

Title:

An Analysis of Outdoor Recreation on Land Slated for Development; Implications for a Social-Ecological System in Boulder, Colorado

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CRedit authorship contribution statement

CG: Writing – original draft, review & editing, Visualization, Methodology, Formal analysis, Conceptualization. CB: Writing –review & editing, Methodology, Project Supervision.

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Abstract

Robust evidence shows that outdoor recreation in natural areas, i.e. places that retain native, ecological character with minimal human intervention, produces public health benefits including physical benefits from exercise, reduced mental stress, increased community connections, heightened place identity, and even increased ecological awareness. But land use planners don't always formally consider these benefits in their planning, which can create tension amongst recreationalists, public health experts, planners and developers. We were interested in the benefits related to outdoor recreation at a popular, community-regulated natural area in Boulder, Colorado, USA, called CU South, that is slated to be closed to the public for the development of a flood mitigation project and university campus. Using mixed methods from recreation ecology and social-ecological systems framework theory, we showed that visitors highly value recreating at CU South for a wide range of health and community benefits, including customary off-leash dog access in a natural setting. We also showed how this site serves as a community hub where locals gather as part of their daily routine. Finally, we demonstrated that the governing institutions, the University of Colorado Boulder and the City of Boulder, acknowledge recreation occurs on CU South, but have not publicly considered the full suite of current recreation benefits in their development plans.

Management implications:

Visitors, including humans and off-leash dogs, who recreate in natural areas receive vast physical, mental and cultural benefits. Our study demonstrated this suite of benefits for visitors and their dogs recreating on a natural area in Boulder, Colorado, USA, which is slated to be developed. We suggest that the governing institutions consider minimizing the loss of these benefits by adjusting their development plans and/or designating alternative natural areas that allow recreation and off-leash dogs.

Keywords: outdoor recreation; recreation ecology; community-regulated; off-leash dogs; natural area; public health benefits

1. Introduction

Outdoor recreation is increasingly recognized for its holistic definition of activities involving connections between humans and natural environments (Blahna, Cervený, et al., 2020; Blahna, Valenzuela, et al., 2020). Connections between humans and natural environments include the heavily documented and studied leisure activities such as hiking, skiing, camping,

trail running, climbing, dog walking, sport fishing, and hunting (Cole, 1999; Hammitt et al., 2015; Liddle, 1997), alongside activities that foster “sense of place, spiritual connections, historical and lifestyle traditions, and existence values” (Blahna, Valenzuela, et al., 2020, p. 14). Humans interact with natural environments for physical and mental health, community, cultural, sustenance and tribal connections, all of which comprise outdoor recreation today (Blahna, Cervený, et al., 2020; Eyles & Williams, 2008).

While the term outdoor recreation is a Western construct, we emphasize the holistic definition, which incorporates the “people and place” kinship that exist independent of a Western outdoor leisure construct (Ho & Chang, 2022, p. 577). For many people, outdoor recreation includes activities that “fulfill a vital part of their lives that go beyond simple leisure time and into the realms of cultural values, life ways, and livelihoods” (Blahna, Cervený, et al., 2020, p. 66). Additionally, outdoor recreation implies that the activity occurs on or with a natural area, which we define hereafter as an environment that retains native ecological character with minimal human intervention (Anderson, 1991; Casetta, 2020; Machado, 2004).

Increasingly, some communities are taking heed of outdoor recreation benefits in their land use and public health planning (Driver & Bruns, 2008; Jacobsson, 2025; Lukoseviciute et al., 2026) based on vast evidence that outdoor recreation on and with natural environments provides significant public health benefits (Eigenschenk et al., 2019; Frumkin et al., 2017; Thomsen et al., 2018; Weybright et al., 2019). Outdoor recreation and nature exposure have been linked with public health benefits such as stress reduction, improved cognitive function, improved physical and mental health, and overall well-being (Allard-Poesi & Massu, 2023; Arthur et al., 2022; Chen et al., 2025; Jimenez et al., 2021; Liu et al., 2021; Middle, 2020; Pomfret et al., 2023; Puhakka, 2021). In addition to public health benefits, outdoor recreation on

and with natural environments provides legitimate economic benefits for communities (Blahna, Cervený, et al., 2020; Carleyolsen et al., 2005; Thomsen et al., 2018), along with environmental benefits, such as the protection of natural areas as places for outdoor recreation (Goldenberg et al., 2026; Larson et al., 2018; Liu et al., 2021; Lukoseviciute et al., 2026; Sumanapala & Wolf, 2019; Thomas & Reed, 2019).

Though the benefits are well-documented, other communities continue to plan and approve developments without considering the benefits of outdoor recreation (Alibašić, 2018; Driver & Bruns, 2008; Jacobsson, 2025; Winter et al., 2020) This can, in turn, incite tension among land use planners, developers, and recreationalists (Brooks & Champ, 2006; Campbell, 1996; Malmcrona Friberg et al., 2026; Reed & Gill, 1997). For example, in the greater Stockholm region, despite national policy ambitions, outdoor recreation is often poorly integrated into land use planning and rarely supported with dedicated personnel or funding (Malmcrona Friberg et al., 2026). To avoid unintended consequences for the public, outdoor recreation and its benefits should be considered in land use planning.

Recreation ecology, which studies the bidirectional interactions between recreational activity and the environment, provides a path to consider outdoor recreation in land use planning (Blahna, Cervený, et al., 2020; Miller et al., 2022; Sumanapala & Wolf, 2019). Recreation ecology includes the well-studied recreation interactions, such as recreating humans degrading soil quality, disrupting wildlife, and polluting water sources (Cole, 1999; Ganteaume et al., 2013; Hammitt et al., 2015; Liddle, 1997), along with the positive interactions of recreation and the environment, including the aforementioned mental and physical health benefits plus, notably, the related health benefits for recreationalists and their dogs (Bekoff & Meaney, 1997; Christian et al., 2013; Middle, 2020; Westgarth et al., 2014), conservation efforts (Cervený & Miller, 2019;

Heffelfinger et al., 2013; Larson et al., 2018), and broader social-ecological feedback loops (Miller et al., 2022; Morse, 2020). Social-ecological system (SES) framework theory (Berkes et al., 2003; Berkes & Folke, 1998; Liu et al., 2007; Ostrom, 2007; Ostrom, 2009; Ostrom et al., 1999) provides a further conduit to assess outdoor recreation as a shared resource (Schlager & Ostrom, 1992), and to discern whether the users and the governance system of an SES align in their valuation of outdoor recreation.

Our study focused on outdoor recreation in a natural area called “CU South”, which is a 308-acre grassland and wetland in Southeast Boulder, Colorado (Figure 1). For the past 30 years, CU South has been open to the public by its landowner, the University of Colorado Boulder, hereafter CU. Though mostly fenced around its borders, CU South has many trail access points and over five miles of trails (Figure 1). Even though the land used to be the site of a gravel mine, it still retains native ecological character. It hosts native grass species and wetland habitat adjacent to South Boulder Creek, which is a designated Colorado Natural Area (Behringer et al., 2019; Colorado Parks and Wildlife, 2023). Though CU posted a rule that dogs must be leashed on site, trail users follow customary rules in which the community of visitors self-regulate dog behavior, and the leash law is unenforced. In essence, the whole area has become a community-managed natural area and dog park. Tensions between trail users and the governing authorities, the City of Boulder and CU, have been prevalent for years, but are in a critical moment because CU South is in a transitional state. Starting in October 2026, CU South is slated to be developed into a high-hazard flood mitigation project by the City of Boulder, hereafter the City, and later, into a university campus by CU (City of Boulder & The Regents of the University of Colorado, 2021; Drugan, 2022; Herrick, 2022).

Studying outdoor recreation at CU South before development presented itself as an ideal recreation ecology case study. Our research questions were: 1) What is outdoor recreation at CU South and what is its value to visitors? and 2) To what extent do the governing authorities understand and incorporate CU South's recreational value into their decision-making? To answer these questions, we documented and analyzed trail visitation, trail visitor characteristics, preferences, and perceptions, and performed interviews with CU and the City. Our analysis provides robust insights that could be valuable to ongoing discussions about the future uses of CU South, an area of high value to many stakeholders.

2. Methods

Our study used a mixed methods research design with four parts, drawing on recreation ecology and SES framework theory: 1) Trail visitation estimation count via an automatic trail-counter device and in-person surveys for corroboration; 2) Administration of a trail visitor survey, documenting visitor characteristics and perceptions, followed by keyword analysis; 3) Formal interviews with CU and the City followed by inductive thematic analysis; 4) An application of our results of recreation at CU South onto an SES framework (Ostrom, 2009).

2.1 Study Site Background

While not designated as a protected natural area, CU South has been a publicly accessible natural area since 1996 when CU purchased the land from a gravel mining company, Western Mobile, Inc. (Drugan, 2022; Prendergast, 1996; University of Colorado Boulder, n.d.). Prior to mining, CU South was a relic, mesic grassland, and tallgrass species prevailed (Behringer et al., 2019; Cherwin et al., 2009). Shortly after purchasing the land, CU and Western Mobile successfully amended the site's original reclamation plan, despite ecological and floodplain concerns (Drugan, 2022; Durgin, 1997; Flatiron Sand and Gravel Co., 1981). CU's amended plan

reduced the water features, such as ponds, from 38 to 4 acres, and instead of removing the raised berm surrounding the former gravel pit to restore the natural floodplain of South Boulder Creek, CU kept the berm and increased its height to ensure “maximum potential development at a future date” (Colorado Division of Minerals and Geology, 1997; Colorado Mined Land Reclamation Board, 1997; Drugan, 2022; Flatiron Sand and Gravel Co., 1981; Finley, 1997; Love & Associates, 1996, p. 1).

In 1998, contractors hired by CU graded the site, covered it with degraded topsoil unusually low in carbon and nitrogen that had been stored from mining operations (Reed et al., 2007), and planted nine species of short and tall grasses, one of which might not have been native, *Poa spp* – CU didn’t publish any documentation, so the species identity is unknown (Behringer et al., 2019). In 2004, research depicted that the site had recovered as a novel grassland with 92% of relative vegetation cover comprised of native species (Cherwin et al., 2009; Seastedt et al., 2008; Seastedt & Suding, 2007), but by 2016 the site’s relative cover of introduced, non-native species had increased from 8-10% to 55% (Behringer et al., 2019).

Despite the gravel mining and reclamation amendments, over the past 30 years the land has proven resilient in its “naturalness,” existing with native species and with minimal human intervention (Anderson, 1991; Casetta, 2020; Machado, 2004). Additionally, CU South is adjacent to the South Boulder Creek Natural Area, which was designated a Colorado Natural Area in 2000 under the Colorado Parks and Wildlife Division to support the protection of significant natural features and phenomena, including biodiverse wetlands and habitat for the federally listed Ute ladies’-tresses orchid and Preble’s meadow jumping mouse (Colorado Parks and Wildlife, 2023). For recreation, CU South has become a popular destination for its trails, from wide gravel paths to dirt singletrack, visited by walkers, runners, cyclists, and birders

(Figure 1) (Herrick, 2022). CU also built tennis courts that are used by student athletes and residents (Metzger, 2024). The only other built facility is a warehouse near South Loop Drive.

