Voice and Sight Tag Program and Leash Regulations on Open Space and Mountain Parks Lands

Baseline Conditions Monitoring Report

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June 2015

City of Boulder
OPEN SPACE & MOUNTAIN PARKS

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Cover photograph: Typical leash interview set-up.

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Executive Summary

The Voice and Sight Dog Tag Program (Tag Program) is a management strategy within the Education and Outreach, Safety and Enforcement, Recreation Opportunities and User Conflict Reduction Initiatives of the Visitor Master Plan (City of Boulder 2005). Under the Tag Program, launched in the summer of 2006, visitors wishing to manage their dog(s) off-leash and under voice and sight control are required to have a voice and sight tag visibly displayed on their dogs. From 2006 through 2014 the process of obtaining a voice and sight tag required an applicant to view a video describing the requirements of voice and sight control, acknowledge understanding of those requirements, pay a fee and complete a registration form. Beginning in January 2015, participants are also required to attend an hour-long in-person Tag Program training session. Dog guardians not registered in the program or who do not have a voice and sight tag visibly displayed on their dog are required to keep their dog on-leash while visiting Open Space and Mountain Parks (OSMP) and other City of Boulder properties where voice and sight control is an option.

Previous monitoring conducted before (2006), immediately after (2007) and almost four years after (2010) the program's launch, as well as other sources of information, indicated that the program achieved some but not all of the original objectives (City of Boulder 2011). In 2011, OSMP was directed by Boulder City Council to evaluate and recommend revisions to the Tag Program. In collaboration with the public and appointed advisors, OSMP has developed a number of Tag Program enhancements designed to improve the program and increase understanding of and compliance with Tag Program requirements. The current monitoring project is scheduled to be conducted before ("baseline"), soon after and three years after implementing Tag Program enhancements to gain an understanding of any measurable change in observed behaviors.

During development of the 2014 protocol, staff determined that repeating the previous methods would not meet current project needs, and a new methodology was created based upon a literature review, public and Open Space Board of Trustees input, professional peer review and professional judgment.

Dog management success is important to maintain quality visitor experiences and for the protection of resources. By the end of the summer of 2010, over 25,000 participants had registered in the Tag Program (City of Boulder 2011) and OSMP receives about 2 million annual dog visits (on and off-leash) (Vaske et al. 2009).

Because the 2006-2010 and 2014 monitoring projects were conducted with different methodologies, only limited attempts will be made to quantitatively compare each interval of tag program monitoring.

Executive Summary

The overall goals of the enhanced Tag Program are to:

- *Increase the proportion of dog guardians visiting OSMP who have control over their dogs as required by applicable regulations, including proof of current dog rabies vaccinations;*
- *Maintain a safe, high-quality visitor experience for all; and*
- *Contribute to natural resource conservation.*

The Tag Program enhancements project's objective relevant to this monitoring study is to:

- *Increase compliance with observed dog regulations and voice and sight control rules.*

Methods

Data for this project were collected on trails with designated dog access across OSMP from May-July 2014. There were 64 locations allocated as both Voice and Sight and Leash Interview component sites, 13 as Voice and Sight only sites, 17 as Leash Interview only sites and 34 as Leash Required sites.

The **Voice and Sight Regulations component** of the monitoring was an observational study designed to evaluate dog guardian compliance with observable aspects of specific dog regulations from the voice and sight ordinances. During field monitoring, data was collected to describe visitor party attributes, dog behaviors and guardian responses. Observations were categorized as "pass" events where no dog behaviors were recorded, "interaction" events where the dog under observation exhibited a behavior toward another person, dog, wildlife or livestock and as "other" events describing situations where the dog was out of sight and/or the guardian issued a command *and* where these observations were not associated with a pass or interaction event. The resulting descriptive data were evaluated and interpreted using the collected information for each party. The use of these data provided context for each party's recorded behaviors and interactions. Evaluation and interpretation was conducted by the monitoring staff for objective indicators such as the number of dogs per guardian or visible tag display. For the more subjective indicators such as charging/chasing wildlife or voice control, project management and ranger staff also participated in determining a final compliance outcome for each visitor party.

The **Leash Interview component** of the monitoring was a visitor interview administered to visitor parties with at least one dog off-leash and without a leash visible to the observer for each off-leash dog. During the interview, each guardian was asked to demonstrate that the guardian possessed a leash for each dog they were managing under voice and sight control.

Additional measures of dog regulation compliance

Two additional measures of dog regulation compliance *not specific to the Tag Program* were monitored during the study period. These two additional components included dog excrement removal and leash compliance on both year-round and seasonal leash-required trails. These measures were added to this project based upon direction received from the Open Space Board of Trustees (OSBT) and project team staff.

- The **Dog Excrement component** was an observational study designed to evaluate dog guardian compliance with dog excrement pickup and removal regulations. This component was executed simultaneously with the Voice and Sight component.
- The **Leash Required component** was an observational study designed to evaluate dog guardian compliance with seasonal and year-round leash laws on OSMP leash-required trails.

Major Findings

Compliance rates for most individually measured attributes and indicators were >70% during baseline (i.e., 2014) monitoring, and overall compliance was 67% (details below). Categories with lower compliance rates were:

- More than 2 dogs off-leash per guardian (12%);
- Excrement pickup (69%); and
- Interactions with wildlife/livestock (50%).

Baseline conditions as characterized during this project along with the results from the two additional monitoring periods (2016, 2018) will inform future discussions about ranges of acceptable compliance rates and associated standards for future dog regulations along with associated compliance studies.

Voice and Sight Regulations

During monitoring of the Voice and Sight Regulations component, 310 visitor parties were observed. The **overall compliance rate was 67%**. Individual compliance results, estimated at the visitor party level, include:

- **Tag display**: 69%
- **Within sight**: 93%
- **No more than 2 dogs per guardian off-leash (8 total visitor parties observed with more than 2 dogs per guardian; 7 parties had more than 2 dogs per guardian off-leash)**: 12%
- **Voice control**: 77%
- **Charging, chasing or otherwise displaying aggression toward any person** or behave toward any person in a manner that a reasonable person would find harassing or disturbing:
    - Including passes (i.e., dog passes by person without interaction) and interactions (i.e., dog and person interact): 92%
    - Including interactions only: 70%
- **Charging, chasing or otherwise displaying aggression toward any dog**:
    - Including passes and interactions: 87%
    - Including interactions only: 81%
- **Chasing, harassing or disturbing wildlife or livestock**:
    - Including passes and interactions: 50%
    - Including interactions only: 29%

Detailed methods for calculating compliance rates at the visitor party level as well as the event level for voice control and the three types of charging are included in the results section of this report.

Leash Interviews

During the Leash Interview component, 302 visitor parties were observed and/or interviewed. Close to 91% of visitor parties observed and/or interviewed had a leash for each dog being managed under voice and sight control. The majority of those parties in compliance with the leash possession regulation had the correct number of leashes visible to the observer (205 visitor parties) and these parties were not contacted for an interview. Ninety-seven visitor parties were contacted for an interview and of these, 70 had the correct number of leashes with them, 13 parties did not and 14 parties had unknown leash possession status because they did not stop and/or stopped but refused participation.

Dog Excrement

The 2014 project included numerous new sampling sites, the majority of which were located beyond the trailhead area. Because of this change, and the possibility that dogs are more likely to relieve themselves near the start of the trail, we anticipated observing fewer events than during the previous project (***n*** ranged from 100-188 during 2006-2010). As expected, we observed fewer dogs defecating. Of the 26 visitor parties observed with one or more such events, 18 parties (69%) both picked up and took the bag with them. Eight parties (31%) did not meet the requirements due to not picking up, or picking up and then leaving the bag on the side of the trail.

Leash Required

Staff observed 238 visitor parties during observation for the Leash Required component. Of these, 195 parties had all of their dogs leashed (82% compliance).

Recommendations

Recommendations for increasing compliance and improving project management include:

1. Further develop decision-making strategies for dog management.
2. Implement strategies to maximize visitor compliance with dog regulations.
3. Increase dog guardians' voice control skills.
4. Re-test observer variability and review the methods during each data collection interval.
5. Refine analysis techniques and database structure.
6. Consider developing new dog monitoring indicators related to ecological health and visitor experience quality.
7. Consider developing new dog monitoring indicators and studies related to understanding the benefits of recreating with dogs.
8. Conduct a study aimed at understanding barriers to compliance with dog regulations on OSMP.
9. Consider communication recommendations from published literature.

Acknowledgements

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Introduction

City of Boulder
Open Space and Mountain Parks
Visitor Master Plan Monitoring
Tag Program and Leash Regulations
Report of 2014 Baseline Conditions

1.0 Introduction

1.1. Tag Program monitoring background

Previous monitoring conducted before (2006), immediately after (2007) and almost four years after (2010) the voice and sight tag program launch indicated that the program achieved some but not all of the original objectives (City of Boulder 2011). Selected results of the previous project include:

- OSMP increased voice and sight control outreach to visitors and some visitors reported an improved understanding of the voice and sight rules because of the program.
- OSMP observed an increase in compliance with some components of voice and sight rules.
- OSMP did not detect any increase in dog guardians' ability to use voice control following implementation of the program.

During 2006-2010, OSMP also measured compliance with dog excrement removal rules. Compliance with these rules ranged from 46% to 63% during the previous 4-year study period.

1.2. Tag Program and leash regulation monitoring purpose

In 2011 OSMP was directed by Boulder City Council to evaluate and recommend revisions to the Tag Program. In collaboration with the public and appointed advisors, OSMP has developed a number of Tag Program enhancements designed to improve the program and increase understanding of and compliance with Tag Program requirements. The current monitoring project is scheduled to be conducted before (2014), soon after (2016), and three years after (2018) implementing Tag Program enhancements (early 2015) to gain an understanding of any measurable change in observed characteristics and behaviors.

1.3. Goals and objective

The overall goals of the enhanced Tag Program are to:

- *Increase the proportion of dog guardians visiting OSMP who have control over their dogs as required by applicable regulations, including proof of current dog rabies vaccinations;*
- *Maintain a safe, high-quality visitor experience for all; and*
- *Contribute to natural resource conservation.*

Introduction

The Tag Program enhancements project objective relevant to this monitoring study is:

- *Increase compliance with observed dog regulations and voice and sight control rules.*

1.4. Guidance from Visitor Master Plan

The Voice and Sight Dog Tag Program (Tag Program) is a management strategy within the Education and Outreach, Safety and Enforcement, Recreation Opportunities and User Conflict Reduction Initiatives of the Visitor Master Plan (City of Boulder 2005). Under the Tag Program, launched in the summer of 2006, visitors wishing to manage dogs off-leash and under voice and sight control were required to have a voice and sight tag visibly displayed on their dogs and comply with all other program requirements.

The 2005 VMP outlined monitoring measures associated with dog management on OMSP (City of Boulder 2005 p. 59, 63, 64). These monitoring measures are included in the Safety and Enforcement, Resource Protection and the User Conflict Reduction initiatives of the VMP. All measures initially had a proposed standard of 90% visitor compliance. This and previous studies are meant to better inform decision making as staff no longer proposes to use the 90% standard when interpreting dog monitoring projects. Additionally, high levels of uncertainty involved in the management of visitor use and natural resources often leads to approaches that receive major revision. Many times the most effective strategies must be discovered through the feedback loops of repeated monitoring and modification; an approach called adaptive management. "An adaptive and cautious approach considers changing circumstances, creates opportunities to incorporate new information and evaluate unanticipated outcomes and minimizes the likelihood of irreversible environmental impacts" (City of Boulder 2005 p. 35).

While potential dog management actions will be implemented through Trail Study Area (TSA) processes and plans, strategies associated with the OSMP management area designation will guide dog management decisions (City of Boulder 2005, p. 48-50) (**Appendix A**). The VMP established the four management area designations (Passive Recreation Areas, Natural Areas, Agricultural Areas, and Habitat Conservation Areas) based upon characteristics of visitation and resource status, and describes general management objectives for each. Management strategies for dog management range from voice and sight control with off-trail opportunities (maximum access) to dogs prohibited (no access). Typically, Passive Recreation Areas have the greatest amount of access for dogs/guardians and Habitat Conservation Areas have the least access.

Methods

2.0 Methods

The 2014 monitoring methods are as similar to the 2006-2010 methods as possible. Because some new components were added, some previously observed behaviors were removed and some definitions were changed, these respective methods have been modified. **Table 1** provides an example of the similarity in the methods between the two study periods.

Because the 2006-2010 and 2014 monitoring projects were conducted with different methodologies, only limited attempts will be made to quantitatively compare each interval of tag program monitoring.

Table 1. Comparison of data collected during 2006-2010 and 2014 monitoring of Tag Program and excrement regulations

Collected Data Type	2006-2010	2014
Work shift attributes (location, time, weather, etc.)	Yes	Yes
Visitor party demographics	Yes	Yes
Tag display	Yes[1]	Yes
Number of dogs off-leash per visitor party	Yes	Yes
Dog behaviors	Yes[2]	Yes
Guardian attempts to manage dog	Yes[3]	Yes
Others present (people, dogs, wildlife or livestock)	Yes[4]	Yes
Others present behaviors/dog interactions	Yes[5]	Yes
Excrement pickup and removal	Yes	Yes
Dog out of sight	Yes	Yes
Visitor party travelled off-trail	Yes	Yes
Dog "passes" of others (no interaction occurred)	Yes[6]	Yes
Visitor party travelled on undesignated trail	Yes	No
Guardian and/or dog entered a closure area	No	Yes

[1] Collected only in 2007 and 2010 post Tag Program launch
[2] Behavior codes and definitions were revised in 2014
[3] Recording of guardian attempts to manage a dog was revised in 2014
[4] Livestock was not recorded in 2010; modified in 2014
[5] Recording of interactions between dogs and others was revised in 2014
[6] Recording of dog "passes" was revised in 2014

Methods

During development of the 2014 protocol, staff determined that repeating the previous methods would not meet current project needs, and revised the methodology based upon a literature review, a reexamination of departmental needs, public and Open Space Board of Trustees input, expert peer review and professional judgment.

The methods presented below are a general description of the methods used during this project. For further explanation on any topic, a detailed protocol for the 2014 project is available from OSMP upon request (VanderWoude & Magtanong 2015). A glossary of terms used in this report can be found in **Appendix B.** The Voice and Sight control definition is included below. *Definitions used in this report (exempting those contained within the Boulder Revised Code) are modified specifically for the purpose of the Tag Program and Leash Regulations monitoring project and should not be considered universal.* Finally, this study is not meant to be exhaustive of every possible human or dog behavior that could be considered a violation of dog management regulations.

Boulder Revised Code – Voice and Sight Control Definition (B.R.C. 6-1-2)

"Voice and sight control" means the ability of a guardian or keeper to adequately control a dog by using voice commands and sight commands (such as hand gestures). In order for a guardian or keeper to have voice and sight control over a dog, the guardian or keeper must: (1) be able to see the dog's actions; and (2) be able to prevent the dog from engaging in the following behaviors, using voice and sight commands, without regard to circumstances or distractions:

(a) Charging, chasing or otherwise displaying aggression toward any person or behave toward any person in a manner that a reasonable person would find harassing or disturbing;

(b) Charging, chasing or otherwise displaying aggression toward any dog;

(c) Chasing, harassing or disturbing wildlife or livestock; or

(d) Failing to come to and stay with the guardian or keeper immediately upon command by such person.

2.1. Study Area

The 2014 study area was primarily based upon the locations of designated trails across OSMP that include official dog opportunities and covered the vast majority of all OSMP-managed trails (**Appendix C)** as of May 2014. Known exemptions include mountain peaks and other hard to reach areas greater than a 60-minute hike in from an access point. The study area only included properties where OSMP has an enforcement responsibility. Elevations ranged from approximately 5,200 to 7,600 feet in a topographically diverse setting including mountain slopes, mesas, bottomlands, canyons and plains. The study area included riparian, grassland, foothill scrub, ponderosa pine, Douglas-fir and sub-alpine spruce-fir forest vegetation falling within the Central Shortgrass Prairie and Southern Rocky Mountains eco-regions as defined by the Nature Conservancy (Bunin 1985; Cooper 1984; Nied et al., 2009).

The 2014 study area included the 2006-2010 sites except for the Red Rocks Trailhead which was excluded due to inadequacies in the ability of observers to see what was needed to meet current

objectives. The 2014 study area also included sites not monitored in previous iterations of this study (**Appendix D).** Sites were located across all OSMP management area designations (**Appendix E**) and within the four Trail Study Areas (**Appendix F**).

Sites for the 2016 and 2018 monitoring projects will be selected from the 2014 list, modified by any necessary changes due to trail closures/construction or regulation changes.

2.2. Preparation for data collection

A system-wide map of all monitoring sites was created using ESRI ArcMap® (**Appendix C**). This map, along with the GIS attribute table, contains all sites and the attributes of each site (**Appendix D**), such as the site's TSA or the estimated visitation rate for the trail. Additional information contained in the attribute table, and documented only for the Voice and Sight Regulations (V/S) component, were the linear length of the field of view and the length of the off-set from the trail to be observed to the point where the observer was physically positioned to collect data.

Before beginning fieldwork, Global Positioning System (GPS) receivers were uploaded with background files including all of the monitoring sites, OSMP lands, designated trails, fences and gates and other files intended to aid field technicians in locating property boundaries, trails, access points and monitoring sites.

Preparation for the V/S component included the creation of a photo map for each observation station (**Appendix G**). These photo maps included access information, photos representing the field of view and adjacent landscape features, the trail(s) to observe, the line(s) of sight, the observation post and other notes about the site. These maps were created to aid in locating the specific monitoring location during the current project, to ensure each observer was observing the same field of view, and for re-locating the sites in the future.

Before leaving the office, the field technicians prepared:

- Site location on GIS map
- GPS unit
- Datasheets
- Gear list
- Photo map
- Access/parking directions

2.3. General methods

Methods included naturalistic[7] observation and face to face interviews. The following criteria were used to select the best location along the trail for each monitoring site in the field (not all sites meet all criteria; see protocol for additional detail on site selection):

- Sight distance of at least 400 feet (Voice and Sight component only)

[7] In this context, *naturalistic* means a research method commonly used by psychologists and other social scientists which involves observing subjects in their natural environment.

- Audio distance of at least 400 feet (Voice and Sight component only)
- Few visual obstructions on/along trail such as boulders, shrubs, trees, trail undulations or switchbacks
- Ease of access and available legal parking for field technician
- Location along trail continuum; need to represent various locations along the trail (trailhead, first quarter mile, interior)
- Recreation setting (combination of biophysical, managerial and social conditions along with infrastructure development); need to represent a range of recreation settings
- Existence of a potential challenge for dog management (water access, prairie dogs, livestock)
- Topographical setting; need to represent flats, hills, peak access, canyons
- Not within a Trailhead Leash area
- Underlain by OSMP owned and managed property (OSMP has enforcement responsibility)

2.3.1. *Voice and Sight (V/S) Regulations Component*

The V/S component of the monitoring was a naturalistic observational study designed to evaluate dog and guardian compliance with observable aspects of specific dog regulations of the voice and sight ordinances. During field monitoring, data was collected to describe visitor party attributes, dog and human behaviors and guardian responses (**Appendix H)**. There is a full list of categorical codes that were used to categorize and standardize observations throughout the monitoring process at the end of **Appendix H**. Observations were categorized as "pass" events when no dog behaviors were recorded, "interactions" when the dog under observation exhibited a behavior toward another person, dog, wildlife or livestock and as "other" when the dog was out of sight and/or the guardian issued a command (and these observations were not associated with a pass or interaction event). These descriptive field data were evaluated and interpreted using the collected information for each party to provide context and a chronological understanding of each party's behaviors and interactions. Evaluation and interpretation was conducted by the monitoring, project management and ranger staff to determine a final compliance outcome for each visitor party.

An important part of the B.R.C. code states that guardians must have voice control over their dog while off-leash. To issue a V/S command means that the guardian spoke an audible command to the dog with their voice; issued commands may include other signals (including but not limited to vocalizations [words, whistles, whoops, etc.], clapping, or by making noises with their person or a device, or by motions, movements or positions of their person); ***and*** that the signal appeared to the observer to be communication intended to establish control of the dog including but not limited to gaining the dog's attention and/or requiring the dog to stop or return to the guardian.

- Intended to establish control means that the guardian spoke discreet commands such as "come here" and that the direction of movement of the guardian, tone of voice and/or rate of speech used by the guardian is more urgent or stern than a friendly or relaxed behavior or tone would be.

For purposes of this report, and to limit ambiguity, we separated commands into those that were clearly meant to establish V/S control over a dog, and "other attempts" that were less clear.

These command events were reviewed by a team of experienced employees at OSMP including Tag Program and monitoring staff along with lead law enforcement staff. Only commands that included a word or phrase associated with a V/S regulation were included in the voice control compliance measure.

For the Voice and Sight component, overall compliance was calculated by quantifying the following variables in each visitor party.

- Tag compliance (visible display of tag);
- Out of sight (dog within sight of guardian);
- More than 2 dogs per guardian;
- Wildlife/livestock violation (charging, chasing or disturbing wildlife/livestock);
- Human or dog violation (charging, chasing, or disturbing a human or dog);
- No response to V/S command of guardian.

If a visitor party was not compliant with any one of these regulations, they were considered noncompliant in the *overall* compliance measure. The number of noncompliant visitor parties was divided by the total observed parties to obtain the compliance measure.

The Dog Excrement component of the monitoring was an observational study designed to evaluate dog guardian compliance with dog excrement removal regulations. This component was executed simultaneously with the V/S component. <u>This component was not designed or intended to measure Tag Program compliance. It is included in this project based upon direction received from the Open Space Board of Trustees (OSBT) on July 10, 2013</u>.

2.3.2. *Leash Interview Component*

The Leash Interview component of the effectiveness monitoring was a visitor interview administered to visitor parties with at least one dog off-leash and without a leash visible (for each off-leash dog) to the observer. During the interview, each guardian was asked to demonstrate that they possessed a leash for each dog being managed under voice and sight control. The interview was designed to evaluate dog guardian compliance with the leash possession regulation. During these shifts, field technicians recorded data as shown in **Appendix I**.

For the leash interview component, compliance was measured at the visitor party level by summing the total number of visitor parties that did not possess a leash for each off leash dog and dividing this number by the total number of visitor parties observed.

2.3.3. *Leash Required Component*

The Leash Required component was an observational study designed to evaluate dog guardian compliance with seasonal and year-round leash requirements on OSMP trails. Due to the time frame of the first data collection period, the only seasonal leash trail to be included in the sampling was the Greenbelt Plateau Trail. During these shifts, technicians recorded data as shown in **Appendix J**.

For the leash required component, compliance was measured by summing the total number of visitor parties that did not have each dog leashed and dividing this number by the total number of

visitor parties observed.

2.3.4. *Violation data*

OSMP Rangers have the authority to issue a summons when they see visitor parties that are in violation of the B.R.C.. Each issued summons can include one or more charges. Staff gathered the data for the number of charges issued that related to V/S violations of the B.R.C. for the same time period as our monitoring (May 1, 2014 – July 31, 2014); codes are shown in **Table 2**.

Table 2. Description of each B.R.C. code collected during the monitoring period

Nature of offense	B.R.C. code
Aggressive Animal Prohibited	6-1-20
Dog running at large	6-1-16
Dogs prohibited	8-3-3
Failure to protect wildlife	8-3-5
Voice and Sight Control Evidence Tag Required	6-13-2

Additionally, we quantified the number of violations against B.R.C. code 6-1-18: Failure to remove animal excrement.

