcement efforts to curb unauthorized trail uses on the Del Mar Mesa Preserve[4], mountain bikers comprised 76.7% of all users and over 85.5% of illegal use at the Preserve. The study followed mountain biking forums on social media and found that comments frequently supported vandalism or implied vandalism. The study also reported that once information on specific locations of study trail cameras was released on social media, the likelihood increased that the camera would be vandalized, removed, or covered.

The City of Chula Vista must recognize these common and entirely foreseeable problems and include at least the following measures in an area specific management plan to address these issues before, not after authorizing mountain biking on City preserves.

- Any legitimate authorized trail system, uses, rules, and environmental conditions must be presented in an area specific management plan reviewed and approved by the City under the California Environmental Quality Act and reviewed and approved by the California Department of Fish and Wildlife and U.S. Fish and Wildlife Service for consistency with the MSCP Subarea Plan prior to authorization of new trails or trail uses.
- Trail users must be considered responsible for knowing the location of authorized trails and preserve and trail rules. Claimed ignorance of the location of authorized trails or rules must not be considered acceptable excuses for violation of rules.

[4] Greer et. al. 2017 (attached).

- Any legitimate authorized trail system must be clearly delineated on paper and digital maps readily available to users online and at trailheads prior to authorization of new trails or trail uses. Trail maps should communicate that trail users will be held responsible for knowing the location of authorized trails and preserve and trail rules.
- Unauthorized trails must be mapped and detailed plans and resources provided for closure and restoration of unauthorized trails prior to authorization of new trails or trail uses.
- Baseline trail conditions and locations must be established prior to authorization of new trails or trail uses and the extent of subsequent unauthorized trail use quantified at least quarterly. Mountain biking must be suspended in the event of documented use of unauthorized trails.
- An approved budget, dedicated staff, and volunteer management infrastructure must be in place prior to authorization of new trails or trail uses including:
    - Installation of all fence and signs with an adequate supply of materials available for replacement following foreseeable vandalism.
    - Contracts for trail maintenance and control of invasive non-native weeds.
    - Contracts for active habitat restoration of existing and foreseeable new constructed unauthorized trails.
    - Rangers regularly present days and nights with authority to write citations.
    - Regular scheduled concentrated law enforcement against use of unauthorized trail and other rule breaking.
    - Organized and active volunteers for peer-patrols and trail maintenance.
    - Organized and active engagement in mountain biking social media to encourage responsible mountain biking.
- The City should establish a means to generate funding for the above activities to manage mountain bike recreation. The City should consider a tax or fee on purchases of mountain bikes or accessories and/or a permit required for use of City trails.
- The City should establish clear trail rules to protect resources and experiences of other trail users prior to authorization of new trails or trail uses including:
    - Prohibit amplified music or other electronic audio.
    - Prohibit motorized vehicles including electric bicycles
    - Establish speed limit of 10mph.

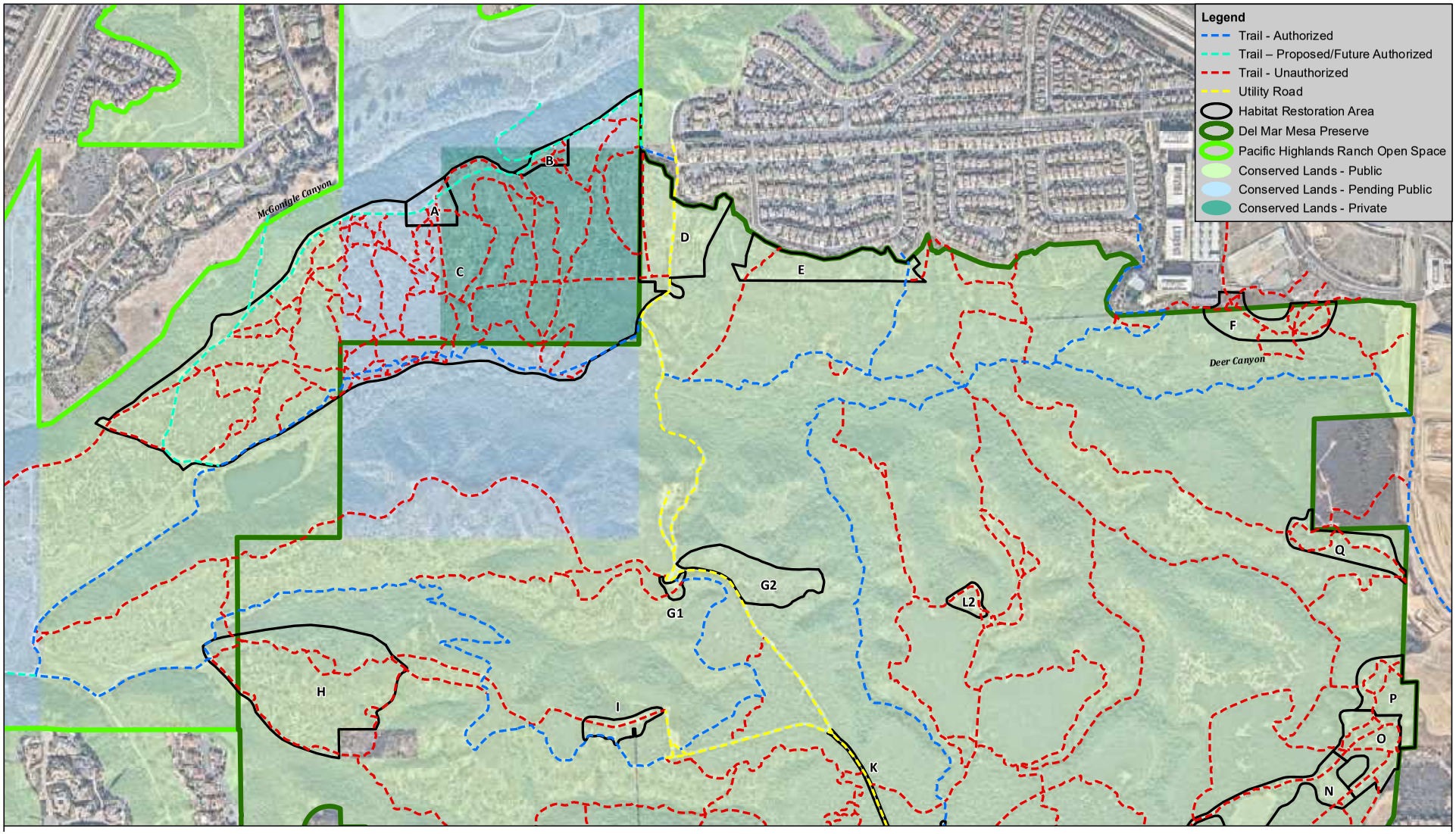
- Bicycles must yield to all other types of trail users.
- Prohibit construction of jumps and embankments.
- Prohibit nighttime use.

Sierra Club San Diego respectfully requests that you delay implementation of the mountain bike pilot program pending preparation of an area specific management plan and availability and dedication of the significant resource necessary to manage the mountain bike pilot program.