Per a 2021 Annexation Agreement, hereafter the AA, towards the end of 2026, the City plans to “construct public improvements to mitigate the risk of flood damage” from South Boulder Creek, including a high-hazard flood mitigation project, “Flood Control Zone” in Figure 1, to protect 2,300 downstream residents (City of Boulder & The Regents of the University of Colorado, 2021, p. 1; Herrick, 2022). Following completion of the flood mitigation project, CU plans to build a campus, i.e. “Development Zone,” with 1,100 residential units, and potentially a stadium and commercial building space (City of Boulder & The Regents of the University of Colorado, 2021; Herrick, 2022). While the AA facilitated a land transfer from CU to the City for flood mitigation and open space, i.e. “Open Space Zone,” it doesn’t explicitly plan for similar recreation opportunities to what CU South currently offers in its natural state (Anderson, 1991; Casetta, 2020; City of Boulder & The Regents of the University of Colorado, 2021; Machado, 2004). This study sought, in part, to clarify plans related to recreation.

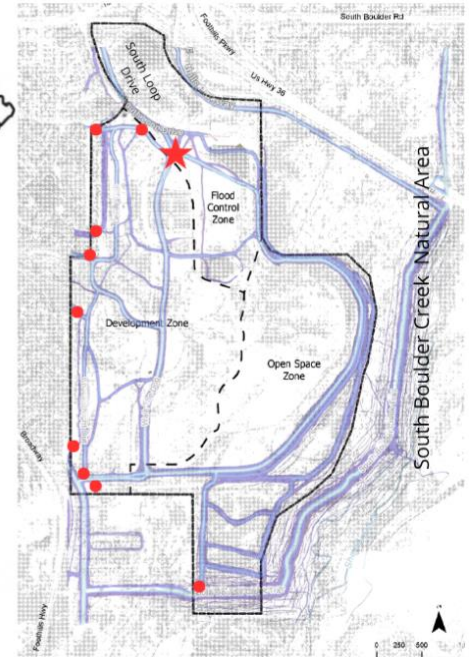


Figure 1: Left: Red dot indicates location of study site in Boulder, Colorado, USA. Right: A Strava global heatmap shows trails in blue and purple. Red star indicates the location of the trail count device off South Loop Drive. Red circles indicate trail access points. Black boundary indicates CU South boundaries, and the dotted lines delineate use zones from the 2021 Annexation Agreement (City of Boulder & The Regents of the University of Colorado, 2021, p. 46). The area to the east (right) and north of CU South is part of the Colorado designated South Boulder Creek Natural Area.

2.2 Trail Visitor Count Estimation

Recording trail visitation is a common type of data collection in outdoor recreation and natural resource management to better understand human visitation of a particular natural area (Pettebone et al., 2010). Considering that recreation count studies using automatic trail-counter devices that record nonmotorized recreation are relatively inexpensive and highly informative (Fisher et al., 2018; Lindsey et al., 2007), this research presented itself as an opportunity to provide data for recreation planning to both the City and CU. Trail visitor count at the Northeast trailhead at the South Loop Drive parking lot was monitored with two independent methods: an automated infrared trail counter device and in-person visual documentation (Figure 2). A Diamond Trail Counter TTC-4430 (Serial TC54556) was installed according to its manual

(Diamond Traffic Products, 2020) at the Northeast trailhead, collecting data from August 19 to October 6, 2025 (Figure 1 & 2). The device sends a beam of pulsed infrared light to a reflector, installed on the opposite side of the trail, which reflects the beam back to the scanner. When the scanner is deprived of a specific number of pulses by an object passing between the scanner and reflector, the device registers an object. Counts from the device reflected total users past the trail where the device was installed, both in and out directions, not number of different users, and counts didn't distinguish among types of users, e.g., cyclists, walkers, runners, or between individuals in a close group, e.g. two people walking side by side count as one, similar to other infrared trail count devices (Lindsey et al., 2007; Pettebone et al., 2010; Turner et al., 2007). Centurion software (Diamond Traffic Products, 2020) was used to download the device's data, recorded in 15-min intervals, to a laptop in the field.

The protocol for adjusting counts from the device follows Pettebone et al. (2010). We conducted in-person visual documentation during seven field sessions lasting approximately one hour, across twelve different hour sessions between 7:00 AM and 7:00 PM during August and September 2025 at the Northeast trailhead. For each trail user or group that passed the device, we documented date and time, trail usage type (e.g. walk, run, etc.), group size, direction of travel (i.e. in or out), presence of dogs and whether on or off leash.



Figure 2: Trail counter affixed to the left metal post at the Northeast trailhead at South Loop Drive’s parking lot, along with the survey solicitation and QR code.

2.3 Trail Count Analysis

In-person observations were found to be offset from the device’s internal clock by a fixed 1-hour and 15 minutes. This offset was applied as a uniform correction (+1:15) to the device’s internal clock, aligning all visually documented events with the device’s timestamps. We compared the observed and device counts at the hourly resolution level ($n = 12$), without double counting at hour boundaries. Following Pettebone et al. (2010), we calculated a linear regression, and 95% confidence intervals, through the origin for the hourly resolution, removing the intercept term to prevent unintended counts when no users pass, like in the middle of the night. We used the through-origin correlation coefficient as the correction factor for our device data. After correcting visitation counts, we compared the data with publicly available data from the same dates including trail visitation data from the City’s Open Space and Mountain Parks (OSMP) Department Visitation Data Explorer, along with OSMP vehicle count data from CU

South's vehicle entrance on South Loop Drive, to better understand total CU South trail visitation (Open Space and Mountain Parks, City of Boulder, 2025). Total counts, e.g. trail visitation and vehicle count, were divided by two to account for in and out directions and displayed in charts to contextualize visitation rates. All analyses were performed in R and RStudio version 2026.07.1 (R Core Team, 2025; Posit team, 2026).

2.4 Trail User Survey

Trail user perceptions of CU South were assessed using a self-administered, voluntary, online survey built in Qualtrics. A QR code posted to six different trail signs across CU South distributed the survey, which was open to respondents from August 22, 2025, through October 31, 2025 (Figure 2). The survey consisted of 15 questions (Appendix A). Nine multiple-choice questions asked about recreation type, frequency and mode of visitation, dog ownership and leash behavior, area of residence, and awareness of the 2021 AA. Six open-ended questions asked about reasons for recreating at CU South, alternative trails they would use if CU South were closed or altered, and the values and benefits they associate with CU South. Respondents were also asked to elaborate about potential uncertainty about future recreation at CU South in a development scenario. As seen in other intercept-style trail surveys (Troped et al., 2009), this survey's sampling approach self-selects for active trail users rather than a random sample of the broader community.

Descriptive statistics including frequencies and percentages were calculated for all closed-ended questions. For open-ended responses, a keyword-frequency approach was used (Goldenberg et al., 2026; Jūrmalis et al., 2022; Popping, 2015). Raw text responses were converted to lowercase, tokenized into individual words (Grimmer et al., 2022) and a custom stop word list removed function words, filler terms, and question-specific context words.

Semantically equivalent terms were consolidated using a custom lookup table iteratively developed from response data (e.g., 'dog,' 'dogs,' 'leash,' and 'off-leash' were merged into 'dog(s) & leash'); 'nature' and 'natural' were merged into 'nature/natural') following Popping (2015). Mental health and wellbeing references—including the phrases 'mental health,' 'wellbeing,' 'wellness,' 'peace,' 'peaceful'—were detected using regular-expression pattern matching and aggregated into a single category ('mental health/wellbeing/peace') prior to word-level tokenization. The top 12 keyword categories were reported for each open-ended question. All analyses were conducted in R and RStudio version 026.07.1 using packages from the tidyverse collection, e.g. readxl, dplyr, stringr, forcats, ggplot2, and patchwork (R Core Team, 2025; Posit team, 2026). A validity check was performed by taking a random sample of thirty answers to Q14 and Q15 each, which were open-ended questions, and backchecking the top keywords by manually reading each response and ascertaining whether the keywords reflected the responses (Popping, 2015).

Survey respondent profiles were compared with the data from the in-person visual observation sessions. Proportions for walking, running, cycling, dog accompaniment, and leash-use were compared across the two datasets. Statistical comparisons used Pearson chi-square tests ($df = 1$), with Bonferroni correction for five simultaneous comparisons, adjusted $\alpha = .010$ (Agresti & Kateri, 2025).

2.5 Managerial Interviews

Semi-structured interviews were conducted with officials from the City of Boulder and CU who had knowledge of CU South's recreational use, management, and planning status. We invited more than one individual from each institution to participate, but only one from each institution participated. One interview was conducted and recorded over the phone, and one was

conducted via written correspondence; both were in English, and individuals were deidentified in the interview transcriptions prior to analysis. Questions were tailored to each institution, allowing for follow-up questions, while still maintaining some comparability across interviews (see Appendix A). Even though we only analyzed two interviews, we still conducted inductive thematic analysis (Braun & Clarke, 2006; Espedal et al., 2022; Malmcrona Friberg et al., 2026). Prior to each interview, officials received written information about the study's purpose and their rights. Informed consent was obtained verbally before each interview. Identities are protected, while institutions are retained.

2.6 Social-Ecological Systems Framing

In the final part of this study, we interpreted our results within a SES framework (Ostrom, 2009). We define recreation as a shared resource because of the following characteristics: 1) CU has allowed public access to CU South for thirty years; i.e., anyone can recreate on the land, thus the space to recreate at CU South is a *shared resource*. 2) There are *rules* that stipulate how recreation is to be shared. The community self-regulates dog and human behavior. Visitors ignore codified dog leash rules. 3) When the 2021 AA passed, it became the *governance system* for the land, stipulating the rights and obligations of the resource users and outsiders (Coriat, 2013; Dolcerocca & Coriat, 2016; Schlager & Ostrom, 1992; Šestáková & Plichtová, 2019). We identified elements of recreation on CU South within the four SES categories, i.e. resource system, resource units, governance, and users, to better understand CU South as a SES and to identify potential interactions and outcomes (Ostrom, 2009).

3. Results

3.1 Trail User Counts

At the hourly resolution comparison ($n = 12$), total observed and device counts were equal (235 vs. 235), with a strong correlation ($r = 0.902$). The regression equation with an intercept was: $\text{Observed} = 0.904 * \text{Device} (\text{SE} = 0.137) + 1.882$; $R^2 = 0.814$ (Figure 3). The through-origin regression equation was $\text{Observed} = 0.963 * \text{Device} (\text{SE} = 0.082)$; uncentered $R^2 = 0.926$. Applying the through-origin slope, 0.963, as the correction factor to the full-period device data (August 18–October 6, 2025) reduced the raw total from 12,484 to a corrected total of 12,022 (a reduction of roughly 3.7%).