2.4. Field methods

For all components, field personnel arrived at the monitoring site at least ten minutes prior to the start of the monitoring period. Most monitoring sites required a hike from the trailhead or other parking area and the time necessary to access the site was appropriately planned for.

2.4.1. *Voice and Sight Regulations Component*

Field personnel did ***not*** wear attire that identified them as OSMP staff and followed written procedures. Once the monitoring session began, the observer watched the first visitor party with one or more off-leash dogs that entered the field of view (from any direction). The observer collected and recorded the visitor party data as shown in **Appendix H**. The observer watched the visitor party the entire time the party remained in the observation area. Once the party that was being observed left the observation area, the observer began observing the next dog-containing party to enter the observation area and repeated the data collection process.

2.4.2. *Leash Interview Component*

During the leash interviews field personnel ***did*** wear attire that identified them as OSMP staff and followed written procedures. Upon arrival at the monitoring location, the observer set up the "Please STOP!" sign (**Figure 1**) near the monitoring site. Once the monitoring session began, the observer attempted to stop the first visitor party with one or more off-leash dogs (and did not have a leash visible for each off-leash dog) that approached the monitoring post from any direction. Staff interviewed willing participants and used the datasheet to collect and record

information as shown in **Appendix I**. Staff did ***not*** attempt to contact the visitor party when leashes for all dogs in the visitor party were visible.

2.4.3. *Leash Required Component*

When monitoring the leash required component, field personnel did ***not*** wear attire that identified them as OSMP staff and followed written procedures. Once the monitoring session began, the technician observed every visitor party with one or more dogs that crossed over the observation point (coming from all directions). The observer collected and recorded the visitor party data as shown in **Appendix J**.

Figure 1. Leash interview sign-i-cade

2.5. <u>GIS digitizing methods-mapping sites</u>

A field technician visited each potential V/S site's area, and then located the best place (greatest field of view, least obstructions and suitable off-trail place to sit) along the specified trail to place the monitoring site. GPS points were collected at the observation posts, along with the off-sets from the trail to the posts and along the fields of view for each monitoring location and were downloaded into a Geographic Information System (GIS) to facilitate digitizing of each V/S component site. The study design included a 60-minute limit to the hiking time necessary to access any monitoring site. Consequently, a handful of the highest elevation and/or hard to reach trail locations on OSMP were not included in the study area.

Leash interview and leash required sites were digitally mapped in the office and field checked during the first visit to them. As needed, points were digitally moved to the most suitable location.

2.6. <u>Quality control procedures</u>

To produce the highest quality data set possible and maintain data integrity, monitoring staff implemented the quality assurance/quality control procedures listed below.

2.6.1. *Training and testing*

Project staff participated in extensive in and out of office training prior to the start of data collection.

<u>Protocol and definitions training</u>

Prior to the start of monitoring, staff members responsible for collecting data received extensive training in the office including things such as: code definitions, scenario review, datasheet review, protocol review, Q/A sessions, numerous group discussions and reading of relevant literature. Project staff also participated in numerous field tests in real-time and these provided an opportunity for staff to observe the behaviors and conditions being evaluated by this

monitoring. Field technicians were trained to identify the current OSMP voice and sight control tag and decipher this tag from other common tags such as the Boulder County rabies tag and the City of Boulder dog license tag (**Figure 2**).

OSMP V/S Tag **City of Boulder dog license** **Boulder County rabies tags**

Figure 2. Dog tags commonly found in Boulder Colorado

<u>Inter-observer variability test</u>

In any study where more than one observer is responsible for collecting data, the results can be compared using an inter-rater reliability (IRR) statistic. Cohen's kappa (κ) is the most commonly used and widely acceptable statistic for comparing IRR (Viera and Garrett, 2005). There were three observes collecting data for this project.

After extensive office and field training, a real-time field test was conducted to measure the level of inter-observer reliability in data collection. During this field test, data collection staff silently and simultaneously completed an observation session of three hours at six sampling locations, representing a range of monitoring site conditions. While data were collected for a variety of variables and behaviors, staff only tested reliability for those behaviors or events that were relevant to the B.R.C and inferred compliance or non-compliance of a visitor party.

Perfect agreement would be indicated by $\kappa = 1$, while agreement equivalent to chance is indicated by $\kappa = 0$. The minimum level of adequate consistency was set at $\kappa = 0.6$, which is an accepted practice among researchers involved in similar studies (Landis and Koch 1977; Sim and Wright 2005). Kappa was calculated in R (R Development Core Team, 2014) using package "irr" (Gamer et al 2012).

Across all variables and all observers, the κ ranged from 0.39-1.00 and averaged 0.75, indicating substantial agreement across observers. The average κ-value of 0.75 is above the normally acceptable 0.6, and thus observations between observers collected during the study period could be considered reliably collected.

2.7. Monitoring design rationale and suggested limitations

Staff were asked by City Council and the Open Space Board of Trustees to re-design the tag monitoring project for 2013-2017 (post-flood dates changed to 2014-2018). The ordinances related to voice and sight control in the B.R.C. do not provide definitive measurable parameters by which a guardian must "adequately control a dog using voice and sight commands" (B.R.C. 6-1-2) in order to prevent specific outcomes from taking place. Thus, staff developed a monitoring project that would align with the legal interpretation of the B.R.C. regarding V/S control by incorporating the thought process rangers use in enforcing these regulations. As such, modifications were made to the 2006-2010 monitoring methods to reflect this new thought process. A full explanation of the monitoring design rationale and the specific changes can be found in **Appendix K**. A list of suggested limitations to the current project is included in **Appendix L**.

Results

3.0 Results

Because the 2006-2010 and 2014 monitoring projects were conducted with different methodologies, only limited attempts will be made to quantitatively compare each interval of tag program monitoring.
Additionally, results presented do not intend to determine the compliance rate for a visitor's entire trip. All rates of compliance should be understood as rates only through the observation zone.

Other notes on interpreting results:

1. Results represent data at the visitor party level; results at the per event level are included in **Appendix M**.
2. Individual or summed values less than .05 are typically not included; totals represent rounding to the nearest tenth of a percent, or to the nearest whole count or percent.
3. Slight differences in individual values and/or sums are due to rounding.
4. Summed values greater than 100% are due to rounding of individual values.
5. All comparisons between years were conducted using the χ^2 test of equality of proportions where $\alpha = 0.05$. When a significant difference was detected, this result is shown in **bold red text.**

3.1. Generalizing to OSMP Dog Guardian Population

The vast majority of OSMP trails were included in the sampling site list. However, as a result of selecting monitoring sites with a maximum of a 60-minute hiking access time, compliance estimates generated by this study can only be generalized to the population of dog guardians that visit trails on OSMP that allow dogs and have similar dog management as to those trails listed in **Appendix D** (i.e. no mountain summits or other areas more than a 60 minute hike in from an access point).

The monitoring study was designed to gain an understanding of the level of compliance with voice and sight requirements, leash regulations and excrement removal across all trails on the OSMP system that met our selection criteria. For each component, staff will pool data from the study sites and will *not compare the individual study sites to each other*. Observations at individual sites were too few to support statistically useful comparisons between sites.

3.2. Voice and Sight Regulations Component

For the Voice and Sight regulations component, we conducted 65 monitoring sessions and sampled a total of 310 visitor parties. The overall compliance rate was 67%.

The monitoring periods were distributed over all days of the week, three time periods per day and varying locations along the trail (**Figure 3**). Sessions occurred at locations of varying visitation volume (high to low volume) and across numerous geographic locations on OSMP. While only 38.5% of all sessions took place in the morning, 56% of all visitor parties were

observed during that time period. Similarly, while about 28% of all sessions took place at the trailhead/start of trail, 38% of visitor parties were observed at those locations. These results suggest that proportionally, more people come to OSMP in the mornings and that more people travel near the trailhead (less people travel to the interior) or potentially become more spread out as trails branch off into different routes.

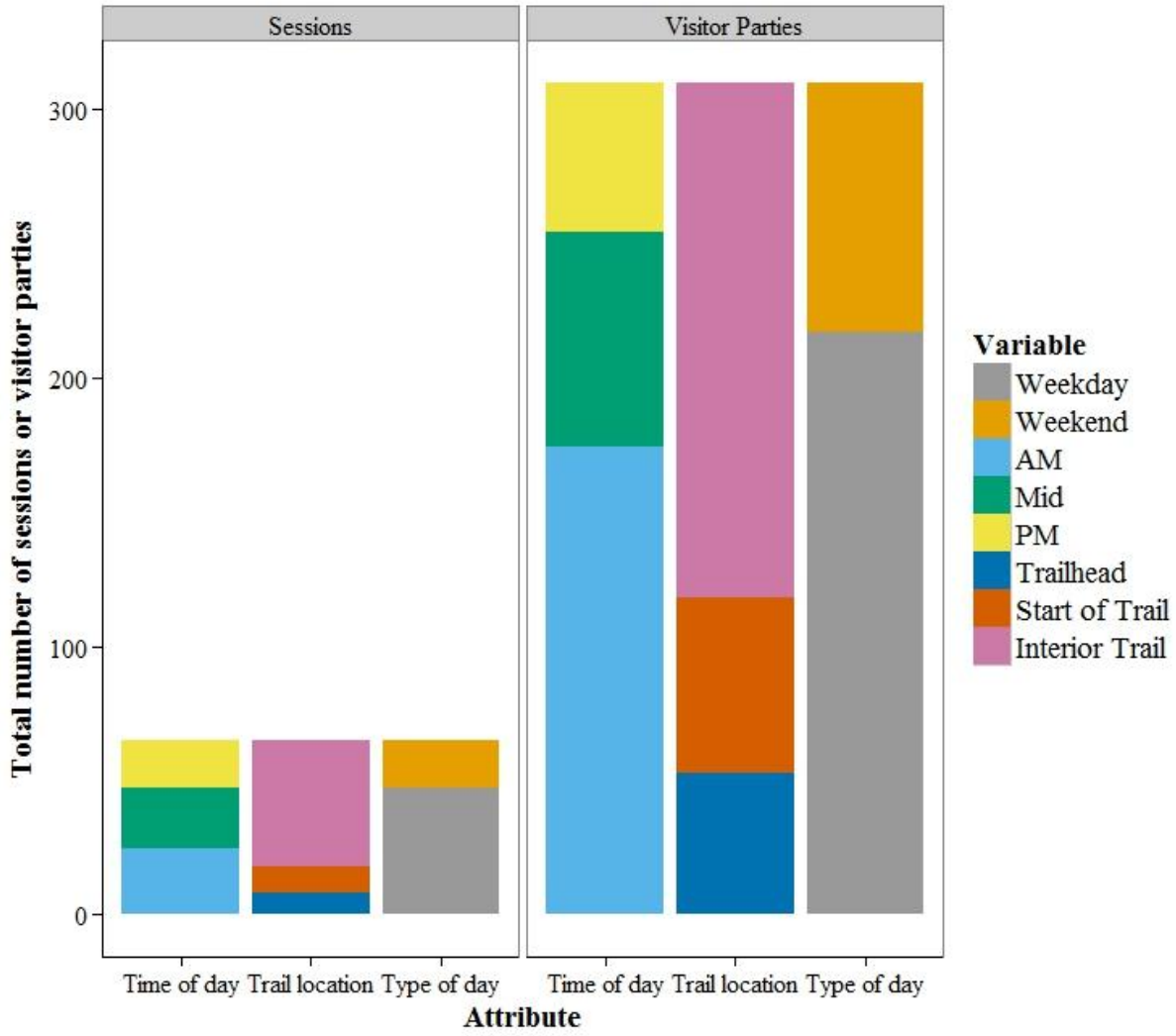

Figure 3. The number of sessions (n=65) and visitor parties (n=310) broken down by attribute for the Voice & Sight component.

Results

Of the 310 visitor parties monitored for the Voice and Sight regulations component, there were 255 hiking, 48 running, 6 cycling and 1 equestrian party (**Figure 4**). Compared to the most recent system-wide visitor survey activity distribution (City of Boulder 2011), there was more hikers, fewer cyclists and about an equal percentage of runners.

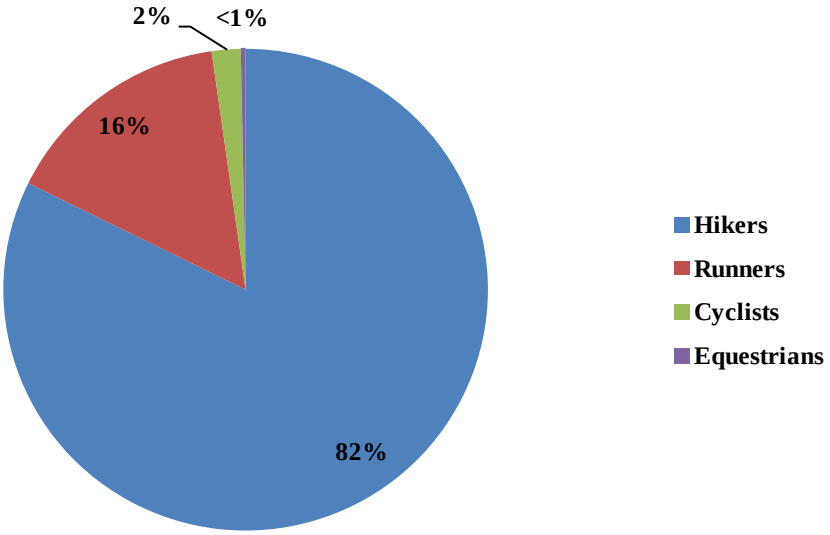

Figure 4. Number of visitor parties (n=310) by activity for the Voice & Sight component.

The majority of visitor parties had only one dog, and very few had more than 2 dogs (**Table 3**). These results are similar to the 2011 OSMP visitor survey, where of the parties that had a dog with them, 77% of people brought 1 dog, 19% brought 2 dogs, and 3% brought 3 or more dogs.

Table 3. Total number of off-leash dogs by visitor party (n=310) for the Voice and Sight component

Number of off-leash dogs	Number of visitor parties	Total number of dogs	Percent of observed parties
1	236	236	76.1
2	60	120	19.4
3	11	33	3.5
4	3	12	1.0
Total	**310**	**401**	**100.0%**

3.2.1. *Overall compliance rate system-wide*

The overall Tag Program compliance rate system-wide (excluding the Leash Interview component which was monitored separately), is 67% (95% CI, 61.2 to 72.0) (**Appendix N**).

Compared to the previous monitoring project (**Tables 4, 5)**, this is somewhat higher. This indicates that there could be an increase in compliance with the Tag Program requirements since the last project was completed. However, because the current project and the previous project are *not directly comparable* due to changes in sampling locations and methodologies, we cannot determine if these results represent a statistical change.

Table 4. Overall Tag Program compliance rates for the years 2006, 2007, 2010, and 2014

Compliance category	Monitoring Year			
	2006	**2007**	**2010**	**2014**
Noncompliant	34%	40%	37%	31%
Compliant	66%	49%	53%	61%
Unsure*	n/a	12%	10%	9%

*Due to unsure tag display

Table 5. Overall Tag Program compliance rates for the years 2006, 2007, 2010, and 2014 (normalized without unsures)

Compliance category	Monitoring Year			
	2006	**2007**	**2010**	**2014**
Noncompliant	34%	45%	41%	34%
Compliant	66%	56%	59%	67%

3.2.2. *Tag display* (B.R.C. 6-13-2 Voice and Sight Control Evidence Tag Required and 6-1-16 Dogs Running at Large Prohibited)

For tag display, we sampled a total of 310 visitor parties. A visitor party was considered compliant if *all* off-leash dogs in the party had a tag visibly displayed. A visitor party was considered noncompliant if *at least one* off-leash dog in the party did not have a tag visibly displayed. A visitor party was considered unsure if at least one off-leash dog had unsure tag display (and the party did not also include a no tag display dog).

Of the 310 visitor parties, 215 parties had tags visibly displayed for all off-leash dogs, indicating a compliance rate of 69.4% ± 5.13%. There were 62 visitor parties that contained at least one off-leash dog with no visible tag (**Figure 5**), indicating a 20% ± 4.45% non-compliance rate with this regulation. Of the 62 noncompliant parties, 52 (84%) had no tags for all off-leash dogs, nine had a mix of tag/no tag dogs (2.9%), and one visitor party had a mix of tag/no tag and unsure tag dogs (0.3%).

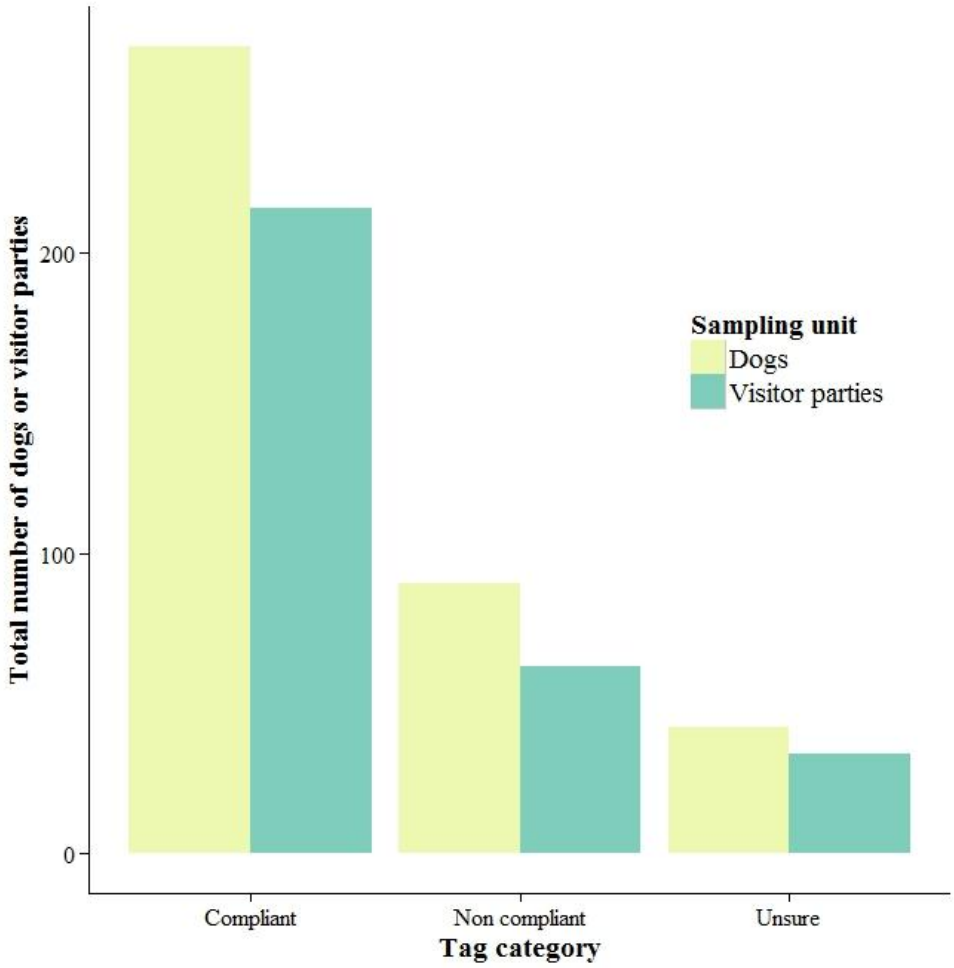

Figure 5. Number of visitor parties (n=310) and dogs (n=401) by tag display for the Voice & Sight component.

During the monitoring of tag display, observers noted 34 visitor parties that had at least one off-leash dog with unsure tag status (observer unable to determine status of tag display). Of these 34, 29 visitor parties (94%) had unsure tag status on all dogs in the party and were not assigned as complaint or noncompliant but rather in a unique category named "unsure". Four of the 34 visitor parties had a mix of tagged and unsure tagged dogs and were also included in the unsure category (1.3%). One of the 34 parties had a combination of tag/no tag/ unsure tag, and thus was included in the group of 62 visitor parties with at least one untagged dog (noncompliant).

The total sample size of all visitor parties in 2007 and 2010 was 1,029 and 1,010 respectively (City of Boulder 2011). In order to compare tag display of visitor parties across years, we removed all visitor parties from previous years with only on-leash dogs. Also, in previous years, unsure tag display was categorized as compliant. In order to compare with the current year, we placed unsure tag display in its own category. The remaining sample size and consequent tag display can be seen in **Table 6**. Data from 2006 is not included here, as 2006 pre-dated the implementation of the V/S program.

Results

Table 6. Yearly comparison of tag display breakdown by visitor party for off-leash dogs for the Voice and Sight component

Tag display	2007 # parties	2007 Percent	2010 # parties	2010 Percent	2014 # parties	2014 Percent
All dogs have tags (compliant)	499	64.0	573	72.3	215	69.4
All no tag (non-compliant)	142	18.2	96	12.1	52	16.8
Mix tag/no tagged, no unsure (non-compliant)	20	2.6	16	2.0	9	2.9
Mix tag/no tagged with unsure (non-compliant)	2	0.3	0	0.0	5	1.6
Mix no tag unsure (noncompliant)	2	0.3	2	0.3	0	0.0
Only unsure (unsure)	107	13.7	90	11.4	29	9.4
Mix yes tag with unsure (unsure)	8	1.0	15	1.9	0	0.0
Total	**780**	**100.0%**	**792**	**100.0%**	**310**	**100.0%**

We used the χ^2 test statistic to determine if there were significant differences in the proportion of visitor parties displaying tags for all off-leash dogs between years. For all tests, $\alpha = 0.05$. For consistency, we removed all visitor parties from the previous years that were comprised of only on-leash dogs. We found a significant increase in compliant visitor parties from 2007 to 2010, and no difference between 2010 and 2014 (**Table 7**).

Table 7. Statistical comparisons between years for tag display for the Voice and Sight component

Years to compare	χ^2	df	p
2007/2010	12.70535	1	**<0.001**
2010/2014	0.97997	1	0.32

3.2.3. *Within sight* (B.R.C. 6-1-2 Definitions)

In 2014, we observed 21 unique parties with one or more dogs that were out of sight one or more times within the observation area, this resulted in a 93% compliance rate (**Table 8**).

Table 8. Yearly comparison of compliance with the out of sight regulation at the visitor party level

Year	2006	2007	2010	2014
# of Visitor parties with at least one off-leash dog	919	780	792	310
# Out of sight	129	61	38	21
Percent noncompliant	**14%**	**8%**	**5%**	**7%**
Percent compliant	**86%**	**92%**	**95%**	**93%**

To compare 2014 results with previous years, we removed all visitor parties with only on-leash dogs from the 2006-2010 data. While the differences between 2006/2007 and 2007/2010 were determined to be significantly different, the compliance rate between 2010 and 2014 were not (**Table 9**).

Table 9. Statistical comparisons between years for the out of sight regulation

Years to compare	$\chi 2$	df	p
2006/2007	16.41536	1	**<0.001**
2007/2010	6.08382	1	**0.014**
2010/2014	1.71712	1	0.19

3.2.4. *No more than 2 dogs off-leash* (B.R.C. 6-1-16. Dogs Running at Large Prohibited)

Out of 8 visitor parties with a total of more than 2 dogs per guardian, 7 visitor parties had too few guardians for the number of off-leash dogs. This indicates a non-compliance rate of 88%.

In 2006, 2007, and 2010, the compliance rate for no more than two dogs off-leash was 6% (1 out of 18 visitor parties), 41% (7/17), and 33% (3/9)[8] respectively. We were unable to calculate the χ^2 statistic for this component between 2010 and 2014 due to a low sample size, however there was a strong decrease with the compliance rate falling from 33% in 2010 to 12% in 2014.