Sincerely,

George Courser

George Courser
Chair, Sierra Club San Diego Conservation Committee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Habitat Restoration Area
Del Mar Mesa Preserve
Pacific Highlands Ranch Open Space
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Conserved Lands - Private
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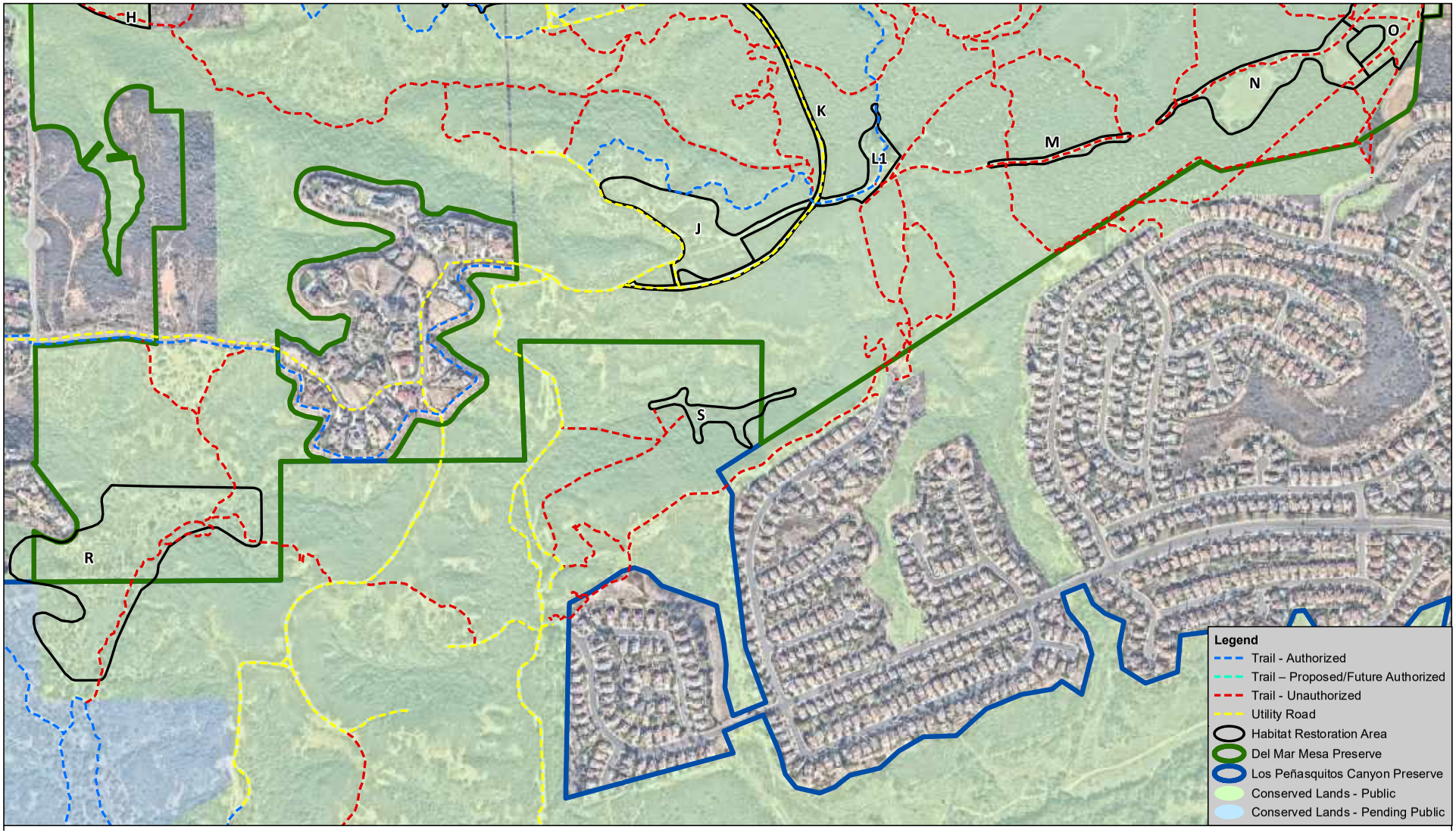
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Trail - Unauthorized
Utility Road
Habitat Restoration Area
Del Mar Mesa Preserve
Los Peñasquitos Canyon Preserve
Conserved Lands - Public
Conserved Lands - Pending Public

ABOVE – Mountain biker on closed trail on Del Mar Mesa Preserve (2020).

BELOW – Vandalized sign and cut fence (2020).

ABOVE – Closed and recovering unauthorized trail spring 2020.

BELOW – Same trail with cut fence and mountain bike tracks autumn 2020.

ABOVE – Closed and recovering unauthorized trail spring 2020.

BELOW – Same trail with cut fence and mountain bike tracks autumn 2020.

ABOVE – Vandalized fence with mountain bike tracks.

BELOW – New constructed mountain bike trail bypassing fenced and signed unauthorized trail.

ABOVE & BELOW – Vandalized fence to access unauthorized mountain bike trails.

ABOVE – Unauthorized mountain bike track constructed in vernal pools (2021).

BELOW – Unauthorized mountain bike track in wildlife corridor (2020).

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Efficacy and perception of trail use enforcement in an urban natural reserve in San Diego, California

Keith Greer*, Katherine Day[1], Sarah McCutcheon[2]

Environmental Planning Department, San Diego Association of Governments, San Diego, CA 92101, USA

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ABSTRACT

This article presents results of enforcement efforts to curb unauthorized trail uses in an urban nature reserve of San Diego, California. We assessed the effectiveness and longevity of enforcement efforts by measuring behavioral changes to redirect users to authorized trails. The study was conducted from May through December 2013 and included photo motion cameras to document human use in three periods: prior to enforcement, during enforcement and after enforcement conducted by California Department of Fish and Wildlife Wardens. In addition, social media sites were monitored to determine user perceptions and attitudes. A total of 7155 photo captures were collected over the 170-day study period. Mountain bikers were the greatest number of users (both legal and illegal) and declined significantly post enforcement. Results demonstrated that enforcement was an effective tool in reducing and sustaining the amount of unauthorized uses in the open space reserve (66.0% decline). Enforcement, however, led to hostility among key user groups that may be counterproductive to larger management effectiveness, as users may go to other unenforced areas for recreation. Lessons learned include the need to balance enforcement; with ample authorized trails for recreational opportunities in natural areas, and the importance of social media in providing ongoing user education, outreach and self-policing forums to discourage unauthorized activities.

Management Implications:

- Management activities to change user behavior through education, signage and outreach can be ineffective in some areas leading to chronic, self-perpetuating problems affecting those resources that were set aside for conservation and outdoor recreation.
- While hard enforcement actions was shown to be a highly effective tool in changing the behavior of users, it can lead to hostility, miscommunication, and create adversity among constituents that could be some of the greatest stewards of urban natural areas.
- Social media was determined to be a highly powerful outreach tool for recreationalist, yet untapped by land managers for promoting prosocial behavior.
- A better understanding of user precipitations, rational for non-compliance and utilization of self-policing polices is needed prior to initiating a hard enforcement campaign.

1. Introduction

The demand for outdoor recreation and nature-based tourism has increased globally over the past fifty years due to increased population, increased leisure time, rise in ecotourism, and increased access to outdoor recreation (Balmford, Beresford, & Green, 2009; Cordell, Betz, & Green, 2008; Jensen & Gutherie, 2006; Page & Dowling, 2002; Steven, Pickering, & Castley, 2011; Monz, Pickering, & Hadwen, 2013). In the United States, almost half of all Americans, or 141 million people, participate in outdoor recreation (Outdoor Foundation, 2015). Non-consumptive outdoor recreation use such as hiking, mountain biking and horseback riding (sometimes referred to passive recreation) (Duffus & Dearden, 1990), is perceived by many users to cause little disturbance to open space areas (Marion & Wimpey, 2007), but can cause unintended negative impacts, especially in sites with high sensitivity (Hadwen, Hill, & Pickering, 2007).