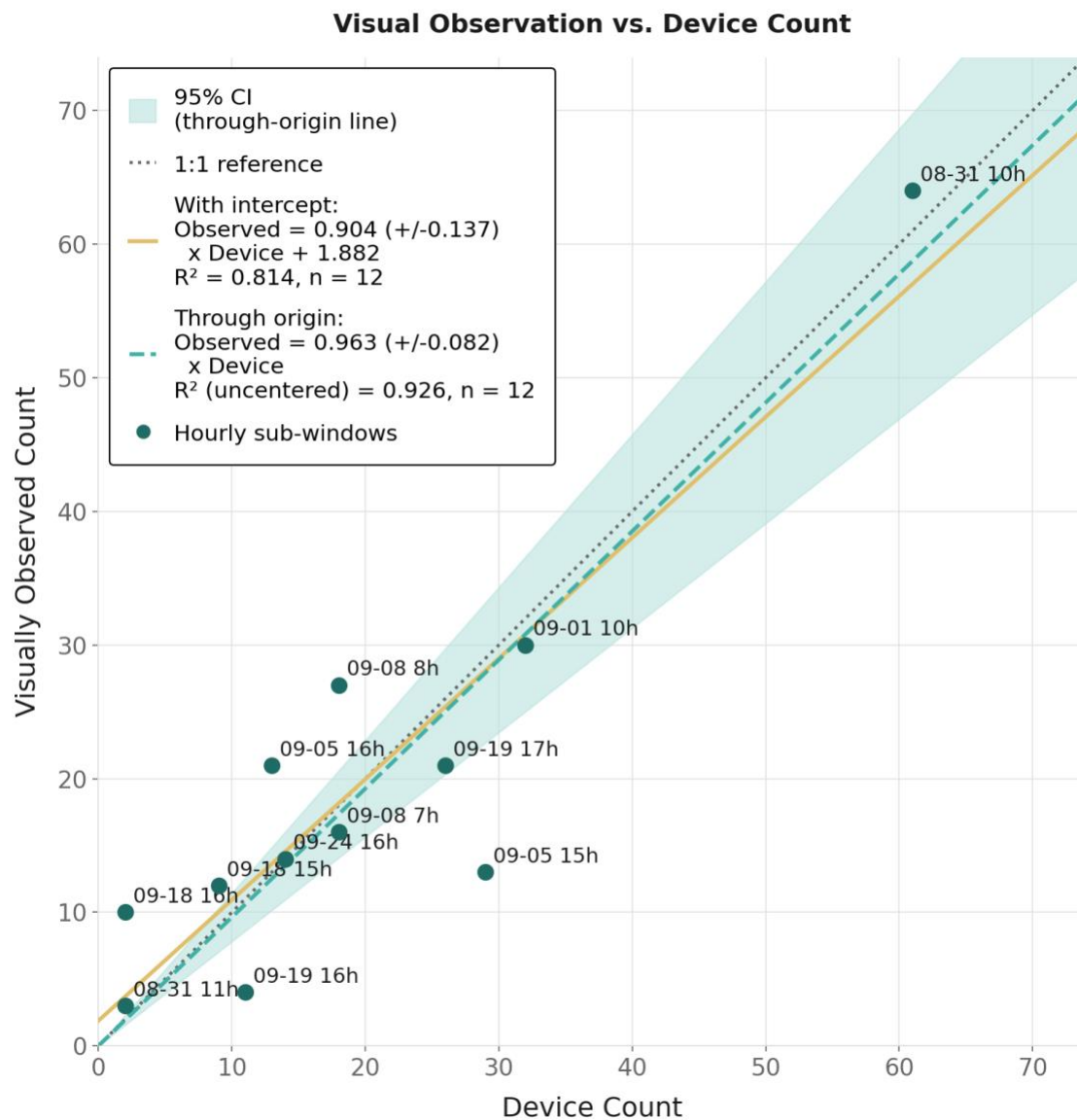


Figure 3: Hourly sub-window comparison of visually observed vs. device counts at CU South Northeast trailhead during August and September 2025 (n = 12), showing ‘with-intercept’ and ‘through-origin’ regression fits and the 95% confidence band on the through-origin fit. The coefficient of through origin equation (0.963) was used as the correction factor on device counts.

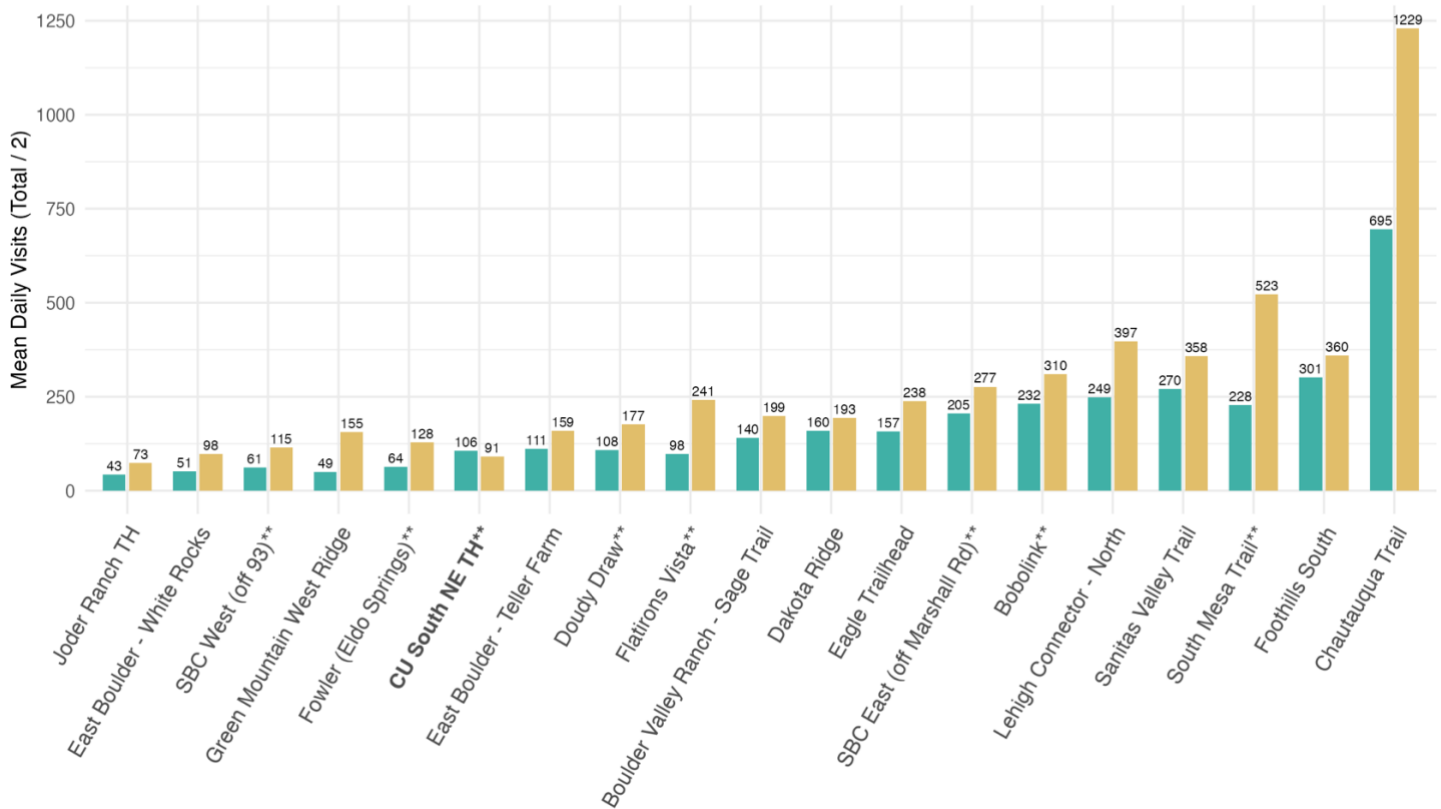
Across the seven-week window from August 19 through October 6, 2025, the CU South Northeast trailhead (TH) recorded a corrected mean of 102 daily visits. Its visitation ranked above five OSMP trails—Joder Ranch TH (52), White Rocks (65), South Boulder Creek West (77), Green Mountain West Ridge (80), and Fowler Trail (83)—and below the remaining thirteen, which ranged from Teller Farm (124) to Chautauqua Trail (847), the busiest trail.

The CU South Northeast TH is the only trail in the entire comparison of 19 trails where mean weekend visitation is lower than mean weekday visitation (106 weekday vs. 91 weekend, a 14.2% decrease). Every other trail in the dataset showed the opposite pattern (Figure 4). The hourly spread of CU South Northeast TH visitation showed a bimodal surge outside of standard work hours (Figure 5). The morning peak near 7:00 AM recorded 10 daily mean visits and the larger afternoon/evening peak near 5:00 PM recorded 11 daily mean visits. Lastly, in comparing the corrected device visit count with OSMP vehicle data on South Loop Drive, the hourly-level linear regression (n = 508 hours, Aug 19–Sep 15) equation was $\text{Visits} = 0.2123 * \text{Vehicles} + 2.2550$; ($r = 0.4628$; $R^2 = 0.214$). See detailed trail visitation comparisons by week and a time series of vehicle data in Appendix A.

CU South NE TH vs. OSMP Trails Weekend/Weekday

Seven Weeks, Aug 19 to Oct 06, 2025

Weekday Weekend ** South Boulder trail



315 **Figure 4:** Mean daily trail visits by weekday and weekend at CU South and OSMP trails
 316 compared over a seven-week period August 19 – October 6, 2025. South Boulder trails are
 317 marked with asterisks and CU South is bolded. TH refers to trailhead. Data from Open Space and
 318 Mountain Parks, City of Boulder (2025).

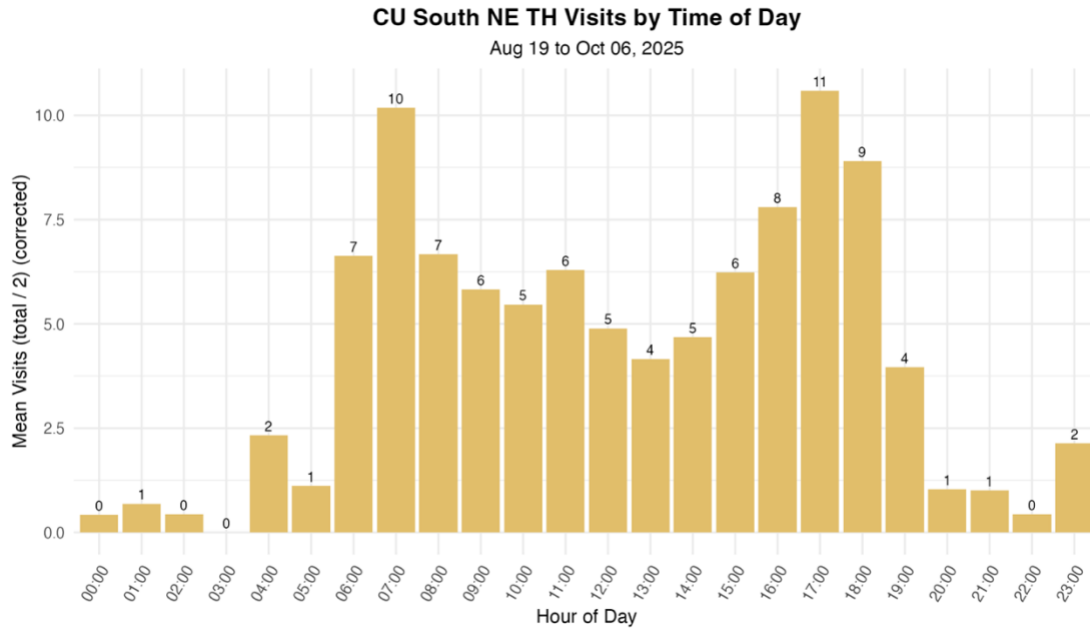


Figure 5: Mean hourly visitation at CU South Northeast Trailhead, August 19–October 6, 2025.

3.2 Trail User Survey

A total of 426 survey submissions were recorded. Valid responses totaled 398 (93.4% valid rate), which excluded one test entry and 27 duplicate responses. Median completion time of valid responses was 5 minutes 30 seconds.