3.2.5. *Charging…person* (B.R.C. 6-1-2 Definitions)

At the visitor party level, compliance is 92% including both passes and interactions and 70% including only interactions (**Table 10**).

[8] In the 2011 City of Boulder report, the original total sample was 10 visitor parties. After re-analyzing the data, we found an error and now report the new sample size as 9 visitor parties.

Table 10. Number, type of event and compliance outcome for events involving other visitors reported at the visitor party level (some parties had more than one type of event).

Type of event/visitor party level	No violation	Violation	Total	Compliance both	Compliance interactions only
Person passes*	111	n/a	111	**92%**	**70%**
Person interactions	22	7	29		
Person and dog passes	11	n/a	11		
Person and dog interactions	9	6	15		
Totals	**153**	**13**	**166**		

**Includes one equestrian pass

When reduced to the *unique number of visitor parties that included one or more events (of any type) involving other people* (n=139),12 visitor parties had one or more noncompliant event and this results in an overall *charging…person* compliance rate of 91%. Of these 12 parties, the majority had tags on all off-leash dogs.

3.2.6. *Charging…dog* (B.R.C. 6-1-2 Definitions)
At the visitor party level, compliance is 87% including both passes and interactions and 81% including only interactions (**Table 11**).

Table 11. Number, type of event and compliance outcome for events involving other dogs reported at the visitor party level (some parties had more than one type of event)

Type of event/visitor party level	No violation	Violation	Total	Compliance both	Compliance interactions only
Dog passes	7	n/a	7	**87%**	**81%**
Dog interactions	20	1	21		
Person and dog passes	11	n/a	11		
Person and dog interactions	9	6	15		
Totals	**47**	**7**	**54**		

When reduced to the *unique number of visitor parties that included one or more events (of any type) involving other dogs* (n=47), 7 visitor parties each had one noncompliant event and this results in an overall *charging…dog* compliance rate of 85%. Of these 7 parties, equal numbers did and did not have tags on all off-leash dogs.

3.2.7. *Charging ……person and a dog* (B.R.C. 6-1-2 Definitions)
In some cases, the observers recorded an interaction including both a person and a dog. Of the 15 visitor parties that had one or more interactions with both a person and a dog, there were 6 parties whose interactions led to the harassment of both a person and a dog (**Appendix M**).

In some instances, the off-leash dog under observation approached an on-leash dog and their guardian. In four of these cases, there was contact between the off-leash dog and the leashed dog and human guardian. In four of these cases (not necessarily the same cases) there was avoidance behavior and/or verbal protest from the human guardian of the leashed dog. Three of these cases resulted in a violation of regulations on the part of the unleashed dog visitor party.

There were also 11 visitor parties with one or more passes of a person and a dog. The compliance rates for these events are included in the appropriate B.R.C. sections/figures above (**Tables 10, 11**).

3.2.8. *Chasing…..wildlife* (B.R.C. 6-1-2 Definitions)

At the visitor party level, compliance is 50% including both pass and interactions events and 29% with only interactions (**Table 12**).

Table 12. Number, type of event and compliance outcome for events involving wildlife/livestock reported at the visitor party level

Type of event/visitor party level	No violation	Violation	Total	Compliance both	Compliance interactions only
Wildlife passes*	3	n/a	3	**50%**	**29%**
Wildlife interactions*	2	5	7		
Totals	**5**	**5**	**10**		

*Includes one livestock event

When reduced to the *unique number of visitor parties that included one or more events involving wildlife/livestock* (n=10), 5 visitor parties each had one noncompliant event and this results in an overall *charging…wildlife* compliance rate of 50%. Of these 5 parties, the majority had tags on all off-leash dogs.

3.2.9. *Voice recall* (B.R.C. 6-1-2 Definitions)
Summarized to the visitor party level for each type of event, overall compliance with the voice control regulation is 77% (95% CI, 64.2 to 87.3) (**Table 13**) (**Appendix N**).

Table 13. Number, type of event and compliance outcome for V/S command events collapsed at the visitor party level (some parties had more than one type of event)

Type of event	Dog response		Total	Compliance rate
	No	Yes		
Pass	1	3	4	75%
Interaction	4	14	18	78%
Isolated	9	31	40	78%
Total	**14**	**48**	**62**	**77%**

When reduced to the *unique number of visitor parties that included one or more command events* (n=57), 13 visitor parties had one or more noncompliant event and this results in an overall voice control compliance rate of 77%. Of the 310 observed visitor parties, 253 did not give a V/S command within the observation zone.

Other observed attempts/methods to control a dog

On numerous occasions (38), field observers noted a guardian communicating with a dog using words or phrases that could not definitively be related to a V/S command (e.g. just a dog's name or words like, "Hey!"). The observers recorded what was said and whether or not there was a response from the dog. Observers also documented a handful (11) of other attempts to control a dog. These included whistling, leashing, and physical restraint. Of these total (49) other observed attempts/methods to control a dog, 37 included a response from the dog and 12 did not. This rate of response (76%) was very similar to the V/S command results.

3.2.10. *Passes summary*
When the dog party under observation "passed by" another person, dog, wildlife or livestock, and the dog exhibited no behavior(s) toward the other being, field staff recorded this as a pass event. Staff recorded a total of 195 passes across 119 visitor parties, and the vast majority of these took place with just people (170), while there were 8 passes of just dogs, 2 of just wildlife, 1 of just an equestrian and 1 of just livestock. There were also 13 passes of a person and a dog.

3.2.11. *Interactions summary*
When a dog displayed a behavior toward another being, an interaction was recorded. Sixty-three visitor parties had one or more interactions with another person, dog, livestock or wildlife (or some combination) and there were a total of 92 interactions documented. Of these 92 interactions, 23 resulted in a violation of the B.R.C. 6-1-2 Definitions section.

3.2.12. *All opportunities summary*
Of the 310 observed visitor parties, 148 had many potential opportunities (287) to interact with other people, dogs, wildlife or livestock or some combination of these. The majority (195) of potential opportunities resulted in a neutral pass and the remainder (92) resulted in an interaction. Of the 287 potential opportunities, 23 resulted in a violation against a person, dog or wildlife.

The majority of parties (162) had no opportunity to pass or interact with another being because no other thing was within the observation zone at the same time as the party under observation.

3.2.13. *Dog excrement pickup and removal* (B.R.C. 6-1-18 Removal of Animal Excrement Required)

While not a requirement specific to the Voice and Sight Tag Program, field observations included collection of data associated with dog excrement regulations. This was the most efficient and feasible way to include these observations within the current project as staff was in place making observations.

Compliance with the regulations requires that a visitor party bags and takes all excrement with them, and thus any visitor party that bags the excrement but does not take it with them, i.e.,

leaves the bag on the side of the trail, was considered noncompliant. To quantify visitor party behavior, we divided noncompliant visitor parties into two categories: "Bagged and left" refers to guardians that bagged their dog's excrement and left the bag, while "No action" indicates that the visitor party did not bag or remove their dog's excrement.

We observed 26 visitor parties with dogs that defecated during the study period. Out of those 26, 18 parties were compliant, i.e., bagged and took the excrement with them. Of the eight noncompliant parties, 4 did not bag their dog's excrement ("no action"), while the other 4 visitor parties bagged the excrement but did not take it with them ("Bagged"). These results indicate a compliance rate of 69.2% (18/26). Of the 8 noncompliant dog parties that did not take all excrement (**Figure 6**), the majority were compliant with tag regulations.

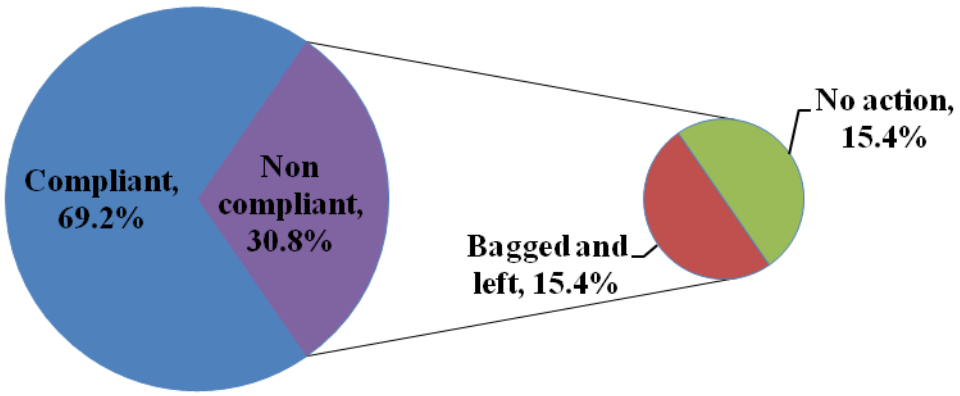

Figure 6. Excrement removal status by visitor party (n=26) broken down by visitor party action

Our sample sizes are considerably lower than other years of data collection (2006-2010) because previously, excrement monitoring was done primarily near trailheads or the start of the trail (where dogs are more likely to defecate), and included observation of parties comprised exclusively of leashed dogs. The sample sizes for 2006, 2007, and 2010 were 188, 100, and 103 respectively. Of those visitor parties, the total number of noncompliant parties for 2006, 2007, and 2010 were 69, 50, and 56. However, here we report the yearly comparison of excrement removal compliance rates and the type of non- compliance with excrement removal (**Table 14**) considering only visitor parties with at least one off-leash dog. Removing the leash-only parties

Table 14. Yearly comparison of excrement removal by visitor party for off-leash dogs

Excrement category	2006	2007	2010	2014
Took all (compliant)	105 (62%)	36 (44%)	38 (41%)	18 (70%)
Bagged and left (non compliant)	30 (18%)	29 (36%)	26 (28%)	4 (15%)
No action (non compliant)	35 (21%)	16 (20%)	16 (31%)	4 (15%)
Total	170 (100%)	81 (100%)	93 (100%)	26 (100%)

from the previous data was necessary to compare compliance of visitor parties with at least one off-leash dog between years. Additionally, because the 2014 project included excrement observations for only off-leash dogs, the comparison tables include data for off-leash dogs only (some parties had on-leash dogs as well but these were not observed).

We used the χ^2 test statistic to determine if there were significant differences in the proportion of visitor parties picking up and removing all excrement between years (i.e., took all). For all tests, $\alpha = 0.05$. For consistency, we removed all visitor parties from the previous years that were comprised of only on-leash dogs. In agreement with the previous report (City of Boulder, 2011), we found a significant decrease in the proportion of compliant visitor parties from 2006 to 2007, with no difference between 2007 and 2010 (**Tables 14, 15**). In addition, we found a significant increase in compliance from 2010 to 2014.

Table 15. Statistical comparisons between years for excrement removal

Years to compare	χ^2	df	p
2006/2007	6.685051	1	**0.009**
2007/2010	0.22755	1	0.633
2010/2014	6.564631	1	**0.01**

3.3. Leash Interview Component

For the Leash Interview component, we conducted 60 monitoring sessions and sampled a total of 302 visitor parties. The monitoring periods were distributed over all seven days of the week, three time periods per day and location (**Figure 7**). Sessions occurred at locations of varying visitation volume (high to low volume) and across numerous geographic locations on OSMP. While 36.7% of sessions were conducted in the morning, 58% of visitor parties were accounted for during the AM sessions. The same pattern was observed in the V/S monitoring. Possible reasons for higher visitation in the morning include lower temperatures and/or personal preference for exercise in the morning.

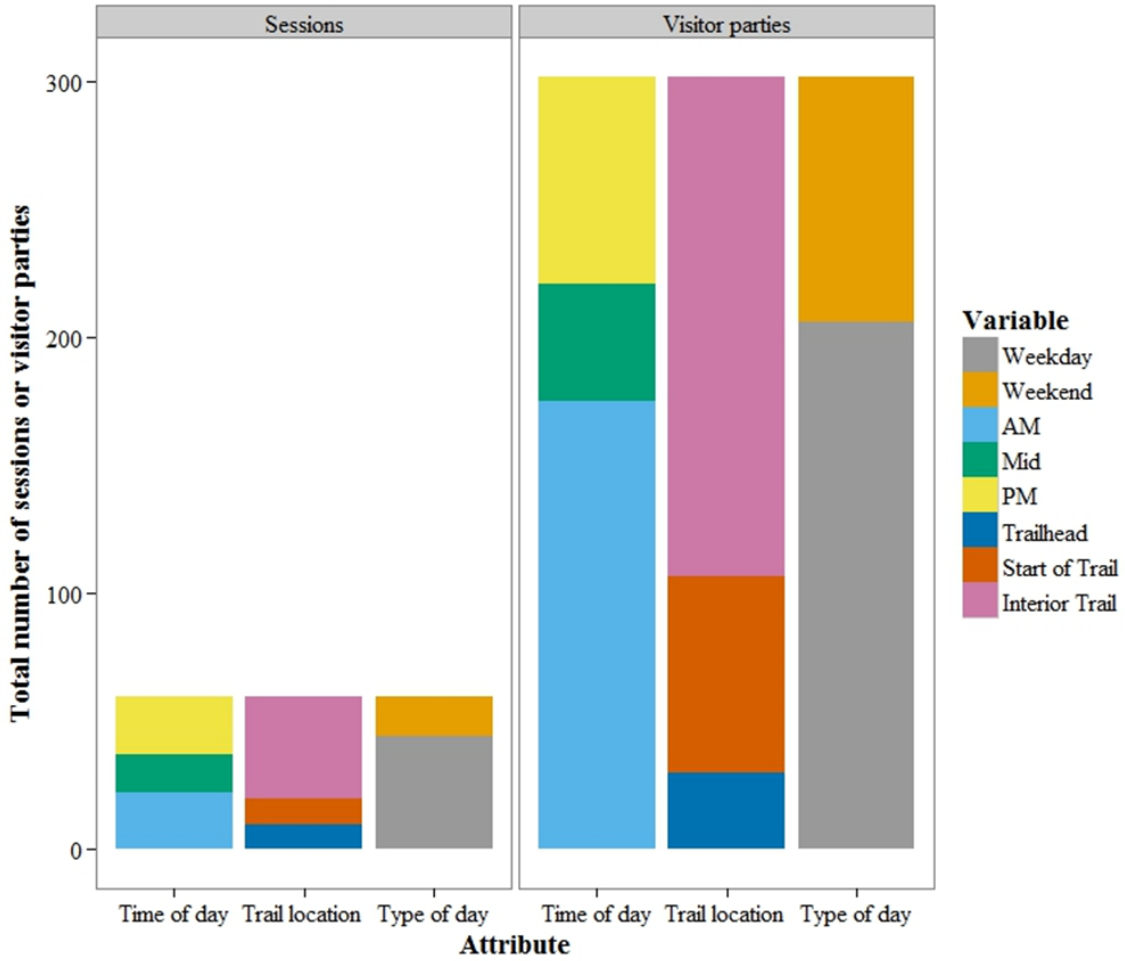

Figure 7. The number of sessions (n=60) and visitor parties (n=302) broken down by attribute for the Leash Interview component.

Out of the 302 visitor parties observed or contacted during the leash interviews, 81.8% were composed of hikers and about 16% were composed of runners (**Figure 8**). The remaining visitor parties were composed of cyclists or climbers. The activity type for one visitor party was not recorded, and this party is reported as "other" in **Figure 8**.

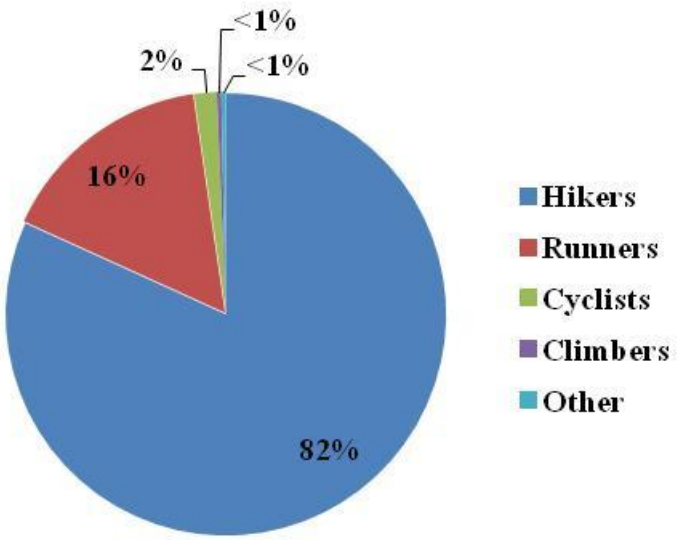

Figure 8. Number of visitor parties (n=302) by activity for the Leash Interview component

The vast majority of leash interview parties had only one dog per party (235, 77.8%) (**Figure 9)**. Fifty-two visitor parties had two dogs per party, while the remaining parties were composed of three, four and six dogs. These numbers are very similar to the visitor party characterization of the V/S component where 76.1% of the parties had only one dog.

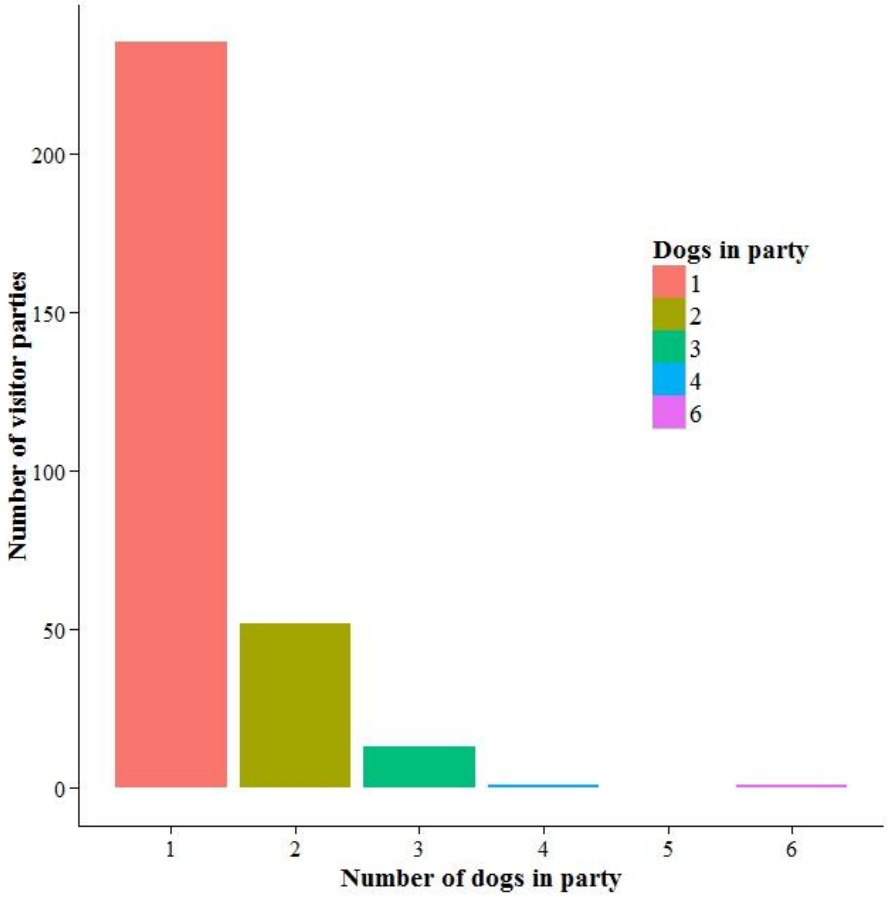

Figure 9. Number of visitor parties (n=302) by number of dogs in party (n=388) for the Leash Interview component.

Of the 302 visitor parties sampled, 275 were either observed as having all leashes (205), or showed the correct number of leashes when questioned by the interviewer (70) (**Figure 10**). These numbers result in a compliance rate of 91.1% for the leash possession regulation. Twenty-seven visitor parties were recorded as unknown compliance or noncompliant. Fourteen visitor parties did not stop when asked and 13 visitor parties did not possess the correct number of leashes for all of their off-leash dogs. For the 14 visitor parties that did not stop when asked, we do not know if they possessed the correct number of leashes and hence did not assign them to a compliance category.

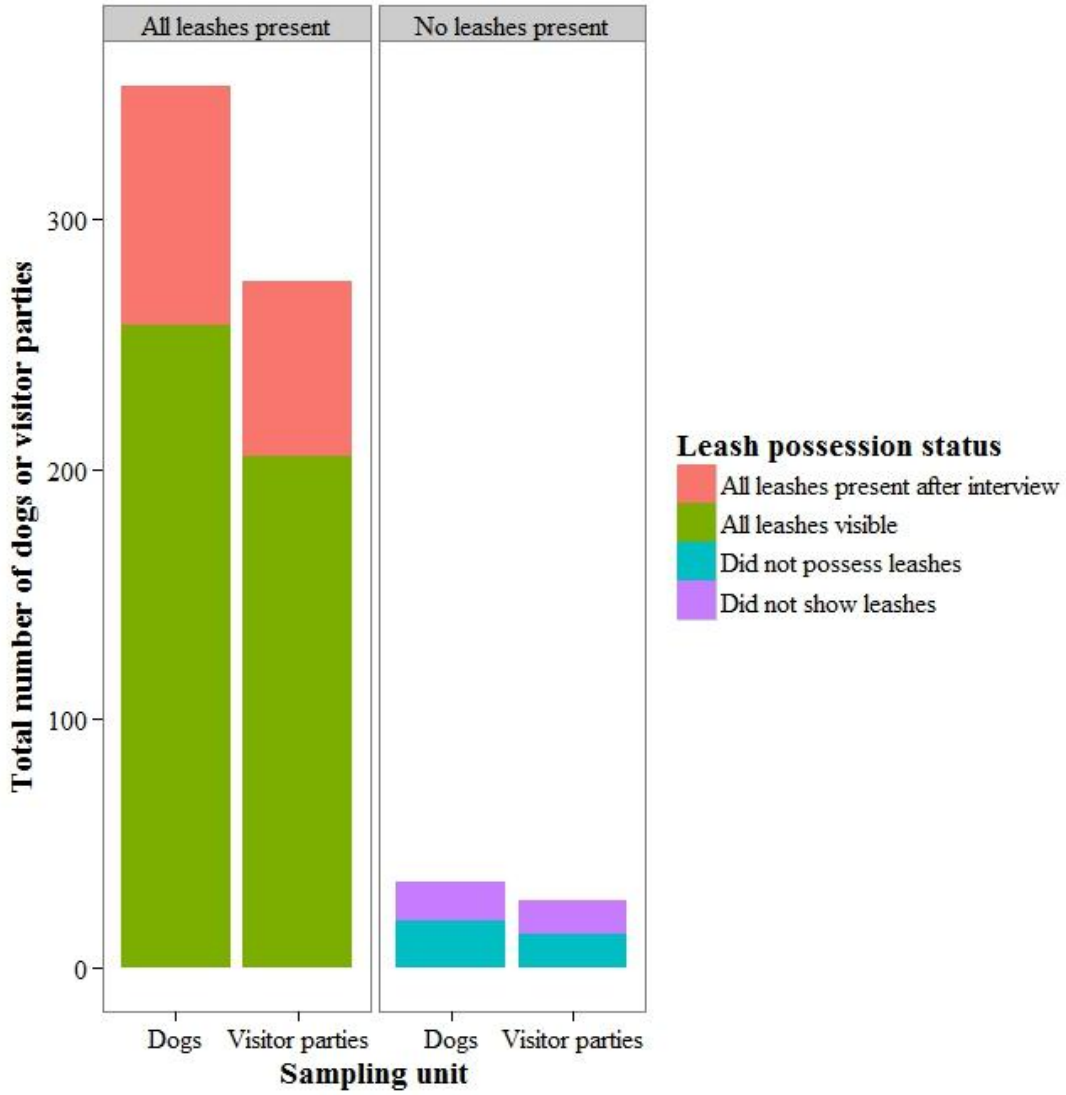

Figure 10. Number of dogs (n=388) and visitor parties (n=302) by leash presence for the Leash Interview component.