The field of Recreation Ecology studies the impacts of recreation users on various biotic and abiotic elements of the landscape (Wagar, 1964). Studies have shown that various types of passive outdoor recreation can result in displacement and reduction of wildlife

* Corresponding author.
[1] Current address: Bren School of Environmental Science and Management, University of California Santa Barbara, Santa Barbara, CA 93106, USA.
[2] Current address: AECOM, 401 West A Street, San Diego, CA 92101, USA.

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(George & Crooks, 2006; Miller, Knight, & Miller, 2001; Taylor & Knight, 2003; Reed & Merenlender, 2008, 2011), the trampling of native habitat and species (Boyle & Samson, 1985; Hardiman & Burgin, 2013), and impacts to soil and water resources (Leung & Marion, 1996; Marion & Wimpey, 2007). Marion and Wimpey (2007) point out users may not be aware of their impacts or legality of their actions. This balance between recreational use and natural resource conservation has become a key element of land management around the world (Leung & Marion, 2000).

To ameliorate the unintended consequence of recreation users, land management strategies include: (1) education of users about potential impacts, (2) containment of uses to areas more resistant to impacts, and (3) disbursement of users to reduce the volume of use (Leung & Marion, 1999). Wynveen, Bixler, and Hammitt (2007) further characterize management activities into soft and hard enforcement actions (this is synonymous to Manning, 1999 indirect and direct management). Soft enforcement aims to reduce illegal use through education, interpretive signage and community relations, while hard enforcement relies on use of tickets, citations and arrests. Education and other soft enforcement actions have been shown to lessen the unintentional consequences of outdoor recreation (Bromley, Marion, & Hall, 2013; Marion & Reid, 2007). For example, Littlefair and Buckley (2008) reported using interpretive messages with the presence of a role model and verbal appeals as the most successful combination in reducing non-compliant behavior in trail usage. Unfortunately in areas with chronic cases of non-compliant use, soft enforcement actions become less effectual and hard enforcement actions become necessary (Gibson, Williams, & Ostrom, 2004; Hilborn et al., 2006; Leung & Marion, 1999). Park, Manning, Marion, Lawson, and Jacobi (2008) noted that 20 years of research points towards the combination of soft and hard enforcement as being most effective in promoting compliance. Hendee and Dawson (2002) recommended that land managers try to use soft enforcement actions first before switching to hard, authoritative direct management techniques.

1.1. Non-compliance theory

Non-compliant behavior is one of the most significant problems reported by management at nature based tourist establishments (Fredman, Romild, Emmelin, & Yuan, 2009; Gramann, Bonifeld, & Kim, 1995; Ward & Roggenbuck, 2003). An outdoor user can identify themselves as having strong environmental conservation values, but still perform non-compliance behavior with environmental regulations (Goh, 2015). So what causes this behavior?

In psychology, the Theory of Planned Behavior (abbreviated TPB) links values and behavior. The three elements of TPB include; an individual's attitude to perform a particular action, the subjective societal norm about that action, and an individual's perceived ease or difficulty in performing a particular behavior. Reviewing non-compliance with trail regulations, Goh (2015) states, "*if a visitor has positive attitudes towards venturing off-trail, has support from important reference groups to venture off-trail and perceives little difficulties in venturing off-trail, he/she will have a higher chance of performing the off-trail behavior*."

Land managers must look at non-compliant behavior as a summation of user's attitude, societal norms and the ease or difficulty of the non-compliance behavior. While values remain relatively fixed for an individual, attitudes are more flexible depending on the surrounding context and social norms. This is related to Wilson and Kelling's (1982) "broken window" theory, where observed unenforced illegal activities encouraged others to expand and continue to reinforce the behavior (also see Stevens (2009)). Using Goh's example, a user's value may be towards natural habitat conservation, but the combination of observed non-compliance by other users, and the ease of non-compliance, may soften or switch their attitude toward unauthorized off-trail use. Additional studies in applying TPB to non-compliance behavior in National Parks include: hunting (Hrubes, Ajzen, & Daigle, 2001), petrified wood theft (Ward & Roggenbuck, 2003), walking dogs off leash (Nesbitt, 2006), and feeding wildlife (Ballantyne & Hughes, 2006).

Land managers aim to encourage prosocial behavior of outdoor users through education and other soft enforcement activities. These efforts are aimed to reinforce a user's attitude towards regulatory compliance and maintain a larger positive societal norm for compliant behavior. Land managers also make it more difficult for non-compliance through hard enforcement activities (International Network for Environmental Compliance and Enforcement , 2009).

1.2. Hard enforcement effectiveness

Little literature exists on how effective hard enforcement actions are in curbing illegal use in nature reserve areas, and how long the effectiveness lasts (Budruk & Manning, 2003; Chavez & Tynon, 2000; Wynveen et al., 2007). While there is limited topic specific literature, general literature from criminology can be used to help guide an enforcement program for trail use, and understand its efficacy. De Waard and Rooijers (1994) evaluated the effectiveness of different methods and intensities of hard enforcement activities to reduce driving speeds on motorways. Their results showed that the largest and longest lasting reduction in driving speed occurred after a high intensity of enforcement, giving support for a direct relationship between fear of citation and speed of choice (De Waard & Rooijers, 1994). The potential of enforcement deters the current non-offender from speeding. Similar experimental approaches have been used to determine the effectiveness of hard enforcement actions for compliance with seat belt (Rood, Kraichy, & Carmen, 1987) and bicycle helmet laws (Gilchrist, Schieber, Leadbetter, & Davidson, 2012). Similar to findings by Park et al. (2008), these studies found that a combination of soft (education) and hard enforcement (ticketing and/or seizure) were more effective in combination than separate. They conclude that a successful, cost-efficient enforcement program would start with an education and outreach blitz and then integrate enforcement into regular traffic duties. Rood, Kraichy, & Carmen (1987) further state that an ongoing public information effort is key to "*enhance and maintain the public's perception of enforcement*" and retain a positive attitude toward the law.

Gavin, Solomon, and Blank (2009) indicate that there is no panacea, and conservation would benefit from more research on the cost effectiveness and time efficiency of hard enforcement efforts. In addition, hard enforcement actions may have consequences on the user's outdoor experience (both for legal and illegal users) and their future support for conservation (Goh, 2015; Marion, 1998; Wynveen et al., 2007). To be effective stewards of natural areas, we must understand the efficacy of hard enforcement actions as a resource management tool, and any unintended consequences of its use.

1.3. Focus of study

The focus of this paper is to determine if hard enforcement actions involving regulations across an urban nature reserve are an effective method of land management. Specifically, this enforcement study (hereafter: Study) focuses on three questions: (1) what is the effectiveness of enforcement leading to a change in non-complaint behavior, (2) if there is a change, does it persist after enforcement is stopped, (3) what are the users attitudes during and after the enforcement activities. The consideration of user attitudes toward the reserve and enforcement methods helps to gain insight into the societal implications of this type of management action.

2. Background

The City of San Diego (hereafter: City), is a growing metropolitan area located in the southwestern corner of the continental United States and is a nationally recognized hot spot for biodiversity and endangered species (Dobson, Rodriguez, Roberts, & Wilcove, 1997; Rutledge et al., 2001), and a region under tremendous growth pressure (San Diego Association of Governments (SANDAG), 2013). As the City expands its urban footprint, native habitat areas are lost to development. In order to preserve natural resources, provide passive outdoor recreation, and maintain scenic and visual relief for its residents, the City has established an interconnected system of nature reserves (City of San Diego, 1997). One of these nature reserves, the Del Mar Mesa Preserve (hereafter: Preserve) is an 866-acre unit of undeveloped chaparral and scrub habitat, managed to benefit both native flora and fauna while allowing compatible recreational uses (City of San Diego, 1997). Part of the Preserve is included in the National Wildlife Refuge (USFWS, 2015).

