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Upholding Civic Doody: Environmental Awareness Explains Pro-Environmental Behavior in the Context of Dog Waste Disposal

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Upholding Civic Doody: Environmental Awareness Explains Pro-Environmental Behavior in the Context of Dog Waste Disposal

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ABSTRACT

Dog waste is a problem for Open Spaces because it can spread diseases and increase soil Nitrogen, which facilitates the growth of invasive species. Dog walkers at Palo Alto Open Spaces are required to throw away dog waste, but there is some deviant behavior. I conducted a survey of 115 visitors to Palo Alto Open Spaces (Baylands Preserve, Arastradero Preserve and Foothills Park) to assess visitor compliance with dog waste regulations, visitor environmental values, and visitor awareness of dog waste impacts. I ultimately wanted to understand what factors could predict a person’s dog waste disposal behavior. I found that 35% of visitors self-reported always disposing of dog waste, and 38% of visitors almost always disposed of dog waste. Most visitors (68%) held strong environmental values, but environmental values were not related to dog waste disposal behavior, which contradicted the widely-used Value-Belief-Norm theory. Only 17% of visitors could name one negative environmental impact of dog waste. Knowledge of dog waste impacts was able to predict a 13% increase in proper dog waste disposal (p = 0.023), which aligns well with the ideas in the Norm-Activation Model. To increase compliance with dog waste disposal regulations in Palo Alto, Open Space managers could create informational signs or brochures that detail the environmental impacts of dog waste because this study showed that information was the limiting factor for dog waste disposal in Palo Alto Open Space parks.
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PREFACE

As a resident of Palo Alto for 10 years, and a frequent visitor to its Open Spaces, I have a strong affinity for the biodiverse parks of the San Francisco Bay Area. In high school, I volunteered with Acterra (now Grassroots Ecology) biweekly and became a preserve steward at Arastradero Preserve. It was there that I learned that purple needlegrass, the California state grass, could live to 200-year and produce 20-foot deep roots that could reduce erosion and raise the water table. Protecting these and similar plants, and thereby maintaining the ecosystem services they provided, has since remained a goal in my life. Dog waste and other external nitrogen inputs threaten California native plants because they eliminate the competitive advantage that natives have over exotics in low-nutrient soils. Despite walking my dog at Arastradero Preserve throughout high school and my passion for native plants, I was then unaware of the consequences of dog waste on the environment. After learning about the detrimental impacts of dog waste, I adjusted my habits to keep my dog on-leash and to pick up all of his waste. I am excited to use the opportunity of a thesis to study people’s dog waste disposal behavior and inform land managers how to increase compliance with dog waste pickup.

ACKNOWLEDGEMENTS

I would like to thank my committee members, Dale Miller, Lisa Corwin, and Cassandra Brooks, for their guidance and support in this project. I appreciate you each taking time out of your schedule to assist me with this project; it would not have been possible to create this without you. Additionally, I would like to thank Amanda Carrico and Victoria Stout, who have allowed me to join their weekly lab meetings and have provided me with feedback on and resources for my project throughout the semester.
INTRODUCTION

Open Spaces provide both ecological and anthropogenic benefits. In the highly developed San Francisco Bay Area, Calif., preserves offer refuge to native flora and fauna, but contamination can threaten the ecological integrity of these parks and irritate human visitors. One such form of contamination, and the subject of this study, is dog waste. I studied the literature on pro-environmental actions and conducted a survey (Appendix 2) of park visitors to understand the potential drivers of dog waste disposal behavior for parks in Palo Alto, Calif. I conducted surveys at Baylands Nature Preserve, Pearson-Arastradero Preserve, and Foothills Park. The three parks represent the biological gradient of the Bay Area. Because the parks are so different, ecologically, distinct messages about dog waste could resonate well in each park. Baylands is a saltwater marsh that borders the San Francisco Bay; it would be easiest to make water-quality related connections here. Arastradero, a mixed oak grassland preserve in the foothills of the Santa Cruz Mountains, is strongly affected by invasive species, which could lend well to education related to dog waste and invasive species facilitation. Foothills Park is the highest in elevation and boasts oak woodlands. Foothills hosts several kids camps and school events and might, therefore, be most interested in public health concerns associated with dog waste. All parks are owned by the City of Palo Alto.

The aim of the surveys was to understand the role of knowledge and values in dog waste disposal behavior. While my survey questions did not fit clearly under one environmental behavior theory, it drew from parks of several pro-environmental behavior frameworks. Working off of these two frameworks, I created three research questions: (1) How do Bay Area park visitors value the environment/wellbeing of Open Spaces? (2) What is the current visitor
knowledge of environmental impacts of dog waste disposal on the environment? (3) Is there a link between values/knowledge and dog waste disposal habits?

