

A Mixed-Methods Social Psychology Application Evaluating the Role of Citizen Science in Mitigating Human-Wildlife Conflict

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Abstract

Human-wildlife conflict (HWC) is a global phenomenon with serious implications for biodiversity conservation and human well-being. Innovative solutions demand greater attention to the social factors contributing to HWC, including human thought and behavior, which can be examined through the lens of social psychology. Using the case of human-coyote conflict in North America, this study employed a mixed-methods social psychology approach to explore the potential for citizen science to serve as a

tool for HWC mitigation. Quantitative surveys and interviews with volunteers in a coyote-focused citizen science program in Colorado revealed that the program is positively affecting participants' attitudes/beliefs and empowering them to take action to address conflicts in their communities. The article concludes with recommendations for future evaluative research in this area as well as ways to more generally improve social-psychology applications in wildlife conservation.

Keywords

attitudes – citizen science – coyote – human-wildlife conflict – social psychology

Introduction

Human-wildlife conflict (HWC) is a global phenomenon with serious implications for biodiversity conservation and human health and well-being. HWC occurs when the needs and behaviors of wildlife negatively affect the goals of humans or when the goals of humans negatively impact the needs of wildlife (World Parks Congress, 2003). Studies from around the world provide evidence of the severity of conflict incidents and point to the need for more integrated, cross-disciplinary approaches that can attend to the “human dimensions” of HWC, including social factors that form the basis for human-wildlife relationships and interactions (Dickman, 2010; Hill, Webber, & Priston, 2017; Pooley et al., 2017; Lischka et al., 2018).

In North America, the coyote (*Canis latrans*) provides a unique and timely case example to explore the social context of HWC problems. The coyote's range has recently expanded to include nearly the entire continent, largely because of the species' remarkable ability to adapt to human-driven system change (e.g., urbanization) (Levy, 2012). The close proximity between coyotes and people in urban areas has led to increased interactions and cases of conflict frequently involving anthropogenic food sources and/or companion animals. Individual and institutional responses to these interactions can be controversial, often revealing deep-seated differences in human perceptions of the fundamental relationship between people and carnivores (Gehrt & Riley, 2010; Pooley et al., 2017). Urban communities experiencing widespread conflicts with coyotes have sought to implement novel interventions that can simultaneously engage citizens and achieve sustained reductions in the extent and severity of conflict incidents.

Grounded in theory from social psychology that has played an important role in applied conservation social science research (Manfredo, 2008; Bennett et al., 2017), the goal of our study was to contribute to innovative solutions by exploring the potential for citizen science to serve as a tool for place-based HWC mitigation. Specifically, as part of a larger ongoing social-ecological investigation in the Denver Metropolitan Area of Colorado (DMA; Poessel et al., 2013), we employed a mixed-methods approach to evaluate a local citizen science initiative focused on provision of educational opportunities to help reduce conflict between people and coyotes.

Social Psychology Approach in Wildlife Conservation

Psychology, and more specifically, social psychology, that accounts for the influence of one's social surroundings, has been a predominant emphasis in the human dimensions of wildlife field – an applied area of investigation employing concepts and methods from the social sciences to understand human-wildlife relationships and thereby informing wildlife conservation efforts (Manfredo, 2008; Jacobs et al., 2018). With a focus on understanding, predicting, and affecting individual thought and behavior toward wildlife, prior research in this area has frequently emphasized such concepts as values, attitudes, beliefs, norms, and behaviors, drawing upon well-known social-psychological models including the value-attitude-behavior (VAB) framework (Homer & Kahle, 1988) and Theory of Planned Behavior or Reasoned Action Approach (Fishbein & Ajzen, 2010).

According to these models, values are foundational cognitions that shape the formation of the many attitudes that develop within an individual. They represent people's fundamental beliefs about how the world should be and define appropriate modes of conduct. Values are slow to form and transcend specific actions and situations, and are typically limited in number compared to other types of cognitions such as attitudes (Schwartz, 2006). Research on values toward wildlife, more specifically, in the United States has revealed two important dimensions predictive of attitudes and behaviors across a host of wildlife-related issues – domination, a view promoting management of wildlife for human use and benefit, and mutualism, wherein wildlife are seen as more human-like and deserving of rights and caring (Manfredo, Teel, & Dietsch, 2016; Manfredo et al., 2021).

Attitudes are defined as the association of a positive or negative evaluation and an object (e.g., issue, entity, behavior) in memory. A relevant example would be attitudes toward coyotes or a particular form of coyote management (e.g., lethal removal), representing a favorable or unfavorable response (i.e.,

whether they are good or bad) to these issues. Compared to values, attitudes are the faster-forming cognitive processes of individuals that are ongoing, highly adaptive, and more context-specific. They vary in terms of salience, importance, strength, and certainty and are often rooted in beliefs about the outcomes of a given issue or behavior (Fishbein & Ajzen, 2010). While early research raised concerns about the utility of the attitude concept, showing a lack of correspondence between attitudes and behaviors, attitude theory in social psychology has made significant advances in recent decades.