Nature reserves in close proximity to urban areas have been shown to have higher instances of illegal activity (Wynveen et al., 2007). While poaching, off-highway vehicles, dumping, and other crimes have been eradicated from the Preserve, illegally created "social trails[3]" have become popular among recreational users who enjoy off-trail biking, jogging, and equestrian activities. Mountain biking, hiking, and horseback riding are currently authorized uses, but are restricted to the north/south service road within the Preserve. Any recreational use that occurs outside of the sanctioned paths within the Preserve is considered unauthorized.

In December 2010, the City commissioned a recreational use survey by Rincon Consultants, Inc (hereafter: Rincon) to document the visitor usage of trails in the Preserve (Rincon, 2011). The survey was conducted to aid the City in developing recommendations for management actions. Six cameras were set up for achieving a "snapshot" of visitor use on the trails starting December 30, 2010, and continued until January 26, 2011. A total of 980 users were captured on the cameras, with mountain biking as the most common use (77%). Based on their findings, Rincon recommended that the City increase enforcement, install deterrent signage and restrictive fencing, and implement a combination of tactical native plantings and placement of woody debris (Rincon, 2011).

Following Rincon's recommendations, City Park Rangers (Rangers) initiated a campaign of soft enforcement activities targeting user education and signage. Rangers held community meetings, provided educational handouts, and placed interpretative signage around the Preserve to educate users about the trail system, protection of local habitats, and the importance of staying on designated trails. An activity log from a Ranger provides a snapshot of outreach efforts, indicating that from December 16, 2011, to May 20, 2013, 63 out of 66 "patrol days" included aspects of education and information sharing, and 25 days were spent installing and repairing signage. Despite these efforts, Rangers were unable to keep up with the vandalism of signs, and it became cost-prohibitive to use official metal signs. Similar to findings by Chavez and Tynon (2000), the Rangers noted that their job had been changed from one of natural resource management to law enforcement.

Despite these outreach and education efforts, as well as access control measures (barriers and fencing), violations continued to increase on the Preserve. Non-compliance became the social norm as more users followed expanding numbers of social trails following Wilson and Kelling's (1982) "Broken Window" theory. As the new social trails pushed further into sensitive resources, concerns were raised by federal and state wildlife agencies on the impacts to the protected wildlife. In 2013, the City requested assistance from the SANDAG[4] to coordinate a project using hard enforcement actions with California Department of Fish and Wildlife Service Wardens.

3. Methods

SANDAG, United States Geological Survey (USGS), California Department of Fish and Wildlife (CDFW), and City staff designed a methodology that built off the 2011 Rincon study, to test the effectiveness of hard enforcement. Using a statistically robust design, trail use was evaluated before, during, and after CDFW Warden enforcement activities. Unlike Rangers, CDFW Wardens are sworn peace officers that can enforce state law and local ordinances against violators in natural resource areas with full powers of detention and arrest.

3.1. Study area

A network of 53 separately owned parcels; the 866-acre Preserve was selected as a pilot area due to requests from the City and its long history of recreational use conflicts described in the Background section. Despite the complexity of federal, state and local government ownerships at the Preserve, the underlying goal is the protection of natural resources among the various land managers. To date over $7.3 million has been invested in acquiring land to promote both the City's open space system and the USFWS' National Wildlife Refuge on the Preserve.

3.2. Enforcement schedule

Hard enforcement (hereafter: enforcement) followed a yearlong soft enforcement effort to curb unauthorized use via community outreach, physical barriers, and signage by Rangers. Trail use data were collected in three monitoring periods: a seven week pre-enforcement period (May 29, 2013 to July 19, 2013) in which signage, fencing, and cameras used for monitoring were in place, but no enforcement efforts occurred, a twelve week enforcement period (July 20, 2013 to October 2, 2013), in which active enforcement was provided by the CDFW Wardens, and a six week post enforcement period (November 7, 2013 to December 19, 2013), which had no enforcement but trails were monitored using cameras. This "before-during-after" study design allowed for a more rigorous analysis of the ability of enforcement to influence user behavior and to determine the duration of any change in use.

Based on the recommendations of the Rincon study (2011) and City staff, CDFW Wardens patrolled the Preserve mainly on weekends and Wednesdays. The weekend patrols occurred throughout the day, and the weekday patrols occurred mainly during the noon hour and after 4 p.m., yet CDFW Wardens avoided a completely predictable schedule so users did not avoid the Preserve at those times. The CDFW Wardens reported the days and times when they either made contact with a person participating in illegal activity, issued a warning, or issued a citation. The CDFW Wardens spent a total of 810 h in the field during the enforcement period of this Study.

3.3. Trail use data collection

Motion detection cameras are widely used for detection and abundance estimate of wildlife in animal ecology studies (O'Connell, Nichols, and Karanth, 2010). We applied this same technology to address change in human trail use prior, during and after the initiation of enforcement. Working with scientists at the USGS and CDFW, SANDAG and City staff followed an improved version of the Rincon study (2011) to better detect changes and trends in recreational use in

[3] A social trail is an unplanned trail caused by repeated use of desired pathways by various user groups (Bradford & McIntrye, 2007).

[4] The San Diego Association of Governments is a regional council of 18 local governments that assist local jurisdictions with issues of regional concern.