While not a measure of compliance for the Leash Interview component, we also recorded the tag display of off-leash dogs during this monitoring. We found that out of 302 visitor parties, 252 had tags for all off-leash dogs (83.4%). Thirty-three (10.9%) visitor parties had no tags for any off-leash dogs, and only six visitor parties (2%) were still marked unsure after the interview (**Figure 11**). The remaining 11 parties had mixed tagged status including one or more off-leash dogs without a tag and these are included in the noncompliant category.

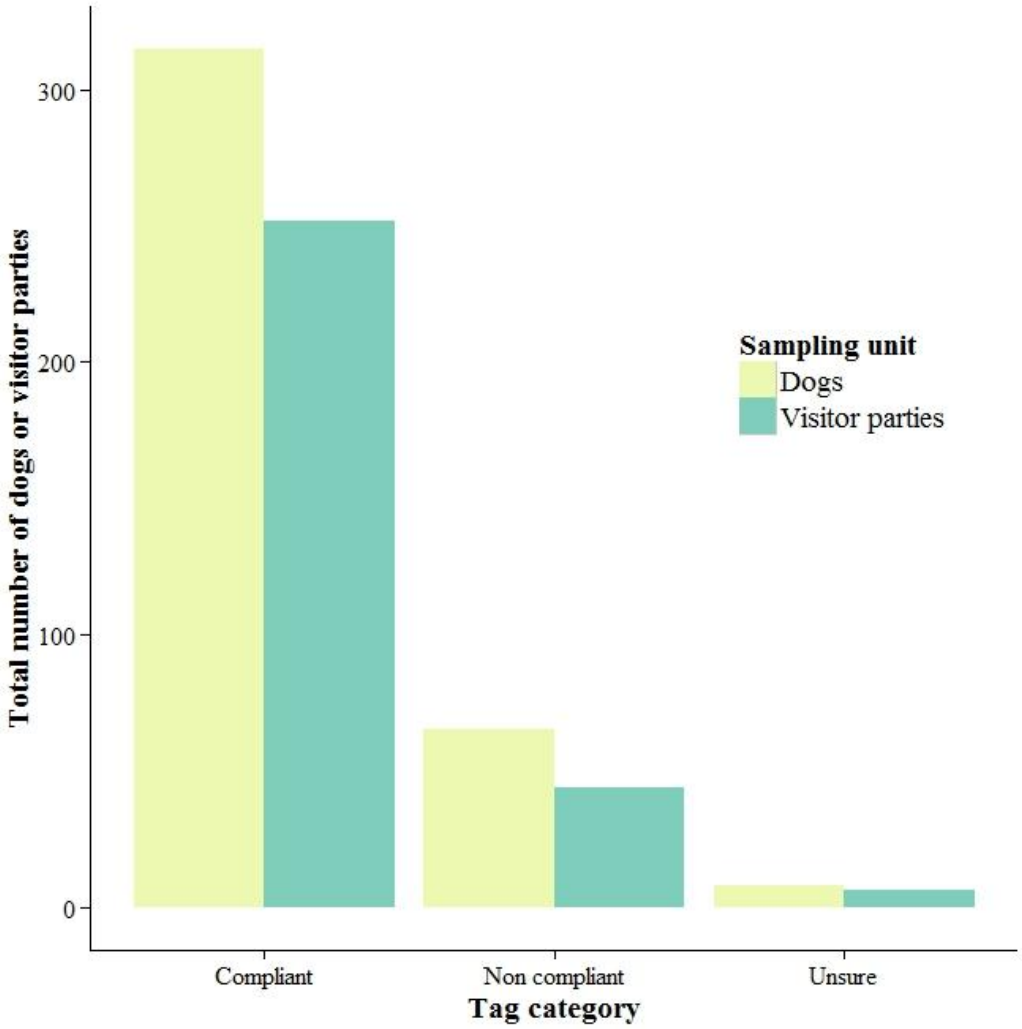

Figure 11. Number of visitor parties (n=302) and dogs (n=388) by tag display for the Leash Interview component.

The Leash Interview component was last conducted in 2006. In 2006, the compliance rate was about 93%, with the vast majority of visitor parties possessing leashes for each off-leash dog (**Table 16**).

Table 16. Comparison of 2006 and 2014 Leash Interview Data

Category	2006	2014
# Visitor parties	393	302
# Parties with leashes for every dog	365	275
# Parties without leashes for every dog	28	27
Compliance rate	**93%**	**91%**

To determine any difference in compliance between 2006 and 2014 we used the χ^2 statistic and found no significant difference in compliance between the two monitoring periods (**Table 17)**.

Table 17. Results of comparison between years for leash possession for the Leash Interview component

Years to compare	χ^2	df	p
2006/2014	0.772569	1	0.379424

3.4. Leash Required Component

For the Leash Required component, we conducted 88 monitoring sessions and sampled a total of 238 visitor parties. Because fewer visitor parties tend to recreate with their dogs on-leash compared to the off-leash areas, this component required more monitoring sessions to reach an adequate sample size. The monitoring periods were distributed over all seven days of the week, three time periods per day, and location. Sessions occurred at locations of varying visitation volume (high to low volume) and across numerous geographic locations on OSMP. Contrary to what was seen during the Leash Interview and V/S monitoring, visitors to leash-only trails had higher visitation rates during the mid-day sessions than the morning sessions. There is also a strong trend for a higher percentage of visitors on the weekend compared to the percentage of sessions (**Figure 12**).

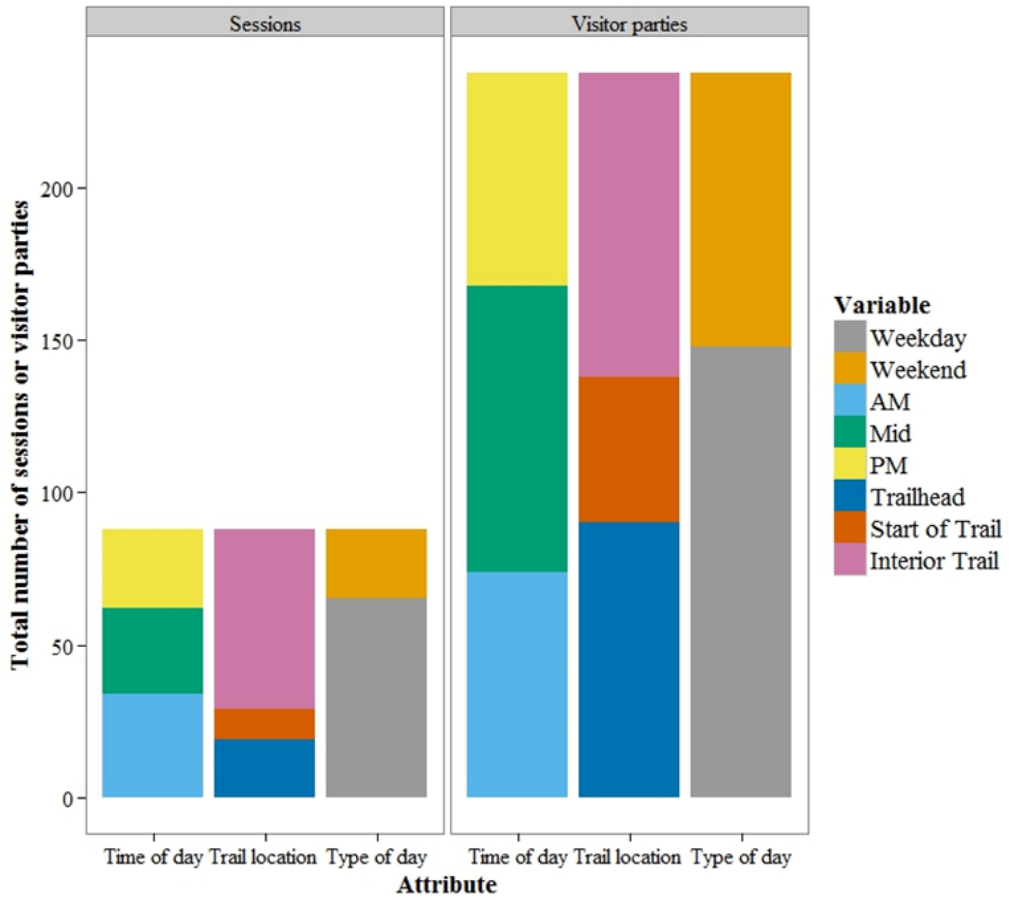

Figure 12. The number of sessions (n=88) and visitor parties (n=238) broken down by attribute for the Leash Required component.

Out of the 238 visitor parties observed during the leash required component, 84% were composed of hikers and about 15% were composed of runners (**Figure 13**). The remaining visitor parties were composed of cyclists and equestrians.

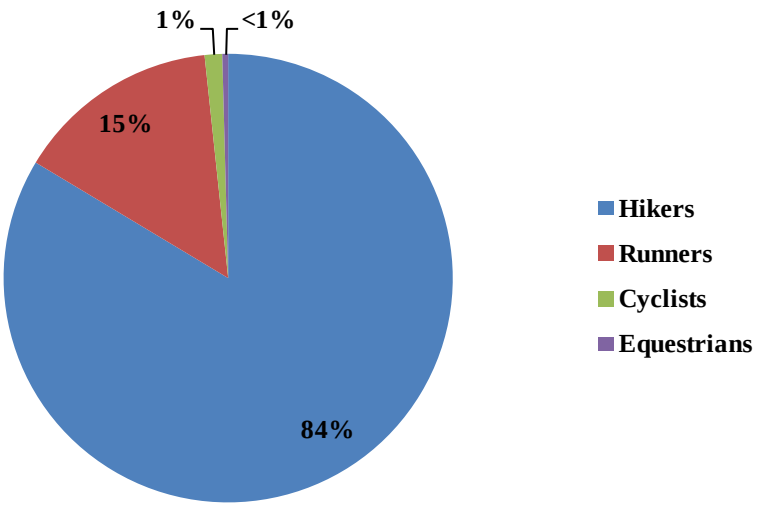

Figure 13. Number of visitor parties (n= 238) by activity for the Leash Required component.

Out of 238 visitor parties, 195 were composed of only on-leash dogs, resulting in a compliance rate of 81.9% (**Figure 14**). Those 14 parties observed on Greenbelt Plateau Trail (seasonal leash required trail) had a moderately lower compliance rate (57%) than those on trails with a year-round leash requirement (83%). Overall 18.1% of observed parties were noncompliant and only 3 visitor parties (1%) had a mix of both on and off-leash dogs.

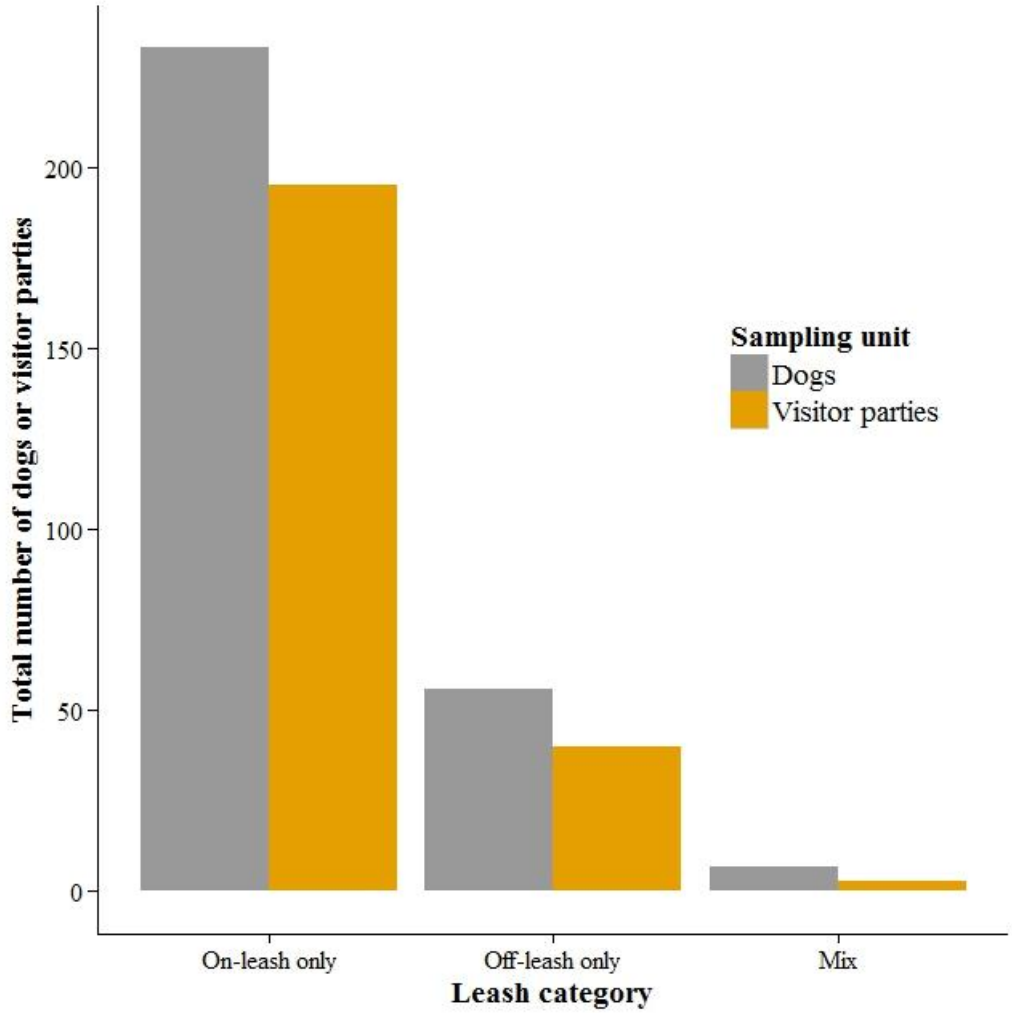

Figure 14. Number of visitor parties (n= 238) and dogs (n= 296) broken down by leash category for the Leash Required component.

During the leash required monitoring, we recorded 40 visitor parties composed of only off-leash dogs. Of these 40 parties, 24 had tags on all their dogs, compared to 11 visitor parties that did not have tags on all their dogs (**Figure 15**). This graph and table does not include the 3 visitor parties that included at least one on and one off-leash dog (mixed leash status).

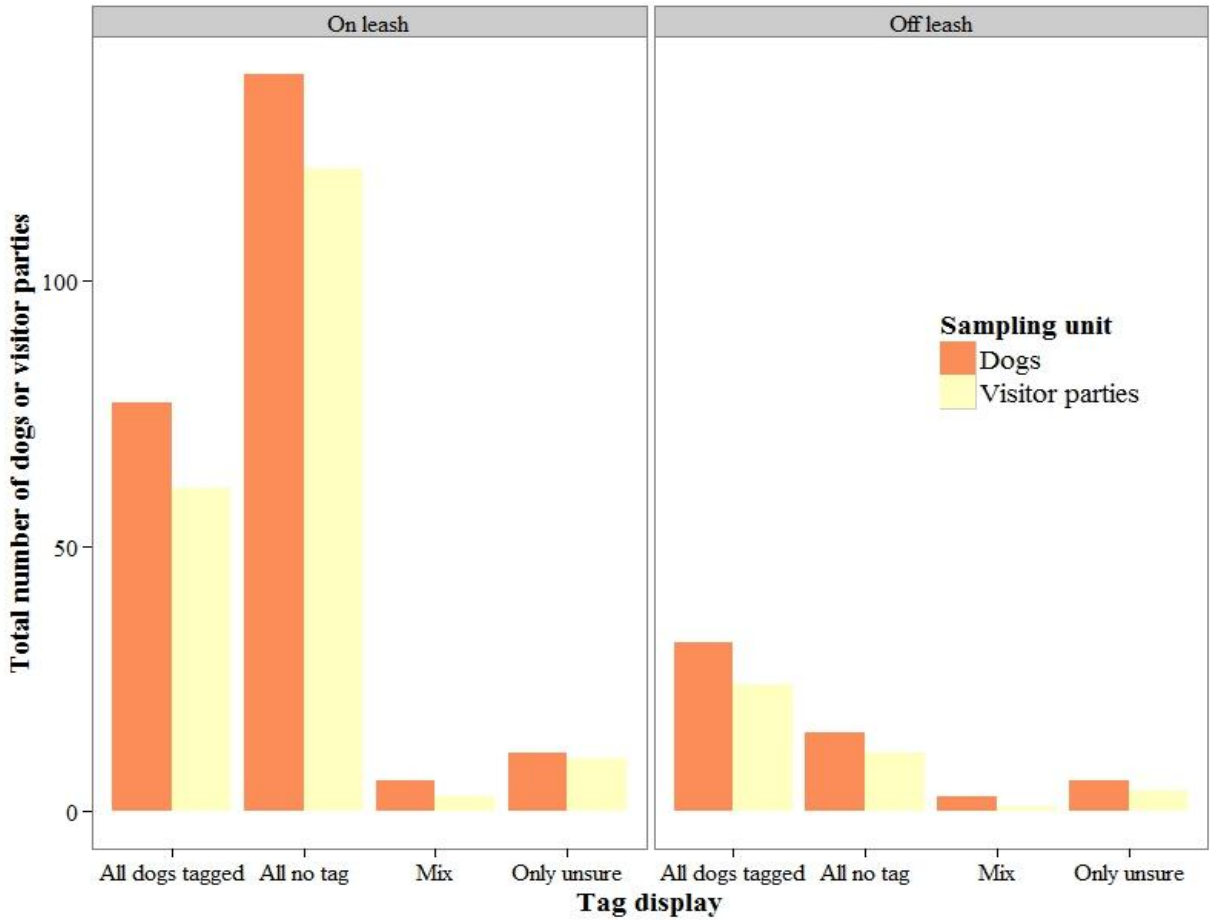

Figure 15. Tag display by leash status and visitor party (n= 235) and dog number (n=289) for the Leash Required component.

3.5 Violation data

Table 18 shows the number of charges issued by OSMP Rangers during the monitoring time period.

Table 18: Number of charges issued by OSMP Rangers and accompanying B.R.C. code during the monitoring period (May 1, 2014 - July 31, 2014).

Nature of offense	Total # of charges	B.R.C. code
Aggressive Animal Prohibited	2	6-1-20
Dog running at large	21	6-1-16
Failure to protect wildlife	0	8-3-5
Failure to remove animal excrement	0	6-1-18
Voice and Sight Control Evidence Tag Required	25	6-13-2

4.0 Discussion

Tag Program success is important to maintain quality visitor experiences and for the protection of natural resources. By the end of the summer of 2010, over 25,000 participants had registered in the program (City of Boulder 2011) and OSMP receives about 2 million annual dog visits (Vaske, Shelby & Donnelly 2009). This project was intended to estimate the 2014 baseline level of compliance with Tag Program requirements directly before implementing the suite of approved program enhancements. The creation of a new baseline, rather than using the results of the previous 2006-2010 project, contributes to a better understanding of conditions at the time program changes are implemented and reduces the chance that measured pre-change conditions are not reflective of the actual conditions on OSMP prior to modification of the program. The primary program enhancements include:

- Attendance of an in-person information/education class
- Proof of rabies vaccination
- Education and outreach strategies
- Modifications to fines and violations causing suspension of participation
- Participant fee(s) revision

This project is scheduled to be repeated soon after (2016) and again three years after (2018) implementing Tag Program enhancements to gain an understanding of any measurable change in observed behaviors.

4.1. Baseline conditions

The 2014 overall Tag Program compliance rate is 67%. Baseline conditions for most individually measured attributes and indicators include compliance rates greater than or equal to 70%. Components with lower compliance rates include more than two dogs off-leash per guardian, excrement pickup and interactions with wildlife/livestock. Baseline condition results from this project along with the results from the two additional monitoring periods (2016, 2018) are meant to inform future discussions and the potential creation of ranges of acceptability and associated standards for future dog regulation compliance measures.

4.1.1. *Voice and sight regulations*

The previous Tag Program monitoring project (2006, 2007, 2010) resulted in overall compliance rates ranging from 56-66%. The current overall compliance rate (67%) is somewhat higher compared to previous years. In particular, voice control compliance increased from the previous range of 56-64% to 77%. This would suggest that Tag Program compliance has improved, or at least that compliance has not gone down, and/or some portion of the change could be a result of methodological changes (such as the elimination of recording conflictive behaviors). Because OSMP has not yet defined an acceptable level of compliance, it can only be said that compliance rates are generally higher compared to previous results.

Lack of tag display had more total noncompliant visitor parties than any other single compliance category. Part of the non-compliance is likely due to people who have never signed up with the program and another part is likely from people who are participants, but have lost and not replaced their tag. OSMP could do a systematic check of parties not displaying a tag. Knowing

if lack of tag display is due to non-participation or lack of attaining a replacement tag could inform future management designed to improve upon the compliance with tag display. For example, reminders to check that each off-leash dog has a current tag could be sent once each mid-year to current participants or areas with higher proportions of visitors that have not ever signed up could receive targeted education or patrol efforts.

Items with the lowest compliance rate and needing special attention include having no more than two dogs off-leash per guardian and interactions with wildlife/livestock. While the number of observations for each of these items was small during the study period, the likelihood of a violation was high when they did occur, and cumulatively over the course of a year across OSMP, the number of occurrences would be in the tens of thousands. These two items could be addressed with targeted patrol and further clarified in outreach materials, trails signs or during the in-person training class.

4.1.2. *Leash interview*

The vast majority of off-leash dog guardians met the requirement to have a leash for each off-leash dog under their care. This indicates that dog guardians are aware of the regulation and are willing to carry leashes for their off-leash dogs. Guardians may also carry leashes for their dogs for personal and the safety of others or to be ready for unforeseen circumstances. Because the 2014 compliance rate was greater than 90%, it is unlikely that OSMP will repeat this component during future intervals of tag program monitoring.

4.1.3. *Leash required*

During observation for the Leash Required component, 82% of observed parties complied with the requirement to keep all dogs under their care on a leash. The 14 parties observed on Greenbelt Plateau Trail (seasonal leash required trail) had a moderately lower compliance rate (57%) than those parties on trails with a year-round leash requirement (83%). The lower compliance rate along Greenbelt Plateau Trail could be attributed to visitors simply being unaware of the seasonal leash requirement, visitors choosing to not comply with the leash requirement (including visitors arriving from surrounding V/S trails who do not want to leash their dog mid-hike) or to a lowered social norm and/or the belief that not leashing their dog is not affecting anyone (because few visitors or no one is on the trail). Correspondingly, the higher compliance rate along year-round leash required trails may imply that visitors to these trails have a greater awareness of the leash law, are used to having their dog on-leash in these areas or may choose to go to a leash required trail purposefully.

4.1.4. *Dog Excrement*

Of the 26 visitor parties observed with a defecating dog, 18 parties (69%) complied with all dog excrement regulations. Compared to the previous monitoring project (ranged from 46% to 63%) this is a higher compliance rate, and this could be attributed to an actual increase in compliance or could be due to sample site selection differences (i.e. having more internal sites).