Research has revealed, for example, that certain kinds of attitudes – those that are stronger and more easily accessible from memory – are more likely to guide behavior; certain factors (e.g., behavioral intentions, ability to perform the behavior) may intervene between attitudes and behaviors; and that consistency is greatest when attitudes and behaviors are measured at the same level of specificity (Fishbein & Ajzen, 2010). Considering these advancements, attitudes remain one of the most highly studied concepts in human dimensions research given their role in being able to understand behavior and describe how people feel about wildlife-related issues (Manfredo, 2008).

Norms, defined as perceptions of how one ought to behave or think, signify the social or group-level influences on individuals. They represent ideal or prototypical thoughts or behaviors that serve to unify and ensure compliance among group members. Norms typically involve sanctions that help give “rights” to the group to control others if they deviate from expected group behaviors. Like attitudes, norms can vary based on the context or specifics of a given situation, and they can have a powerful (though oftentimes underestimated) influence on individual behavior (Schultz, 2011). A relevant example of norms would be the perceived social pressure to behave or respond in a certain way toward coyotes and coyote-related issues.

An important contribution of this overall approach lies in its ability to differentiate among key concepts that may have different implications for conservation-related issues. As an illustration, the terms attitudes and values often get used interchangeably in the literature, and yet they are delineated as unique concepts in social psychology. Values are not likely to be influenced readily at an individual level, as they are formed early on in youth through socialization and accumulation of experience and tend to remain stable within individuals over time (Schwartz, 2006; Manfredo et al., 2016). However, values can be very effective in organizing people to action if appropriately applied through “values framing” strategies in communication (Clayton, Litchfield, & Geller, 2013). In comparison, attitudes, which are the more immediate antecedents to behavior, are more transient and therefore easier to affect. We adapted this conceptual approach for use in our case study investigation of human-coyote conflict in the United States.

Case Study of Human-Coyote Conflict

Background

Urbanization is an important contributor to the rise in HWC worldwide and the growth of human-carnivore conflicts in North America. Certain species such as coyotes demonstrate generalist tendencies in their foraging (e.g., use of both anthropogenic and natural food sources) and habitat requirements (e.g., use of natural cover patches within residential neighborhoods), making them well-suited to adapt to urban environments (Poessel, Breck, & Gese, 2016; Poessel, Mock, & Breck, 2017). Coyotes may also be more predisposed than some other carnivores to survive in, and even newly colonize, urban areas due to their heightened ability to tolerate human presence (Sol, Lapiedra, & Gonzalez-Lagos, 2013). Evidence of a close association between coyotes and humans over several millennia appears in the North American archeological record, and the species has played a prominent cultural role in Native American oral literatures (Melendez, 1987). In modern times, the relative ubiquity of human-coyote interactions may be contributing to the species' emergence as an important "surrogate" or symbol of discord over wildlife management (Goedeke & Herda-Rapp, 2005).

While coyotes typically pose a minimal threat to people, attacks on humans have recently escalated (Timm & Baker, 2007). From 1960 to 2006, for example, there were 142 documented cases of coyote attacks (defined as resulting in a bite to the victim) on humans in North America. In 30% of these cases, many of which involved children, coyotes were being fed by people in the area (White & Gehrt, 2009), suggesting that the habituation of coyotes to humans due to intentional or unintentional feeding could be a driving force in the rise in attacks in urban environments. Although there have only been two documented coyote-caused human fatalities, one in California in 1981 and one in Nova Scotia in 2009, this increasing trend of attacks is a concern to wildlife management authorities and residents of many metropolitan areas.

The DMA is an example of a rapidly growing urban environment currently experiencing a rise in human-coyote conflict. It is an urban area, as defined by the US Census Bureau (2015), which includes the City of Denver and surrounding suburbs. Until 2007, there had only been four reported coyote attacks on humans in Colorado history (Timm & Baker, 2007). In 2009, three attacks occurred in the City of Denver (City & County of Denver, 2010). Suburban locations within the DMA experienced similar incidents more recently, with three attacks on children in Broomfield in 2011 and one in Boulder in 2013 (Steffen & Whaley, 2011; Mitchell, 2013). Coyotes in the DMA also pose a growing threat to pets (companion animals). As an illustration, from 2003 to 2010, there were 471 reported pet attacks in the area (Poessel et al., 2013).

While there are multiple intervention strategies, wildlife management authorities are faced with the growing challenge of determining what management options are feasible and effective in urban settings (Breck, Poessel, & Bonnell, 2017). Tied to this challenge is declining public support for certain traditional options such as the lethal removal of coyotes involved in conflict incidents (Martinez-Espineira, 2006; Sponarski, Miller, & Vaske, 2018). Among the non-traditional alternatives being explored are citizen science programs designed to engage local residents in wildlife-related research and management as a way of addressing the human behavior component of HWC.