I predicted that park visitors will value preserve wellbeing but be largely unaware of the detrimental environmental consequences of dog waste. If there is this breakdown between values and awareness, that would mean that even people who value the environment will not pick up dog waste because they are unaware that dog waste is detrimental to the environment. The theories that I studied operate as linkages from information to norms to behaviors. If the earliest connection in the chain is broken, it might be challenging to test the influence of later ideas.

BACKGROUND

In the background section, I will detail the public health and environmental concerns associated with dog waste and introduce potential solutions to the problem.

Detrimental Impacts of Dog Waste

Dog waste poses several problems to park systems nationwide. Each year, an estimated 10.6 million tons of dog waste are generated in the United States, which can harm ecosystem and human health when not properly disposed (Stevens and Hussman, 2017). Dog waste is considered an environmental hazard for its high nitrogen (N) content, antibiotic resistance, and potential to spread disease (OSMP, 2018; Cinquepalmi, 2013; Horn et al., 1990; Johnson, 1999). It is also the leading cause of phosphorus pollution in urban watersheds (Hobbie et al., 2017). Overabundant N in an ecosystem can lead to decreased species richness and can facilitate the spread of invasive species, which are both leading concerns for land managers (Tilman, 1987; Davidson et al., 2012; City of Boulder, 2010). Dog waste can also be a public health concern and spread bacteria like Campylobacteriosis, E. coli, Salmonellosis, Yersiniosis and parasites such as
giardia, roundworm or tapeworms, all of which are communicable to humans (Canadian Public Health Association, n.d.).

Importance of Individual Action

A debate exists amongst environmental psychologists as to the efficacy of individual action versus policy initiatives. Critics of individual action argue that it is insignificant and can be counter-productive when the action exhausts people to the point of inhibiting political action (Wagner, 2011). Others feel that in a time of extreme environmental degradation, motivating personal action to protect ecosystems is paramount (Dietz et al., 2009). In the case of dog waste, motivating individuals to act responsibly is an especially obvious choice given that the impact of each individual is tangible and easily preventable. Therefore, it is important to understand how to motivate individuals to pick up dog waste. Inspiring action, however, can be challenging, and campaigns that aim to encourage pro-environmental behavior often fail (Blumstein and Saylan, 2007). These failures have been attributed to psychological barriers such as a lack of awareness for the problem or solutions, low environmental values, and the inconvenience of certain actions (Turaga et al., 2010). Successful education campaigns to encourage pro-environmental behavior have knowledge as a barrier to action and have easy fixes (Ryan et al., 2013).

The pathway is generally considered to begin with information (Turaga et al., 2010; Stern et al., 1999; Schwartz, 1970), which leads to the formation of values and those values influence behaviors (Figure 1). The transition from an attitude to a behavior can be an especially challenging barrier (Steg and de Groot, 2012), but it is possible that visitors to Open Spaces in Palo Alto are stuck at the initial bottleneck of information. It is therefore worth studying the linkages of education and values that feed into one’s behaviors. Social psychologists describe a person’s decision to make pro-environmental behavior (PEB) as analogous to a transaction:
when the cost of not helping the environment (e.g. guilt) outweighs the cost of performing the action (e.g. inconvenience or price) then the PEB will be performed (Turaga et al., 2010).

![Diagram of environmental behavior models]

**Figure 1** A simplified version diagram of leading environmental behavior models.

Literature Review

Several psychological frameworks have been posited to attempt to explain PEB. At the core, they explain the linkages between awareness, attitudes and behaviors. In the “psychological frameworks” section, I describe the theories that informed my survey design. I then explore the role of information in environmental behavior. Finally, I explore how parts of the Theory of Planned Behavior explain gaps in the other theories that I discuss.

Psychological Frameworks

A leading environmental psychology framework, the Value-Belief-Norm theory (VBN), combines three older models to explain how pro-environmental attitudes form (Stern et al., 1999). It posits that a combination of information and personality create personal codes of ethics for each person (called values), which people apply to their behaviors. The VBN theory has been successful explaining how to create public support for environmental causes (Steg et al., 2005; Oreg and Katz-Gerro, 2006) but fails to link attitudes (public support) to behavior. The gap between pro-environmental attitudes and PEB is addressed by the Theory of Planned Behavior (TPB), which claims that behaviors are driven by intent (Turaga et al., 2010). Pro-environmental Behavior studies typically examine VBN and TPB in contrast to each other, but they can also be viewed as building on each other. Pro-environmental attitudes can be explained by VBN, and
TBP links attitudes to PEB (Figure 2). In this study, I addressed one of three theories that feed into VBN.