4.2. Potential barriers to regulatory compliance

Several researchers have proposed frameworks to classify reasons why visitors engage in behaviors considered to diminish visitor or resource quality such as failing to properly manage their off-leash dog or violating park rules (Widner-Ward & Roggenbuck 2003, Miller et al. 2001, Gramann & Vander Stoepp 1986, Nesbitt 2006, Borrie & Harding 2002). Other researchers have categorized the actions themselves rather than the motivations behind the action in an effort to explain visitor behavior and propose management strategies to effect change if the behavior is considered unacceptable (Hendee et al. 1978, Hendee and Dawson 2002). Collectively, these ideas could be used to better understand possible barriers to compliance with dog regulations.

Where available information is not the limiting factor, some of the hypothesized explanations for visitor noncompliance include (Miller et al. 2001, Borrie & Harding 2002, Gramann & Vander Stoep 1987, Hendee & Dawson 2002):

1. Cognitive failure in the form of faulty decision-making,
2. Ineffective attitude shift when presented new information,
3. Habituated behaviors,
4. Lack of awareness of a problem,
5. Presence or absence of an underlying ethic,
6. Lack of the necessary skill to carry out appropriate behaviors,
7. Normative influences and social pressures,
8. Cognitive overload when exposed to more than one message at a time,
9. Attitudes toward park regulations are established long before on-site visit.

Social norms (Donnelly et al. 2000) could influence the likelihood that a dog guardian chooses to comply with V/S regulations. When visiting OSMP, dog guardians may think the expected norm is to control their dogs, but maybe not to the level of control demonstrated in the video or as explained in the in-person education class. Additionally, dog guardians may not experience guilt (as a result of breaking the expected norm) if they don't achieve the demonstrated level of control. This potential lack of obligation and internal sanction could lead to a weaker perceived norm and result in a dog guardian not meeting the V/S requirements.

Another barrier to compliance could be the perceived lack of OSMP ranger presence. Although there is no data to empirically estimate how often visitors encounter an OSMP ranger, the odds of a visitor party encountering a ranger on a given visit are likely very small. There are few rangers on patrol relative to the number of acres managed by OSMP and to the number of visitors on OSMP-managed lands. OSMP rangers also assist with resource protection, respond to emergencies and lead educational efforts, further minimizing their available time to conduct standard patrols and reducing the likelihood that visitors encounter a ranger on a given visit. This unlikelihood of encountering a ranger could weaken any external pressure experienced by dog guardians to comply with V/S rules. Across all 2014 monitoring periods, rangers were noted during:

- Zero of 65 V/S sessions;
- One of 88 leash required sessions; and
- Three of 60 leash interview sessions.

Discussion

A better understanding of which factors most limit compliance could inform more effective strategies in achieving compliance. Depending on which factors are limiting compliance, managers might apply different management strategies. For example, if interpretation of the situation seems to be problematic, managers could pursue educational efforts or B.R.C. ordinance clarifications that very clearly illustrate why certain situations are problems or may be illegal. Or, if visitors are having a hard time successfully implementing voice control, OSMP could work with the community and local dog trainers to set up V/S control classes with the objective of teaching the behaviors required to meet V/S regulations.

4.3. Standard setting

The 2014 results provide information to OSMP managers and other staff that is useful for guiding decisions about dog management on OSMP trails and more specifically, to potentially create new standards for which future monitoring projects would be designed to measure success or failure. The 2014 overall system-wide Tag Program compliance rate indicates that about two-thirds of dog guardians met the requirements while in the observation zone.

4.4. Perception of Effects

Past research suggests that land managers often differ from visitors in their perception (types and level of impact) and their evaluation or interpretation of such impacts (positive or negative) (Farrell et al., 2001; Kim et al., 2003; White et al., 2001). For example, a dog approaching an oncoming hiker without permission may be interpreted by agency management as unacceptable while some visitors may view the interaction as beneficial to their enjoyment. Or, different visitors on the trail may have different views on the same observed visitor/dog behavior.

When a disparity exists between land manager and public perceptions of system conditions, conflict and distrust can arise as visitors may believe that the agency is “creating problems” when, from the visitor perspective, there aren’t any problems to address (Dorwart et al. 2004). As managers work to address the perceived problems, perhaps through visitor regulation or enforcement, frustration on both sides has the potential to escalate and contribute to an unproductive relationship. Manning (1999) states “objective and systematically collected information is needed from visitors about what defines satisfying recreation experiences”. Therefore, it is critical that land managers work with their stakeholders to identify the range of perceived conditions, how these may differ from the agency perspective, and to work toward management strategies that most stakeholders can support.

This difference of opinion has been part of community dog regulation discussions for many years. For example, current project results indicate that of all the visitor parties with an off-leash dog that passed or interacted with another dog, 87% of these parties resulted in compliance with the regulation not to charge, chase or otherwise display aggression toward another dog. However, in essence, this means that more than 1 out of 10 visitor parties had a noncompliant interaction with another dog. Some people may think this is acceptable and some people may think this is unacceptable.

4.5. Management suggestions

Visitor and dog management has the potential to be contentious, particularly for public agencies. Decision-making often requires scientifically collected data and in-depth community conversations. Because OSMP has no established ranges of acceptability for visitor and dog behaviors, debate and frustration about what should or shouldn't be considered "ok" continue. Working toward resolution will require agreement on ranges of acceptability for measured indicators and metrics. OSMP could also consider adding more details or examples of what is prohibited to the B.R.C. definitions and further clarification of "out of sight" (e.g., dog walking behind a person or ahead, how far).

The City Charter section of the B.R.C. describes the purposes of open space (B.R.C. Article XII, section 176) but includes no priorities or rankings. This has been interpreted to mean that equal weight should be given to all purposes, including recreation opportunities and ecological conservation. Because the on-going community conversations regarding visitor and dog management often involve whether or not acceptable recreation access is given and/or unacceptable ecological change is occurring, OSMP would benefit from defining acceptable conditions or changes and implementing studies as needed to determine whether or not conditions are acceptable.

Lastly, the population of Boulder County and visitation to OSMP has increased over time (City of Boulder 2005). Thus, gaining a shared understanding with the community on what successful dog management looks like will be beneficial to all OSMP stakeholders. Successful management of this activity will likely need to include broadly accepted objectives with measurable attributes and ranges of acceptable conditions. Without these, there could be a need to modify future visitor patterns and designations because of (then perceived) unacceptable impacts of past and current generations. Creating new visitor regulations or restrictions in the future could be considered not fair to existing or future economic supporters of the OSMP system.

5.0 Recommendations

Adaptive management often necessitates adjustments to initial management strategies based on information acquired through monitoring. This monitoring project evaluated a set of dog management regulations across the OSMP system. The results presented in the preceding sections are intended to inform conversations to identify which dog regulations are working and areas for improvement with current visitor and dog management strategies. The recommendations outlined below are provided to help refine these strategies to move toward success with recreation/dog management objectives while maintaining high quality visitor experiences and natural resource conditions on OSMP.

5.1. Further develop decision-making strategies for dog management

As part of the VMP (City of Boulder 2005, Table 4.1), an approach was developed to assess and manage for dogs on OSMP lands (**Appendix A**). This approach was based upon the four management areas and intended to be used during future TSA planning efforts. This approach could be further developed to provide more clarity and definitions from which to make dog management decisions during each TSA process. For example, specific recommendations for behavior within certain habitat types (rather than entire management areas) or particular areas to avoid, such as trails with actively grazing cattle, could be directly stated.

5.2. Implement strategies to maximize visitor compliance with dog regulations

A few recommended strategies to maximize visitor compliance with dog regulations include:

1. Develop a comprehensive recreation management strategy/plan which includes recreation/dog management objectives and ranges of acceptability.
2. Undertake a visitor study to better understand the factors that contribute to decision-making by dog guardians with regards to how they choose to manage their dogs. Such an understanding can foster a productive relationship between OSMP and dog guardians and could contribute to the design of strategic actions to achieve OSMP's recreation/dog management objectives.
3. Better define the "problem", and implement strategies to inform visitors specifically about the "problem" from the OSMP perspective. Strategies might include new education modules, hands-on workshops, hikes or the development of new messages and signs along the trail.
4. Continue to encourage reporting by rangers, other field staff and volunteer trail guides of dog interactions observed on the system. This kind of information can be helpful at identifying areas for rapid response before patterns of incompatible behaviors become established and more difficult to change.
5. Better define the rules; remove "gray areas" as feasible. For example, tag program rules could directly state whether or not dogs travelling behind a guardian is allowed or at what distance or under what conditions (e.g. dog is ahead around a bend in the trail) the dog is no longer under "sight" control.
6. Develop a shared departmental perspective on interpreting the more subjective components of V/S control. Use this shared understanding to reduce the subjectivity of regulations.

7. Develop formal OSMP guidelines for dog etiquette/expectations for behavior on the trail.
8. Be transparent and direct about what is the law and what is trail etiquette.

5.3. Increase dog guardians' voice control skills

When attempting to use voice control to manage their dog, 77% of the visitor parties were successful in 2014. This observation suggests that some dog guardians and their dogs did not show (and may not have) the skills necessary to comply with the level of immediacy expected for voice control. If this is true, strategies aimed at increasing guardians' and their dogs' skill in using voice control should improve compliance with this component of the V/S rules.

To foster community acceptance and participation in increasing voice control success, OSMP could sponsor specific dog training classes aimed at promoting voice control skills. Training sessions could be organized by OSMP as part of the department's outreach and education efforts working in conjunction with experienced dog trainers to teach and relate common control challenges and possible training techniques to improve voice control.

5.4. Re-test observer variability and review the methods during each data collection interval

During the 2014 dog monitoring set-up, staff conducted lengthy office and field tests to establish shared definitions and protocols. Great care was taken in reducing inter-observer variability and the amount of perceived subjectivity in data collection efforts. As new field technicians are hired, re-testing and review of the methods will need to occur based upon the variability observed between the new set of field staff assigned to the project. When working on any revisions to existing protocols, project staff should consider a critical peer-review by experts in the Recreation Management and Animal Behavior fields.

5.5. Refine analysis techniques and database structure

As time passes, new or unmet data and/or analysis needs will become apparent. A few ideas to consider are:

- Develop additional spatial and non-spatial analyses techniques to evaluate the dog monitoring data including:
  - Assess compliance by geographic sub-set such as existing OSMP management areas or by dog visitation volume;
  - Assess the locations of noncompliant events and identify "hot spots"; and
  - Develop dog management indicators or metrics that integrate spatial information on resources of interest such as trail condition or visitor infrastructure (such as doggie stations).
- Refine the dog monitoring GIS database to provide quick and easy reporting and display of desired data;
- Revise the database to be more efficient and useful based upon project revisions that occurred along the way.

5.6. Consider developing new dog monitoring indicators related to ecological health and visitor quality

There is potential for dogs to negatively impact ecological resources and/or the quality of the visitor experience. This project specifically included chasing wildlife as an observed behavior, but other indicators of ecological health could be developed. For example, OSMP could consider developing new monitoring indicators that would measure pertinent components of ecological health in relation to various dog regulations such as: dominant species cover and condition; total non-native species cover; wildlife status and water quality. Relationships between the ecological datasets and dog datasets could be explored with geospatial and statistical analyses. If OSMP would like to better understand the relationship between recreation with dogs and ecological conditions and/or change, *formal research work is suggested*.

OSMP could develop a potential new "social impact" indicator designed to understand the level of acceptability with "dog or guardian behavior X" or the number of unpleasant dog encounters during a visitor trip using a social norm curve (**Figure 16**, adapted from Manning 2011). This new indicator could be informed through visitor inquiry, on-site surveys, community conversations and other public input and then systematically measured through various monitoring studies. Results from these types of inquiries could contribute to future discussions/creation of behavioral ranges of acceptability.

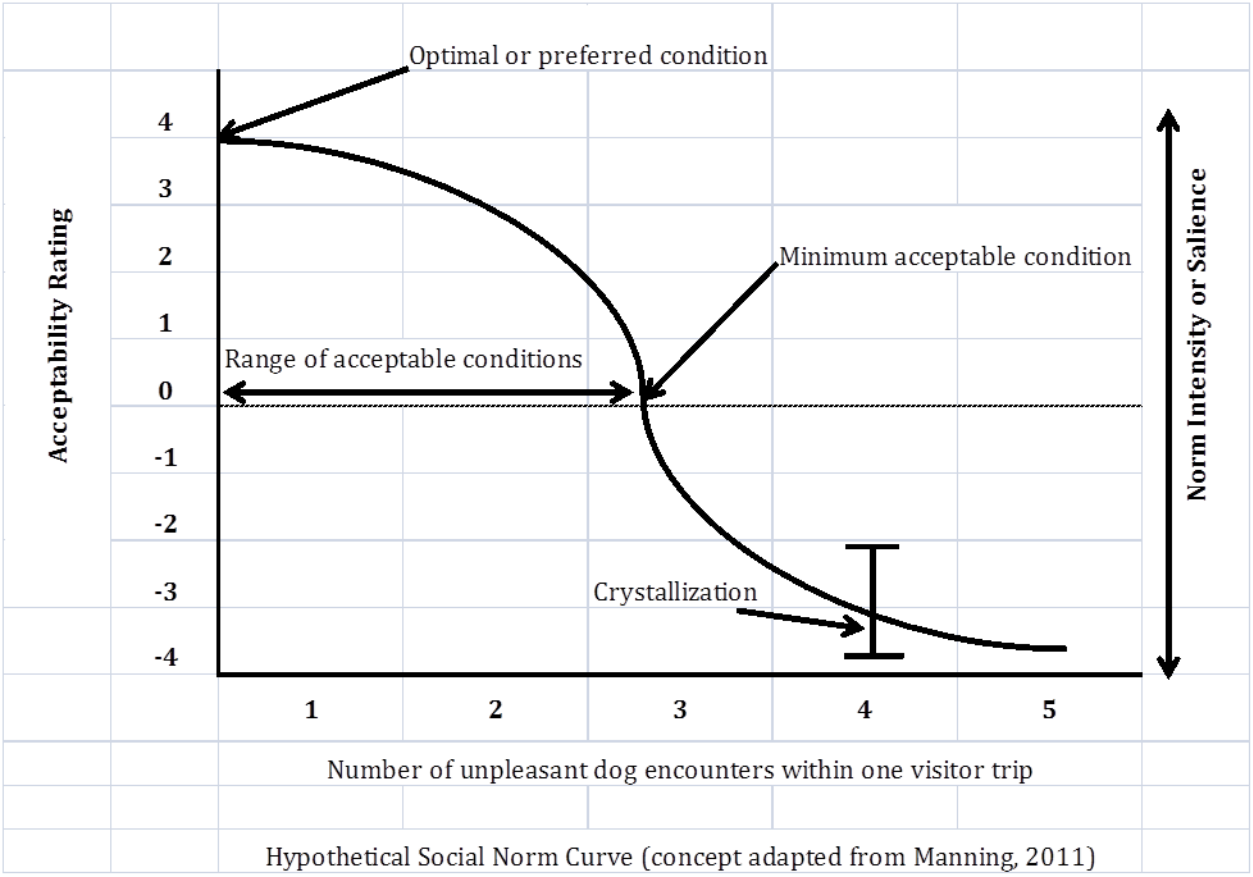

Figure 16. Social norm curve applied to the number of unpleasant dog encounters within one visitor trip

5.7. Consider developing new dog monitoring indicators and studies related to understanding the benefits of recreating with dogs

OSMP could conduct formal studies to understand the benefits of recreating with dogs from the community perspective. Having the Tag Program in place encourages people to spend time/exercise with their dogs and doing so can lead to various benefits including:

- Sense of well-being;
- Higher quality of life;
- Improving dog and human health;
- Socialization for dog and guardian;
- Bonding time between dog and guardian;
- Personal visitor safety.

5.8. Conduct a study aimed at understanding barriers to compliance with dog regulations on OSMP

OSMP could formally conduct research into the barriers to compliance with dog regulations both from the visitor perspective and from the agency perspective. Because these two perspectives necessarily operate together (not in isolation), both perspectives should wholly be taken into account when attempting to understand compliance barriers.

5.9. Consider communication recommendations from published literature

Numerous researchers have put together summaries of steps managers and communication teams can take to foster effective communications and visitor management success (Miller et al. 2001, Dowart et al. 2004).

A few of these include (Adapted from Miller et al. 2001 and Dowart et al., 2004):

1. Teach how to recognize situations where visitor behavior is contributing to unacceptable conditions, such as dogs chasing wildlife.
2. Illustrate ideal situations and desired behaviors, such as asking permission before your dog approaches another visitor party.
3. Emphasize individual responsibility and behavioral accountability, such as not responding with “He’s friendly” when your dog approaches/jumps on another visitor (they may not like it).
4. Collaborate with local opinion leaders and stakeholders to foster peer education and promotion of recommended behaviors, such as FIDOS sponsoring educational opportunities modeling tag program expectations.
5. Determine what conditions and impacts your visitors perceive and are concerned about, such as directly asking “what do you see” and “why does it matter”.
6. Be explicit and transparent about the rationale underlying management decisions and policies, such as clearly stating why certain trails are dogs prohibited or why a given trail’s dog management regulation may be changing (share with staff and volunteers so they can respond correctly when asked).

Recommendations

OSMP could also support and encourage further research focused on assessing visitors' perceptions of conditions, how they attribute responsibility and how they affect visitor experience quality.

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Appendices

Appendix A. Management strategies and actions for dog management by management area designation (City of Boulder 2005, p. 53, Table 4.1).

Passive Recreation Area Strategies	Natural Area Strategies	Agricultural Area Strategies	Habitat Conservation Area Strategies
Visitors are strongly encouraged to keep dogs on-trail. Dog management is predominantly voice and sight control. Dogs on-leash, dogs prohibited or seasonal dog requirements may be implemented.	Visitors are strongly encouraged to keep dogs on-trail. Dog management is predominantly voice and sight control. Dogs on-leash, dogs prohibited, or seasonal dog requirements may be implemented.	Visitors are strongly encouraged to keep dogs on-trail. Dog management is predominantly voice and sight control. Dogs on-leash, dogs prohibited, dogs on corridor voice and sight control, or seasonal dog requirements may be implemented.	Dogs are required to be on-trail, with some exceptions allowing on-corridor voice-and-sight control. Dog management is predominantly on-leash. Dogs on-leash, Dogs prohibited, dogs on corridor voice and sight control, or seasonal dog requirements may be implemented.

Appendix B. Glossary of terms
Definitions used in this report are modified specifically for the purpose of the dog management monitoring project and should not be considered universal except for those quoted from the Boulder Revised Code.

Boulder Revised Code – Animal Control Related
6-1-2 Definitions
http://www.colocode.com/boulder2/chapter6-1.htm#section6_1_2

"Guardian" means owner.

"Leash" means a chain, rope, cord, or strap with a clip or snap for rapid attachment to a choke chain, collar, or harness, all the parts of which are of sufficient strength to hold at least four times the weight of the dog and are suitable for walking the dog and controlling it.

"Owner" means each person who owns an animal. If an animal has more than one owner, all such persons are jointly and severally liable for the acts or omissions of an animal owner under this chapter, even if the animal was in possession and control of a keeper at the time of an offense.

"Voice and sight control" means the ability of a guardian or keeper to adequately control a dog by using voice commands and sight commands (such as hand gestures). In order for a guardian or keeper to have voice and sight control over a dog, the guardian or keeper must: (1) be able to see the dog's actions; and (2) be able to prevent the dog from engaging in the following behaviors, using voice and sight commands, without regard to circumstances or distractions:

(a) Charging, chasing or otherwise displaying aggression toward any person or behave toward any person in a manner that a reasonable person would find harassing or disturbing;
(b) Charging, chasing or otherwise displaying aggression toward any dog;
(c) Chasing, harassing or disturbing wildlife or livestock; or
(d) Failing to come to and stay with the guardian or keeper immediately upon command by such person.

Other Terms

Event: A unit of observation developed to define the parameters for which an observation is separate from another or the next observation and to define one line item from the next on the datasheets. Events can be passes, interactions, commands given or out of sight occurrences.

Field of view/Observation zone: The extent of the landscape to be included in the observation. The field of view includes areas off-trail within the observation zone typically within 180° equidistant from the observer and to include the depth of field as defined by the flushing distances of wildlife species included in this study. The field of view is also defined by the typical visual and auditory observation abilities of a field technician.

Frequency distribution: The number or percent of subjects within each possible response for a particular variable.

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Inter-rater or Inter-observer reliability: The degree to which different raters/observers give consistent ratings/estimates of the same phenomenon using the same rating system; variation which occurs between observers when collecting and interpreting field data. http://www.socialresearchmethods.net/kb/reltypes.php

Naturalistic observation: A research method commonly used by psychologists and other social scientists which involves observing subjects in their natural environment. This type of research is often utilized in situations where conducting lab research is unrealistic, cost prohibitive or would unduly affect the subject's behavior. http://psychology.about.com/od/nindex/g/naturalistic.htm

Out of sight: The dogs in a visitor party are not within the immediate 360° field of view of the guardian(s) at all times.

Recreation setting: A combination of the physical, biological, managerial and social conditions within a recreation area that give value to a place (Clark and Stankey 1979).

Reliability: The extent to which an experiment, test or any measuring procedure yields the same result on repeated trials. http://writing.colostate.edu/guides/page.cfm?pageid=1386

Sampling Frame: The sampling frame consists of two components: 1) All the OSMP trails with designated dog opportunities meeting our selection criteria and 2) All the dates and time periods within the data collection period.

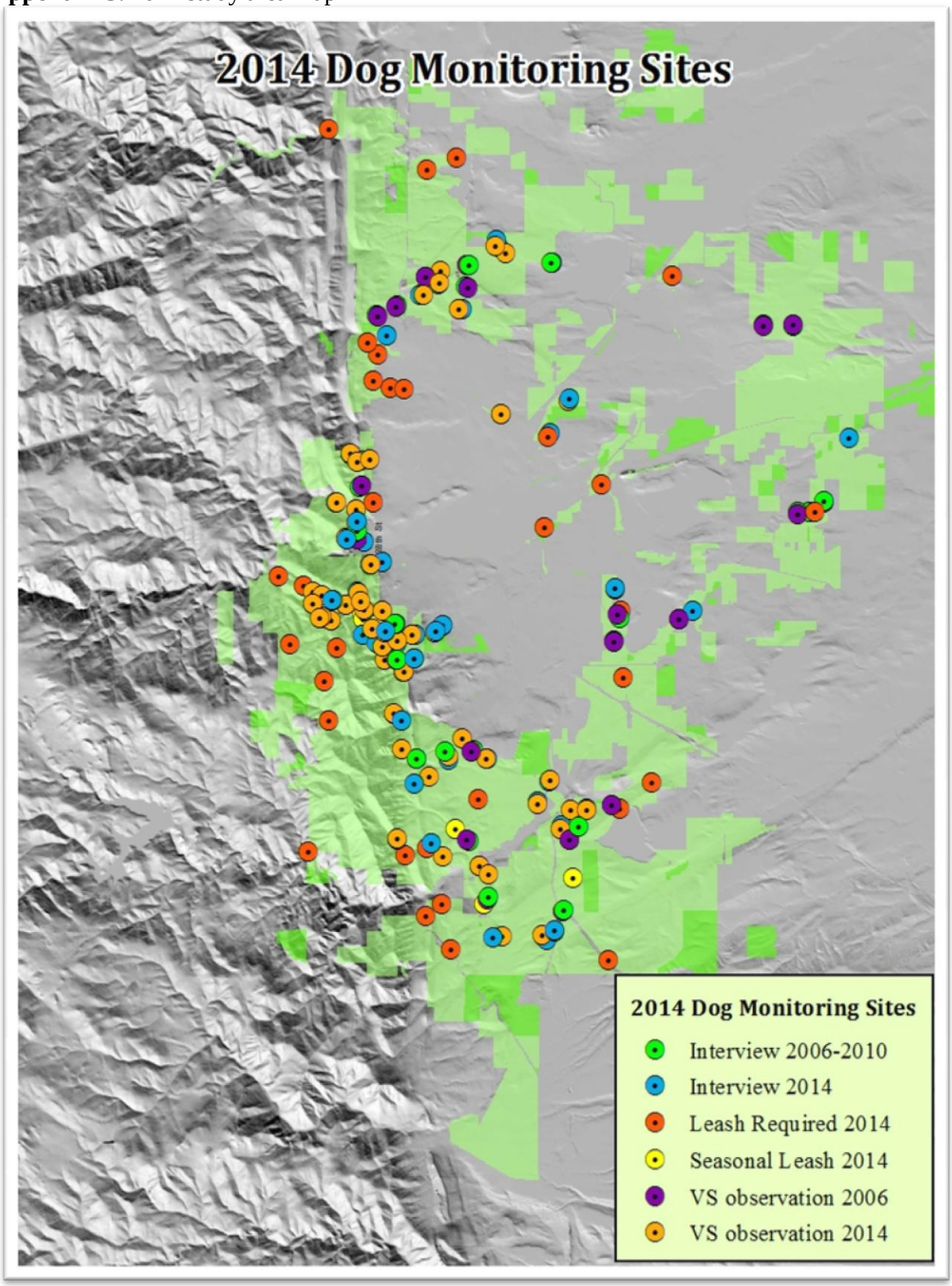
Target Population: The group of interest to be investigated.