Role of Citizen Science

Citizen science (CS) is a method that relies on volunteers to collect data for research investigations (Silvertown, 2009). While this technique has historically been used heavily in ornithological studies, it has started to gain traction in HWC situations, including those involving coyotes, to identify potential “hot spots” of conflict by asking residents to report their experiences with wildlife (Weckel, Mack, Nagy, Roderick, & Wincom, 2010). A well-recognized benefit of CS is that it can be a cost-effective way to collect large amounts of data for projects requiring widespread observations. It is also increasingly recognized as a valuable tool for enhancing residents’ knowledge of ecological systems and the scientific process, and empowering them to take part in resource stewardship and management (Evans et al., 2005; Conrad & Hinchey, 2011; Jordan, Gray, Howe, Brooks, & Ehrenfeld, 2011; McKinley et al., 2017). These qualities have resulted in greater attention to the application of CS in conservation (Dillon, Stevenson, & Wals, 2016).

While not new, recent criticisms have been that more strategic investments are needed to help CS reach its full potential to benefit people and the natural world (e.g., Bonney et al., 2014; Wals, Brody, Dillon, & Stevenson, 2014; McKinley et al., 2017). Renewed attention is centered around the role of CS in promoting synergy between science and environmental education; importance of place and place-based identity in human-nature relationships; more meaningful forms of public engagement to achieve social-ecological outcomes; and new opportunities for data collection and sharing resulting from greater access to information and new communication technologies. Capitalizing on these elements can result in CS providing “useful input to environmental scientists while simultaneously empowering citizens to engage in ongoing debates about local and global sustainability issues and what needs to be done to address them” (Wals et al., 2014, p. 584).

A primary reason for considering CS more specifically in relation to human-coyote conflict is that, in addition to facilitating collection of data, it has the potential to increase public understanding of coyotes and coyote-related

issues. By teaching local residents about coyote ecology and behavior and involving them in conflict mitigation efforts, CS programs may increase the capacity for communities to deal with conflict situations. As evaluative research is largely lacking in this context, there is a need to determine whether these programs can in fact lead to desired changes in participant understanding and behavior and therefore serve as a useful tool for HWC management. More broadly, despite significant attention in recent literature, evidence for the social-ecological impacts of CS is still deficient. Notably, among these impacts, additional research is needed on the conservation education outcomes in terms of CS participants' improved understanding and engagement in conservation issues (Dillon et al., 2016).

Our study was designed to help address these gaps by exploring the potential for a CS program known as Coyote Watch to contribute to human-coyote conflict mitigation in the DMA. The objectives were to (a) assess the psychological effects of the program over time on participants' attitudes, beliefs, behavioral intentions, and knowledge regarding coyotes; and (b) explore the broader impacts of the program, including the extent to which participants used their program education and observation experiences to act in their communities to prevent and manage conflict with coyotes.

Materials & Methods

Program Description

Coyote Watch is a CS program that provides educational opportunities with the express purpose of helping to reduce conflict between people and coyotes. This program was formed in January 2012 by the City of Aurora's Open Space and Natural Resources Division, and as of May 2013, during the time of this investigation, the program had trained over 300 residents and government officials throughout the DMA. The primary objectives of Coyote Watch are to educate volunteers about the biology and behavior of coyotes in relation to human activity in the DMA, collect coyote behavior observation reports to determine which areas might be at greater risk for conflicts, and reduce biased incident reporting. The latter, which may contribute to distortions in public perceptions, can occur when residents or the media only report certain types of incidents (e.g., human and pet attacks), rather than accounting for the full array of experiences including sightings and behaviors tied to the ecological services coyotes provide (e.g., rodent control).

Prior to program participation, volunteers complete a training session consisting of a three-hour presentation on (a) program purpose and objectives; (b) basic coyote ecology and behavior; (c) previous research on the frequency of

conflict incidents (e.g., human and pet attacks) in relation to other coyote-related interactions (e.g., sightings); (d) conflict-inducing human behaviors, such as food conditioning; and (e) steps that can be taken to prevent and mitigate conflict, including hazing techniques. As part of the training, volunteers are shown examples of different behaviors that urban coyotes exhibit (e.g., feeding, yip-howling, den-guarding), as captured on camera, with detailed explanations of the activities. The session ends with the volunteers practicing how to identify these behaviors and look for visual and auditory clues to accurately report sightings and behavioral observations using a standardized reporting form.

Following the training, participants are invited to log on to a password-protected website and record any coyote interactions they experience. Interactions include a broad range from seeing or hearing coyotes to hazing them. The reporting form includes a map function as well as an opportunity to gauge coyote responses to hazing on a scale from -4 (coyote is most averse) to 1 (coyote actually approached observer following hazing). Observation and reporting occur by opportunity, not assignment – that is, participants are encouraged to use the website to report coyote observations but are not assigned specific locations or timeframes for doing so.