![Diagram](image)

**Figure 2** The NAM (rectangle) explains how "ascribed responsibility" and "awareness of consequences" forms behaviors, which help to create values. The VBN (triangle) describes that when people create personal codes of ethics (values), those inform their behavior. TBP (circle) farther explains the link between pro-environmental values/attitudes and pro-environmental behavior. My study specifically examines the bolded/italicized parts of each of these larger frameworks.

My survey tested part of the Norm-Activation Model (NAM), which theorizes that there are two conditions to fulfill before a person’s attitude will change: (1) a person must be aware that an action will have positive consequences for that person’s values, and (2) a person must feel some responsibility to act (Schwartz, 1970). When these conditions are satisfied, a person will feel morally obligated to act. Although not initially applied to environmental actions, the theory has gained popularity among environmental psychologists and has been applied to PEB (Turaga et al., 2010). In the context of this study, the model would suggest that picking up dog waste is preceded by caring about the environmental impact of dog waste, which would be preceded by the knowledge that dog waste is an environmental hazard (Figure 1). Several previous papers have studied how increasing environmental knowledge encourages PEB with mixed results (van der Werff and Steg, 2016; Theil et al., 2011; Eastman et al., 2014).
Can Information Drive Behavior?

Some researchers hypothesize that knowledge of environmental issues is an initial barrier to pro-environmental behavior (Gifford, 2011; McKenzie-Moher, 1999). In this case, a lack of knowledge can mean either ignorance of a problem or ignorance of its solution (Gifford, 2011). When uncertainty surrounds a problem or solution, it can exacerbate inaction because people may perceive the consequences of their actions to be less severe than they are (Shu and Bazerman, 2010). In a meta-analysis, it was found that knowledge of environmental problems and solutions were two of the top six strongest characteristics correlated with intent (Hines et al., 1986). If people are informed of a problem and solution, they may be motivated to change their behavior (McKenzie-Moher, 1999).

In a study of real estate managers, Fryxell and Lo (2003) found that environmental knowledge and values were correlated with minor environmental actions (i.e. selectively reading environmental news articles) but did not translate to business behaviors (i.e. recycling waste on project sites). This could support the idea that only some environmental behaviors could be explained by VBN, which Turaga and associates presented in 2010. However, the questions that Fryxwell and Lo (2010) used to assess environmental knowledge were general and did not pertain to the specific environmental effects of business decisions that the land managers could make. It could be that the land managers were aware of how environmental systems worked generally but that they were unaware of their impact on the environment as land managers. The inconsistent impacts of education on behavior that were demonstrated in Fryxwell and Lo’s study are a small representation of a larger debate in environmental psychology regarding the role of environmental knowledge on behavioral intent.

It is known that knowledge is an imperfect driver of behavior, and some of these imperfections could come from how environmental education is presented. Blumstein and Saylan
(2007) argue that environmental education in its current form does not convey the message of personal accountability. Shu and Bazerman (2010) blame this lack of accountability on our innate discount of the future and inability to perceive problems to be as severe as they are, and also mention that it is challenging to develop experiential learning plans related to pro-environmental behaviors. Instead of blaming our human nature, Blumstein and Saylan (2007) blame the way we are teaching environmental education. In their opinions, we must be teaching why certain behaviors are problematic and how to fix them. Other researchers suggest that environmental education must take place outside of a traditional classroom because the most important type of environmental education is teaching environmental sensitivity, which can only be achieved in nature (Carmi et al., 2015).

In the case of dog waste in Boulder Open Space, there are already clear indications of how to fix the problem of dog waste. Bags and signs are provided reminding people to clean up after their dogs. What is missing, however, is an environmental reasoning behind the law. It could be that Boulder residents have strong environmental values and are aware of threats to Boulder Open Space but that they do not make the link between dog waste and negative environmental externalities. Understanding how a behavior can impact the environment is one of the crucial steps in environmental action (Shu and Bazerman, 2010) that could be missing from Boulder Open Space dog waste disposal information.

Successes and Failures of Educational Campaigns

Although there is limited information on the outcomes of dog waste abatement campaigns, there is extensive literature analyzing successful and unsuccessful environmental campaigns in general. This literature review focuses on papers that assessed the relationship between education and personal litter or pollution habits. Studies often conclude by calling for an
increase in environmental awareness (Theil et al., 2011), but it is likely that this is not always the effective solution.