3.2.1 Close-ended Visitor Profile and Behavior Questions (Q1-Q7)

Figure 6 depicts survey responses to Q1 through Q7. The standout results are that 84% of trail visitor survey respondents are usually accompanied by at least one dog (Q2) and 84% of those dogs are usually off leash (Q3). There is high frequency usage: 75% of all respondents visit at least weekly (Q4). Visitors are highly localized; 66% of respondents reside in South Boulder, but a non-insignificant percentage, 12.3%, visit from outside city-limits (Q6). Among the 267 respondents who mentioned a specific neighborhood where they live (Q7), most wrote the South Boulder neighborhoods Martin Acres, Tantra (tied, $n = 22$ each) and Table Mesa ($n = 16$), followed by the neighboring town of Louisville ($n = 14$).

CU South Trail Visitor Survey Fall 2025: Visitor Profile Questions

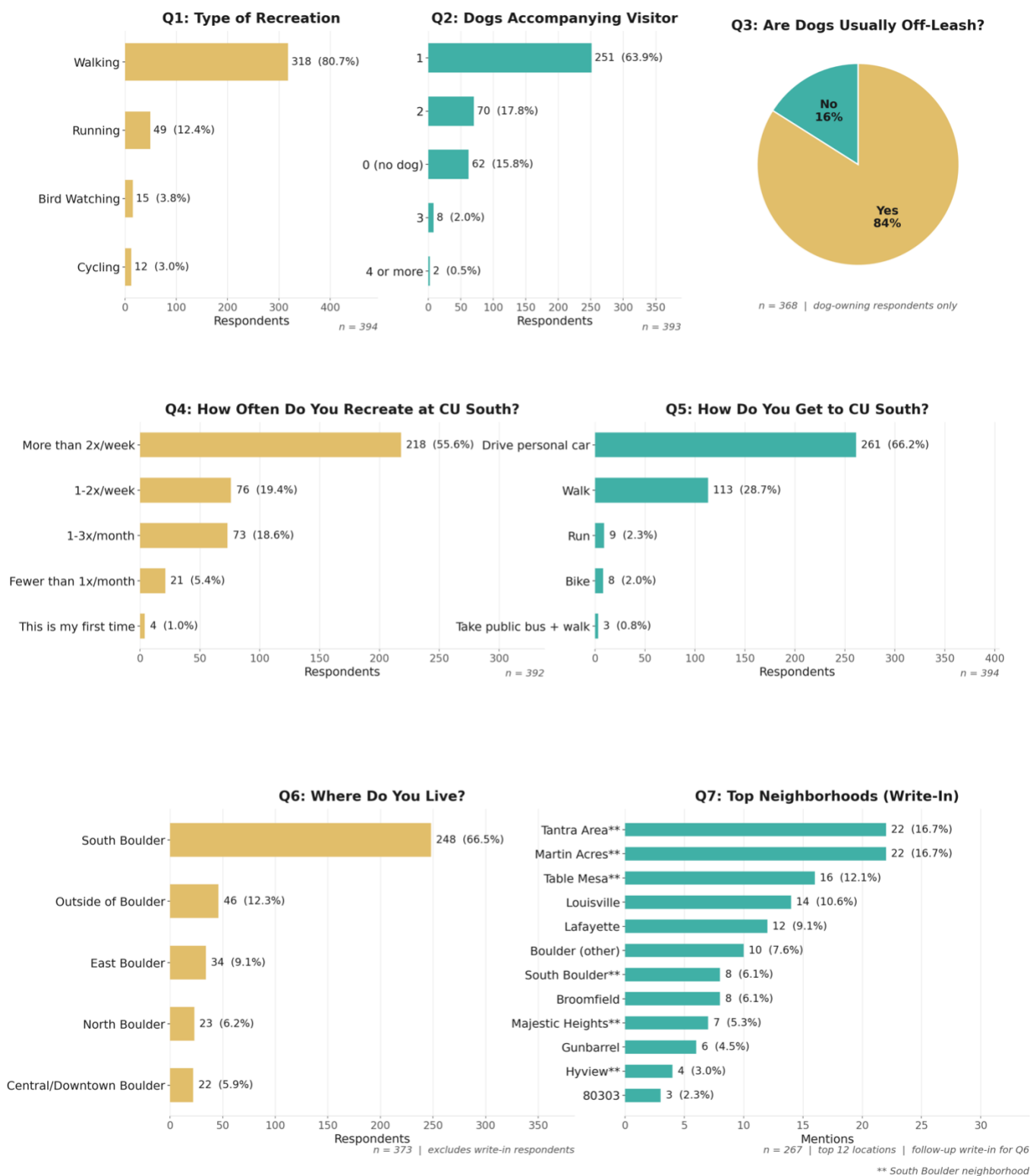


Figure 6: Survey results for Q1 through Q7 detailing visitor characteristics and recreation behaviors.

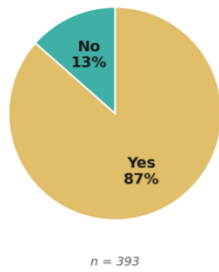
3.2.2 Awareness, Sentiment and Value Questions (Q8-Q15)

Figure 7 depicts survey responses to Q8 through Q15. Results of note included high awareness of the AA, 86.5% (Q8) and yet most respondents, 56%, indicated they would not want to recreate at CU South if the trails were shorter, paved, had less surrounding unmanicured vegetation, and/or nearby buildings (Q9). In all the open-ended survey questions, twenty-five responses included distaste for “paved trails.” Respondents overwhelmingly mentioned off-leash dog access as the primary reason they choose to recreate at CU South (dog(s) & leash; 336 mentions among 375 respondents) (Q11). Prominent secondary reasons included the natural setting (nature/natural; 76), scenic beauty (beautiful; 69), water (water; 55), open space (space; 52), proximity or easy access (close; 51), and scenic views (views; 50). One visitor answered Q11, “Don’t like paved trails and walking amongst buildings. I like the area wild and the wildlife.” Of the respondents who identified alternative trails to CU South (if CU South was closed to the public for an extended period or altered) Shanahan Ridge was cited most frequently, followed by South Boulder Creek Trail, Marshall Mesa, and Bobolink Trail (Q12). Notably, 11% of respondents were unable to identify a suitable alternative or indicated they were unsure.

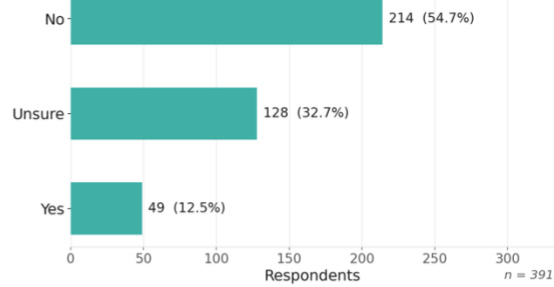
Keyword analysis of responses to Q14 (n = 358) – What do you value about CU South in its current form? Do you receive any benefit from recreating here? – revealed off-leash dog access (dog(s) & leash; 248 mentions), the natural setting (nature/natural; 97), open space (space; 61), scenic beauty (beautiful; 53), and wildlife (40) as highly valued, in line with Q10 and Q11 responses. Water features (water; 35), and views (views; 34) were also mentioned frequently. Mental health, wellbeing, and peace were also a commonly mentioned (grouped as ‘mental health;’ 32).

CU South Trail Visitor Survey Fall 2025: Awareness, Sentiment & Value Questions

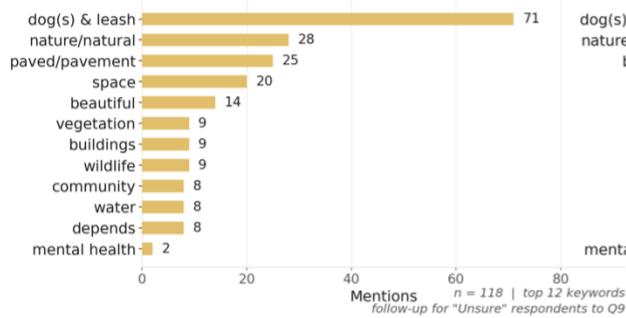
Q8: Aware of 2021 Annexation Agreement?



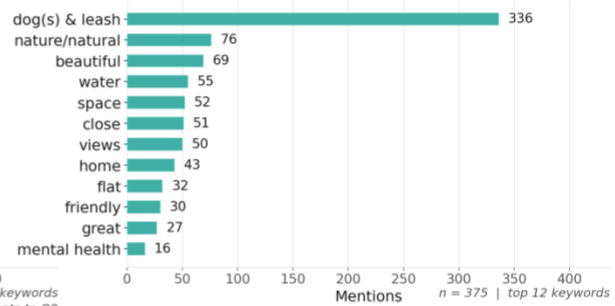
Q9: Would Still Recreate After Trail Changes?



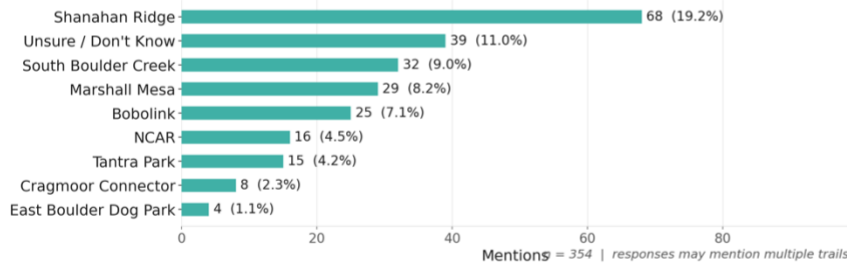
Q10: Why Unsure About Future Recreation



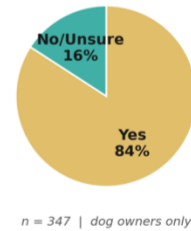
Q11: Why Choose CU South vs. Other Trails



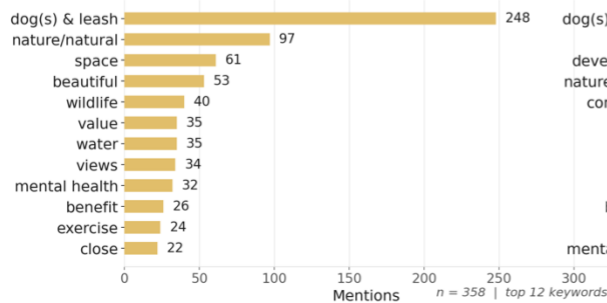
Q12: Alternative Trails Mentioned if CU South Were Closed or Altered



Q13: Aware of Leash Laws at Alternate Trails?



Q14: What Visitors Value About CU South



Q15: Anything Else to Share

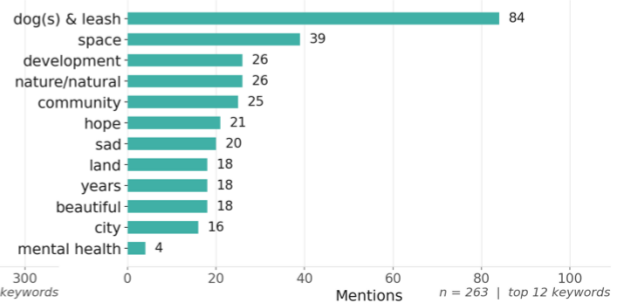


Figure 7: Survey results for Q8 through Q15 detailing visitor sentiments related to recreation at CU South.