Data Collection

Our study population consisted of two groups of Coyote Watch volunteers: (a) new volunteers and (b) all remaining volunteers who had been previously trained. Our mixed-methods approach included onsite and online surveys and interviews, which were approved for use with human subjects prior to implementation (Colorado State University IRB protocol 13-4195H). We administered a pre-program survey onsite to all new volunteers at the beginning of program training sessions in February and March 2013. This survey was intended to assess participants' attitudes, beliefs, behavioral intentions, and knowledge prior to the program. We then administered an online survey in August 2013 to the same individuals. Volunteers received an initial email containing a link to the survey, followed by weekly reminders for one month. Tied to our first objective, this survey replicated questions from the pre-program survey to facilitate comparisons across time. We also administered the online survey in a similar fashion to the previously trained group of volunteers in May 2013, providing a larger pool of participants from which to generalize about program impacts.

For our second research objective, the online survey sent to both groups also contained open-ended questions asking volunteers to indicate what they had gained or learned from participating in Coyote Watch. Finally, we conducted semi-structured interviews with a subset of individuals, including previously

trained (Fall 2012) and new (Spring 2013) volunteers, to learn more about their program-related experiences and how the program may have influenced them. The second author recruited interviewees through an open call to all trained volunteers and conducted the interviews in person at meeting places chosen by participants and, in some cases, in pairs with volunteers who requested this arrangement given that they regularly participated in program activities with their partners. Interviews were recorded with volunteers' permission and lasted approximately 20 to 60 minutes each.

Measurement

We measured general attitudes toward coyotes on the onsite and online surveys by asking, "Overall, do you think having coyotes in the area near your home is good, bad, or neither?" Respondents recorded their answers on a 7-point scale from "extremely bad" to "extremely good." We measured attitudes toward management actions for dealing with negative human-coyote interactions on a 7-point scale from "highly unacceptable" to "highly acceptable" (Table 1). We measured beliefs with a set of 12 statements intended to represent advantages and disadvantages of having coyotes present in the area near one's residence (Table 2). Development of these statements was informed by a phone elicitation (Fishbein & Ajzen, 2010) to identify salient beliefs about coyotes that was conducted with a small random sample ($n = 25$) of DMA residents for a related study in October 2012 (Don Carlos et al., unpublished data).

TABLE 1 Comparison of participants' attitudes toward coyote management actions before and after program participation

Attitudes ^a	Participation in coyote watch		<i>t</i> -value	<i>p</i> -value	<i>d</i> ^b
	Before program	After program			
Leave the coyote alone/ monitor the situation	5.52	6.27	2.11	.04*	.47
Frighten or "haze" the coyote away	5.90	6.67	2.97	.006*	.70
Capture and relocate the coyote to another area	3.94	3.15	2.22	.03*	.44
Lethally remove the coyote	2.26	2.15	.85	.40	.12

TABLE 1 Comparison of participants' attitudes toward coyote management (*cont.*)

Attitudes ^a	Participation in coyote watch		<i>t</i> -value	<i>p</i> -value	<i>d</i> ^b
	Before program	After program			
Lethally remove all coyotes found in the area	1.43	1.39	.00	1.0	.00
Provide education for local residents about how to deal with coyotes near their homes	6.77	6.97	2.68	.01*	.60

a Attitudes measured on a scale from 1 = "highly unacceptable" to 7 = "highly acceptable."

b Cohen's *d* effect size measures, with criteria of .20, .50, and .80 indicating small, medium, and large effects, respectively (Cohen, 1988).

* Results significant at a $p < .05$ level.

TABLE 2 Comparison of participants' beliefs about coyotes before and after program participation

Beliefs ^a	Participation in coyote watch		<i>t</i> -value	<i>p</i> -value	<i>d</i> ^b
	Before program	After program			
I enjoy seeing coyotes in the area near my home.	5.48	5.82	1.10	.28	.21
I enjoy knowing coyotes are in the area near my home even if I never see one.	5.27	5.70	1.70	.10	.24
Coyotes pose a threat to the safety of children in the area near my home.	3.27	2.64	2.72	.01*	.39
Coyotes pose a threat to the safety of pets in the area near my home.	5.36	4.82	2.12	.04*	.42

TABLE 2 Comparison of participants' beliefs about coyotes (cont.)