One study that attempted to reduce litter and pollutants measured self-reported behavior before and after an education campaign to raise awareness of littering (Taylor et al., 2007). The campaign found increases in self-reported proper disposal behavior but did not see an increase in knowledge surrounding litter and pollution issues (Taylor et al., 2007). It is possible that the subjects who received the educational treatment did not learn from the program but at least felt guilty for polluting, and therefore were less willing to report negative environmental behaviors. Unfortunately, the educational material was unavailable, so it is difficult to diagnose exactly what could have been changed to increase awareness and compliance.

If environmental education is only effective when the root problems are explained (Blumstein and Saylan, 2007), then studies must assess how well respondents understand the environmental impacts of a behavior to accurately gauge environmental education on the subject. Additionally, it could be that knowledge only influences behavior through the intermediate construct of values or attitudes (Latif et al., 2013; Aman et al., 2012). Awareness of environmental problems can make people sympathetic to environmental problems, but more is needed to elicit PEB.

Influence of Values on Behavioral Intent

Environmental education is at risk of only engaging those who already hold pro-environmental beliefs (Carmi et al., 2015). At best, this can waste resources, and at the worst, it can harden the resolve of those who are anti-environmental. It is therefore important to understand how values can interact with education when promoting environmental behavior (Carmi et al., 2015). When environmental education correlates with behavior, it can be largely explained by the interacting variable of emotional regard for the environment (Carmi et al.,
Aman and associates (2013) also found that attitudes toward the environment, rather than environmental education, was more important in determining likelihood of pro-environmental behavior. The study administered a survey that attempted to correlate people’s environmental attitudes and knowledge with behavioral intent, but it was assessing likelihood of green purchasing, which could conceivably have distinct outside factors from the outside factors that influence dog waste disposal behavior (Aman et al., 2013). As such, it could be challenging to directly compare influences of green purchasing behavior to influences of dog waste disposal habits.

Additionally, it would be interesting to pair self-reported survey results with observations of actual behavior. Both papers that attributed intent to values (Carmi et al., 2015; Aman et al., 2013) used self-reported surveys to measure behavior, which could be inaccurate.

However, the idea that values and education can both influence behavioral intent is important for Palo Alto, Calif. In Palo Alto, where a strong precedent of pro-environmental values can be seen through the passing of policy that increases sales taxes to fund Open Space, connecting education to environmental values would likely make a large difference in behavior. The study system already has strong environmental values, as does Palo Alto, which makes it fertile ground for educational campaigns that tell the public why certain behaviors are problematic for the environment.

The VBN theory is targeted at explaining environmental behavior and therefore may seem like the obvious framework to use when attempting to understand why people do not pick up their pets’ waste. However, previous studies aimed at explaining environmental behaviors prefer the predictive power of TPB over the VBN theory (Aguilar-Luzón et al., 2012; Kaiser et
al., 2006). Ultimately, I believe that aspects of all three theories are necessary to understand the factors that feed into environmental decision making in the context of dog waste disposal.

In a 2006 study of German university students, Kaiser and associates found that TPB explained 95% of environmental behavior, whereas the VBN theory could only explain 64% of behavior. In the study, a survey was distributed to students that asked questions to reveal students’ use of the aforementioned main principles of TPB and VBN in decision making (Kaiser et al., 2006). Together, “attitude,” “subjective norms,” and “perceived behavioral control” (all components of TPB) accounted for 76% of variance in environmental behaviors (Kaiser et al., 2006).

In addition to appeal and social norms, TPB also incorporates the idea of beliefs to explain behavior (Ajzen, 1991; Kaiser et al., 2006; Turaga et al., 2010). One of several beliefs is a person’s perceived behavioral control, which is the most applicable to environmental studies. This belief measures how much people feel that their actions can impact their surroundings. People feel that the ramifications of negative environmental behaviors are so temporarily removed that they are inconceivable (Soliman et al., 2018; Spence et al., 2012). Additionally, the phenomenon of a “drop in the bucket” can make people feel like their individual actions will not change global problems (Soliman et al., 2018). It is possible that in a smaller system, like Boulder Open Space, visitors could see the impacts of their actions and therefore be more willing to change behavior.

