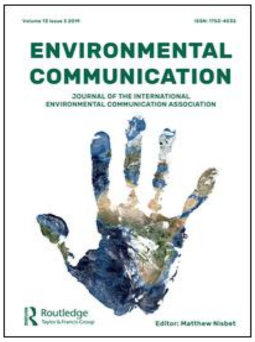

Routledge
Taylor & Francis Group

Environmental Communication

ISSN: 1752-4032 (Print) 1752-4040 (Online) Journal homepage: https://www.tandfonline.com/loi/renc20

Metaphor, Trust and Support for Non-native Species Control

Patrice A. Kohl, Steve J. Collins & Martin Eichholz

ENVIRONMENTAL COMMUNICATION
https://doi.org/10.1080/17524032.2019.1703779

Routledge
Taylor & Francis Group

RESEARCH ARTICLE

Metaphor, Trust and Support for Non-native Species Control

Patrice A. Kohl [a], Steve J. Collins[a] and Martin Eichholz[b]

[a]Nicholson School of Communication and Media, University of Central Florida, Orlando, FL, USA; [b]Kelton Global, Los Angeles, CA, USA

ABSTRACT

This experimental study used a representative sample of U.S. residents (*N* = 1,042) to test whether the use of the term "invasive" increases support for non-native species control efforts. The term invasive had a small influence on support for two out of three non-native species control methods. Trust in government predicted support for all three control methods, and trust in scientists predicted support for two of the methods. We also found stronger support for control methods using gene editing technologies than control methods using poison.

ARTICLE HISTORY

Received 13 May 2019
Accepted 2 December 2019

KEYWORDS

Metaphor; trust; invasive species; gene drive; synthetic biology; conservation

Introduction

Humans have deliberately and accidentally moved many species beyond their natural geographic range. In the United States alone, there are an estimated 50,000 introduced non-native species (Pimentel, Zuniga, & Morrison, 2005). These non-native species can outcompete native species, spread disease or otherwise disrupt local ecosystems (Paolucci, MacIsaac, & Ricciardi, 2013; Vitousek, D'antonio, Loope, Rejmanek, & Westbrooks, 1997). For decades, scientists and conservation practitioners have referred to such organisms as "invasive" species (Elton, 1958). In recent years however, a polarized debate has emerged around the terminology used to talk about species that hail from elsewhere. Some criticize campaigns against "invasive" species as having troubling rhetorical parallels with militaristic metaphors portraying invasive species as biological enemies (Chew & Laubichler, 2003; Kueffer & Larson, 2014; Larson, 2005). Critics argue the value-laden language of "invasion" biology has clouded the science and obstructs rational discussion and decision-making and call for the adoption of more neutral terminology (Lidström & West, 2017). To date there has been no examination of how such language affects public support for campaigns to remove and control the spread of non-native species. Yet, public support is fundamental to successful non-native species management (Genovesi & Bertolino, 2001; Warner, 2012). In this study, our main objective was to test whether using the "invasive" metaphor might influence support for various methods for controlling non-native species.

We also examine how trust and the type of control method being proposed might shape support. Many non-native species control programs are carried out by government scientists. And activists opposing efforts to remove invasive species have been known to mobilize public opposition by appealing to distrust, and particularly distrust of government agencies (Warner & Kinslow, 2013). In the present study, we therefore examined the role of trust in government and trust in scientists in support for non-native species control methods.

Finally, we compared support for non-native species removal across three types of control methods: (1) conventional lethal methods using poison; (2) methods using advanced gene editing

CONTACT Patrice A. Kohl patrice.kohl@ucf.edu Nicholson School of Communication and Media, University of Central Florida, 12405 Aquarius Agora Dr., Orlando, FL 32816, USA

technology to disrupt reproduction and; (3) methods using advanced gene editing technology to reduce survival. Poison is a common tool used to remove non-native species, especially on islands, where non-native mammals such mongoose, rats and mice often devastate native bird species (e.g. Borel, 2017; Marris, 2019). However, there have been a growing number of proposals to replace poison campaigns on islands with control methods involving the release of wildlife carrying edited genes that could reduce survival fitness or disrupt reproduction in the non-native population (Borel, 2017; Marris, 2018; Regalado, 2017). Consequently, in this study we also examine how support for gene editing methods compares with the use of poison as a control method among members of the American public.

Literature review

Metaphor and invasion biology

Metaphors help us learn by linking things we understand to things we do not. They are the lenses through which we see (Lakoff & Johnson, 2003), influencing the way we "think, reason and imagine in everyday life" (Gibbs, 1998, p. 89). The use of metaphors is pervasive in all discourses. In scientific discourses metaphors shape understandings of a wide range of natural phenomena and technologies (Barua, 2011; Leuven et al., 2009; O'Keefe et al., 2015). We rely on water metaphors to understand electrical "current" and "flow." We use the word "cloud" as a metaphor for the Internet in cloud computing. Children learn that wetlands act as a "sponge" and a "filter" to control flooding and clean water (Davenport, Frankel, & Parry, 2003).