Beliefs ^a	Participation in coyote watch		<i>t</i> -value	<i>p</i> -value	<i>d</i> ^b
	Before program	After program			
Coyotes help control populations of rabbits and other small animals in the area near my home.	6.33	5.91	1.75	.09	.35
There are no benefits to having coyotes in the area near my home.	1.97	1.91	.67	.51	.12
Coyotes are important to the natural ecosystem in the area near my home.	6.21	6.55	1.54	.13	.29
Having coyotes in the area near my home is an inconvenience.	2.72	2.52	.80	.43	.11
I'm concerned about risks posed by having coyotes in the area near my home.	3.15	2.52	1.76	.09	.32
Learning how to co-exist with coyotes is a normal part of living here.	6.51	6.64	.85	.40	.13
Coyotes do not belong in the area near my home.	1.78	2.06	.89	.38	.18
I shouldn't have to change what I do in the area near my home because coyotes are present.	2.24	2.24	.00	1.0	.00

a Beliefs measured on a scale from 1 = "strongly disagree" to 7 = "strongly agree."

b Cohen's *d* effect size measures, with criteria of .20, .50, and .80 indicating small, medium, and large effects, respectively (Cohen, 1988).

* Results significant at a $p < .05$ level.

Respondents indicated their level of agreement with each statement on a 7-point scale from "strongly disagree" to "strongly agree." We measured behavioral intentions on a 5-point scale from "very unlikely" to "very likely" by asking respondents to indicate how likely they were to participate in certain activities

TABLE 3 Comparison of participants' behavioral intentions before and after program participation

Behavioral intentions ^a	Participation in coyote watch		<i>t</i> -value	<i>p</i> -value	<i>d</i> ^b
	Before program	After program			
I am likely to store garbage indoors or in a garage/shed.	4.18	4.36	.73	.47	.13
I am likely to store pet foods indoors or in a garage/shed.	4.72	4.79	.26	.80	.07
I am likely to supervise pets when they are outdoors.	4.31	4.64	1.53	.14	.20
I am likely to frighten or haze away a coyote that is near my home.	3.94	4.39	2.33	.03*	.37
I am likely to alert local authorities if I see a coyote near my home.	1.73	1.94	.91	.37	.18

a Behavioral intentions measured on a scale from 1 = "very unlikely" to 5 = "very likely."

b Cohen's *d* effect size measures, with criteria of .20, .50, and .80 indicating small, medium, and large effects, respectively (Cohen, 1988).

* Results significant at a $p < .05$ level.

that may minimize the risk of negative interactions with coyotes (Table 3). To measure knowledge, we asked respondents to rate the accuracy of seven statements by selecting "true," "false," or "not sure" for each (Table 4). These statements were developed using educational materials presented at Coyote Watch trainings that were aimed at dispelling myths about coyotes in urban settings.

To explore additional outcomes that may have resulted from program participation, the online surveys asked volunteers in an open-ended format: "indicate one thing you feel you've gained or learned as a result of participating in the Coyote Watch Program." Additionally, we asked interview participants the following questions:

1. Can you tell me about any experiences you've had since joining the program?
2. Are there things you feel you've learned as a result of participating in the program?

TABLE 4 Comparison of participants' knowledge of coyotes before and after program participation

Knowledge scores ^a	Participation in coyote watch		<i>t</i> -value	<i>p</i> -value	<i>d</i> ^b
	Before program	After program			
In residential neighborhoods, coyotes' primary food is domestic pets. (False)	.90	.94	.44	.66	.12
In urbanized environments, coyotes spend the majority of their time in undeveloped areas. (True)	.32	.61	2.75	.01*	.60
Coyotes are strict carnivores (only eat meat). (False)	.87	.87	.00	1.0	.00
Relocating coyotes is the most effective and humane way to resolve coyote conflict with people in the Denver Metro Area. (False)	.68	.74	.70	.49	.14
In areas where coyotes live in close proximity to humans, coyote attacks on humans are rare. (True)	.90	.97	1.44	.16	.46
A coyote following a human while walking a dog is considered to be an aggressive act. (False)	.35	.58	2.04	.05*	.46
Coyotes are only active at night. (False)	.90	1.00	1.79	.08	.46

a Knowledge measured using response categories of "true," "false," and "not sure." Responses were recoded for analyses into 1 = "correct," 0 = "incorrect" (with "not sure" assigned a score of 0).

b Cohen's *d* effect size measures, with criteria of .20, .50, and .80 indicating small, medium, and large effects, respectively (Cohen, 1988).

* Results significant at a $p < .05$ level.

3. Do you feel that the program has had an impact on you, and if so, how?
 - a. Do you feel it's affected any of your habits or behaviors? (if yes, explain)
 - b. Since joining the program, have you discussed coyotes or coyote issues with other individuals (if yes, approximately how many)?

Further questions regarding program-related experiences and impacts arose in some cases organically, as many of the participants were eager to share stories about unique interactions with coyotes or conversations they had with non-participants during their volunteer observation outings.