An individual’s behavioral intent (the final mediator of TBP measure) was the strongest predictor of behavior in Kaiser and associates’ 2006 study, and it accounted for 98% of the variation in environmental behavior. In a study of Boulder Open Space dog waste disposal, intent could explain 89% of variation in behavior (Blenderman et al., 2018). According to Ajzen
intent is driven by appeal, social norms and perceived behavioral control. However, when Kaiser and associates (2006) combined the effects for these three factors, that only accounted for 76% of behavior, but intent accounted for 98% of behavior. This means that 22% of the feeders of intent still must described. I believe that this gap can be partially accounted for using knowledge and values from the VBN theory.

A previous study of dog waste behavior that was conducted in Boulder, Colo., successfully used the TPB to explain dog waste behavior. In Boulder, there are signs posted at trailheads about dog waste pick-up and bags provided. In the Bay Area, however, there are no signs or bags, which may put the Bay Area behind Boulder in terms of awareness of dog waste impacts. I think it is important However, in the Bay Area, where comparatively few parks allow dogs and no information about dog waste exists at trailheads, I think we need to first establish the links that lead to environmental attitudes before examining the link between environmental attitudes and behavior (Figure 1).

METHODS

This study took place in January 2018. Data were collected through a survey of visitors to three Palo Alto, California parks: Foothills, Arastradero, and Baylands (Appendix 3). Dogs are permitted on-leash at Palo Alto Open Space preserves. At Foothills Park, dogs are only allowed on weekdays. Technically, only Palo Alto residents can visit Foothills Park, but it is common knowledge that rangers do not check identification on weekdays. Baylands Nature Preserve is a mixture of preserved shoreline and landfill. It is more common for visitors to walk on the landfill area, compared to the natural area. The survey table was set up in front of the trailhead that leads to the landfill area.
Data Collection

All English-speaking park visitors over 18-years-old were recruited to participate in the study. Those who declined were thanked and left alone. Each survey took approximately three minutes. Baylands and Foothills were surveyed once, and Arastradero was surveyed twice (Appendix 3). Arastradero Preserve was surveyed on one weekday (slight rain) and one weekend day (sunny). Foothills was surveyed on one weekday because dogs are only allowed on weekdays. I visited Foothills on two other weekdays, but rain kept visitors away. Baylands was surveyed on one weekday (sunny).

The survey did not have an incentive and participants may have stopped at any time. The Institutional Review Board waived the need for written consent on the grounds that the study was not high risk for the participants and that there was no identifiable information collected. I still obtained informed oral consent (Appendix 1).

I wore the same University of Colorado jacket to recruit participants at all three trailheads. I set up a card table with a poster taped to the front that read, “help an undergrad research project and your parks: take a 3-minute survey.” One booth made of cardboard was constructed and left next to the card table to give people the option to complete the survey in more privacy.

Data Analysis

The data were analyzed using RStudio and the associated “car,” “Matrix,” and “lme4” packages. I ran linear mixed models to test for relationships between (1) dog waste behavior and awareness and (2) between dog waste behavior and values. The data for awareness and values, which were the predictor variables, were ordinal, and I used linear regressions because I wanted to be able to convey changes in the response variables as percent effects. Additionally, I wanted to be able to use a mixed model to account for an effect of the different parks.
RESULTS

This study surveyed 115 individuals across three Open Space parks in Palo Alto, Calif.

Of the responses, 44 were collected at Arastradero Preserve; 51 responses were collected at Baylands Park, and 20 responses were collected at Foothills Park. Of the respondents, 52.2% were dog owners, and 33.9% brought their dogs to Open Space. Of the dog walkers at Open Space, 38.5% reported that they sometimes or always had their dogs off-leash while visiting Open Space.

Research Questions One & Two

To assess the value park visitors placed on the environment, I combined the answers from three questions so that people who valued the environment the highest would have a score of 3, and people who valued the environment the least would have a score of 15. The mean environmental value was 3.61 (indicating strong environmental values), and 69.7% of respondents answered that they strongly agreed with all value statements (Figure 3).

![Visitor responses to environmental value statements](image_url)

**Figure 3** Scale of the environmental values of park visitors where 3 is the highest level of care for the environment and 15 would be the lowest amount of environmental worth. Environmental values increase as the graph goes left. The vertical line shows the average of the responses.
Responses addressing the environmental impacts of dog waste were coded into six categories: (1) beneficial, (2) disrespectful, (3) did not know, (4) no impact, (5) strong, and (6) pollution (Figure 3). In some cases, there were multiple code types listed by one individual; I categorized these responses based on the first type listed. There were 21 individuals who left the question blank and are not included in Figure 3. There was no difference between type of response and waste disposal behavior. Therefore, I re-classified respondents as either being unaware or aware of the issue of dog waste on the environment. Respondents in the first four categories were considered unaware, and respondents from categories five and six were considered environmentally aware (Figure 4). Only 34% of park visitors who responded to the question understood that dog waste posed an environmental threat, and only 17.3% of all visitor could accurately name one environmental problem exacerbated by dog waste.