Metaphors can also influence attitudes, support, and behavioral intentions (Corner & Pidgeon, 2015; Johnson & Taylor, 1981; Liu, Geng, Ye, & Zhou, 2019). In an experimental study in China, for example, researchers found individuals were more likely to report pro-environmental behavioral intentions after reading an environmental article, when the article included the anthropomorphizing metaphor "mother nature" (Liu et al., 2019). And in a UK study asking participants about geoengineering, researchers found that comparing atmospheric aerosol technologies to volcanoes and likening sequestration technologies to trees increased public acceptance (Corner & Pidgeon, 2015).

The conservation sciences are inundated with metaphorical language used to categorize species including "keystone," "umbrella," "flagship," and last but not least – "invasive" species (Barua, 2011). Among such metaphors "invasive" (or sometimes "invasive alien") has drawn critical attention due to its normative undertones. "Invasion" is one term in a cluster of interrelated terms often used in scientific and popular discourse to evoke militaristic imagery around the issue of non-native species. Almost from its inception, invasion biology has been couched in militaristic terms. Charles Elton, widely considered the father of invasion biology, opens his seminal book on invasion biology by evoking images of warfare in a chapter titled "The Invaders" (Elton, 1958). Militaristic metaphor continues to define discourse around invasive species in academic and popularized science media (e.g. PBS, 2018; Sinclair, 2018). In a six-episode series on the Florida Everglades titled "Battleground Everglades," for example, PBS titled its episode on invasive species "War on Invasive Species" (PBS, 2018). Lidstrom et al. argue that the "term 'invasive aliens'" has fueled dangerous ideas about the natural world, mobilizing "'vigilante' volunteer groups" who rip up "hated invaders" (2017).

There appears to be little empirical evidence on the topic of how metaphors might shape perceptions of non-native species issues or support for efforts to control non-native populations. However, studies suggest metaphors or message frames that attribute agency to a natural entity can increase perceptions of risk and influence behavioral intentions (Hart & Larson, 2014; Liu et al., 2019; Matlock, Coe, & Westerling, 2017). In an experiment asking college students to evaluate a fire, students who read about a "monster fire" estimated that it burned more acres and houses, than students reading about a "major fire" (Matlock et al., 2017).

Similar results were found in an experiment testing the effects of message framing on perceptions of invasive plants and willingness to take action against the plant species (Hart & Larson, 2014). The study compared a "driver" message frame, in which the invasive plants were depicted as directly causing ecological impacts, and a "passenger" message frame, in which the invasive plants were depicted as spreading in response to change. Compared to the passenger frame, the driver frame increased perceptions of the risk posed by the invasive plants, which contributed to willingness to take action (Hart & Larson, 2014). In this study we propose that attributing agency to a species by describing it as *invasive* could have a similar effect. On the other hand, talking about a non-native species as "invasive" species differs from talking about a non-native species as a "driver" in important ways.

The term invasive casts non-natives as an adversary and has become central to the militaristic metaphoric language used to motivate action against non-native species. As a tool for shaping interpretations about problems and solutions, metaphors do not always work as expected. If a metaphor is not perceived as being apt (e.g. a fisherman is a spider), it can hinder processing and fail to influence interpretations (Thibodeau & Durgin, 2011) Similarly, a metaphor can also fail when it seems applicable to the problem, but not to the solution inferred (Landau, Arndt, & Cameron, 2018).

Results of experimental studies testing the influence of militaristic metaphors in messages addressing science-related issues have been somewhat mixed (Flusberg, Matlock, & Thibodeau, 2017; Hauser & Schwarz, 2019). Participants in an online experiment who read a message titled "The *War* Against Climate Change," for example, expressed greater willingness to increase conservation behavior than participants who read a message titled "The *Race* Against Climate Change" (italics added) (Flusberg et al., 2017). In a similar experiment, however, a message describing cancer as a "battle" and a "fight" generated more fatalistic beliefs about cancer prevention than a message that did not use the "battle" and "fight" metaphors (Hauser & Schwarz, 2019). Furthermore, participants receiving a message with the "battle" and "fight" metaphors were no more likely to report they would take action in response to a cancer scare.

Using invasive as a metaphor might increase a sense of urgency to take action against non-native species. On the other hand, it is possible that casting non-natives as an aggressor might generate doubt about whether non-native problems can be successfully addressed. Without empirical evidence, we cannot necessarily assume that audiences will perceive the invasive metaphor as apt to the non-native species problem or inferred solutions (Landau et al., 2018; Thibodeau & Durgin, 2011). Even if the metaphor is seen as apt to the problem, it might suggest "surrender" is a better option than fighting to control the problem.

In this study we test the role of the term "invasive" on support for control methods for non-native species. While some of the studies above reinforce the metaphoric expression with additional manipulations to text, in this study we limit our experimental manipulation to the presence or absence of the term "invasive" to isolate whether the normative weight of this term alone influences support.