Analysis

We entered and analyzed survey responses in SPSS (Chicago, Illinois). We conducted paired samples *t*-tests to compare responses between pre-program and online surveys on attitude, belief, behavioral intention, and knowledge measures. For these analyses, we coded responses to knowledge items as 1 "correct" or 0 "incorrect" and summarized using an additive index to formulate an overall knowledge score for each participant. Individuals who responded "not sure" were given a score of zero for that item. We used an alpha level of $p < .05$ to designate statistical significance and computed effect size measures (Cohen's *d*; Cohen, 1988) to aid in determining the practical significance of the findings.

We coded responses to open-ended survey questions and interviews using open, axial, and selective coding techniques to determine major thematic categories (Neuman, 2006). First, we analyzed responses for broad themes and condensed them into coded categories (e.g., "conflict"). Next, we applied the resulting codes to identify subcategories within themes. For example, we separated the theme "conflict" into three subcategories: understanding root causes of conflict, learning new tools to handle conflict, and using new skills from the program to prevent conflict with coyotes. Finally, we organized and combined codes into broad categories to develop a conceptual framework recounting the overall narrative of the volunteers regarding program-related impacts (Neuman, 2006). In this last stage, 12 major themes were divided into two generalizations about program impacts, which are presented in more detail in the Results. Triangulation of the data was achieved by using multiple data sources (i.e., survey and interview responses; Olsen, 2004).

Results

Eighty-one new volunteers joined Coyote Watch in February ($n = 40$) and March ($n = 41$) 2013. Seventy-one of these individuals completed the onsite

survey (88% response rate), and 34 also completed the online post-program survey (51% response rate). Additionally, 67 of the 128 previously trained volunteers completed the online survey, resulting in a 52% response rate. Ten volunteers participated in the interviews: two individuals and one couple from the new volunteer group, and two individuals and two couples from the previously trained group.

Pre- and Post-Participation Comparisons

Volunteers' general attitudes toward coyotes before ($M = 5.03$) and after ($M = 5.30$) program participation were not statistically different ($t = 1.47, p = .15, d = .18$). Approximately 70% of respondents felt that having coyotes in the area near their home was a good thing, even before joining the program. In contrast, attitudes toward certain management strategies for dealing with negative human-coyote interactions did significantly change (Table 1). Actions that became more acceptable included: "leave the coyote alone/monitor the situation," "frighten or haze the coyote away," and "provide education for local residents about how to deal with coyotes near their homes." Results indicated a decrease in acceptability for "capture and relocate the coyote to another area." There were no significant differences for acceptability of lethal removal strategies. Regardless of participation, volunteers generally did not support lethal control; over 80% of the participants were against these measures before joining the program.

For most belief statements, volunteers' pre- and post-participation scores were not significantly different (Table 2). However, differences were found for statements representing threats coyotes may pose to children and pets in local areas, with program participation contributing to a reduced level of concern for these potential risks. To illustrate, 30% of volunteers indicated they were concerned about the risks coyotes pose to children before the program, but only 18% did so afterwards. Likewise, 83% agreed initially that coyotes pose a threat to pets, but after joining the program, that percentage decreased to 71%.

Despite program participation, volunteers were not more likely to store garbage or pet food indoors, supervise pets when outdoors, or alert local authorities about coyotes seen near their homes to minimize the risk of negative interactions with coyotes (Table 3). With the exception of alerting local authorities about the presence of coyotes (where 79% were unlikely), a high percentage of respondents (76–94%) reported they were already likely to engage in these activities before the program. Volunteers did indicate, however, a greater likelihood of hazing coyotes seen near their homes after (82%), compared to before (72%), participating.

In general, volunteers were knowledgeable about coyotes before the program (Table 4). Nevertheless, findings showed significant differences between overall pre- ($M = .71$) and post-participation ($M = .82$) knowledge scores ($t = 3.06$, $p = .009$, $d = .64$). Individual-item comparisons indicated a higher likelihood of correct scoring following program participation for the statement, "In urbanized environments, coyotes spend the majority of their time in undeveloped areas." Before the program, only 32% of respondents correctly answered this question, but after participation, 64% answered accurately. Differences were also noted for the statement, "A coyote following a human while walking a dog is considered to be an aggressive act," where respondents were correct 36% of the time before participation and 61% after participation. Comparisons for the remaining five knowledge items were not statistically significant.

Broader Impacts

Two broad generalizations about program impacts emerged from the qualitative data: (a) Coyote Watch precipitates a new knowledge of coyotes and human-coyote interactions; and (b) the program creates empowerment among volunteers. These basic themes will be discussed in more depth and supported by specific quotes from participants. To ensure confidentiality, we assigned survey participants a random identification number corresponding to their group of volunteers: new volunteers who attended the February 2013 training of Coyote Watch (1001–2021), new volunteers who attended the March 2013 training (3000–3038), and previously trained volunteers (4001–4145). Additionally, we replaced the names of interviewees with alias initials.