![Visitor responses to environmental impacts of dog waste](image)

**Figure 4** Number of survey respondents to explain that dog waste impacts the environment in each different way.

**Research Question Three**

I combined the answers for on- and off-trail disposal habits to create a “disposal score” (Figure 5). I use the disposal score when I correlate environmental values and environmental
education to dog waste disposal habits. The disposal score spans from 2 (never picks up dog waste on- or off-trial) to 10 (always picks up dog waste on- and off-trail).

![Visitor waste disposal behavior](image)

**Figure 5** Combining the question that targeted dog waste disposal behavior on-trail (scale of 5) and the question that targeted off-trail disposal (scale of 5). I developed a metric to determine how visitors generally dispose of dog waste. The more frequently an owner disposes of dog waste correctly, the further left the owner would be on this graph.

I ran a linear mixed model to account for the random effect of park. There was not an effect of park on disposal behavior. Dog owners who were aware of the negative environmental consequences of dog waste were significantly more likely to dispose of dog waste properly ($p = 0.023$) (Figure 6). Awareness of the negative impacts of dog waste on the environment could explain a 13% increase in correct dog waste disposal (Figure 6).
Figure 6 Comparing the dog waste disposal practices of visitors who were aware and unaware of the environmental consequences of dog waste. Visitors who were aware of the impact are represented on the right. The more likely a visitor is to dispose of dog waste correctly, the higher the disposal score.

There was no relationship between environmental values and dog waste disposal behavior (p = 0.833). Environmentally aware respondents were no more or less likely to have strong environmental values (p = 0.269).

Other Inquiries

The majority (82%) of dog owners reported that they always picked up their dog waste when it was on-trail (Figure 7a) and 34% of dog walkers always picked up waste that was off-trail ($X^2 = 13; p = 0.32$) (Figure 7b). There was no effect of dog being on-leash and the likelihood that a dog owner would pick up the dog waste on the trail (p = 0.508) or pick up dog waste off trail (p = 0.916).
The frequency of park visitors is not tied to environmental values (p = 0.827), but 3% of differences in environmental education can be explained by frequency of visits to Open Space (p = 0.043) such that the more a visitor visits a park, the lower that visitors’ environmental awareness (Figure 8). The small effect size means that even though the result was statistically significant, it likely does not hold real-world value. There are several other factors that play into people’s environmental awareness outside of park visitation, which likely hold more real-world influence. Visitation frequency was unrelated to waste disposal practices (p = 0.913).

Two survey questions targeted if people felt they had control over the environment or the well-being of their local parks. I categorized these as “perceived behavioral control.” Most visitors surveyed strongly agreed or agreed with both questions that targeted perceived behavioral control (Figure 9). If respondents strongly agreed with both questions, they would have a score of 2. The less control they felt they had over environmental wellbeing, the higher
their score would be. The maximum score would have been 10. This metric for perceived behavioral control was not correlated with dog waste disposal habits \( (p = 0.895) \).

![Visitor perceived behavioral control of environmental wellbeing](image)

**Figure 7** The perceived behavior control of respondents to influence the environmental wellbeing of their parks or of the wider globe. Perceived control increase as the graph goes left. Vertical line shows the average feeling of behavioral control.

**DISCUSSION**

The results of this study support that parts of VBN can explain dog waste disposal behavior. The study did not test the predictive power of all links in VBN or TPB. The first step in the casual chain (Figure 1), knowledge, was directly related to behavior, but no other steps were related to behavior (e.g. values and convenience). My hypothesis that awareness of dog waste consequences can influence behavior was therefore partly confirmed. The three research questions that I asked were answered: (1) How do Bay Area park visitors value the environment/wellbeing of Open Spaces? (2) What is the current visitor knowledge of environmental impacts of dog waste disposal on the environment? (3) Is there a link between values/knowledge and dog waste disposal habits?