Validity: The degree to which a study accurately reflects or assesses the specific concept that the researcher is attempting to measure. [Colo site]

Visitor trip: A trip to the study area, regardless of how much time a visitor spent on OSMP during their trip.

Voice and Sight Tag Program: An OSMP program designed to certify dog guardians' understanding of what "voice and sight" dog management means while visiting OSMP lands. After watching a video demonstrating what voice and sight dog management means, a dog guardian can purchase a green tag for their dog allowing them to manage their dog under voice and sight control in designated areas.

Appendix C. 2014 study area map



Appendix D. List of monitoring sites included in 2014 sampling frame listed by Trail Study Area

Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Bobolink Trail New	Both	East	High	Start of Trail
Boulder Creek Path - Foothills	Leash Required	East	Low	Interior Trail
Centennial Greenway	Both	East	Low	Start of Trail
Cherryvale TH	Leash Required	East	Low	Trailhead
Cottontail Trail	Leash Required	East	Low	Interior Trail
Cottonwood TH	Interview	East	Low	Trailhead
Cottonwood TH	Leash Required	East	Medium	Trailhead
Cottonwood Trail	Both	East	Low	Start of Trail
Dry Creek Trail New	Both	East	High	Interior Trail
East Boulder - Teller Lake ADA	Leash Required	East	Medium	Interior Trail
East Boulder-Teller Lake Trail	Interview	East	Medium	Start of Trail
East Boulder-Teller Lake North Trail	Interview	East	Medium	Trailhead
Gunbarrel TH	Both	East	Medium	Trailhead
Gunbarrel Trail	Both	East	Medium	Interior Trail
KOA Lake Greenway	Leash Required	East	Very Low	Interior Trail

Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
South Boulder Creek at EBCC	Both	East	High	Interior Trail
South Boulder Creek Greenway	Leash Required	East	High	Start of Trail
Teller Farm TH	Both	East	Medium	Trailhead
Teller Farm Trail	Both	East	Medium	Interior Trail

*Both means the site was used for the observation and the interview components

Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Buckingham Park	Leash Required	North	Medium	Trailhead
Cobalt Trail	Observation	North	Medium	Interior Trail
Degge Trail	Both	North	Medium	Start of Trail
Eagle Shelter	Both	North	Medium	Interior Trail
Eagle TH	Both	North	Medium	Trailhead
Eagle West New	Both	North	Medium	Start of Trail
Foothills North Trail	Interview	North	Medium	Trailhead
Foothills South/Old Kiln	Leash Required	North	High	Interior Trail
Foothills TH New	Both	North	Medium	Start of Trail

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Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Foothills Trail	Both	North	Medium	Interior Trail
Fourmile Creek Greenway	Both	North	Low	Interior Trail
Hidden Valley Trail	Both	North	Medium	Interior Trail
Lefthand Trail	Leash Required	North	Low	Interior Trail
Lefthand Trailhead	Leash Required	North	Low	Trailhead
Mesa Reservoir Trail	Both	North	Medium	Interior Trail
North Rim Trail	Both	North	Low	Start of Trail
Old Kiln Trail	Leash Required	North	Medium	Interior Trail
Sage TH	Both	North	Medium	Trailhead
Sage Trail	Both	North	High	Interior Trail
Wonderland Hill Trail	Leash Required	North	Low	Start of Trail
Wonderland Lake TH	Leash Required	North	Medium	Trailhead
Wonderland Lake Trail	Leash Required	North	High	Interior Trail

*Both means the site was used for the observation and the interview components

Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Coal Seam Trail	Both	South	High	Interior Trail
Cowdrey Draw	Leash Required	South	Medium	Interior Trail
Doudy Draw TH	Observation	South	Medium	Trailhead
Doudy Draw/Community Ditch New	Both	South	Medium	Interior Trail
Flatirons Vista South Trail	Interview	South	Medium	Interior Trail
Flatirons Vista TH	Both	South	Medium	Trailhead
Flatirons Vista Trail	Both	South	Medium	Interior Trail
Fowler Trail	Leash Required	South	Low	Start of Trail
Greenbelt Plateau Trail	Leash Required	South	Medium	Interior Trail
Greenbelt Plateau Trail	Both	South	Medium	Interior Trail
High Plains Trail	Leash Required	South	Low	Interior Trail
Marshall Lake Lookout	Leash Required	South	Low	Interior Trail
Marshall Mesa TH	Observation	South	High	Trailhead
Marshall Mesa Trail	Observation	South	High	Interior Trail
Marshall Mesa/Community Ditch	Interview	South	High	Interior Trail
Marshall Valley Trail	Both	South	High	Interior Trail

Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Post Office Access	Leash Required	South	Very Low	Start of Trail
Prairie Vista Trail	Both	South	Medium	Start of Trail
Spring Brook Loop North	Leash Required	South	Medium	Interior Trail

*Both means the site was used for the observation and the interview components

Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
1st/2nd Flatiron Trail	Interview	West	Medium	Interior Trail
Amphitheater Trail	Both*	West	Medium	Start of Trail
Amphitheater Trail	Leash Required	West	Medium	Start of Trail
Anemone Trail	Both	West	Medium	Interior Trail
Baseline Trail	Interview	West	Medium	Interior Trail
Baseline/Bluebell-Baird	Leash Required	West	Medium	Trailhead
Bear Peak West Ridge/Bear Canyon	Leash Required	West	Medium	Interior Trail
Bluebell - Baird Trail	Both	West	Medium	Interior Trail
Bluebell Road	Both	West	High	Interior Trail
Centennial TH	Both	West	Medium	Trailhead

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Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Chapman TH	Both	West	Low	Trailhead
Chapman Trail	Leash Required	West	Low	Start of Trail
Chautauqua Trail	Interview	West	High	Interior Trail
Contact Corner Trail + Spurs	Both	West	Low	Start of Trail
Crown Rock TH	Observation	West	Medium	Trailhead
Crown Rock Trail	Both	West	Medium	Start of Trail
Dakota Ridge Trail	Leash Required	West	Medium	Start of Trail
Dakota Ridge Trail	Both	West	Medium	Interior Trail
E.M. Greenman	Leash Required	West	Medium	Interior Trail
East Ridge Trail	Both	West	High	Interior Trail
Eldorado Canyon Trail	Leash Required	West	Low	Interior Trail
Enchanted Mesa Trail	Both	West	Medium	Interior Trail
Fern Canyon Trail	Observation	West	Medium	Interior Trail
Fern Meadow - Cragmoor Trail	Observation	West	Low	Start of Trail
Flagstaff Trail	Both	West	Low	Interior Trail

*Both means the site was used for the observation and the interview components

Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Flatirons Loop Trail	Both	West	Medium	Interior Trail
Four Pines TH	Both	West	Low	Trailhead
Four Pines Trail	Both	West	Low	Start of Trail
Goat Trail	Observation	West	Low	Start of Trail
Green Mountain West Ridge/Green Bear	Leash Required	West	Medium	Interior Trail
Gregory Canyon Trail	Both	West	Medium	Interior Trail
Homestead Leash Trail	Leash Required	West	Medium	Interior Trail
Homestead Trail	Observation	West	Medium	Interior Trail
Homestead/Mesa Trail	Interview	West	Medium	Interior Trail
Kohler Mesa Trail	Both	West	Low	Interior Trail
Lehigh Connector - South Trail	Both	West	Low	Start of Trail
Lost Gulch Trail	Leash Required	West	Medium	Trailhead
Lower Big Bluestem/Bluestem Connector	Leash Required	West	Low	Interior Trail
Mallory Cave Trail	Both	West	Low	Interior Trail
Mesa/Bear Canyon-NCAR Trail	Interview	West	Medium	Interior Trail

Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Mesa/Enchanted Mesa	Both	West	Medium	Interior Trail
Mesa/N. Shanahan	Both	West	Medium	Interior Trail
Mt Sanitas Trail	Both	West	High	Start of Trail
Old Mesa Trail	Leash Required	West	Low	Interior Trail
RangeView Trail	Observation	West	Low	Interior Trail
Realization Point TH	Both	West	Low	Trailhead
Red Rocks	Interview	West	High	Interior Trail
Red Rocks Spur Trail	Interview	West	High	Start of Trail
Red Rocks Trail New	Observation	West	High	Start of Trail

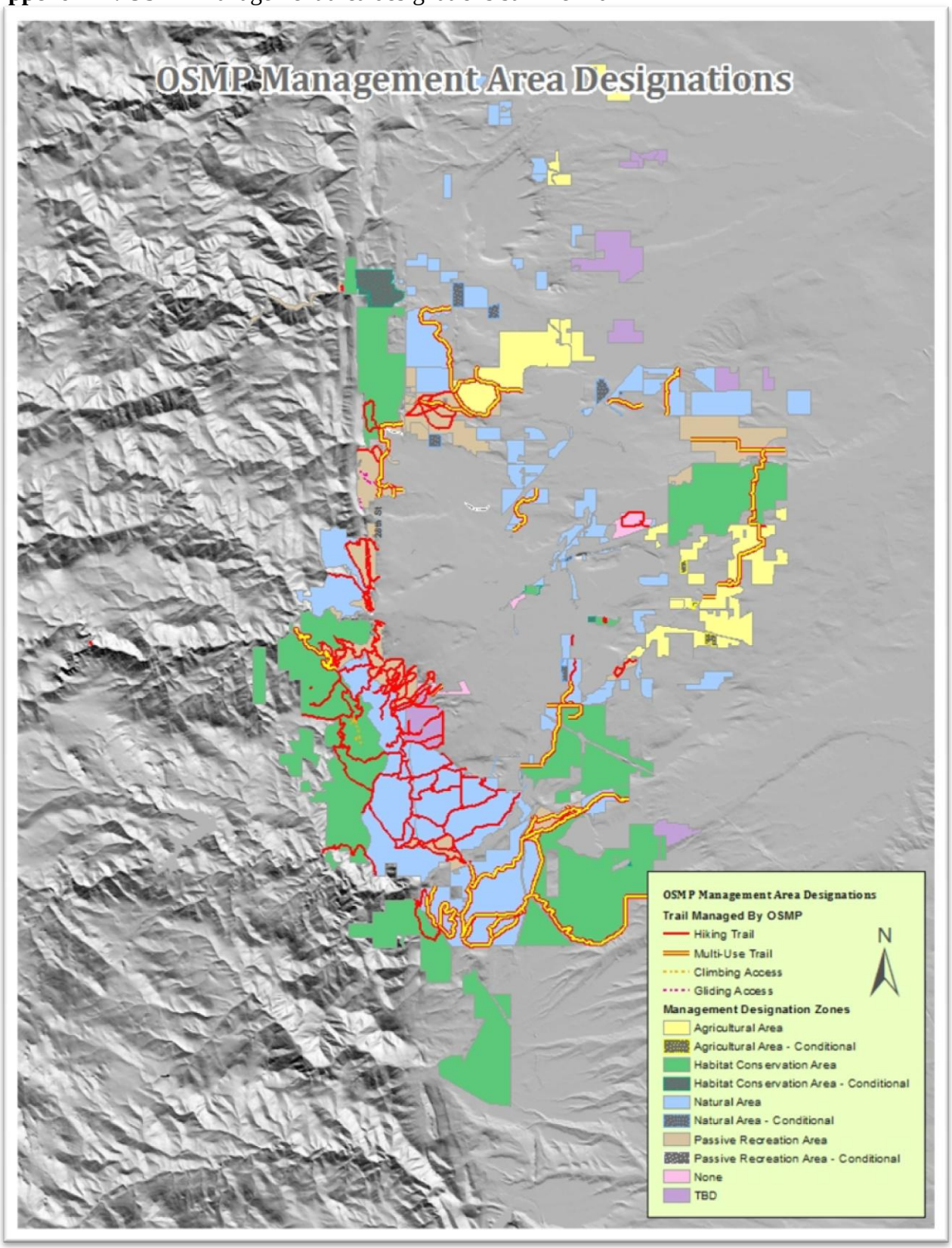
*Both means the site was used for the observation and the interview components

Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Sanitas Valley Trail	Both	West	High	Interior Trail
Shadow Canyon North	Both	West	Medium	Interior Trail
Shanahan - North Fork	Interview	West	Medium	Interior Trail
Shanahan - South Fork Trail	Observation	West	Medium	Interior Trail

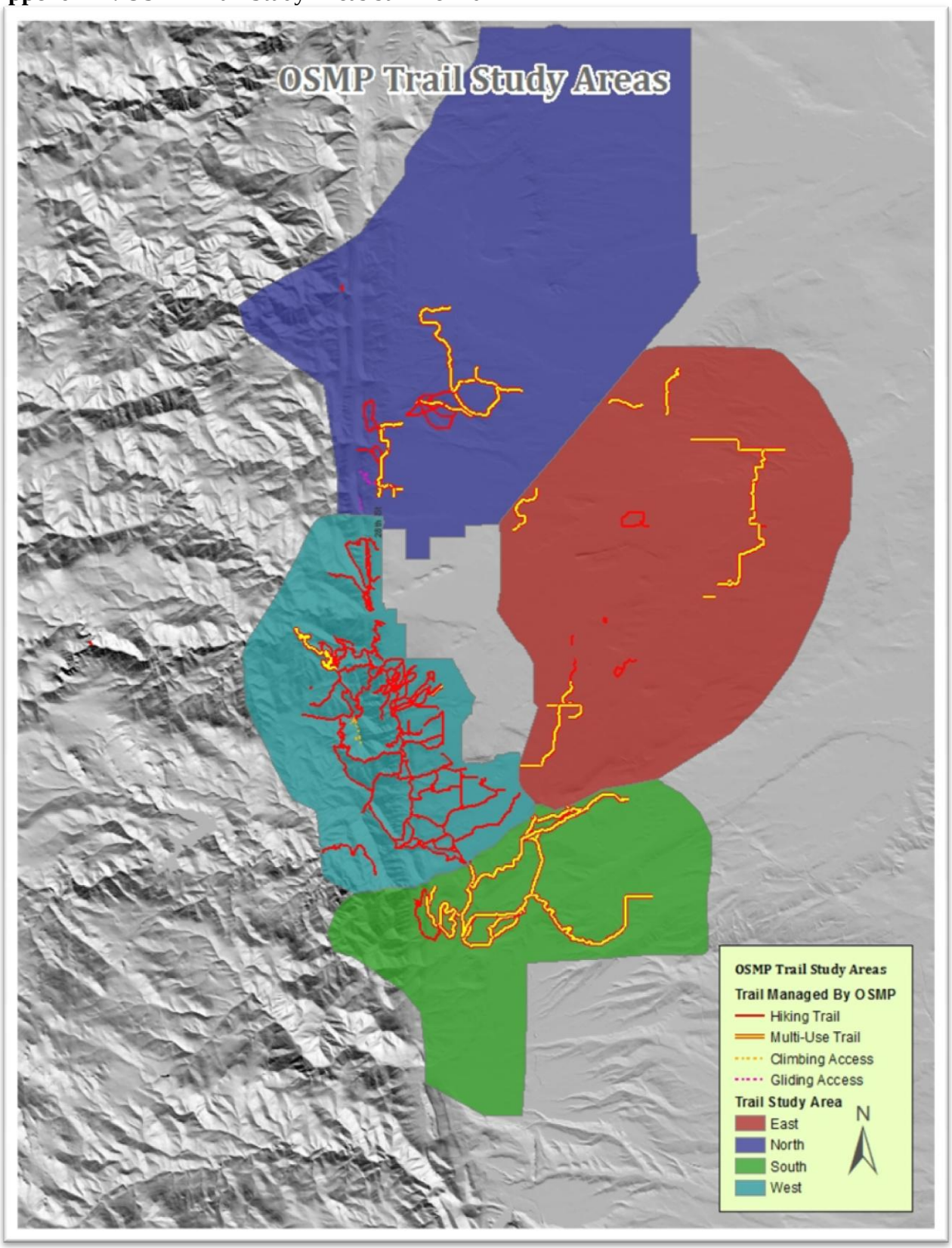
Site Name	Site Type	Trail Study Area	Visitation Volume	Trail Continuum
Shanahan Connector	Both	West	Medium	Interior Trail
Shanahan Ridge	Both	West	Medium	Start of Trail
Shanahan -South Fork/Mesa Trail	Interview	West	Medium	Interior Trail
Skunk Canyon Trail	Both	West	Medium	Interior Trail
South Boulder Creek West TH	Both	West	Medium	Trailhead
South Boulder Creek West Trail	Both	West	Medium	Interior Trail
South Mesa TH	Both	West	High	Trailhead
South Mesa Trail New	Observation	West	High	Interior Trail
South Mesa/Big Bluestem	Interview	West	Medium	Interior Trail
Sunshine Canyon Trail	Both	West	Medium	Interior Trail
Tenderfoot Trail	Both	West	Low	Interior Trail
Upper Chautauqua Trail	Both	West	High	Interior Trail
Ute Trail	Both	West	Low	Interior Trail
Viewpoint TH	Interview	West	Low	Trailhead
Viewpoint Trail	Both	West	Low	Interior Trail

*Both means the site was used for the observation and the interview components

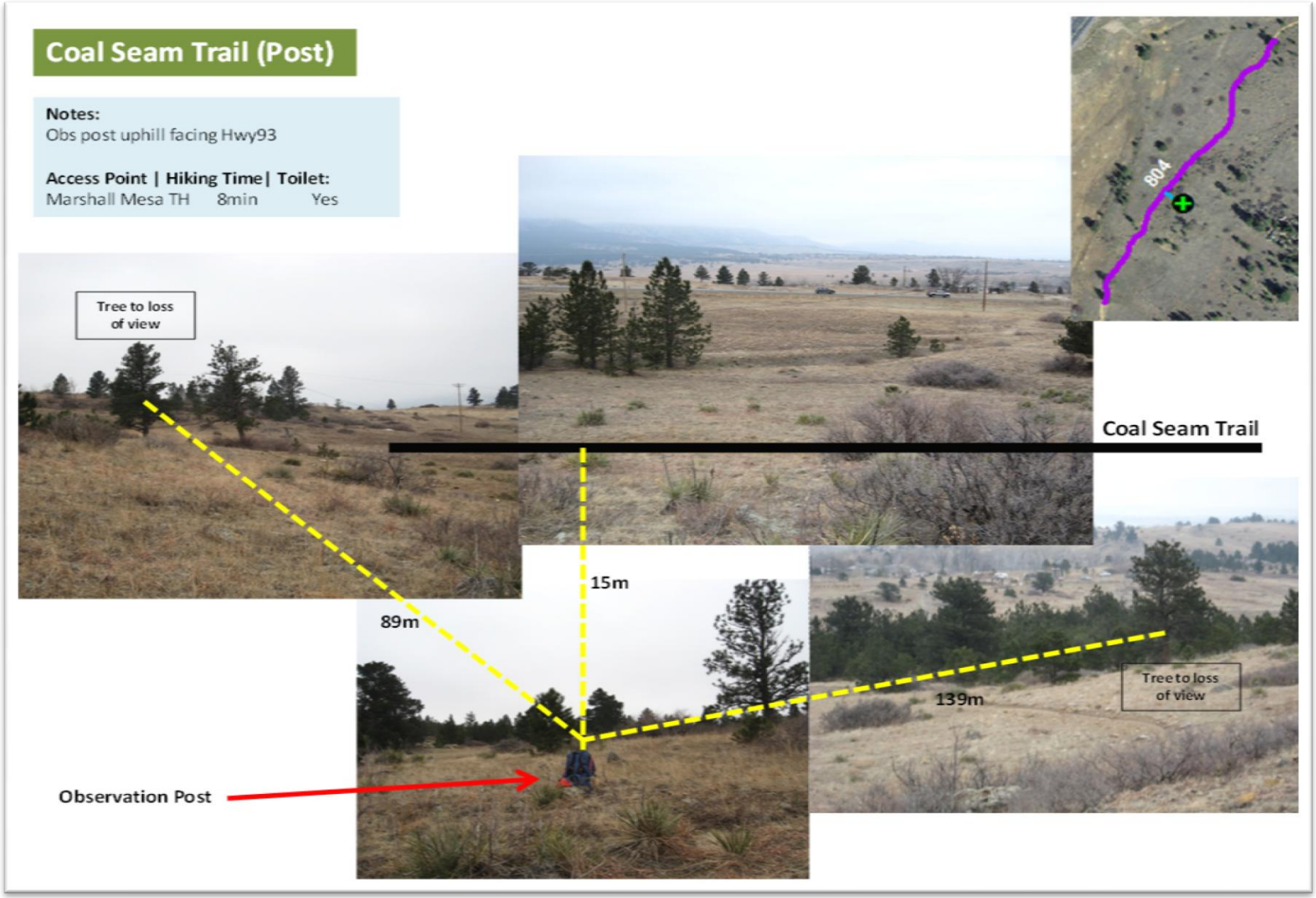
Appendix E. OSMP management area designations summer 2014



Appendix F. OSMP Trail Study Areas summer 2014



Appendix G. Photo map example



Appendix H. Voice and sight datasheets and codes

Voice and Sight Tag Project Monitoring Data Sheet: VISITOR PARTY* (Observation of visitor parties with 1+ off-leash dogs)

Session ID:	Date (mm/dd/yy):	Location:	Observation Zone: ☐ Trailhead ☐ Start of Trail ☐ Interior
Start Time (24-hour):	End Time (24-hour):	Time Period: ☐ AM ☐ Mid-Day ☐ PM ☐ Partial Session	Challenge for VS Control: ☐ Water ☐ Livestock ☐ Prairie Dogs ☐ None
Skycover: ☐ Sunny ☐ P Cloudy ☐ Overcast	Temp: ☐ 40 ☐ 50 ☐ 60 ☐ 70 ☑ 80 ☐ 90 ☐ 100	Precip: ☐ None ☐ Rain ☐ Snow	Wind (m/h): Closure: ☐ YES ☐ NO Observer:

Visitor Party Number	Field VP Number	Visitor party data										Excrement			OSMP presence	NOTES
		People (#1-n), ind activity type H R B E C O combined with #	Dogs #1-n	Visible leashes #0-n	Leash with tag #0-n	Leash no tag #0-n	Leash tag unsure #0-n	Off leash with tag #0-n	Off leash no tag #0-n	Off leash tag unsure #0-n	More than 2 dogs off leash Y=1 N=0	Poop: # of times, 0-n	Pick up ALL Y=1 N=0	Took ALL bag Y=1 N=0	0=No R/S 1=Ranger 2=Staff	include change in weather, visitor party characteristics, off-leash/on-leash dog poop, etc.