Precipitates a new knowledge. Results revealed that nearly all volunteers acquired a new understanding of coyotes and coyote-related issues. While some recalled specific information they had obtained about coyotes, such as diet and behavior, many others explained they had acquired a deeper meaning from their Coyote Watch experiences. The sample quotes demonstrate this range of knowledge and the perspectives gained from participation.

Many volunteers reported that they learned a lot about coyote biology and behavior:

4030: "I've learned that coyotes are very tolerant of us humans. They are still pretty wary, but will put up with, and live with, a lot of different human activities."

4042: "Their main diet is not cats and Chihuahuas. Really! I didn't know that [they eat] wild fruits."

4142: "I loved the meeting and learned great info about how coyotes think and act. [I've learned] what body language means and how things weren't as they are portrayed in the media."

4090: “I found out that coyotes move around, probably for better food and shelter. I did find out that if you leave them alone, they will leave you alone. I have a large dog, so I do know that helps.”

Participants also explained that the program impacted the way they view coyotes, and they are now looking at the species in a new positive light:

K N: “I have seen some coyote behavior that I had not viewed before – e.g., barking, woofing, howling. This was very exciting. The coyotes I have viewed have been very respectful of humans. I do not have much fear of them; perhaps that is not a good thing. To watch how they protect their pups has been heartwarming.”

1004: “Coyotes are not as big a threat as I originally assumed them to be, and I respect their boundaries more.”

D D: “... I am looking at coyotes in a totally different way.”

Impacts on participants were described in some instances as the realization that coyotes and people can and should be able to inhabit the same places:

4045: “We need coyotes and have to get along with them, as they are an important part of the ecosystem.”

3001: “... Although I see that they could become a problem, I have much more empathy for their situation and want to make sure that if they **MUST** be destroyed, it is done in a humane way ... no leg-hold traps, no traps that are not monitored closely and checked frequently.”

S D: “One lady at my HOA [Home Owner’s Association] told the HOA to get rid of them and she pretty much got booted out of the room. They were here first. Live with it.”

Further, some participants indicated that Coyote Watch taught them about how human behaviors play a role in driving negative interactions with coyotes:

3006: “It is mostly our [people’s] fault that has resulted in encounters [that are] not favorable to either species.”

4068: “Many people are misinformed about the behavior of coyotes.”

4001: “People still ignore warnings about coyotes and let their pets out unsupervised.”

Volunteers also recounted how the program taught them how to reduce the likelihood of negative interactions with coyotes:

4113: "I've learned the skills to haze a coyote."

4006: "I'm more alert to watching for coyotes."

4092: "I learned to keep my dogs on leash in coyote habitat areas."

Creates empowerment. Many volunteers explained how Coyote Watch gave them the confidence to take action and inform others about what to do when dealing with human-coyote interactions in the future:

4029: "Confidence. I took both of my daughters, who were afraid of getting out of the house because of coyotes, to the training program. Since they learned about the coyotes – habitat, habits, hazing techniques, etc. – they are more confident and not as scared."

3034: "Gained the courage to haze if I ever get the chance."

4111: "Confidence when telling others about coyotes, and knowing what to do if I see a coyote."

Another element related to empowerment that volunteers felt they gained was a stronger tie to their community and a sense of being able to make a difference in that context:

4012: "Feeling a part of my community, part of the solution, and more educated about coyotes in general."

4108: "It takes a community to learn to live with coyotes successfully."

3004: "This is a coordinated effort to better understand this species, and [I] learned there are new ways to gather information."

Results also revealed how volunteers were going a step further with the knowledge and greater sense of confidence acquired through the program by taking action to prevent negative interactions with coyotes.

D D: "I do go out with my dog now and that is something I didn't do before. I check the yard before she goes out even though she's a fairly large dog, but I've heard stories, so why take the chance?"

W L: "[I] was walking once ... and a lady had a little dog off leash. They [the coyotes] had a den nearby, so I yelled at her to call her dog. Sure enough, the dog comes racing back with two coyotes on its tail.... I picked up some little rocks and tossed them, which seemed to be enough to make them take off...."

S D: "There are a couple of places along the trail [in which] there is a short chain link fence and people leave their small little yappy dogs out,

and once I stood between a dog and a coyote because the coyote could go right over the fence....”

Additional impacts of the program resulted from participants disseminating information that they had obtained to others. Several volunteers described how they were not only educating their neighbors and members of close social networks, but also strangers they encountered while out making observations for Coyote Watch:

WL: “People will come up and approach us and ask about coyotes ... people want information....”

KN: “We’ve gotten to know the other people who walk in the parks and we talk about what we saw, what the coyotes are doing, and why.”

4101: “We need to learn to live with coyotes; I’ve been able to talk to people who are scared of coyotes.”

2022: “Understanding coyote behavior has been a valuable asset when talking to JeffCo [Jefferson County] open space park visitors and neighbors.”

4052: “I pretty much knew next to nothing about coyotes before, so I learned a lot of new information that I can use to teach other people.”