Visitors to Palo Alto Open Spaces highly value the environment but are largely unaware that undisposed dog waste threatens the environment. Environmental values were not related to
dog waste disposal behavior. There are several factors that could explain why environmental values were not related to environmental behavior. First, people tend to exaggerate good behavior when answering surveys (Chao and Lam, 2009). It could be that people self-reported higher environmental values than were accurate. In some cases, a person can hold several values, and certain values are favored in some situations. For example, a person might value the environment but still drive to work because the value of convenience outranks the value of environmental wellbeing. Second, there might not have been enough variation in the predictor variable (environmental values) to be able to see a trend even if it does exist. The limited variation also indicates systemic error because only a select part of the population was represented. Likely, people who visit parks are more likely to care about the environment, and that could influence other responses. Because of the limited variability in values responses, it is challenging to draw connections between values and behavior. Third, it could be that environmental values are simply not related to behavior. However, in the Bay Area, where environmental passions have driven citizens and cities to make green-choices, it seems unlikely that values and behavior would not be linked. Additionally, copious other studies have found that values can relate to behavior (Latif et al., 2013; Stern et al., 1999; Fryxell et al., 2003), which makes this explanation unlikely. Finally, in my study, I asked broad environmental values questions, which did not relate to dog waste specifically. Comparatively, the Boulder study by Blenderman and associates (2018) did ask values questions specifically about dog waste and found that values could explain dog waste disposal behavior. It could be that only specific values relate to behavior and that broader values are less clear indicators of behavior.

In the case of dog waste disposal in Palo Alto, the results suggest that values cannot explain behavior because there is little variability among how much people value the
environment and because most visitors are missing awareness, which is a prerequisite link in the chain to PEB. If people value the wellbeing of Open Space but are unaware that dog waste is detrimental to environmental health, they would be unlikely to clean dog waste because they would not know that their actions were counter-productive to their values.

Another study that examined environmental values and education concluded that environmental education influenced environmental values, which ultimately determined environmental behavior (Latif et al., 2013). It is possible that a similar phenomenon could occur here: once visitors are informed of the detrimental impacts of dog waste, environmental values might predict disposal behavior in Palo Alto Open Spaces.

Knowledge of dog waste’s impact on the environment was the strongest predictor of dog waste disposal habits measured in this study. This finding supports NAM, which is its own behavioral theory and part of VBN. Stern and associates (1999), Schwartz (1970), and Turaga and associates (2005) write that knowledge is the first barrier to PEB. Because so few people in this study were knowledgeable about dog waste, I was unable to test subsequent links in the chain between knowledge and behavior. Without understanding the consequences of an action, it would be impossible for an individual to form beliefs and values around the issue. In the future, it will be important to also test the influence of factors such as intent on dog waste disposal.

There was no relationship between disposal and awareness that leaving waste irritated other visitors. This contradicts other studies that highlight the importance of social pressures in influencing behavior (Karp, 1996; Ajzen, 1991; Schwartz, 1970). A small number of people used emotionally charged language to respond about the impact that dog waste has on other park visitors. Words such as “hate,” “mad,” and “stupid people” signaled that the issue of dog waste was more inflammatory that I had anticipated. Some visitors were mad at dog owners, and some
dog owners were nervous that more parks would be closed to dogs based on the results of my study. I assured visitors that I was not affiliated with the parks, and did not have the authority to ban dogs, and going forward, it will be important to emphasize that the parks have the best interests of the ecosystems and visitors in mind.

There were two questions in the survey that targeted a visitor’s “perceived behavioral control,” an idea presented by Ajzen as part of the TPB (1991). The idea is that if people feel they can make a non-zero impact on a problem, they are more likely to help. In the case of this study, most visitors felt they were able to affect the ecosystems of their local parks, and that sentiment was unrelated to dog waste disposal. Again, education on dog waste could make people aware that picking up after their dogs is a meaningful way to protect the environment.

Frequency of park visits was significantly, negatively correlated with environmental knowledge (as measured by awareness of the negative impacts of dog waste). In other words, the more a person visited a park, the less likely that person was to understand the environmental consequences of dog waste.

Contrasting a similar study that was conducted in Boulder, Colo. (Blenderman et al., 2018), I found no relationship between dogs being walked on- versus off-leash and dog waste disposal behavior. I tested leash behavior with on-trail defecation, off-trail defecation, and the combination of both (the disposal score used above). There was no relationship between leashing dogs and where they defecated. I found this strange because it seems as though if a dog is on-leash, it would be hard for it to defecate off-trail. It is possible that people are self-reporting better behavior than they practice. One reason for this is that residents are worried that parks will close to dogs. Several respondents were concerned that I would try to ban dogs from more Bay Area parks. In the South Bay, there are few parks still open to dogs, so it is reasonable to surmise
that owners report that they are on their best behavior. In addition, several people commented that dog waste was not as much a problem at Palo Alto parks compared to other parks around the San Francisco Bay. These comments seemed to be made to highlight how responsible Palo Alto dog walkers were with their dogs’ waste.