2013 Voice and Sight Monitoring Data Sheet: INTERACTIONS and V&S CONTROL (observation of visitor parties with 1+ off-leash dogs)

Date (mm/dd/yy): | Closure: ☐ Yes ☐ No | Time Period: ☐ AM ☐ Mid-Day ☐ PM | Location: | Obs Zone: ☐ Trailhead ☐ Start of Trail ☐ Interior | Observer:

		Opportunity					Interactions (Dog A = off-leash dogs in visitor party under observation)								Voice & Sight Control					
Field VP Number	Event Number	Pass or Interact (select one) P=Pass I=Interact	Other # and (select one) H-D-W-L-E	# and Dog A ABC	Dog A tag Y=1 N=0	Off Trail Y=1 N=0	Contact Y=1 N=0	Wl.Belw 0=No R 1=Flee 2=Alert 3=Charge	Direction 1=DogA 2=Person 3=DogB	# and PBelw ABC	# and Dog B ABC	Dog B tag Y=1 N=0	Dog B Leash Y=1 N=0	Injury Y=1 N=0	Enter Closure Y=1 N=0	Out of Sight Y=1 N=0	Guardian Response 0=No attmpt 1=VS attmpt 2=Alt attmpt 3=VS+Alt	Command (verbatim if possible)	Hear Y=1 N=0	Dog A Response 0=No R 1=Stop+Attn 2=Change
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									
Other specific (select one):			☐ Observer	☐ Bird ☐ Rabbit	☐ Prairie Dog ☐ Deer		☐ Fox Squirrel ☐ Pine Squirrel			☐ Abert's Squirrel ☐ Other	Notes:									

PERSON BEHAVIOR	DEFINITION	EXAMPLES	RELEVANT B.R.C CODE
No behavior observed			N/A
Verbal invitation	Vocalizations (e.g. words, whistles, sounds etc.) directed towards the dog ; “attention-getting” (Horowitz & Bekoff 2007); could be initiated or response	Approaching visitor says "Oh my gosh, you are so cute. Come here!"	
Physical invitation	Hand and/or arm is extended away from the person’s body and towards the dog; “contact seeking” (Vas et al 2005); could be initiated or response	Approaching visitor kneels down and extends arm toward oncoming dog	
Avoidance	Moving away, head/body averted, hands up palms out	Approaching visitor steps laterally away or off-trail to avoid contact with oncoming dog	
Verbal protest	Verbal statements and/or noises accompanied by gestures (hands up palms out, shaking head, etc) directed towards dog and/or guardian expressing objection to dog presence and/or behavior	Approaching visitor says "Keep your dog away from me"	
Physical protest	Body movements directed towards getting dog to stop the behavior or	Approaching visitor kicks leg out to get dog away from	

PERSON BEHAVIOR	DEFINITION	EXAMPLES	RELEVANT B.R.C CODE
	for harming the dog	his/her feet	
Other	Any other behavior observed		

DOG BEHAVIOR	DEFINITION	EXAMPLES	RELEVANT B.R.C CODE
No behavior observed			N/A
Jumping/pawing	PHYSICAL CONTACT REQUIRED; A jumping or pawing dog is one with movements between the moment the paws leave the floor until they are back in contact with the ground (Ladha et al 2013) (front or all paws) with front paws working independently of each other. A pawing action corresponds to repeated backwards pulls toward the dog's belly and hind legs of a single paw (Ladha et al 2013)	A dog jumps up and makes physical contact with another human; a dog paws a child's legs as he/she walks by	6-1-16. Dogs Running at Large Prohibited. 6-1-20. Aggressive Animals Prohibited. (Would need to be combined with a negative response from receiving party or a prohibited behavior to be considered violation)

DOG BEHAVIOR	DEFINITION	EXAMPLES	RELEVANT B.R.C CODE
Charging/chasing	A charging or chasing dog is one that incorporates gaits galloping and trotting resulting in forward motion of the dog (Ladha et al 2013) and/or a "violent rush forward" with the head/body oriented toward "other" present; other present could be wildlife, livestock, person or dog	Dog chasing a fleeing deer or charging an approaching dog	6-1-16. Dogs Running at Large Prohibited. 6-1-20. Aggressive Animals Prohibited. 8-3-5. Wildlife Protection
Aggression display	An aggressive animal is one that bites, claws, or attempts to bite or claw any person; bites, injures, or attacks another animal; or in a vicious or terrorizing manner approaches any person or domestic animal in an apparent attitude of attack, whether or not the attack is consummated or capable of being consummated.	Frontal display with teeth and lips showing (Abrantes 1997); Continuous vocalizations of low tones (growling); Attempts to make firm mouth contact or attempts to bite	6-1-16. Dogs Running at Large Prohibited. 6-1-20. Aggressive Animals Prohibited. 8-3-5. Wildlife Protection
Barking	Barking is vocalization of loud sounds. The head is often elevated and thrown forward at the moment of the bark (Ladha et al 2013); can be directed at other (Horowitz 2009); "attention-getting" (Horowitz & Bekoff 2007); elevated intensity or frequency	A dog is repeatedly barking at a bird on the side of the trail; dog is standing still on the trail continuously barking at an approaching visitor party	6-1-16. Dogs Running at Large Prohibited. 6-1-20. Aggressive Animals Prohibited. (Would need to be combined with a negative response from receiving party or a prohibited behavior to be considered violation)

DOG BEHAVIOR	DEFINITION	EXAMPLES	RELEVANT B.R.C CODE
			8-3-5. Wildlife Protection

Default values

Code#	Description	Example
999	Missing value	Observer forgets to code variable
777	Unsure	Observer is unsure dog pooped
555	Not applicable	Tag display for leashed dog

Appendices

Appendix I. Leash interview datasheet

2014 Voice and Sight Monitoring Data Sheet - Visitor Party for Leash Interview (visitor parties with 1+ off-leash dogs)

Session ID:	**Date (mm/dd/yy):**	**Interviewer:**	☐ Partial Session	**Obs Zone:** ☐ Trailhead ☐ Start of Trail ☐ Interior Trail
Start Time (24hr):	**End Time (24hr):**	**Time Period:** ☐ AM ☐ Mid-Day ☐ PM	**Location:**	
Skycover: ☐ Sunny ☐ P Cloudy ☐ Overcast	**Precip:** ☐ None ☐ Rain ☐ Snow	**Wind (m/h):**	**Temp:** ☐ 40 ☐ 50 ☐ 60 ☐ 70 ☐ 80 ☐ 90 ☐ 100	

Visitor Party Number	Field VP Number	People (#1-n), incl activity type H R B E C O combined with #	Dogs (1-n)	Leashed with tag (0-n)	Leashed no tag (0-n)	Leashed unsure (0-n)	Off leash with tag (0-n)	Off leash no tag (0-n)	Off leash unsure (0-n)	Visible leashes (0-n)	Stop 0=No 1=Yes 2=Refuse	Show leash 0=No 1=Yes	Leashes shown (0-n)	**Notes** (include ranger presence Y=1/N=0)	Ranger

Appendix J. Leash required datasheet

2013 Voice and Sight Monitoring Data Sheet - Visitor Party for Leash Required Trails

Session ID:	**Date (mm/dd/yy):**	**Observer:**	☐ Partial Session	**Obs Zone:** ☐ Trailhead ☐ Start of Trail ☐ Interior Trail
Start Time (24hr):	**End Time (24hr):**	**Time Period:** ☐ AM ☐ Mid-Day ☐ PM	**Location:**
Skycover: ☐ Sunny ☐ P Cloudy ☐ Overcast	**Precip:** ☐ None ☐ Rain ☐ Snow	**Wind** (m/h):	**Temp:** ☐ 40 ☐ 50 ☐ 60 ☐ 70 ☐ 80 ☐ 90 ☐ 100

Visitor Party Number	Field VP Number	People (#1-n), incl activity type H R B E C O combined with #	Dogs (1-n)	Leashed with tag (0-n)	Leashed no tag (0-n)	Leashed unsure (0-n)	Off leash with tag (0-n)	Off leash no tag (0-n)	Off leash unsure (0-n)	**Notes** (include ranger presence in the area Y=1/N=0)	Ranger

Appendix K. Rationale for 2014-2018 Monitoring Design

Staff were asked by City Council and the Open Space Board of Trustees to re-design the tag monitoring project for 2013-2017 (post-flood dates changed to 2014-2018). Since the ordinances related to voice and sight control in the Boulder Revised Code (B.R.C.) do not provide definitive measurable parameters by which a guardian must "adequately control a dog using voice and sight commands" (B.R.C. 6-1-2) in order to prevent specific outcomes from taking place, staff developed a monitoring project that would align with the legal interpretation of the B.R.C. regarding voice and sight control by incorporating the thought process rangers use in enforcing these regulations. Since enforcement of the V/S regulations of the B.R.C. requires a perspective that looks at behaviors in context (as part of a situation) rather than as isolated components, we accomplished this alignment by hiking with rangers on patrol and obtaining real-time information on encounters involving dog guardians. For example, an interpretation of "out of sight" in relation to V/S control is typically incomplete when only the ability to see the dog is used as rationale for issuing a summons. Typically, a violation of V/S control that would receive a summons requires the guardian not seeing the dog and that specific dog behaviors outlined in the B.R.C. are not prevented from taking place. This information gave monitoring staff insight for understanding specific situations where rangers would write tickets versus using alternative options such as issuing warnings or engaging in educational talks. We began developing a *context-specific* monitoring project, with the emphasis on capturing dog behaviors and guardian responses that are specifically outlined in the B.R.C. for situations involving chasing, harassing or disturbing people, other dogs, wildlife or livestock. Furthermore, the re-design separates monitoring into two distinct processes for those regulations that are more subjective in interpretation: 1] the collection of descriptive data by trained observers and 2] the evaluation of the collected data by a committee comprised of monitoring and project management staff along with the ranger supervisor for compliance determination. In other words, compliance would not be determined in the field by the observers to address public comments regarding observer bias for the more subjective components of the regulations.

To understand the level of compliance for dog regulations on the entire system, seasonal and year-round leash trails were included in the 2014 monitoring design in addition to voice and sight trails designated with low visitor volume. To ensure that we were collecting data on voice commands directed at controlling dog behaviors versus dog guardians conversing with their dogs, we included an auditory component where observers were required to be able to hear and record guardians' specific commands.

Changes to the 2006-2010 protocol implemented during the 2014-2018 project:

1. Removed conflictive behaviors terminology (as documented in 2006-2010).
2. Added a mid-day weekday monitoring period.
3. Added a late afternoon/early evening weekend monitoring period.
4. Added observation of leash-compliance in year-round and seasonal leash-required areas.
5. Added a summary of ranger observations, incidents, summons and convictions.
6. Added additional V/S and Leash Interview component monitoring sites including very low to high volume locations along with sites located more interior (farther from trailhead areas) on the OSMP system.
7. Eliminated observation of leashed only dog parties for the V/S component.

8. Modified behavior coding strategy and behavior definitions.
9. Added recording commands given along with dog/guardian responses.
10. Moved off-trail sites used in 2006-2010 as needed to facilitate auditory monitoring of dog guardian commands.
11. Changed to random site selection.
12. Changed to everyday sampling for the V/S and Leash Interview components; this wasn't designed, but rather implemented to meet the desired sample size within a shortened data collection phase.
13. Removed "unsure" tag observation from compliant proportion to become unique category.
14. Added "livestock" to potential off-trail challenges list for dogs.
15. Removed determination of "negative" or "positive" interactions in the field.
16. Revised determination of overall compliance to be evaluation outcome for each visitor party to include interpretation of each visitor party's collected attributes, interactions and commands; determination of compliance *will not occur in the field* by the data collector, and *will be determined later in the office* by a team representing monitoring, project team and ranger staff.

Appendix L. Suggested limitations

1. Even with a well-defined coding system, human, dog, wildlife and livestock behavior observation involves some level of subjectivity associated with classifying situations and interpreting outcomes.

2. The observation zone includes only a portion of any one visitor trip. The length of visitor trips reported by dog guardians during the 2010-2011 Visitor Survey ranged from less than 30 minutes to more than 2 hours (**Table L1**). Any rates of compliance calculated should be understood as compliance rates through the observation area only. We cannot measure compliance rates for an entire visitor trip.

Table L1. Length of visitor trip to OSMP by activity type (City of Boulder 2012)

Visit length	Hikers	Runners	Cyclists	Dog Guardians	Other
<30 minutes	10%	26%	20%	**19%**	12%
30 to 59 minutes	26%	49%	34%	**41%**	21%
60 to 89 minutes	24%	15%	18%	**20%**	18%
90 to 119 minutes	17%	7%	12%	**9%**	19%
120+ minutes	24%	3%	16%	**11%**	30%
Total	100%	100%	100%	**100%**	100%

3. Reporting results by sub-group tag or no tag display as a measure of Tag Program participation/non-participation results in some level of unknown error as we cannot assume those parties observed without a visible tag displayed on a dog are not program participants and vice versa. Also, for visitor parties of more than one person, we can't know for sure if the person that "calls" to a dog is a Tag Program participant; all we can observe is whether the dog has a tag on or not.

4. Some number of observed dogs will have "unknown tag display" due to poor visibility, long fur, tag pouches, etc. There is no way to know if off-leash dogs with unknown tag display are being managed by Tag Program participants. Observations with unknown tag display will be analyzed as both a unique category and normalized according to the observed proportions, and thus, results for the overall compliance measure will include some number of observations that were actually indeterminate for the indicator "visible display of tag". It is likely that the number of unsures will be greater for the observation component compared to the leash interview component due to the greater distance between the dog and the field technician.

5. We have no way to interpret how visitor parties with dogs differ from non-dog parties in reference to human/dog/wildlife responses; we can't say if dog parties have more, similar or less impact because we are not measuring human/dog/wildlife responses associated with non-dog parties.

Appendix M. Compliance results at the event level
During each observation period, field observers recorded each instance (event) of each item presented below to better understand off-leash dog management.

Charging…person (B.R.C. 6-1-2 Definitions)

At the event level, of the 33 interactions with just a person, there were 7 interactions that led to the harassment of a person by a dog (**Table M1**). These 7 violations were attributed to 7 unique visitor parties.

There were also 171 (including one equestrian) passes of just a person and 13 passes of a person and a dog. Collectively with the interactions mentioned above and those included below as part of a person and dog interaction (21), this equals 238 compliance opportunities with another person. There were a total of 13 violations resulting in an overall compliance rate of 95%. When considering the compliance rate for only passes, by default, the rate is 100%. The compliance rate for only interactions is 76% (41 of 54).

Table M1. Number, type of event and compliance outcome for events involving other visitors reported at the event level

Type of event/event level	No violation	Violation	Total	Compliance both	Compliance interactions only
Person passes*	171	n/a	171	**95%**	**76%**
Person interactions	26	7	33		
Person and dog passes	13	n/a	13		
Person and dog interactions	15	6	21		
Totals	**225**	**13**	**238**		

*Includes one equestrian pass

Charging…dog (B.R.C. 6-1-2 Definitions)

At the event level, of the 27 interactions with just a dog, there was 1 interaction that led to the harassment of a dog by another dog (**Table M2).** Also out of the 27 interactions with a dog, there were 6 visitor parties whose off-leash dog approached a leashed dog. In 1 of these 6 incidents, the off-leash dog was out of sight of its guardian. There was no contact observed between the off-leashed and leashed dogs.

There were also 8 passes of just a dog and 13 passes of a person and a dog. Collectively with the interactions mentioned above and those included below as part of a person /dog interaction (21), there 69 compliance opportunities with another dog were observed. There were a total of 7 violations resulting in an overall compliance rate of 90%. When considering the compliance rate for only passes, by default, the rate is 100%. The compliance rate for only interactions is 85% (41 of 48).

Table M2. Number, type of event and compliance outcome for events involving other dogs reported at the event level

Type of event/event level	No violation	Violation	Total	Compliance both	Compliance interactions only
Dog passes	8	n/a	8	**90%**	**85%**
Dog interactions	26	1	27		
Person and dog passes	13	n/a	13		
Person and dog interactions	15	6	21		
Totals	**62**	**7**	**69**		

Chasing…..wildlife (B.R.C. 6-1-2 Definitions)

At the event level, of the 11 interactions with wildlife (includes one livestock event), 9 interactions led to the harassment of wildlife by an off-leash dog, with a total of 5 unique visitor parties involved in the 9 interactions (**Table M3**). There were also 3 passes of wildlife/livestock.

Table M3. Number, type of event and compliance outcome for events involving wildlife/livestock reported at the event level

Type of event/event level	No violation	Violation	Total	Compliance both	Compliance interactions only
Wildlife passes*	3	n/a	3	**36%**	**18%**
Wildlife interactions*	2	9	11		
Totals	**5**	**9**	**14**		

*Includes one livestock event

Voice recall (B.R.C. 6-1-2 Definitions)

At the event level, there were a total of 83 observed command events distributed over passes, interactions and isolated command events. Isolated command events describe events when the dog was not passing or interacting with any other person, dog, wildlife or livestock, and the guardian issued a command to the dog. Staff recorded 4 command events during passes, 23 during interactions and 56 command events not associated with a pass or an interaction event. The successful response rate for commands issued during passes, interactions and isolated command events was 75%, 70% and 75% respectfully and the overall voice control compliance rate was 73% (**Table M4)**.

Table M4. Number, type of event and compliance outcome for V/S command events at the event level

Type of event	Dog response		Total	Compliance rate
	No	Yes		
Pass	1	3	4	75%
Interaction	7	16	23	70%
Isolated	14	42	56	75%
Total	**22**	**61**	**83**	**73%**

Appendix N. Confidence interval calculation methods and results

Methods

To determine the reliability of our overall compliance estimates (60.7% based on the raw data; 66.4% based on the data without the "unsure" observations; 66.7% based on the normalized data), we calculated the 95% confidence interval (CI) for compliance. The CIs were calculated by looking up our observed estimate at the probabilities of 0.025 and 0.975 using a quantile function for a beta (interval 0 to 1) distribution. For example, for the lower CI, the corresponding syntax in R would be: qbeta(0.025, number of successes, number of failures - 1). This was repeated for voice command response, one of the constituent components of overall compliance.

To determine the minimum number of field observations necessary to obtain the observed overall compliance estimate, we used a random sampling algorithm. From the data vector of length *N* (N = 283, which is the total number of observations [310] minus those observations that were "unsure" [27]), we randomly sampled *n* records, where *n* could include every integer value between 5 and *N*. For each level of n (i.e., 5, 6, 7…283), the random sample was repeated 1000 times. From the random sample, compliance was calculated. We then plotted compliance (y axis) against number of observations (*n*), and overlaid two horizontal lines to represent the 95% CI around the observed compliance estimate. The minimum sampling effort is the number of observations (*n*) where all 1000 random samples fall within the 95% CI. This routine was repeated for voice command response compliance; in this case, *N* = 57.

Results

Overall compliance was 60.7 (95% CI, 55.0 to 66.1) for the full dataset; 66.4 (95% CI, 60.6 to 71.9) for the data without the "unsures"; and 66.7 (95% CI, 61.2 to 72.0) for the normalized dataset. The minimum number of samples necessary to obtain the observed compliance value of 66.4 was 199 (vs. the 283 observations collected; **Figure N1**). For voice control response, compliance was 77.2 (95% CI, 64.2 to 87.3) and the minimum number of samples necessary to obtain this value was 41 (vs. the 57 observations actually collected).

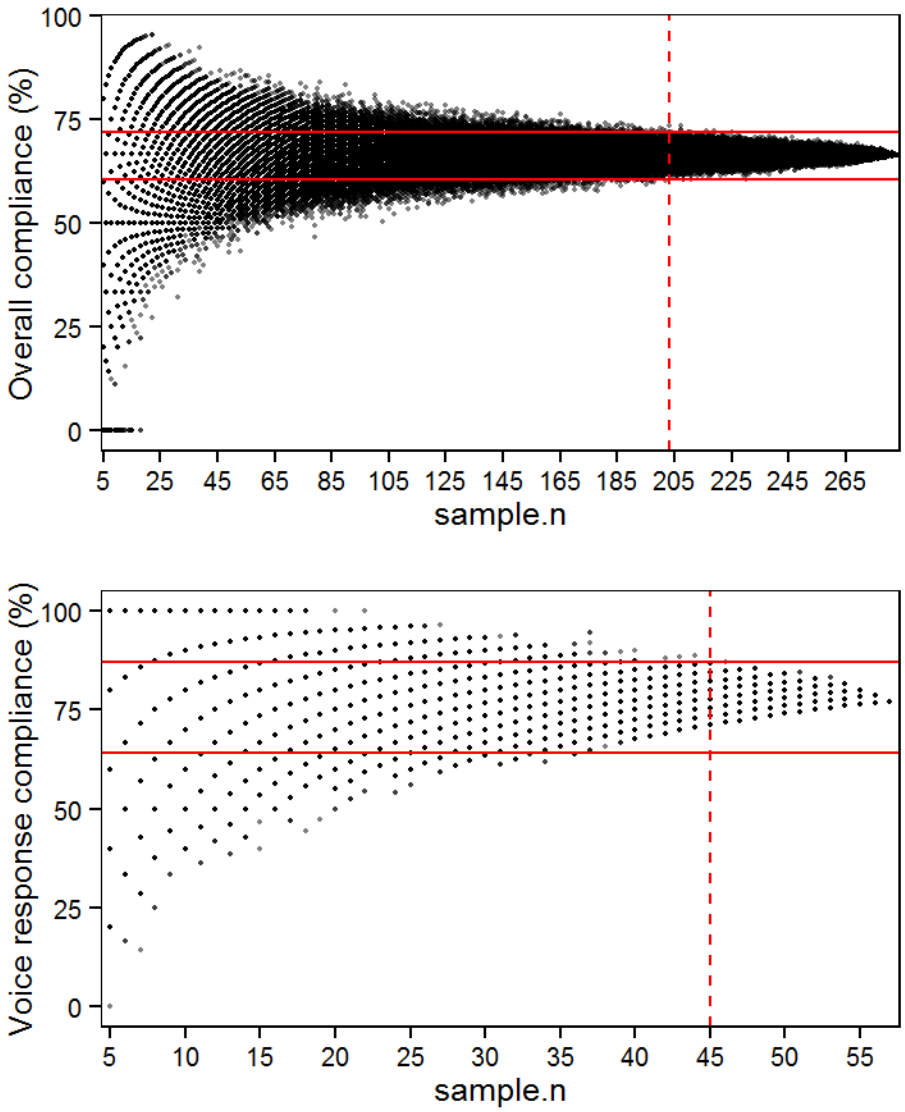


Figure N1. A random sampling algorithm was used to determine the minimum number of observations required (vertical, dashed line) to obtain the observed values for overall compliance (upper panel) and voice control compliance (lower panel).

Appendix O. Examples of social science theory constructs which could be used to better understand off-leash dog guardians

There are numerous social science theory constructs related to visitor management and recreation behavior that could be used to improve the quality of the visitor experience quality and Tag Program success. This information can help managers better understand off-leash dog guardians and design new strategies for improving conditions and monitoring change.