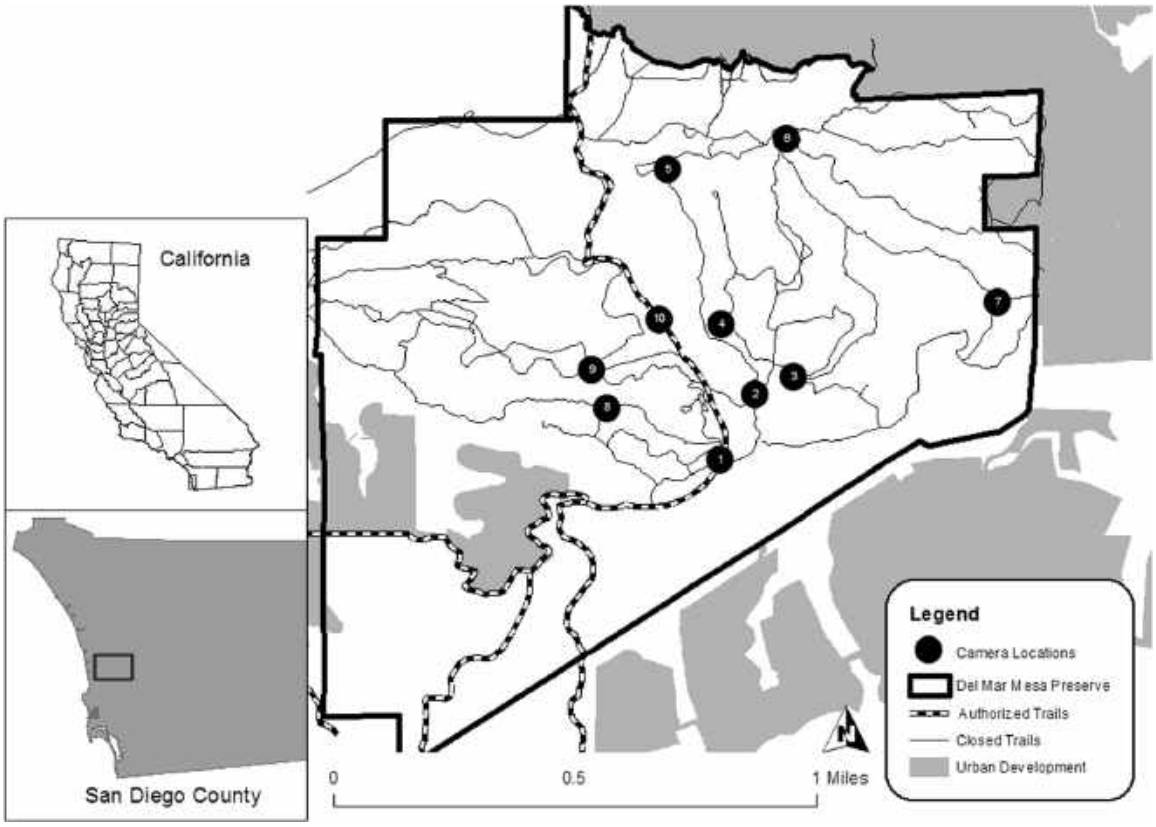

Fig. 1. Del Mar Mesa preserve study area.

the study area.

City staff and Rangers placed Bushnell Trophy Cam High Definition (HD) wildlife camera traps in ten locations throughout the Preserve to capture users on all authorized trails and surrounding unauthorized trails traversing key areas of wildlife habitat (Fig. 1). Where possible, cameras were installed low to the ground in order to prevent the capture of identifiable facial information. Cameras were also angled down the trails to provide more time for the camera to trigger and capture activity, rather than angled directly across trails. Eight cameras (No. 2 though No. 9) were placed on closed trails previously identified by Rangers as areas that received varying levels of illegal off-trail recreational activity. The remaining two cameras (No. 1 and No. 10) were positioned on open, approved trails. Camera No. 1 was placed at the split of a legal trail and an illegal trail. Images collected from this camera were evaluated carefully and divided into legal or illegal use; any photograph where this was not clear was marked as unknown and discarded from analysis.

The Bushnell Trophy Cam HD is equipped with a motion sensor and a 0.6 s trigger speed. Based on prior work by Rincon (2011) and field-testing, this speed was adequate to capture fast moving users on mountain bikes, without a high rate of missed images. Each camera was pre-loaded with an eight-gigabyte storage card and placed within a locked, camouflaged security box. Cameras were affixed to sturdy trunks of shrubs with heavy-duty zip ties. City Open Space management interns retrieved images weekly, and routinely monitored the camera settings to ensure proper functionality. Each capture was recorded as a single entry containing type of user, time of day, and number of users in the photo. All captures were recorded, but only “legitimate" triggers of the camera were included in the analysis and excluded captures of field staff setting up the cameras, accidental triggers from brush, and duplicate captures of the same users.

Throughout the Study period, Rangers, interns and volunteers monitored cameras in order to identify, minimize, and correct vandalism quickly to prevent further data loss. Vandalism experienced included the theft of two cameras, the placement of brush over cameras to block the motion-sensitive trigger, and manipulations of the lock box and supporting structure to point the cameras away from their intended position.

3.4. Social media tracking

To address our research question of changes in the attitudes of recreation user prior, during and after the enforcement activities, we tracked posting on social media sites. This gave us an unfiltered insight into user's views and the societal implications of this type of management action in real time. The Preserve is primarily used by hikers, joggers, horseback riders, and mountain bikers. However, the Rincon study (2011) showed that mountain bikers comprised the largest majority of all users (77%). For this reason, mountain bikers represent an important community on the Preserve, so information regarding their perspectives of the Study was desired. Additionally, an exhaustive search for other blogs, websites, and forums for hiking and equestrian groups did not reveal any posts referencing the Study, limiting social media monitoring to mountain biking forums. Fortunately, the mountain biking community is well organized, and a majority of all mountain biking comments were found on three active blogging sites: San Diego Mountain Biking Association (sdmba.com), a Southern California mountain biking forum (Dirttreaders.com), and a national mountain biking forum (Mtbr.com). The forums are used by mountain bikers to share reviews on equipment and trails, and to express their opinions, sentiments, and concerns on developments in the mountain biking community. Monitoring active online mountain biking forums provided an avenue to track the responses and perceptions of users. Additionally, the posts shed some light on the effectiveness of the Study.

One of the authors searched all three forums using key phrases, such as: Del Mar Mesa, City of San Diego, enforcement, and trail closure, among others, to scan for threads relating to the Preserve or enforcement. This included threads started specifically on the topic of

the Preserve or enforcement, as well as threads on other topics that included comments about the Preserve or enforcement. Additionally, if a news article was released about the Study, the forums were searched for any reactions to the article. The various forums were reviewed for key topics that stood out among the rest due to the amount and frequency of posts. All posts or comments related to the Study were teased out and inserted into a comment database. As the Study progressed and patterns in the comments emerged, the comments were sorted into one or more broad topic categories: cameras/vandalism, enforcement, ticketing, self-policing, and effectiveness. While comment content was most important, the metadata relating to the comments also provided helpful information and was cataloged. In particular, the date of the posting signaled trends and reaction times to the enforcement efforts and various Study enforcement periods.

3.5. Data analysis

Statistical analysis followed Zar (1999) using Microsoft Excel 2010 and PAST version 2.17 statistical software (Hammer, Harper, & Ryan, 2001). Images captured from camera data were cataloged into an Excel spreadsheet along with the date, time, camera number, enforcement period, quantity, type of use, and if the trail was open or closed. Trail users were categorized into various user groups (i.e., mountain biker, hiker, or equestrian). To examine changes in trail use during the Study period; we performed statistical analysis comparing the count of trail users within each user group during each of the three enforcement periods (i.e., pre enforcement, during enforcement and post enforcement). This allowed us to track changes in trail use to detect any change, and the persistence of change as a result of the enforcement activities. The enforcement type (i.e., pre, during or post) was the independent variable, and the count of trail users was the dependent variable. Information on the use of closed or open trails was used in the analysis to evaluate compliance with regulations throughout the Study.

Change in human use over the Study was conducted using a tie-corrected Kruskal-Wallis test which is often referred to as a non-parametric one-way ANOVA based on ranks. The level of significance, alpha, was set at 0.05. Post-hoc pairwise comparison tests was conducted using the Mann-Whitney pairwise test with a Bonferroni correction. A non-parametric method of analysis was determined to be more appropriate due to the heterogeneity of variance among sampling periods (i.e., variance between the periods of enforcement activities).

4. Results and discussion

4.1. Camera captures

Based on the review of images captured during the 170 day Study, 7155 users were photographed within the Study site. Camera No. 1 had the most user captures (3456) and Camera No. 7 had the least (24). The cameras did not capture any off-highway or unauthorized vehicles anytime during the Study.

Four main classes of human users were originally identified: mountain bikers, hikers/runners, horseback riders, and miscellaneous (other user type). Of total users, 5490 were mountain bikers. This user group comprised 76.7% of all users and was therefore three times more likely to be seen on the trails than any other user group. Since mountain bikers represented such a large user type, the results were divided into two main categories for the analysis; mountain bikers and other users. Our results show that the majority (66.9%) of the use within the Study area was illegal use, and over 82.7% of illegal use was off-trail mountain biking (Table 1).