In Q14's validity check, we concluded that the keywords mostly reflected the open-ended answers but note that the answers contain emotional nuance that the keywords lack. More than half of the thirty random answers portrayed an emotional connection to the natural landscape and even a reliance on CU South as part of their routine. One visitor answered Q14, "I wouldn't get out every day without it." Lastly, Q15 responses confirmed that dogs and off-leash access are paramount to visitors, (dog(s) & leash; 84 mentions), followed by concern over losing open space (space; 39) and concern over development (development; 26) that could hinder the site's naturalness (nature/natural; 26). Emotion was common; 21 respondents expressed hope it wouldn't be developed and 20 respondents indicated sadness about the site's future. One visitor answered Q15, "This place is my favorite spot in Boulder. Our family uses it every day and it has improved our quality of life." In the validity backcheck, keywords reflected the open-ended answers as general themes. Responses from the randomly selected responses for the Q14 and Q15 validity checks are shown in Figure 8.

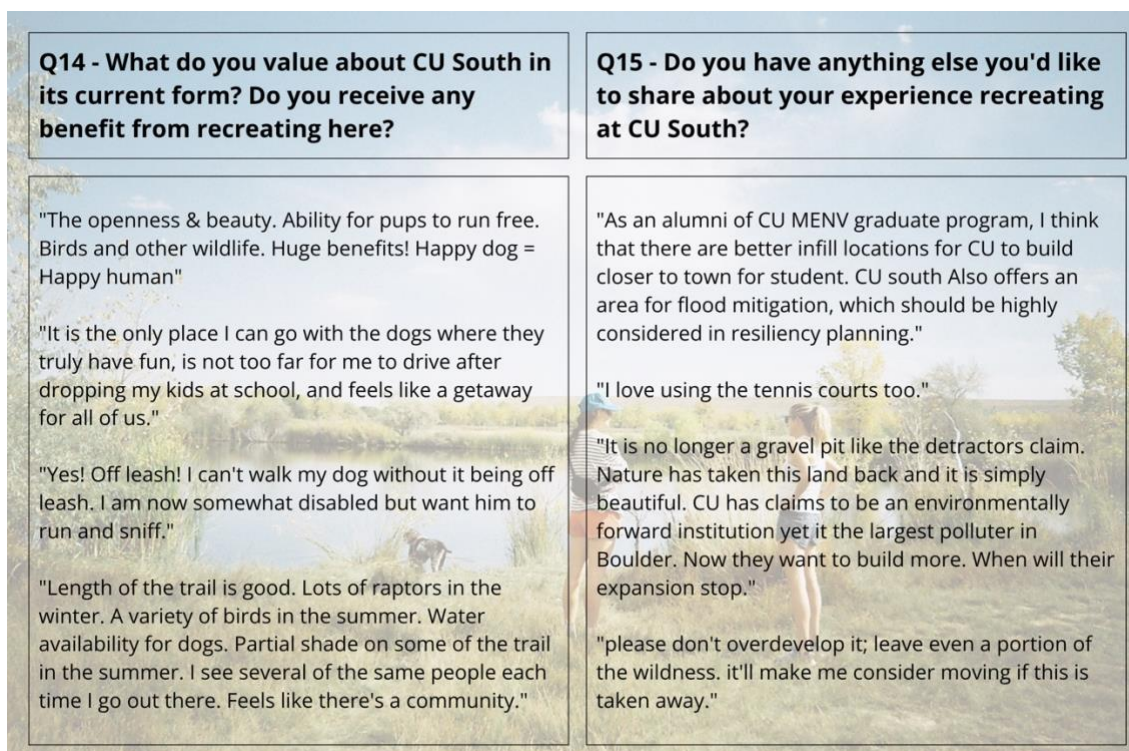


Figure 8. Responses from the thirty randomly selected responses from the validity checks of Q14 and Q15 are illustrated over a photograph of two women and off-leash dog at a pond at CU South, August 2024 (Clare Gallagher).

3.2.3 Survey Respondent Profile Results Compared with Visual Documentation

Chi-square tests ($df = 1$) comparing combined visual observation ($n = 237$) and survey ($N = 398$) proportions found no significant difference in activity type for running (11.4% vs. 12.3%; $\chi^2 = 0.05$, $p = .827$), cycling (1.3% vs. 3%; $\chi^2 = 1.60$, $p = .206$), or off-leash dog use (84.8% vs. 88.8%; $\chi^2 = 1.50$, $p = .221$). Walking rates were marginally higher in visual observation (87.3% vs. 79.9%; $\chi^2 = 5.74$, $p = .017$). Dog accompaniment rates differed significantly (69.6% vs. 83.2%; $\chi^2 = 16.00$, $p < .001$). Detailed statistical comparisons can be found in Appendix A.

3.3 Institutional Interviews

The main theme derived from the interviews is that the governing institutions emphasize that there are significant trade-offs involved with their management of CU South. Both the CU and City of Boulder officials acknowledged CU South is a recreational area for Boulder residents, but implied that the benefits of their respective developments are more important than current recreation. When asked explicitly about the current recreational value of CU South, the CU official declined to answer but later acknowledged that “open space is really important to people in Boulder and across Colorado,” and via the AA, the university is able “to give back a little” with the designation of 119 acres as “permanently protected open space” for “habitat restoration and for recreational use.” The **City of Boulder** official recognized that “CU South currently provides recreation value for some community members and visitors,” but underscored that CU South is a “key location for critical flood mitigation” and that AA plans include “new recreational facilities intended to serve University staff and students as well as the broader Boulder community.” Importantly, the City official stated that the newly designated 119 acres of

open space have been “identified as an environmental mitigation area...for an extensive habitat and wetland restoration initiative over the next five years. During this restoration project, the site will be closed to the public to ensure ecological success.” That being said, the City official invited “visitors who have utilized CU South” to enjoy the broader City system – over 46,000 acres and 155 miles of developed and maintained trails – “as long as they comply with regulations.” When asked about anticipation of off-leash dog impacts, the City official recognized “the existing visitor use at CU South, specifically those involving recreation with dogs,” and emphasized visitors can use dog parks, and of the 155 miles of trails, “89% are open to dogs on leash” and many others support off-leash dogs via the voice and sight program.”

Further, when asked about the current ecological value of CU South, including studies by CU ecologists (e.g., Behringer et al., 2019; Cherwin et al., 2009; Reed et al., 2007; Seastedt et al., 2008; Seastedt & Suding, 2007), neither official had comments. However, the CU official repeated that the AA “acknowledges the value of open space,” evident with the transfer of 119 acres to the city, including the transfer of water rights needed for habitat restoration and maintenance. The City official said that “the necessary planning studies, assessments and discussions between CU and the city considered the ecology of the land and informed the 119 acres that will be restored and managed as city open space.” And that this land provides “an opportunity for wetland and riparian preservation and restoration.”

When asked about how the land encompassed by CU South fits into larger sustainability goals of the city and university, each institution had differing answers. The CU official said that “the development of CU Boulder South directly supports the campus priorities of fostering student, faculty, and staff success, while also balancing the community's desire for flood protection and for open space.” The CU official stated that developing CU South will contribute

to CU’s Climate Action Plan (CAP), which has a goal “to achieve a 50% emissions reduction by 2030 and then carbon neutrality by 2050,” by addressing “scope three emissions resulting indirectly from CU Boulder operations, which includes students and faculty commuting to and from campus.” The official implied that by concentrating housing at CU South, commuting emissions would decrease and “entry-level housing inventory” would open across Boulder.

The **City** official said that the development plans for CU South provide “a net benefit to the community, including enhancements to environmental features, the creation of wetlands, future recreational opportunities and important flood protection measures that will increase community resilience over time.” The City official further said that the flood mitigation development was the key reason for how their plans fit into their CAP because it functions as “climate resilience infrastructure. By restoring floodplain function, preserving open space and using nature-based approaches to reduce risk, the site supports both ecological health and community safety.” Overall, it is evident that the development of the flood mitigation project, the transfer of land for open space and the campus development are prioritized over recreation and ecological benefits currently offered by CU South. These are seen as critical trade-offs by the management institutions and align with public voting results of the AA, which passed in favor of development.

3.4 Social-Ecological Systems Application

From our results, we mapped recreation at CU South onto a SES framework (Ostrom, 2009; see Appendix A). The key findings include the following: the **users** of the resource are the humans and their dogs (collectively, visitors) who recreate on the land with a high degree of frequency. Users report benefits including community building, mental and physical health and connection to a natural landscape, especially with off-leash dogs. The **resource system** includes

the trails, the visitors' recreation experiences, and the wildlife and flora mentioned by the visitors as part of their recreation experience: hawks, bald eagles, owls, raptors, heron, meadowlarks, bluebirds, hummingbirds, blue grosbeaks, sandhill cranes, Wilson's snipe, rattlesnakes, bull snakes, coyotes, deer, elk, bobcats, frogs, toads, snapping turtles, painted turtles, fish, copepods, foxes, bears, prairie dogs, butterflies, insects, grasshoppers, ducks, and Preble's meadow jumping mouse. Plants mentioned include Ute ladies' tresses orchid, unmanicured vegetation, rare grasses, sedges, rushes, cottonwoods, willows, prickly pear cactus. The **resource unit** is experiential in nature and has poor mobility because the resource is highly location dependent. The **governance systems** include two complex institutional authorities: CU and the City of Boulder, along with the 2021 AA, which is a 92-page document. The local community norms are another institution, represented by the visitors who routinely recreate at and self-regulate their behavior at CU South, disregarding official rules. The high awareness of the AA amongst visitor respondents in the survey (86.5%) indicates that visitors are aware of the impending land development. The passing of the AA by voters in 2021 and 2022 represented public engagement and showed that the residents overall favor development

We predict a future **outcome** will be that development may jeopardize the recreational resource that offers good social outcomes, e.g. community building, mental and physical health benefits and high place attachment to a natural area.

4. Discussion

4.1 Visitation Statistics: Locals Rule

Our results likely underestimated visitation at CU South. The < 1 correction factor was somewhat surprising because it's more common for trail use counting devices to undercount visitors (Greene-Roesel et al., 2008; Pettebone et al., 2010). However, by applying the 0.96

correction factor to our device data, we are confident that our corrected mean visitation counts, 102 visits per day, are conservative, and these are only for one trailhead at the South Loop Drive parking lot. The vehicle count data compared with our corrected trail visitation data confirms that our visitation counts only account for a fraction of total CU South visitors. The vehicle comparison linear equation indicates that for every counted trail visitor, there were roughly four to five cars visiting CU South. Thus, we can conclude that there are significantly more visitors to CU South than our trail device data documented. This gap presumably includes visitors like those using the tennis courts, as they did not pass the device counter and visitors to other trailheads. We also hypothesize that there are visitors who didn't drive into South Loop Drive nor passed our trail counter device, but entered and exited other trailheads, which are accessed from within neighborhoods and other trails.

The close agreement between the visual observation of trail visitors and the trail visitor survey for off-leash behavior (84.8% vs. 88.8%) supports the survey's primary finding regarding off-leash dogs. The slightly higher walking rates via visual observation (87.3% vs. 79.9%; $\chi^2 = 5.74$, $p = .017$) could be from the survey offering birdwatching as a "type of recreation" answer, whereas visual observation didn't distinguish walkers from birdwatchers. And we did not distinguish anglers either in the survey or visually. Dog accompaniment rates differed significantly, which could be attributed to the survey question asking, "Are the dogs usually off leash for most of your time at CU South?" Presumably, more dogs would be on-leash at the visual observation site, which is next to a parking lot, than during the rest of their time at CU South. The difference also could be attributed to some dog-walking visitors who saw the researcher at the trailhead and subsequently entered the CU South trails via a different trailhead. We hypothesize this behavior is because some visitors and their dogs may not want to engage

with people who appear to be doing work or who may be affiliated with an authority institution, especially if the visitors were disregarding official leash rules.