The works of Nesbitt (2006) and Williams et al. (2009) include a focus on the role of dog guardians' attitudes and beliefs in influencing compliance with dog regulations and could be useful in determining how guardians choose to manage their dogs. Attitudinal factors, which include a person's beliefs and attitudes about a behavior or action, can play a significant role in shaping visitor behavior (Marion et al. 2008). In the absence of strong contextual factors, such as uniformed personnel or visual cues, attitudinal factors are largely responsible for determining visitor behavior (Stern 2000, Williams et al. 2009). Given this, dog guardians' beliefs and attitudes need to be better understood and used to inform future management strategies and improve visitor experience quality.

Elaboration Likelihood Model

Elaboration is the extent to which a person carefully thinks (active cognition) about presented information and/or arguments contained in a persuasive communication. **The Elaboration Likelihood Model** (**Figure O1**) distinguishes between the peripheral route and the central route of persuasion as two paths that can lead to attitudinal (and behavioral) change (Petty & Wegener 1999, Petty & Cacioppo 1986). Generally speaking, the peripheral route of persuasion is intended to elicit a temporary attitude shift (through credibility/authority of the source or other quick visual cues) and gain the desired response from the message reader while the central route, which relies on "visitor attention, consideration and internalization of the message" (Marion & Reid 2007), is intended to foster a long-term attitude/behavior change through activation of more complex cognitive function and internalization of the attitude change.

The Elaboration Likelihood Model could be used to implement a suite of messages ranging from very little need to a highly developed need for cognition for testing reader response within V/S or other dog regulation trail areas of interest. Those messages which elicit the greatest level of compliance could be piloted in other areas for further testing and/or used in areas with compliance problems.

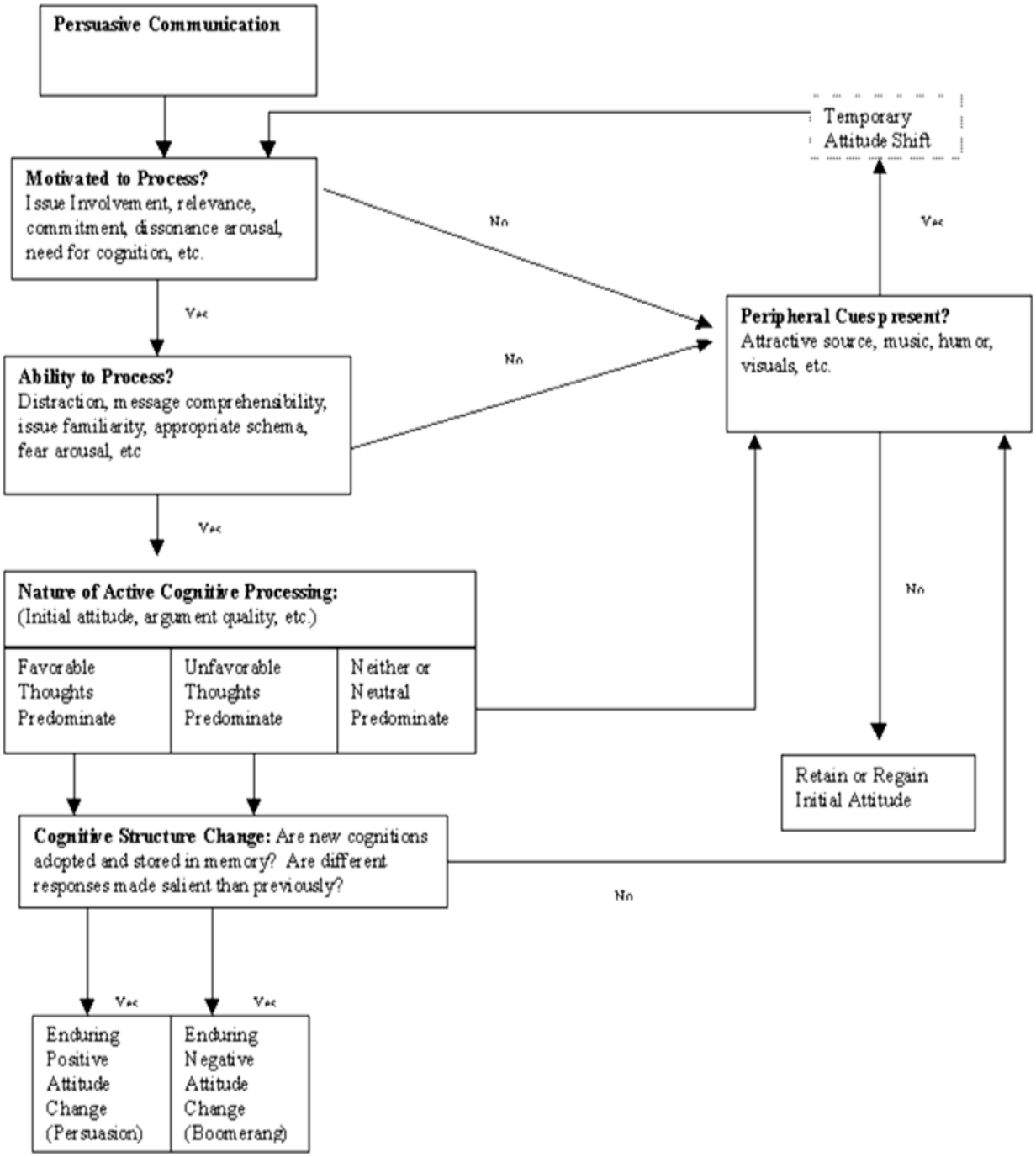


Figure O1. The Elaboration Likelihood Model (Petty & Cacioppo 1986)

The Theory of Planned Behavior (Ajzen 2006)

Within the construct of **The Theory of Planned Behavior** (**Figure O2**), human behavior is influenced by:

- Beliefs about the likely outcomes of the behavior and the evaluations of these outcomes (behavioral beliefs);
- Beliefs about the normative expectations of others and motivation to comply with these expectations (normative beliefs); and
- Beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors (control beliefs).

These three behavioral intention antecedents lead to attitude and subjective norm development along with a person's level of perceived behavioral control. Collectively, these three inputs contribute to a person's formation of a behavioral intention which, if nothing intervenes within the context of the given situation, leads to an expressed behavior.

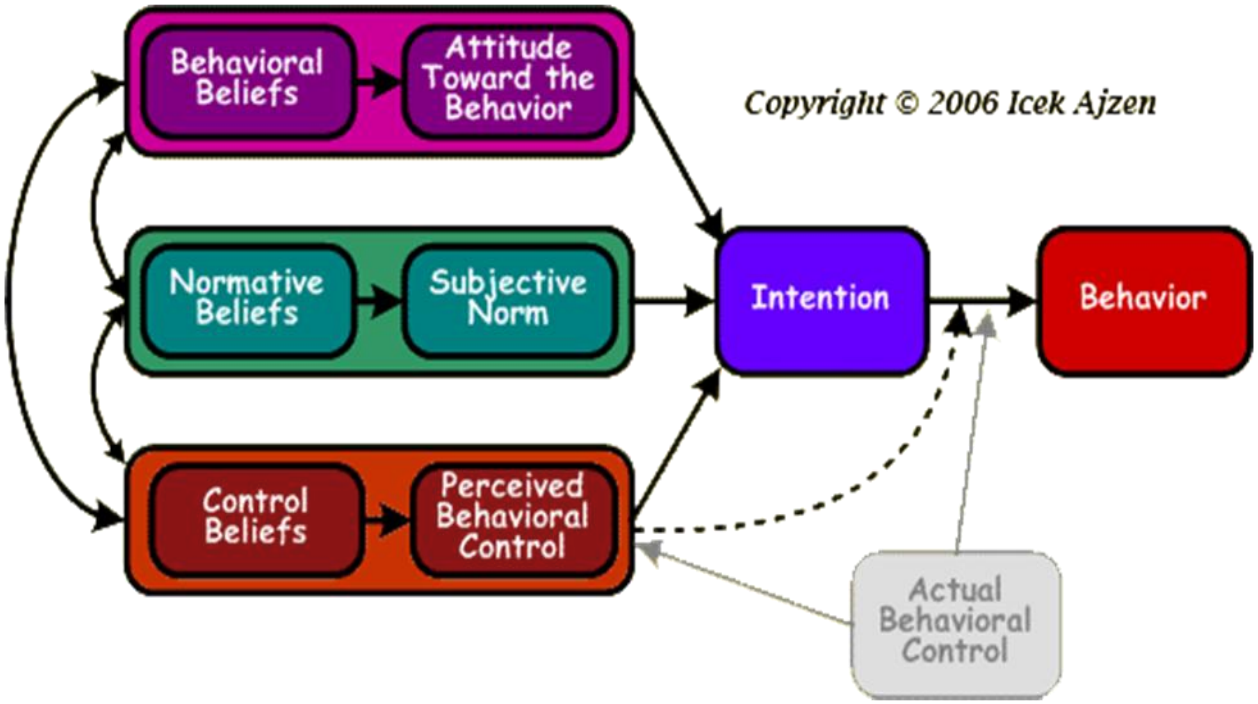


Figure O2. The Theory of Planned Behaivor (Ajzen 2006)

For example, applied to the behavior of interest "dogs jumping on people" (Edwards & Knight 2006), the Theory of Planned Behavior could be used to understand which component of behavioral intent (behavioral beliefs, normative beliefs or control beliefs) is contributing most to how dog guardians manage this behavior (**Figure O3**). This knowledge, in turn, could be used to design future studies, outreach strategies, ideas for further public inquiry, management strategies, education curricula revisions and targeted persuasive message creation.

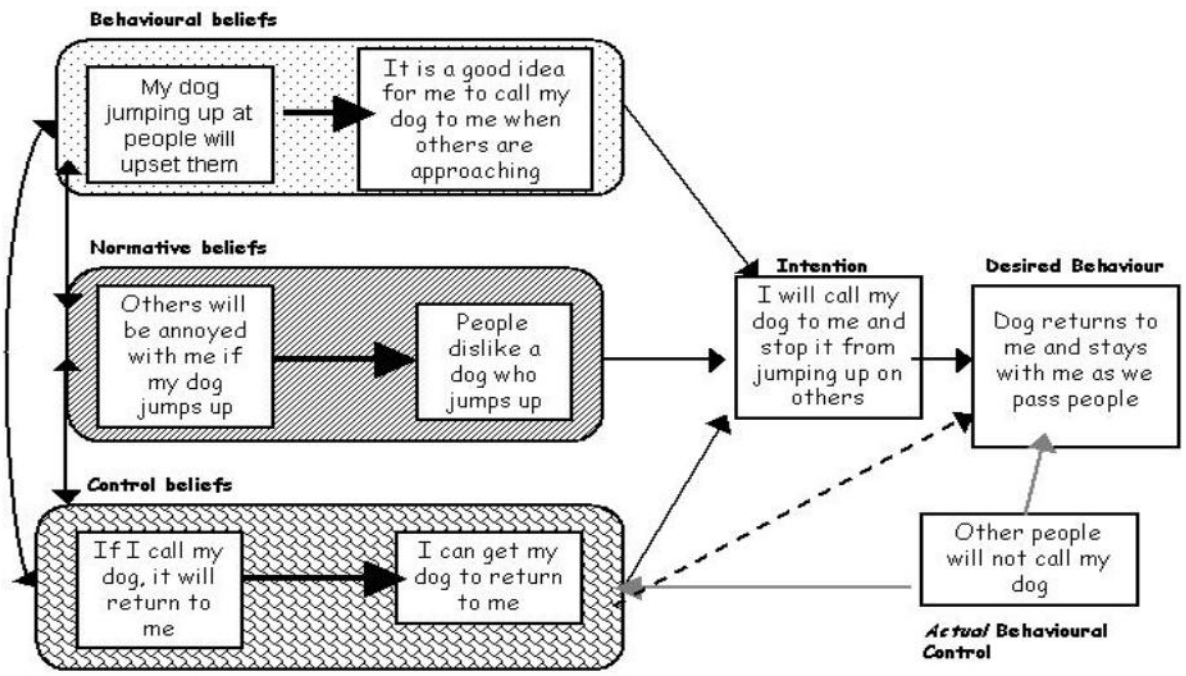


Figure O3. Theory of Planned Behavior applied to the behavior of interest "dogs jumping on people" (Edwards & Knight 2006)

Depreciative Behavior Taxonomies

Several researchers have organized depreciative behavior frameworks and/or classification systems aimed at understanding the motivation or rationale behind the behavior. Widner-Ward and Roggenbuck (2003), following Gramann and Vander Stoep (1987), suggested that one potential explanation of depreciative behaviors was a person's choice not to comply with perceived social norms. They proposed a **taxonomy of depreciative behaviors** comprising five typical violations:

1. Unintentional – "I did not know I was doing something wrong."
2. Uninformed – "I did not know harvesting firewood for my campfire could negatively affect the area's animals."
3. Releasor cue – "I saw everybody else doing it."
4. Responsibility-denial – "I did not contribute to this problem." and
5. Status confirming – "All my friends are doing it."

The **Depreciative Behavior Taxonomy**, as adopted from Hendee et al. 1978, outlines five categories of depreciative visitor behavior and assigns them each a likelihood that any intervention strategy would result in a modification of visitor behavior (**Table O1**).

Table O1. General typology of depreciative visitor behavior and the potential degree of effectiveness for intervention strategies

Type of behavior	Examples	Potential degree of effectiveness
Illegal actions	Cutting fence line Not picking up dog poop	Low
Careless actions	Walking side by side blocking trail Nuisance activity (e.g., shouting)	Moderate
Unskilled actions	Unable to manage dog using voice and sight control Unable to perform cyclist tripod yield	High
Uninformed actions	Not walking through mud Not having extra poop pick up bag Walking off trail	Very high
Unavoidable actions	Human/dog waste disposal Loss of ground cover vegetation at trailhead	Low

These factors interplay and can be additive in nature. For example, visitors who allow their dogs to chase birds or squirrels near the trail are likely not intentionally trying to harm wildlife. They may also have seen other people/dogs doing so and may think that the managing agency should excuse and accept such trailside activity. In this example, we see visitor actions which are simultaneously unintentional, releasor cue and responsibility denial related.

Namba and Dustin (1992) suggested that **depreciative behavior** is most effectively addressed by clearly articulating (to visitors) the behaviors that are unacceptable and further relating the behaviors to specific unwanted consequences. Land managers also need to provide visitors with an option to "do the right thing" to ensure voluntary compliance with recommended behaviors.

Another idea concerning why depreciative behavior occurs was first discussed by Hardin (1968) in his "Tragedy of the Commons" paper. The "**commons dilemma**" view contends that depreciative behaviors occur in recreation areas because visitors may deny the potential negative impacts to everyone else when rationalizing the benefit to self. For example, the benefit from allowing a dog to run around freely accrues to the individual and the dog, while all the other visitors (and non-human beings) share the cost of an unmanaged dog. To the visitor, the perceived benefit of running freely outweighs the perceived cost to everyone else in the park.

Any of the Depreciative Behavior Taxonomies could be used to design future visitor surveys, focus groups, interviews, or other studies designed to understand the reasoning behind unwanted depreciative behaviors such as dogs jumping on people or dogs chasing wildlife.

Information-Processing Model of Persuasion and Behavioral Change

The **Information-Processing Model of Persuasion and Behavioral Change** (McGuire 1985), graphically displays the steps required to attain the desired response from a reader exposed to a persuasive message (**Figure O4**). These steps include:

- **Exposure**: Visitor is exposed to an educational message
- **Attention**: Visitor processes the message
- **Comprehension**: Message is understood
- **Yielding**: Visitor accepts the message and changes their attitude
- **Retention**: Visitor retains the message and attitude
- **Behavior**: Visitor behaves in accordance with changed attitude (or learns how to)
- **Avoidance/reduction of impacts**: Resource or experiential impacts are avoided or reduced

These steps require careful thought and consideration in the kinds of communication used, the message content, the message source, the targeted receivers/audience and the desired behavioral choices that are expected to follow.

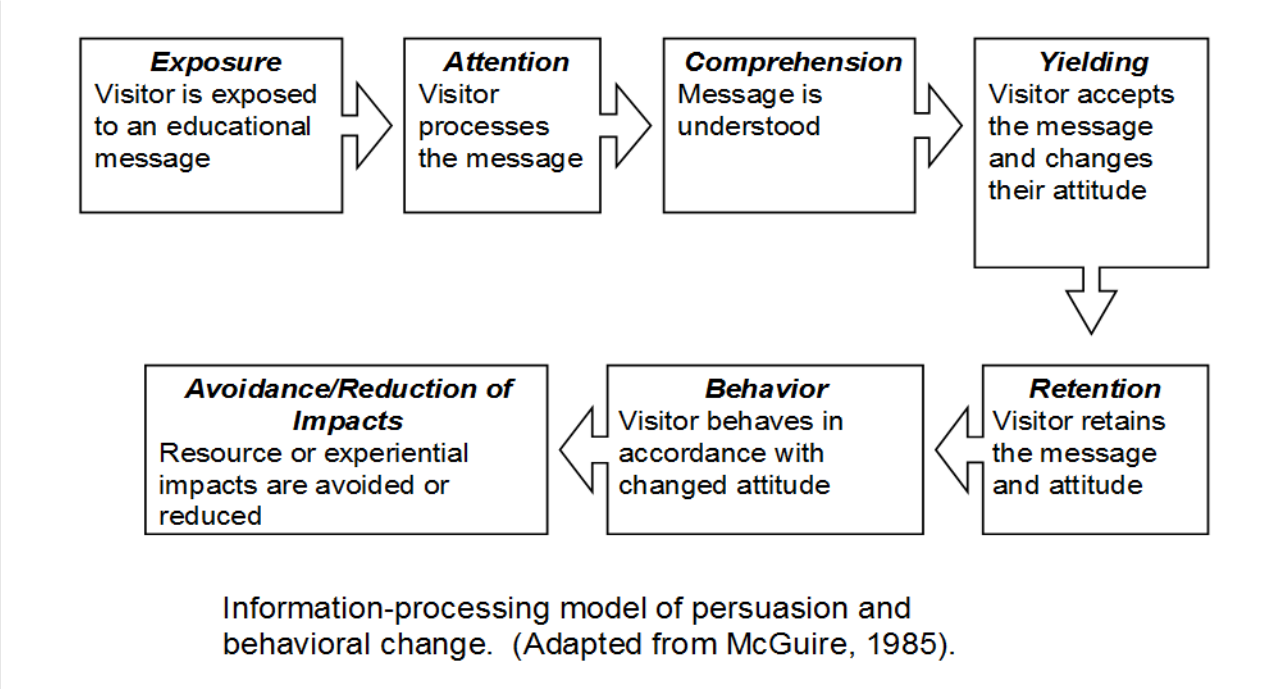


Figure O4: Information-Processing Model of Persuasion and Behavioral Change (McGuire, 1985)

The Information-Processing Model of Persuasion and Behavioral Change could be used to design future behavioral compliance studies, pilot or long-term message studies, behavioral choice interviews or other studies designed to understand the effects of selected messages at reducing unwanted depreciative behaviors such as dogs jumping on people or dogs chasing wildlife.

Value-Attitude-Behavior Model (cognitive hierarchy of human behavior)

As displayed in **Figure O5**, values represent the "top" of the cognitive hierarchy of human behavior. Values are few in number, slow to change, central to beliefs and transcend situations (Vaske & Donnelly 1999). They affect human beliefs and attitudes, which in turn, affect behavioral intentions and actualized behaviors. Depending on the desired outcome (short-term or long-term behavioral change), OSMP could design future monitoring studies to determine the most salient values, attitudes and belief systems contributing to observed visitor behaviors. Generally speaking, if seeking long-term behavioral change, interventions will need to address and focus upon those items (values and value orientations) at the top of the cognitive hierarchy.

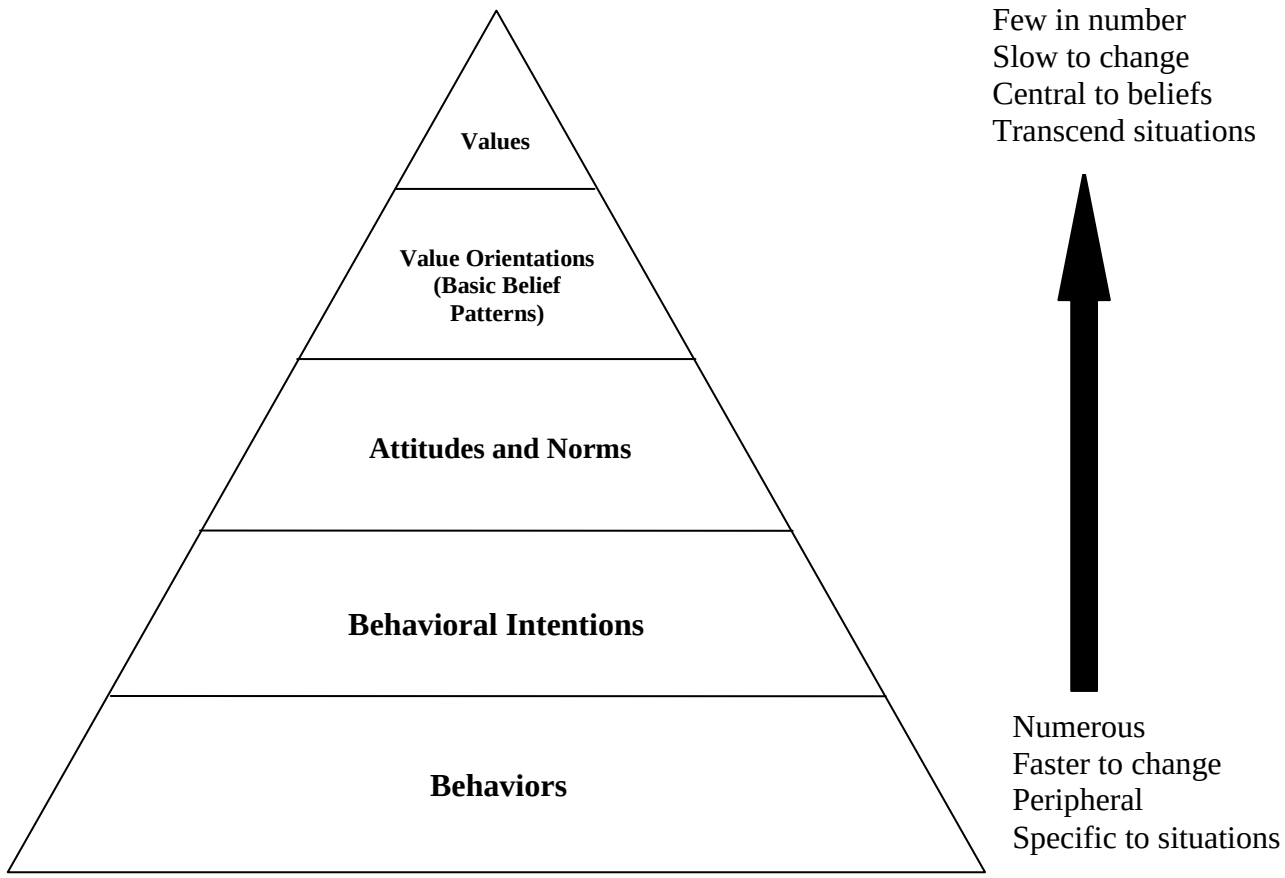


Figure O5. Value-attitude-behavior model

THE END.