JS: “There’s a lady here on the corner ... and she has ... coyotes. They actually have beds and food. If you were a coyote, wouldn’t you want to sleep there? I would. They like heated beds. I swear if someone had told me that lady had brought those coyotes in over the winter, I would not be surprised. I’d [have] been, ‘oh, she’s nuts.’ So of course, I had to go over there and give her the what for.”

Conclusion

In his 2011 article in *Conservation Biology* entitled “Conservation means behavior,” Schultz highlighted the significance of human behavior in contributing to conservation problems and the need for behavior changes as solutions. As he and others (e.g., Clayton et al., 2013; Bennett et al., 2017) have recently noted, psychology holds the promise of helping to address this need, given its emphasis on understanding how and why individuals behave the way they do. Grounded in theory from social psychology that has been adapted for use in understanding wildlife and other conservation issues (Manfredo, 2008), the overarching goal of our case study was to explore the potential for CS to serve as a tool for urban HWC mitigation. We did so by evaluating an ongoing program in Colorado known as Coyote Watch.

Altogether, the findings indicated that Coyote Watch is having positive impacts on participants' understanding of and responses to coyote issues. Through a mixed-methods approach, we were able to obtain a more holistic, in-depth understanding of program impacts that would not have been possible through reliance on traditional metrics of evaluation (e.g., knowledge tests). Further, by going beyond simply a focus on knowledge and attitudes, we concluded that CS can affect human behaviors that often underlie the cause of as well as the solution to conservation problems such as HWC.

While the results of quantitative surveys administered before and after program participation did not show significant changes in overall attitudes toward coyotes, which were relatively favorable to begin with, the findings did reveal increased knowledge of and support for certain coyote management strategies such as hazing – a recommended practice by local authorities. Qualitative data from open-ended survey questions and interviews corroborated quantitative findings and demonstrated that the program is not only providing participants with enhanced knowledge of coyotes and their ecology, but it is also empowering individuals to act and encourage others to do the same to prevent and manage conflicts with coyotes in their communities.

During the interviews, participants reported feeling more confident and better equipped to deal with conflicts; less fear and greater respect for coyotes and their place in the ecosystem; a stronger sense of community and making a difference; and a desire to share what they learned with others. These broader impacts reveal how CS can contribute to greater individual and community capacities to address conservation challenges such as HWC, a relatively underexplored phenomenon in this space. Given that norms and interpersonal interactions can be powerful influences on behavior (Schultz, 2011), we see strong potential in the ability of CS to help “scale-up” efforts to produce behavior change. As suggested by our findings with participants' reports of excitement about sharing their new knowledge and experiences with others in their social networks, CS may play an important role in cultivating norms and motivating others to get involved and change their own behaviors (McKinley et al., 2017).

Our results suggest that CS may offer an innovative alternative and/or complement to traditional forms of HWC mitigation (e.g., lethal control), and Coyote Watch may serve as a model to help other educational programs gauge the success of their efforts and ultimately improve their effectiveness on the ground. While CS initiatives have received increased attention in conservation as a means for generating scientific knowledge as well as environmental education and public engagement (Dillon et al., 2016), evidence of the social and ecological outcomes of these initiatives, including effects on conservation attitudes and behaviors, is still limited (Jordan et al., 2011; Toomey & Domroese,

2013). We therefore encourage additional evaluative research building on our approach that can help CS maximize its potential, particularly in the wildlife conservation context.

Examples of future avenues to explore include investigations of the longer-term impacts of programs such as Coyote Watch. For example, to what extent do participants continue to practice learned behaviors and actively engage in conflict mitigation efforts in their communities over time? In addition, are these efforts leading to changes in the rates of actual conflicts or conflict potential in those areas? Other questions worth considering relate to ways to improve the reach and effectiveness of HWC CS programs. As an illustration, it would be valuable to learn more about the characteristics of volunteers in these programs, including their motivations for involvement and the extent to which they represent the broader populations of fellow residents.

More generally, we conclude with recommendations for how to improve the utility of social psychology applications in wildlife conservation in the future. First, there is a need for more holistic systems approaches involving greater integration with the ecological sciences as well as other social science disciplines. This would expand the focus on individual thought and behavior to include an understanding of how individuals interact with and are impacted by broader group-level (e.g., social networks, social identities), cultural (e.g., prevailing value systems), societal (e.g., urbanization), and institutional (e.g., policies, governance structures) forces; and also ecological (e.g., wildlife abundance, habitat suitability, animal behavior) factors (Manfredo et al., 2014; Lischka et al., 2018). Another area recommended for future research would be the role of emotions. Social psychology applications have largely focused on cognitive factors such as attitudes. However, emotions can also have a strong influence on conservation behaviors, including those contributing to negative human-wildlife interactions, and play an important role in behavior-change strategies (Manfredo, 2008; Wieczorek Hudenko, 2012).

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