The most notable finding in the comparison of trail visitation rates is the split between weekdays and weekends. At CU South, there is more weekday visitation versus the OSMP trails, all of which experience more weekend visitation, suggesting that CU South visitors skew local, supported by the hourly peaks before and after work hours (Figures 4 & 5). This result contrasts with most documented trail visitation patterns worldwide, which show that weekends receive more visitation than weekdays (Creany et al., 2026; Farías-Torbidoni et al., 2023; Lindsey & Nguyen, 2004; Lindsey et al., 2007; Oswald Beiler, 2024). Our results indicate that CU South is a unique recreation site and deserves further examination, as performed in the survey and interviews. Knowing that a flood mitigation project is one of the reasons for closing recreation access to CU South, a future survey could ask perceptions about the value of flood mitigation in comparison to the value of recreation. Such information could elucidate a better picture of how visitors balance these values.

4.2 Survey and Interviews

4.2.1 Recreation at CU South and Public Health Benefits

The high frequency, routine visitation – over 55% of visitors indicated they visit more than two times per week (Figure 6) – suggests that recreation at CU South is part of many visitors' lifestyles. The survey results (Figure 7 & 8) support the definition by Blahna, Cervený, et al. (2020) and Blahna, Valenzuela, et al. (2020) that outdoor recreation provides not only physical benefits from leisure activities, but also mental benefits from being outside in a natural space, community, sense of place, and lifestyle connections (Blahna, Valenzuela, et al., 2020).

The trail visitor survey responses further confirm that CU South is frequented by routine trail visitors with over 66% of survey respondents residing in South Boulder (Figure 6).

And aside from dogs and leash access being the number one value for visitors (discussed below), Q11 responses indicated that visitors choose CU South's trails over others because they're natural, close to home, friendly and support mental health (Figure 7). Thomsen et al. (2018) showed that outdoor recreation in an undeveloped, natural area offers significant potential to address physical and mental health issues. It's worth analyzing whether the high frequency visitation to CU South enhances the physical and mental health benefits for recreating visitors because Thomsen et al. (2018) assessed benefits for visitors recreating at destination natural areas, e.g. national park, national forest, wildlife refuge. Q4 responses showed that 75% of CU South visitors are recreating there at least once a week, showing, again, that recreating at CU South is part of visitors' lifestyles and routines. Presumably, the public health benefits may be even greater from CU South recreation than those from infrequently visited destination locations. Additionally, Weybright et al. (2019) showed how prevention science can utilize the known benefits of outdoor recreation in preventing or reducing health-related diseases. From the governing institutions interview responses, it appears as though CU and the City are not considering, at least not publicly, the potential loss of such public health benefits in their CU South planning. In the interviews, neither official offered a plan in which equivalent, natural area recreation is offered at CU South – the City's 119 acres may not even allow recreation and CU's plans for recreation are of the developed variety, e.g. "recreational facilities," even potentially a "sports field with fixed seating for attendance up to 3,000 people," according to the AA (City of Boulder & The Regents of the University of Colorado, 2021, p. 17). But the literature is clear: recreating in natural spaces, even being exposed to undeveloped nature, contributes positively to

physical and mental health (Allard-Poesi & Massu, 2023; Arthur et al., 2022; Chen et al., 2025; Eigenschenk et al., 2019; Frumkin et al., 2017; Jimenez et al., 2021; Liu et al., 2021; Pomfret et al., 2023).

Puhakka (2021) showed that even though choosing to recreate in nature is not always the easiest choice, especially in an urban area, university students still scheduled outdoor recreation in nature for its benefits of increased physical activity, emotional and cognitive renewal, strengthening of social relationships and reduction of negative physiological effects of various stressors. Bowler et al. (2010) even found that people experience more positive benefits, e.g. attention, energy and tranquility, from a walk or run in a natural environment in comparison to a synthetic, built environment. Our survey results support this. Most responses to the questions related to why people recreate at CU South included mentions of wildlife, wild, vegetation, nature and natural space, and views (Figure 7). Puhakka (2021) also showed that university students preferred to recreate in a natural environment, suggesting that land-use planning should emphasize multisensory benefits, including fresh air and sounds of wildlife such as birdsong. Our survey results, especially responses to Q10, Q11, Q14, and Q15, lead us to conclude that recreating at CU South in its current natural state produces public health benefits and highlights a major opportunity for the City and CU to consider incorporating the preservation of publicly accessible natural areas in their CU South planning.

4.2.2 Ecological value

Emerging research documents the value of local trails functioning as “pathscapes,” which Chu et al. (2026) describe as areas where ecological awareness, health-seeking behaviors, and place-based identity converge. Indeed, the trail survey responses suggest CU South could be a pathscape because visitors portray awareness of natural surroundings, healthy physical and

mental behavior and place-based identity (Figure 7 & 8). As already mentioned, visitors value the nature, wildlife and land itself. The survey results – especially the emotional connection visitors reported having to nature and wildlife seen in Q14 and Q15 responses – compared with the institutional interviews present a genuine tension.

The interview results show that the institutions value the land's future ecology by focusing on the future of the 119 acres designated as open space, but even still, neither CU nor the City specify what is being restored in this land nor when or if recreation will be permitted. While both institutions stated the development of CU South contributes to their climate and sustainability goals, neither institution has measured the carbon sequestration value of the land. The City's OSMP has published an extensive carbon sequestration analysis on OSMP land, which could serve as a proxy for CU South (Open Space and Mountain Parks, City of Boulder, 2023). We encourage future research to perform a carbon sequestration analysis of CU South specifically, which was not included in OSMP's analysis since CU was the sole landowner at the time, which could assist in an economic valuation of the land in its current form based on carbon sink capacity. Grasslands have been well-studied for their carbon sequestration value (Bai & Cotrufo, 2022; Hungate et al., 2017), along with wetlands (Euliss et al., 2006; Patton et al., 2015). Such valuation should be incorporated into CU's CAP, following the path of other universities that are valuing their natural land capital in their CAPs, such as Colgate University's forests (Bianco et al., 2017), Ohio State University's wetlands (Mitsch et al., 2014) and University of Lampung's green spaces (Banuwa et al., 2019). One New Zealand university study accounted for the carbon sequestration value of trees on campus and found that the natural sink accounted for only 6% of total university emissions, most of which derive from overseas

business travel, emphasizing that while accounting for natural carbon sinks is important, it's only a part of emissions mitigation (De Villiers et al., 2014).

Leal Filho et al. (2024) further argue that universities should optimize their land as carbon sinks to enhance their role in advancing sustainable practices, research, and education. Furthermore, according to CU's CAP, the commuting of faculty, staff and students contributes 16,407 MTCO_{2e} emissions annually – without distinguishing the contribution of each group. Meanwhile, CU business travel for business-related activities contributes 19,954 MTCO_{2e} emissions annually (University of Colorado Boulder, 2024, p. 79). The CU official's emphasis that building a new campus would positively impact the overall CAP is not backed by CU's CAP data. Future carbon accounting research could measure the carbon emissions specifically from CU student commuting and compare that with the expected emissions from a campus development, along with the loss of carbon sequestration from the development of the land, resulting in a more accurate picture of university emissions.

The City's cited their flood mitigation project as a nature-based approach, but the high-hazard dam doesn't fit within the ecological definition of nature-based solutions, which broadly includes ecosystem management interventions that maintain or enhance multiple ecosystem services to improve human well-being while also supporting biodiversity (Cohen-Shacham et al., 2019; Ramachandran et al., 2024). However, the 119 acres of new open space designation could possibly count as a nature-based solution as a restored wetland (Cohen-Shacham et al., 2019).

4.2.3 Dogs, dogs, dogs

The outstanding result of the entire survey is that visitors most value the community-regulated, customary leash rules at CU South (Figure 7). These have, in effect, been grandfathered in by the trail visitors' high usage and by the absence of university enforcement

(Figure 8), though not legally allowed (Huber, 2014). The health benefits already mentioned can be extended to the visitors' dogs (Bekoff & Pierce, 2019), which in turn creates a positive feedback loop of the visitors receiving even more benefits. In a review of dog-walking correlates, Westgarth et al. (2014) found that for many dog owners, being able to walk their dog off leash in suitable environments, e.g. off-leash dog areas, is important and that such environments encourage human social interaction. Indeed, Middle (2020) showed that off-leash dog parks have great potential to facilitate social interactions and stress reduction for dog owners. Meanwhile, Christian et al. (2013) showed evidence of a positive relationship between dog owners and walking versus people who don't own dogs.

Another key finding from the survey is that visitors not only value bringing their dogs, but they also highly value the naturalness of the land for their off-leash dogs. They value the grassland, the ponds, the unpaved and unmanicured trails, the wildlife and the views (Figure 7), which is supported by animal behavior studies that show "unleashing" dogs positively contributes to giving them the best possible lives (Bekoff & Pierce, 2019). Indeed, in a study performed on OSMP trails, Bekoff and Meaney (1997, p. 23) concluded that "the well-being and interests of dogs should not summarily and dismissively be compromised when dogs and people attempt to share limited [recreational] space." They found that "a higher percentage of people reported that the quality of dogs' experience of the outdoors would be compromised more than their own enjoyment if dogs could not walk off leash in areas where this is currently permitted" (Bekoff & Meaney, 1997, p. 23). Trail visitors emphasized in the survey that there are no equivalent trails or parks that provide such recreation opportunities for them and their dogs as CU South, and they lamented that they are uncertain about how to replace what CU South offers their dogs – a 308-acre natural area with ponds and community-enforced regulations. That being

said, CU South was never designed to be a large, natural area dog park. The use of the space evolved over time, due to lack of enforcement by officials and community enforced social norms. It is unique and irreplaceable in this way – for example, dogs swim in ponds in front of signs that say, “no swimming.” CU and the City never intended for CU South to evolve into a place of community-regulated off-leash benefits.

The City official’s acknowledgment of off-leash dog behavior at CU South is important and suggests that the city is aware of CU South’s current benefit to trail visitors and their dogs. The City’s invitation to use the vast OSMP trail network and dog parks should also be noted, as off-leash access is possible on most of these trails for dogs that enroll in the City’s Voice and Sight tag program (City of Boulder, n.d.-b). Indeed, it is harder to find trails in Boulder where dogs are forbidden. Further, city dog parks offer a combined 8.55 acres of off-leash dog park across four different parks, East, Foothills, Howard Heuston, Valmont (City of Boulder, n.d.-a). The trail visitor survey results (Figure 7) suggest that nearby trails such as Shanahan Ridge, South Boulder Creek, Marshall Mesa and Bobolink (which turns into South Boulder Creek East, which doesn’t allow dogs) could see an increase in visitation. As shown in Figure 4, these trails already experience relatively high visitation.

Further investigation into the impacts of off-leash dogs on the grassland and wetland ecosystems of CU South is warranted, along with study of how potential future displacement of additional visitors and dogs to other trails could impact those ecosystems. Research has shown that nutrient input from dogs’ fecal matter may influence biodiversity, ecosystem functioning and co-determine restoration outcomes (De Frenne et al., 2022); although the overall impacts of off-leash dogs on natural areas vary depending on ecosystem (Lenth et al., 2008). Buchholz et al. (2021) showed in dry grasslands that dogs may facilitate biological invasions via eutrophication

and disturbance, but overall relationships with species richness were weak and management may reconcile conservation and moderate dog walking in urban grassland areas. On the other hand, De Frenne et al. (2022) suggested that off-leash dog parks could help manage the consequences from nutrient input from dog fecal matter.