Similar to the prior Rincon study (2011), Sunday was the busiest day of the week, with 21% of total users (including 22% of mountain bikers), followed by Saturday with 18% of total users (including 19% of mountain bikers). Use during the weekdays remained relatively consistent with a slight increase on Wednesday. On Saturdays and Sundays, the highest portions of users were found in the mornings. Evening use of the Preserve increased for all users Tuesday through Friday. These results are not surprising and indicate that the Preserve is used more during traditional off work hours.

Table 1
Type of user by enforcement period: count (% within period).

Type of user	Pre		During		Post		Total
Mountain Bikers	2955	(83.5%)	1630	(74.0%)	905	(64.0%)	5490
Other (Hiker, Runner, Equestrian)	583	(16.5%)	574	(26.0%)	508	(36.0%)	1665
Total Number of Observations	**3538**		**2204**		**1413**		**7155**
Total Survey Days	52		75		43		170
Observations/ Survey Day	68.0		29.4		32.9		42.1

4.2. CDFW Warden contact information

Within the first week of the during enforcement period, the CDFW Wardens came in contact with over 65 illegal users of the Preserve. As the during enforcement period continued, there were fluctuations, but the total amount of warnings, citations, and contacts made by the CDFW Wardens decreased over the Study. During the total 12 weeks of enforcement, the Wardens had 327 total contacts with the public, in which they educated users about authorized trail use (327), issued warnings for trespassing in closed areas (118), and/or wrote citations (140).

4.3. Change in use

Overall use of the Preserve decreased from 3538 users during the pre-enforcement period to 2204 and 1413 users during and post enforcement, respectively. Since the amount of monitoring days differed across three enforcement periods during the Study, the values were normalized based on the number of survey days. The overall trend showed a decrease in use from 68.0 users per day prior to enforcement, to 29.4 and 32.9 users per day during and after enforcement, respectively (Table 1). This decline in use of the Preserve over the Study is statistically significant (H_c =44.69, $p < 0.01$) based on a Kruskal-Wallis test. Post-hoc pairwise comparisons indicated that the change in average daily use is significant between the pre-enforcement monitoring period and both during and post enforcement periods ($p < 0.01$ for each pairwise combination), but not between the during and post enforcement periods (p=0.51).

An examination into the types of use reveals that prior to enforcement activities, the majority (78.7%) of the use within the Study area was illegal, and over 85.5% of the illegal use at the Preserve was mountain biking. Illegal mountain bike use decreased 66.0% over the Study; from an average of 43.5 users per day prior to enforcement to 9.1 users per day post enforcement (Table 2). At the same time, legal mountain bike use remained the same at approximately 10 users per day. Other illegal use also decreased from 7.4 users per day to 3.5 users per day, while other legal use increased from 3.6 to 7.8 users per day. Table 2 shows changes in use by enforcement period.

The reduction in number of mountain bikers observed over the course of the Study is statistically significant between the three enforcement periods for both illegal ($p < 0.01$) and legal users (p=0.01), based on a Kruskal-Wallis test (Fig. 2). Further analyses via Mann-Whitney pairwise comparison test with a Bonferroni correction shows a significant decrease in illegal mountain bike use between both the pre and during enforcement ($p < 0.01$), and the pre and post enforcement ($p < 0.01$); however, there was no significant difference in

Table 2
Type of use by enforcement period: count (average users per day).

Type of use		Mountain bikers		Other (Hiker, Runner, Equestrian)		Total	
Illegal		Count	x̄ /day	Count	x̄ /day	Count	x̄ /day
	Pre	2261	(43.5)	385	(7.4)	2646	(50.9)
	During	1065	(14.1)	239	(3.2)	1304	(17.4)
	Post	391	(9.1)	152	(3.5)	543	(12.6)
	Subtotal	3717		776		4493	(66.9%)
Legal							
	Pre	528	(10.2)	188	(3.6)	716	(13.8)
	During	417	(5.6)	328	(4.4)	745	(9.9)
	Post	429	(10.0)	337	(7.8)	766	(17.8)
	Subtotal	1374		853		2227	(33.1%)
	TOTAL:	5091	(29.9)	1629	(9.6)	6720	

Note: Does not include 435 observations (399 mountain bikers and 36 other users) where type of use was recorded as "Unknown".

the amount of illegal mountain bike use between the during enforcement and post enforcement periods (p=0.63). With respect to legal mountain biking, Mann-Whitney pairwise comparisons shows a decrease in legal riding during enforcement (p=0.02), but no significant change between pre and post enforcement (p=0.82). The amount of illegal mountain biking dropped quickly and stayed low after enforcement occurred, while legal mountain bike use dropped during enforcement and came back to existing levels post enforcement.

Similar to mountain biking, illegal other users experienced a significant decrease over the study period ($p < 0.01$) with pairwise comparison tests showing a decrease between the pre and during enforcement ($p < 0.01$) and pre and post enforcement ($p < 0.01$), but not during enforcement and post enforcement (p=0.32). Legal other users actually showed a significant increase in use post enforcement compared to pre or during enforcement periods ($p < 0.01$), but not between the pre and during enforcement periods (p=0.49).

The total amount of mountain bike use (including legal and illegal usage) decreased from the average use across the three periods of the Study. With illegal mountain bike use decreasing and legal mountain bike use staying the same, it is not known where the illegal bikers went. This indicates that there may be location flexibility within the mountain biking community. Since no control areas were established, it is possible that mountain bikers chose to avoid the Preserve and ride in other areas not monitored by this Study. Other users had a similar significant decrease of illegal use, but a significant increase in legal use, indicating that the use remained relatively fixed, as seen in Table 2 and Fig. 2.

4.4. Social media tracking

Social media in the form of mountain biking forums was monitored throughout the Study. Four topics stood out among the rest due to the amount and frequency of posts. Those topics were cameras/vandalism, enforcement, ticketing, and self-policing. Many comments indicated that there was severe misunderstanding about the Study, frustration about enforcement, and general distrust in City staff among users. The social media forums provided excellent insight not only into the mountain biking community, but also into how quickly user behavior changes occurred and if those changes reflect a larger change in social norms towards use of illegal trails. The first citation issued in the Preserve was on July 20, 2013 and by July 26, 2013 the word had spread through the forums (Dirttreader.com, *LPQ Ticket Sighting*, July 26, 2013). This thread alone had 66 posts, while later threads (Mtbr.com, *Tickets Being Issues on ALL of Del Mar Mesa aka Tunnels*, July 29, 2015) had 585 posts to date and over 68,836 views.