My study did not wholly fall under either the frameworks of the TPB or the VBN theory. Instead, my study showed that awareness of the environmental consequences of improper dog waste disposal was the strongest determinant of pro-environmental behavior, which most closely aligns with NAM. Increasing awareness of the environmental and human impacts of dog waste could increase compliance with correct dog waste disposal practices.

CONCLUSIONS

People generally comply with dog waste disposal laws. There is a larger compliance breakdown when dogs defecate off-trail than when dogs defecate on-trail. Reminding visitors upon their arrival that dog waste anywhere in the ecosystem is harmful could increase proper dog waste disposal. Several visitors that I interacted with requested more information on the impacts of dog waste on the environment. Visitors to Arastradero Preserve were especially curious to know how dog waste compared to horse waste. Other visitors wondered how leaving bagged dog waste compared to leaving un-bagged waste. Several concerns were raised about plastic pollution. Yet other visitors seemed to shift blame away from dogs and onto other environmentally detrimental behaviors. For instance, multiple visitors to the Baylands and Arastradero seemed upset that I was targeting their dogs when the adjacent golf courses seemed to be a much bigger source of Nitrogen. Ultimately, if more information is disseminated to park visitors about the impacts of dog waste on the environment, it could increase compliance with dog waste disposal regulations and address inquiries and concerns of visitors to Palo Alto Open
Spaces. Any information posted would need to make clear that parks were not planning to ban dogs because the issue of dogs on Open Space can be a sensitive topic for dog owners and other outdoors enthusiasts.
BIBLIOGRAPHY


Canadian Public Health Association, n.d. Human diseases transmitted by dog poop.


City of Boulder Open Space and Mountain Parks (2010). Grassland ecosystem management plan.


APPENDIX

Appendix 1. The introduction and informed consent.

Purpose of the Study

The purpose of the study is to understand barriers for dog waste disposal. We hope to use this information to develop techniques that could make dog waste disposal easier and more common-place on Bay Area trails.

We expect that you will be in this research study for 5—10 minutes today.

We expect about 150 people will be in this research study.

Explanation of Procedures

This survey is part of a research project at the University of Colorado – Boulder to study knowledge of and attitudes toward pet waste in Bay Area parks. Participation in this study entails listening to me read this consent form to you or reading it yourself, giving spoken (oral) consent to the researcher, and completing a five-minute survey. You can choose to complete this survey anywhere in the vicinity of the study both. The researcher will provide you with a private cardboard booth in which to take the study if you desire.

Voluntary Participation and Withdrawal

Whether or not you take part in this research is your choice. You can leave the research at any time and it will not be held against you.

Appendix 2. The survey that was distributed to park visitors.

Interviewer will hand out the following survey:

1. How frequently do you visit Bay Area open spaces (i.e. Foothills Park, Baylands, Arastradero Preserve, etc.)?
   a. Once or more a week
   b. Once or twice a month
   c. Once or twice a year

2. Are you a dog owner (if “no” please skip to question 5)?
   a. Yes, on-leash only
   b. Yes, off-leash only
   c. Yes, on and off leash
   d. No

3. Do you take your dog to Bay Area open spaces (if “no” please skip to question 5)?
   a. Yes
   b. No

4. Please mark how the following activities describe your behavior:
   a. I bring my own dog bags
   b. If my dog poops on or near the trail, I bag it and take it with me
   c. If my dog poops far off the trail, I will find and pick it up
   d. When my dog poops, I bag it and leave it to pick up on my return
      i. I can remember to pick up bags that I have left for later
      ii. I can find bags that I have left for later
   e. I do not pick up my dog’s waste
f. I keep my dog on a leash and under physical control at all times while in the preserve

Response options:
5. Never
6. Sometimes
7. About 50% of the time
8. Frequently
9. Always

5. In your opinion, how does dog waste ecologically impact open space?
6. In your opinion, how does dog waste impact other visitors to open space?
7. Please mark your attitude toward the following statements:
   a. Maintaining environmental health and resilience matters
   b. Protecting the ecosystems of open spaces are important
   c. Invasive species pose a threat to open space health
   d. Avoiding environmental and health hazards on open space is important
   e. I have the ability to positively affect the environment in a meaningful way
   f. There are actions I can take to improve the health of Bay Area open spaces

Thank you!

Appendix 3. Maps of the three parks included in the study. Stars represent sampling sights.