4.3 Limitations, Future Research & Management Implications

In future studies at CU South, year-round data collection would be superior to our data collection of seven weeks. Additionally, our study did not analyze tennis players or tennis-associated visitors to CU South as the focus was on the natural area. Even still, reports have documented that tennis court access is a challenging problem for tennis players in Boulder especially after 15 courts were demolished to build private student apartments at the old Millenium Hotel site in central Boulder (Herrick, 2023; Metzger, 2024). Our study also didn't record specific data on fishing or meditating, both of which were mentioned by visitors in the survey results. Finally, outdoor recreation researchers are not only installing traditional recreation monitoring devices, but also employing emerging techniques like accessing and analyzing visitor generated data, e.g. social media posts, geo-tags and activity tracking data (Fisher et al., 2018; Loosen et al., 2023; Reinhardt et al., 2024). Creany et al. (2026) showed that accessing "Strava Metro" mobility data may be more cost-effective than traditional recreation monitoring techniques. Analyzing such data in the future may be beneficial for CU South recreation planning.

The survey and interviews had some limitations as well. We acknowledge that the survey intentionally targeted visitors to CU South versus the broader Boulder community. Future studies could expand the selection pool to include people who recreate elsewhere, comparing visitation rates and experiences. Further studies could also survey the users to better understand their

perspectives on the development of the space, including the trade-offs between recreation values, flood mitigation, and student housing. Additional interviews with more city and university officials, as well as representatives from other institutions, could provide further insight as well, as our interviews were limited to two individuals.

There is vast opportunity to research CU South as development unfolds. For example, future studies could assess what type of habitat restoration occurs on the 119 acres; if and how recreation is allowed on the 119 acres or other parts of CU South; if increased trail visitation numbers, dog-related conflict and or ecological impacts influence OSMP trails. Future research as development progresses could also include passive acoustic monitoring as a method for measuring the impacts of development on CU South wildlife (Teixeira et al., 2024; Vaughn & Quinn, 2025). A specific management suggestion is that “Development Zone” managed by CU could be used for ecological research before campus development begins, which would contribute to CU’s commitment to their campus as a living lab (University of Colorado Boulder, 2024, p. 32). CU and the City could even permit manipulative ecological research to assess the impact of development on the grasslands and wetlands.

5. Conclusion

Here, we present a unique case of a deeply embedded, community-regulated natural area that is being developed. Recreation at CU South provides vast benefits ranging from physical to mental health, to social community ties, to lifestyle benefits of routinely connecting with wildlife and nature. And most visitors enjoy these benefits with their dog(s) off leash, though the official rules require dogs to be on-leash. These benefits are complicated by the 2021 AA that paved the way for development of CU South into a flood mitigation project and university campus. The 2021 AA also transfers 119 acres of the land to OSMP for restoration, but whether recreation will

be allowed, and when, is uncertain. What is clear from our study is that the benefits of recreation are not prioritized by CU and the City to the same extent as the other benefits of flood mitigation and development. We suggest a more comprehensive consideration of the benefits of recreation at CU South in the continuation of CU South’s planning. This could result in the alteration of current plans to minimize the loss of recreation benefits and/or the explicit acknowledgment that current recreation benefits are not a priority in the future of CU South. This study builds on the literature that shows the importance of explicitly considering the benefits of recreation in land use planning if such benefits are to be protected. Land use issues, even when extremely local, are complex with competing values and trade-offs. It remains to be seen if conflict will ensue as development unfolds at CU South, as has been seen in other cases. In the meantime, users have continued recreating and will be holding a goodbye celebration at the site the day before construction ensues. This celebratory action reinforces the profound connection to community, and the potentially irreplaceable physical and social benefits that CU South provides.

Compliance with Ethical Standards

IRB Approval/Protocol Number: 25-0407; MOU Regarding the Land Use for Environmental Studies Research on University of Colorado South Campus Property Between The Regents of the University of Colorado, a body corporate (“University”) And The Department of Environmental Studies (“EStudy”) Signed August 11, 2025.

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Data

Data are available upon request from the corresponding author.

Appendix A. Supplementary material

Supplementary material to this article can be found online.

Declaration of generative ai in the writing process

During the preparation of this work, we used Claude for coding assistance in R. After using this tool, we reviewed and edited the code as needed and we take full responsibility for the content of the publication.

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Appendix A

Supplementary Material

2.4 Trail User Survey

CU South Recreation Study SURVEY

Q1. What type of recreation are you usually doing on CU South trails?

- ☐ Walking
- ☐ Running
- ☐ Cycling
- ☐ Bird Watching

Q2. How many dogs usually accompany you?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

Q3. Are the dogs usually off-leash for most of your time at CU South? *(Answer only if dogs accompany you)*

- ☐ Yes
- ☐ No

Q4. How often do you recreate at CU South, on average?

- ☐ More than 2x/week
- ☐ 1–2x/week
- ☐ 1–3x/month
- ☐ Fewer than 1x/month
- ☐ This is my first time

Q5. How do you usually get to CU South?

- ☐ Walk
- ☐ Run
- ☐ Bike
- ☐ Drive personal car
- ☐ Take public bus + walk

Q6. Where do you live?

- ☐ South Boulder
- ☐ North Boulder
- ☐ Central/Downtown Boulder
- ☐ East Boulder

- Outside of Boulder
- Other (write in below)

Q7. If "Other," where do you live? *(optional write-in)*

Q8. Are you aware of the 2021 Annexation Agreement and the development of CU South campus set to begin as early as 2027?

- Yes
- No

Q9. Would you still want to recreate here if the trails were shorter in length, paved, had less surrounding unmanicured vegetation, and/or nearby buildings?

- Yes
- No
- Unsure (elaborate below in Q10)

Q10. If unsure, please elaborate:

Q11. Why do you choose to recreate here at CU South versus other trails?

Q12. If the CU South trails were closed to the public for an extended period or altered from their current form, where do you think you'd likely recreate instead? Nearby areas include Marshall Mesa, South Boulder Creek Trailhead, Bobolink, NCAR, Tantra Park, Cragmoor Connector, Shanahan Ridge, East Boulder Dog Park.

Q13. Follow-up for trail users with dogs: Are you aware of any dog leash laws on the trails you would relocate to? *(Answer only if dogs accompany you)*

- Yes
- No / Unsure

Q14. What do you value about CU South in its current form? Do you receive any benefit from recreating here?

Q15. Do you have anything else you'd like to share about your experience recreating at CU South?

2.5 Managerial Interviews

Interview Questions for CU South Recreation Study

IRB Record/Protocol Number: 25-0407

Questions for University of Colorado Officials

- 1) What are your thoughts on the current recreational value of CU South, as-is?
- 2) Have you ever recreated on CU South, and would you like to share anything about your experience?
- 3) What are your thoughts on the current ecological value of CU South, as-is? Happy to share more about the [novel grassland](#) studies performed on this land by CU ecologists, if you're not aware (Seastedt & Suding 2007; Seastedt et al. 2008; Cherwin et al. 2009; Reed et al. 2007; Behringer et al. 2019).
- 4) How do you think the university will support or reimburse the city for potential recreation spillover to nearby city-managed trails?
- 5) How does the CU South Campus Development plan fit into the university's larger sustainability goals and the Climate Action Plan?
- 6) How does the value of a new campus compare with the value of recreation and undeveloped land, especially in terms of the university's sustainability and climate goals?
- 7) In line with this, can you talk about the value of potentially selling CU South (per a clause in the Annexation Agreement) instead of developing it – how would selling CU South fit within the university's larger climate and sustainability goals?
- 8) How do you think CU will justify potential loss of recreational and ecological value with a campus development?
- 9) Would putting a dollar amount on the recreational value and/or the carbon sequestration value of CU South, as-is, assist the university in development planning, and is this already part of the planning?
- 10) How do you think the university will communicate with the public about the future potential loss of the current recreational value of the land? For example, there are thousands of trail users that are concerned about losing CU South as-is: do you think the university will have a public relations campaign about this?
- 11) How do you think the university will justify developing CU South considering potential future enrollment decline, as part of the potential national trend?
- 12) Do you think the university would ever consider not developing CU South and/or charging an admission fee to offset loss of income from forgoing the campus development?
- 13) How do you think the university values recreation and conservation in comparison to economic profit and development?
- 14) Anything you'd like to add to be included in this interview that I didn't ask about?

Questions for City of Boulder Officials (response written in email)

- 1) What are your thoughts on the current recreational value of CU South, as-is?
- 2) Have you ever recreated on CU South, and would you like to share anything about your experience?
- 3) What are your thoughts on the current ecological value of CU South, as-is? Happy to share more about the [novel grassland](#) studies performed on this land by CU ecologists, if you're not aware (Seastedt & Suding 2007; Seastedt et al. 2008; Cherwin et al. 2009; Reed et al. 2007; Behringer et al. 2019).
- 4) Does the city anticipate trail use spillover onto city-managed trails once CU South is developed?
- 5) How do you anticipate the city will manage additional recreation impacts; in particular, related to off-leash dogs?
- 6) How do you think the university will support or reimburse the city for potential recreation spillover to nearby city-managed trails?
- 7) Concerning the 119 acres that will come into OSMP management, per the 2021 Annexation Agreement, how will off-leash dogs be involved, if at all, in that area?

- 8) How does the city-managed land of CU South fit into the City of Boulder’s larger sustainability goals and Climate Action Plan?
- 9) When would the public be informed of the type of recreation available, if any, in the OSMP – managed part of CU South? For example, will the public be able to use potential future trails in that area during the flood mitigation construction work?
- 10) How do you think the city might communicate with the public about the future potential loss of the current recreational value of the land? For example, there are thousands of trail users that are concerned about losing CU South as-is: do you think the city will have a public relations campaign about this?
- 11) How do you think the city values recreation and conservation in comparison to economic profit and development?
- 12) Anything you’d like to add to be included in this interview that I didn’t ask about?