4.4.1. Cameras/vandalism

The forums often provided information as to whether a camera had been vandalized or compromised. Comments sometimes warned people of the locations of the cameras; such as *"I saw a new 'game camera' installed outside the gate to the eucalyptus grove"* (Mtbr.com, *Tickets being issues on ALL of Del Mar Mesa aka Tunnels*, November 12, 2013). Occasionally those comments sparked a discussion related to some sort of vandalism or implied vandalism, such as, *"A little bird told me there is a game camera loosely zip-tied to a tree about half way down T2 on the right hand side. A strong wind blew through the area and flipped the camera around so it's no longer facing the trail but it's still there…"* (Mtbr.com, *Tickets being issues on ALL of Del Mar Mesa aka Tunnels*, November 15, 2013). Once specific information on a camera's location was released, the likelihood that

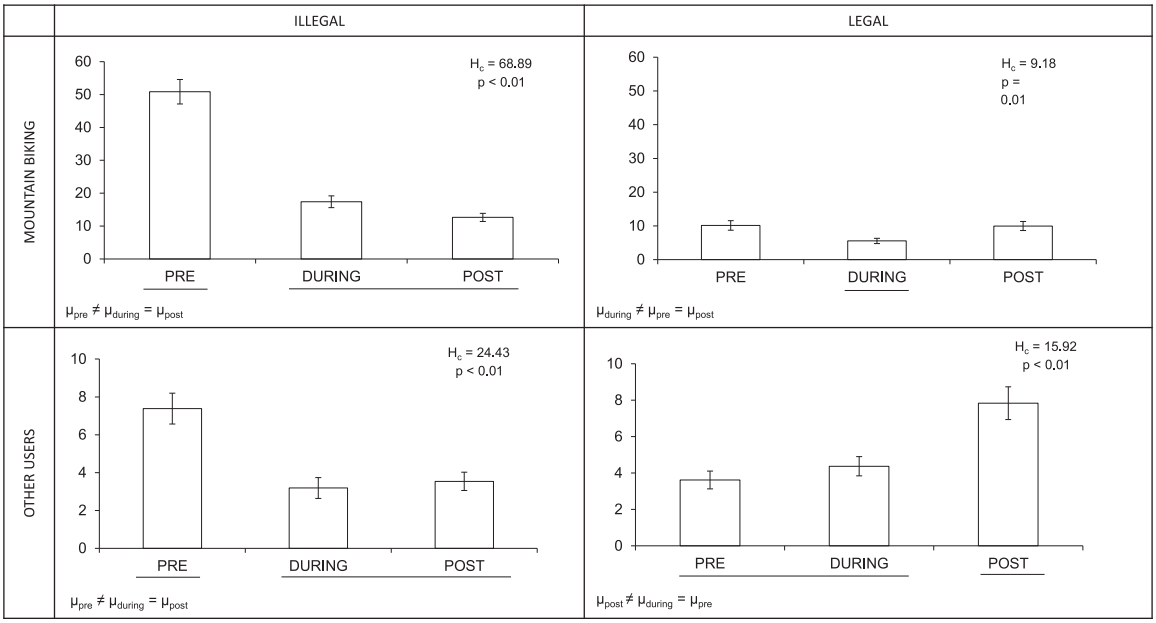

Fig. 2. Change in average observed use per day over the Study. Standard error of mean is shown with error bars. Hc = Tie corrected Kruskal-Wallis test statistic and p-value of significance. Results of pairwise comparison tests are depicted for each enforcement period.

the camera would be vandalized, removed, or covered increased. The following comment reports both vandalism and possible theft, "*And there is a camera there, too – mounted low on a post to the right of the metal gate just off the fireroad. Someone had put a shopping bag over it on Friday, but it was gone on Saturday*" (Dirttreaders.com, *LPQ Ticket Sighting*, July 29, 2013).

Comments from the forums not only provided insight towards the attitude of mountain bikers, but the comments also enlightened staff as to whether or not they needed to take action to uncover, repair, or replace the cameras. These comments could prompt an increased effort to further hide the cameras and better secure them to their locations.

4.4.2. Enforcement

Many comments on the forums fell under the general topic of enforcement, including the sharing of dates, times, and locations that users believed the CDFW Wardens would be out and ticketing. This is an example of one such comment, "*I saw a Ranger giving a guy a ticket between the eucalyptus trees and the gate at the top of the mesa on Wed. 7/24/13 around 5 pm*" (Dirttreaders.com, *LPQ Ticket Sighting*, July 26, 2013). One user even suggested setting up a Twitter hashtag so that bikers could track and report on the dates and times of enforcement to better avoid wardens.

Various users shared their frustration of what seemed to them the criminalization by City and CDFW officials of mountain bikers. Many of the trails at the Preserve are social trails, created by users and not the City. These trails are illegal, yet many have been around for years and riders feel they have prescriptive rights to use the trails. Posts indicated that some riders believe that since they did not create the trails, they shouldn't be cited for using them, "*… the majority of the trails on DMM were created by migrant workers, dirt bike riders, kids and SDG & E trucks*." (Mtbr.com, *Tickets being issues on ALL of Del Mar Mesa aka Tunnels*, August 2, 2014). Comments like this lend to the belief that some mountain bikers believe that only the initial trail creation is harmful and not the repeated use that follows. There were also posts that indicated that the riders believed that a two foot path could not pose a threat to flora and fauna in the area, "*…but to the original query, what data is available that 2' wide dirt trails destroy flora off trail or threaten endangered fauna? this is nature we are talking about, and nature adapts. can it adapt to thin dirt trails that occupy less than one half of one percent of the area? prove to me it can't, with data. in fact most urban areas utilize limited recreation to aid in preservation with this very model in mind; legal use deters illegal abuse.* (Dirttreaders.com, *Is there a war on mountain biking in San Diego?*, November 20, 2013). The perceived abrupt change from an uncontrolled recreation area to an actively managed natural habitat area, led to hostility even though it was preceded by months of education, signage and fencing. This is interesting insight for land managers trying to educate specific user groups.

4.4.3. Ticketing

Many posts referenced the ticketing aspect of the enforcement program. Riders discussed the tickets that they, or someone they knew, received. There was a lot of misinformation surrounding the topic of tickets, and the ticket price alone was reported by several users as different values. The misinformation available on the forums could have potentially negatively affected the Study. On the other hand, self-education may have deterred other riders from taking their chances riding an illegal trail. Here is one example of a post regarding ticketing: *"…if the California Game Warden catches you, you get ticketed for PC 602 (trespassing). The ticket is $475. I was caught behind gate (walking my bike) and was told all tunnels were off limits unless something has changed. If it's your first time judge might suspend your fines but ur on probation for a year. If u get caught while on probation for the same thing the fine is doubled $950 (Current plus suspended amount)."* (Dirttreaders, *LPQ Ticket Sighting*, August 23, 2013).

4.4.4. Self-policing

While some of the posts suggested vandalism, theft, and harassment, there were several posts that encouraged other bikers to respect the preserved areas and self-police one another. For example, one user posted, "G*ive the trails a chance to dry out from the rain today and tomorrow. [Del Mar Mesa] and [Penasquitos Canyon] do not handle rain well. La Costa would be a better choice*" (Mtbr.com, *Tickets Being Issues on ALL of Del Mar Mesa aka the Tunnels*, November 19, 2013). Other times, the policing focused on the preserve's sensitive habitat, "*On a side note, I also saw bike tracks through the middle of the pools. We are really not helping our cause if we keep doing dumb moves like that…"* (Mtbr.com, *Tickets Being Issues on ALL of Del Mar Mesa aka Tunnels*, August 10, 2013). Some people encouraged others to stay off of the closed trails of the Preserve so that the process of reopening the trails could play out: "*Tunnels is still officially closed, everyone reading this should stay off the closed trails regardless of if it is being patrolled. The more people who violate the closure, the harder it is for those who are trying to get it opened back up, through the correct channels, even if it is taking a long time. Don't make their job harder"* (Mtbr.com, *Tickets Being Issues on ALL of Del Mar Mesa aka Tunnels*, December 19, 2013). This positive discourse illuminates the potential to have well-known and respected mountain bikers act as liaisons between the City and the larger mountain biking community. These representatives could share with the bikers the facts of the Preserve and urge them to abide by the regulations, and the representatives could also share the grievances of the mountain biking community with the City and Park Rangers. These exchanges could take place on social media as well as in person, with the potential for information patrols with the Park Rangers.

4.4.5. Effectiveness

In addition to the results that the Study produced through photo captures, CDFW Warden data, and City Ranger data, there were also qualitative ways to study enforcement effectiveness using online forums. In response to a question about whether or not the rangers were still monitoring the area, one member wrote: "*I would have to say no BUT the rangers can/ will ticket and its still off limits"* (Mtbr.com, *Tickets Being Issues on ALL of Del Mar Mesa aka Tunnels,* February 16, 2014). Posts such as this indicate that users were hesitant to return to illegal trails without verification that the Wardens have left. This trepidation and hesitation leads to a longer lasting effect of the enforcement even once the Wardens are gone. This is similar to the results found De Waard and Rooijers (1994) in their study, discussed above, on reduction in automotive speeding as a result of potential for citation by law enforcement.

4.5. Limitations

There were many confounding factors in the Study that could account for the changes in use, but it is difficult to determine which factors played a role, if any. The Study design originally called for a balanced design of equal days in each of the three enforcement periods. Due to staffing issues and camera problems, unequal sampling occurred in each period of the Study. Weather is likely one of the main confounding factors, since trails were closed following rain events; and recreation is self-limiting on days with high temperatures. Another factor was daylight savings time; with darkness occurring earlier toward the latter part of the Study, it may have been difficult for some users to recreate after work. This may have led to people choosing other times to recreate, or to avoid the Preserve altogether in those months. Other influences include holidays and summer vacation. Of note, the start of the enforcement period coincided with the start of the school year. While, these limitations were present, the very strong signal observed in the Study provides confidence that methodological challenges did not infer with the stated research goals.

For future studies, it is recommended to balance the data by making each time period of the study be an equal number of days. If a similar study were conducted, it would be beneficial to have control cameras placed at other surrounding preserves to monitor if enforcement in one preserve caused users to switch to other locations for recreation. Monitoring other preserves could indicate if there was a high crossover of mountain bike users from one preserve to the next, and potentially provide insight into the level of flexibility of recreation usage.

Results obtained through social media tracking were limited to those posted on public mountain bike blogging websites. Future studies may want to include other modes of media that could be valuable to the study, such as local focused Facebook Groups, Facebook Pages, and Twitter feeds, along with any other website requiring memberships for access.

5. Conclusion

Open space enforcement by CDFW Wardens was determined to be an effective method of reducing unauthorized use in an urban natural area. Prior to enforcement, mountain bikers comprised the largest group of illegal recreationists in the Preserve. However, post enforcement there was not only a decrease in total illegal use, but illegal mountain biking was no longer significantly higher than other user types. Our results support conclusions made by Gramann et al. (1995) that the threat of sanctions (hard enforcement) has a more general utility and effectiveness in curbing non-compliance behavior than outreach to promote "awareness-of-consequence" of user actions (soft enforcement). Additionally, Gramann et al. (1995) found that the soft enforcement mechanisms were more effective in rural outdoor recreation areas than in urban outdoor recreation areas.

Illegal use in this Study did not rise back to the levels prior to enforcement, suggesting that a shift in behavior was maintained during the 43-day post enforcement period. However; Claridge, Chea-Leth, and Chhoan (2005) analyzed the effectiveness of both soft and hard enforcement actions to curb wildlife crime (e.g., logging and poaching) in Southwestern Cambodia, and concluded that hard enforcement actions as a strategy alone will *"lead to an expensive and never-ending cycle of law enforcement."* Fiscal implications of various enforcement approaches needs to be considered by land managers.

Mountain biking forums were informative and provided valuable insight of that particular user group's perception of enforcement and support for unauthorized activities. Posts containing evidence of hostility towards and distrust of Wardens, Rangers, and City conservation efforts increased throughout the Study. This increase in hostility is consistent with findings from previous literature regarding hard enforcement (Goh, 2015; Marion, 1998; Wynveen et al., 2007). These findings are also compatible with Hockett, Clark, Leung, Marion, and Park (2010) who reported that National Park visitors were less supportive of increased enforcement presence, restrictions and fines, and would rather be managed indirectly with educational signs. User opinion interpreted from the monitoring of social media sites and forums indicate that many users were hesitant to return to the unauthorized areas of the Preserve after enforcement had stopped for risk of ticketing. Merry (2010) concluded that social media has great potential to engage and educate the public on environment issues, and that it is far from being realized. Our Study came to the same conclusion, and a social media component is recommended prior and during any future enforcement efforts to help educate and reduce misinformation and distrust of staff among recreation users. The responsiveness and volume of social media followers represents an untapped opportunity for targeted education and outreach.

These findings have broad implications for urban outdoor recreation managers that are experiencing high rates of unauthorized usage. The Theory of Planned Behavior postulates that an individual's inclination toward prosocial behavior is a combination of social norms and the ease of non-compliance. This Study showed that soft enforcement aimed at public education and redirecting social norms was not sufficient in curbing illegal trail use in an urban natural area. The movement towards citations and the threat of citations was effective at redirecting behavior by making non-compliance more risky. This in turn had an unintended consequence of promoting hostility amongst a large user base.

Hendricks, Ramthun, and Chavez (2001), concluded that a peer-group of volunteers were the most successful approach at encouraging prosocial behavior. This is a form of "community policing", which focuses on building ties and working closely with members of the user community. Rowe et al. (1998) found that community-based policing had a significant effect on the prevention of serious injuries related to non-compliance with alcohol use and speed regulations in snowmobile use.

The authors believe that the use of social media combined with community policing can be a powerful tool to redirect user attitude, and subsequent behavior, through peer-to-peer education about environmental impacts, answer questions regarding authorized uses, and warn users of potential sanctions for non-compliance. Managers of outdoor recreational areas facing high levels of unauthorized use need to consider the cause of the user behavior in context of non-compliance theory such as TPB, and possible unintended consequences, in order to develop a successful enforcement strategy.

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Keith Greer is a regional environmental planner and ecologist for the San Diego Association of Governments (SANDAG) where he is the manager of the *TransNet* Environmental Mitigation Program. This innovative program provides $850 million dollars of sale tax funds for the advance mitigation of habitat impacts from future infrastructure projects, and includes development of best management practices and regional collaboration for open space management and biological monitoring. Mr. Greer has worked on all aspects of biological mitigation including land acquisition, adaptive management and biological monitoring over the last 26 years. He holds a Bachelor of Science in Biology and a Masters in Geography, with an emphasis in natural resources and environmental policy.

Katherine Day is a current graduate student in Environmental Science and Management, focusing her studies on economics and politics of the environment with respect to conservation planning, energy, and climate. She is expected to graduate in June 2017 with a Master Degree from the Bren School at UC Santa Barbara. She has worked and conducted research in regional government, local environmental non-profit organization, and international community based non-profit organization roles to promote environmental protection, coastal preservation, shoreline restoration, public access, water quality, wildlife connectivity, and habitat mitigation strategies.

Sarah McCutcheon graduated from California Polytechnic State University, San Luis Obispo in 2012 with a BS in Environmental Management. After graduating she worked for two years for the San Diego Association of Governments. In 2016, Sarah graduated with her Master of Environmental Science and Management from the University of California, Santa Barbara's Bren School of Environmental Science & Management. Her master's research focused on the effects of fire management in the wildland urban interface. While in graduate school she worked as an Environmental Data Science Intern at the National Center of Ecological Analysis and Synthesis. Sarah now resides in San Diego, California and works as a biologist for AECOM.