3. Results

3.1 Trail User Counts

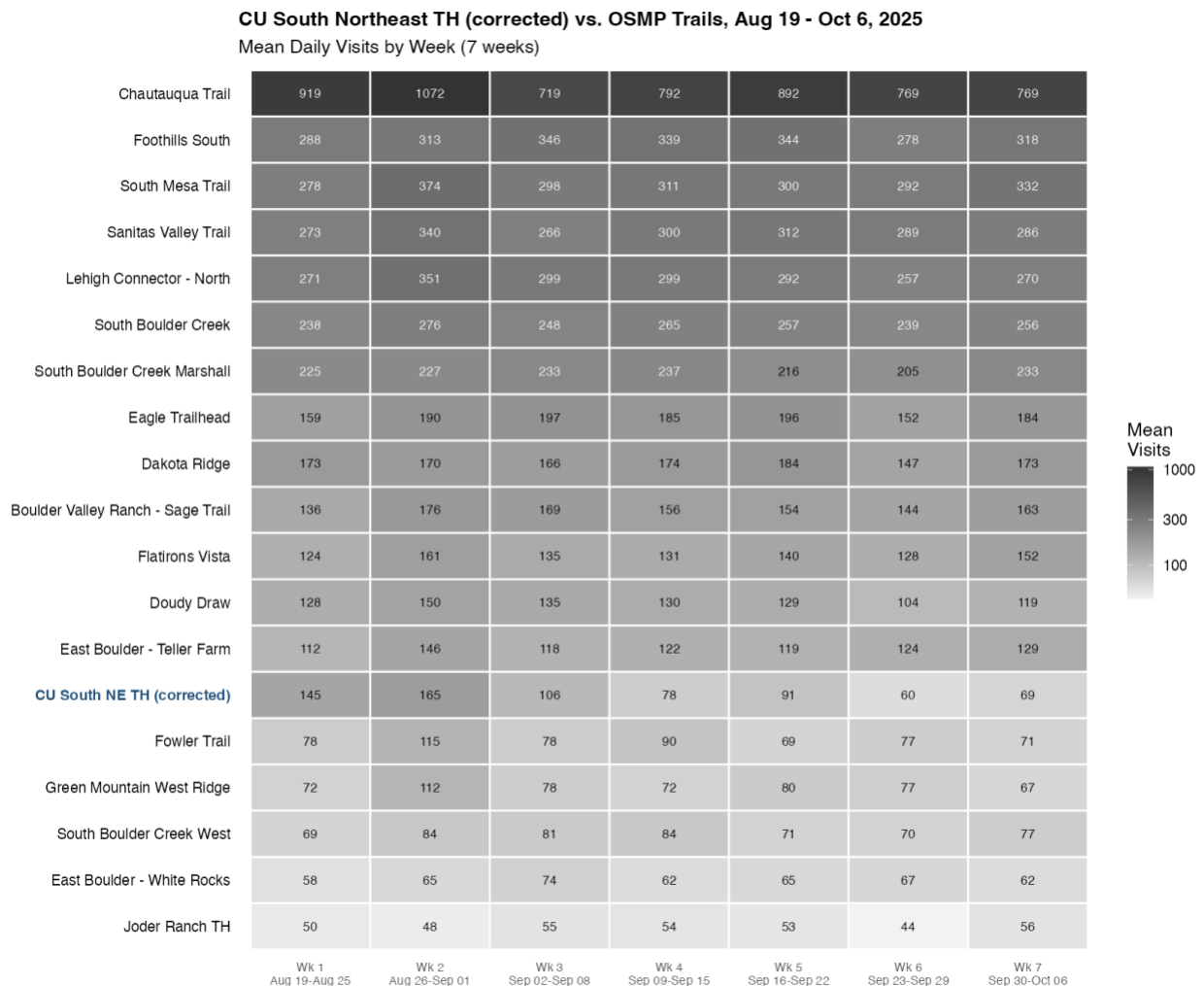


Figure 1: Heatmap of trail visitation by week from Aug 19 to Oct 6, 2025 for Open Space and Mountain Parks Trails and CU South Northeast trailhead (corrected).

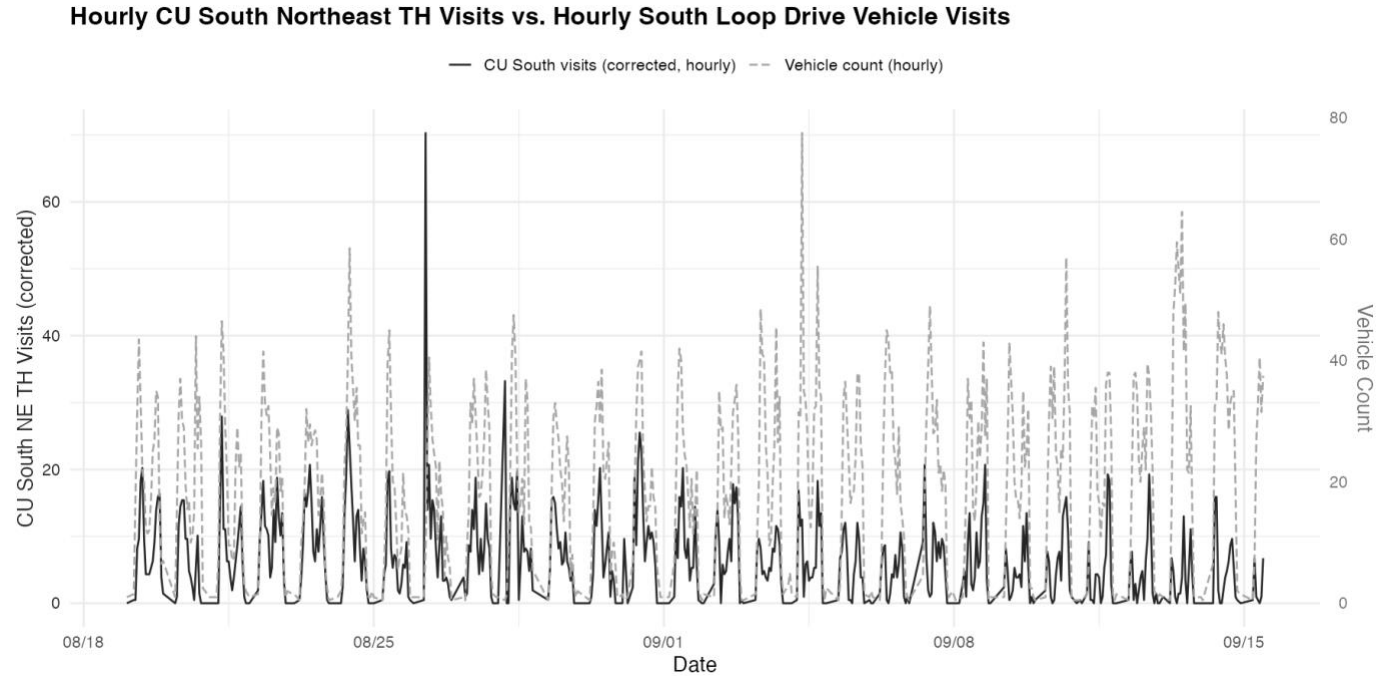


Figure 2: Time series chart of vehicle visits at South Loop Drive from August 19 to Sept 15, 2025 compared with the CU South Northeast trailhead visits

3.2.2 Survey Respondent Profile Results Compared with Visual Documentation

Table 1. Cross-method comparison of visitor profile estimates: visual observation ($n = 237$) vs. survey ($N = 398$).

Note. χ^2 = Pearson chi-square ($df = 1$). All expected cell counts ≥ 5 . Bonferroni-corrected $\alpha = .010$ (5 comparisons); *** $p < .001$ survives correction. Cohen's h : $|h| < 0.2$ negligible, 0.2–0.5 small.

Metric	Visual ($n=237$)	Survey ($N=398$)	Diff.	χ^2	p	Cohen's h	Sig.
Walking	207/237 (87.3%)	318/398 (79.9%)	+7.4 pp	5.74	0.017	$h = +0.20$	*
Running	27/237 (11.4%)	49/398 (12.3%)	-0.9 pp	0.12	0.730	$h = -0.03$	ns
Cycling	3/237 (1.3%)	12/398 (3.0%)	-1.7 pp	1.97	0.160	$h = -0.12$	ns
With dogs	165/237 (69.6%)	331/398 (83.2%)	-13.5 pp	15.94	<.001	$h = -0.32$	***
Off-leash (dog users)	140/165 (84.8%)	294/331 (88.8%)	-4.0 pp	1.59	0.207	$h = -0.12$	ns

3.4 Social-Ecological Systems Application

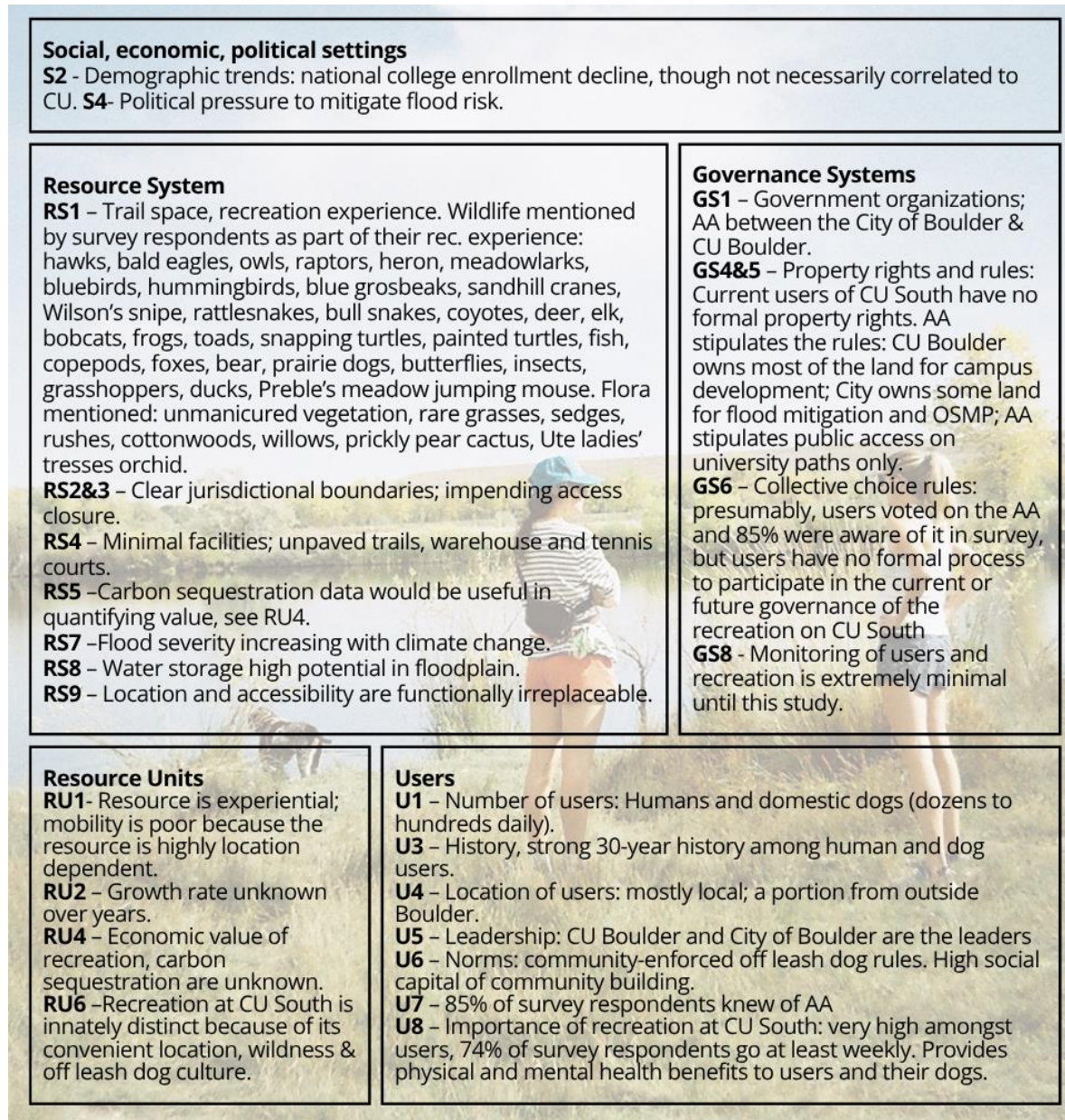


Figure 3: Recreation at CU South applied to an SES framework following Ostrom (2009) overlaying photograph of two women and an off-leash dog at the center pond at CU South from August 2024 (Clare Gallagher).