Non-native species control methods

The removal of non-native species from natural areas often generates pushback from members of the public (Cavalier, 2014; Temple, 1990; Venton, 2013). Non-expert publics tend to be less supportive of invasive species removal efforts than those working in conservation (Fischer, Selge, van der Wal, & Larson, 2014). Studies consistently find that the use of chemicals (i.e. poisons and herbicides) is an especially disfavored method among lay individuals (Barr, Lurz, Shirley, & Rushton, 2002; Dunn, Marzano, Forster, & Gill, 2018; Gordon, Brunson, & Shindler, 2014; Jetter & Paine, 2004). Indirect, non-lethal control methods such as the use of contraception are often evaluated as most acceptable (Dunn et al., 2018). However, currently available options for population control through contraception are often cost prohibitive and impractical (Kirkpatrick, Lyda, & Frank, 2011).

With the development of CRISPR gene editing tools and CRISPR-based gene drive, conservation biologists are now considering gene editing applications as a possible alternative to traditional approaches for removing non-native species (Corlett, 2017; Marris, 2018; Moro, Byrne, Kennedy, Campbell, & Tizard, 2018). Two possible methods have been proposed. One method would take a lethal approach: using gene drive to spread a trait throughout the population that would reduce survival (Champer, Buchman, & Akbari, 2016). A second method would be to disrupt reproduction by, for example, spreading sterility or biasing reproduction toward male offspring (Champer et al., 2016; National Academies of Sciences Engineering and Medicine, 2016).

Some have suggested removing non-native species using genetic engineering could provide a more humane and publicly acceptable alternative to poisons and other control methods unpopular with the public (Marris, 2018; Temple, 1990). If public stakeholders are more tolerant of gene editing control methods, conservation practitioners might use them to work towards more socially acceptable management practices. There is little empirical data available to answer the question of whether lay members of the public might find gene editing control methods more palatable than traditional methods. However, recent survey data on public attitudes toward gene editing in wildlife as a conservation tool, suggests Americans believe the risks would outweigh the benefits (Kohl, Brossard, Scheufele, & Xenos, 2019). In this study, we begin to explore this question by comparing public support for the use of poison as a control method with support for control methods that use gene editing.

Trust in scientists and government

People tend to be "cognitive misers" who prefer to collect no more information than necessary to make a decision (Fiske & Taylor, 1991). In other cases, we don't have access to all the information we might like. In either case, trust can serve as a valuable heuristic whereby trust in particular actors can be substituted for judgments about a complex issues (Brossard & Nisbet, 2007; Rousseau, Sitkin, Burt, & Camerer, 1998).

Rousseau et al. (1998) define trust as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Rousseau et al., 1998, p. 395). When people evaluate an actor's trust, among other things, they're thinking in terms of not only that actor's honesty but also whether that actor is acting in the public interest (Lang & Hallman, 2005).

Researchers have found varying support for different institutional actors along varying dimensions (Critchley, 2008; Lang & Hallman, 2005; Lubell, 2007). Lang and Hallman (2005) examined individuals' trust in different institutional and societal actors as sources of information about genetically modified foods. They categorized 10 sources of information into three factors: watchdogs, merchants and evaluators. Evaluators, which included scientists, universities, medical professionals and the federal government, were the most trusted. And among the evaluators, scientists were the most trusted. The federal government ranked seventh overall.

A large body of research has consistently found higher levels of public trust in science than in government (e.g. Lang & Hallman, 2005; MacKeracher, Diedrich, Gurney, & Marshall, 2018; Priest, 2001). Additionally, trust in government and government initiatives has been eroding for decades (Chanley, Rudolph, & Rahn, 2000; Dalton, 2005), while trust in science has remained remarkably stable since the 1970s (Funk & Kennedy, 2018; Gauchat, 2012). By contrast, Smith (2015) notes that government trust is at an historic low, with fewer than one in five U.S. citizens expressing trust in the federal government.

Trust in institutional actors has been used to predict attitudes toward a wide range of science-related issues. Previous studies have linked trust with perceptions of risk relating to cancer and nanotechnology (Lee, Scheufele, & Lewenstein, 2005; Trumbo & McComas, 2008), environmental policy and spending (Chanley et al., 2000; Fairbrother, 2016; Konisky, Milyo, & Richardson, 2008; Rudolph & Evans, 2005), and attitudes toward biotechnology (Peters, Lang, Sawicka, & Hallman, 2007; Priest, 2001).

Trust in government predicts support for environmental policy and spending (Barnes, Evans, Hazel, Brownell, & Nesse, 2017; Chanley et al., 2000; Konisky et al., 2008; Rudolph & Evans, 2005), while trust in science has been shown to lead to increased support for everything from genetically modified foods (Lang & Hallman, 2005), to stem cell research (Critchley, 2008) and nanotechnology (Lee et al., 2005). Lee et al. (2005) found that trust in science decreased the perceived risk of nanotechnology and increased support for the technology after controlling for scientific knowledge. Priest (2001) used survey data to examine public attitudes toward biotechnology. Trust in scientists, industry, government regulators and consumer organizations strongly predicted support for biotechnology.

In a multi-country study, Fairbrother (2016) found that political trust predicted differences in support for environmental protection at both the individual-level and at the country-level. Konisky et al. (2008) found that in the United States trust of the federal government was correlated with support for the government tackling such issues as global warming and threats to biodiversity. The researchers also found that overall government trust (measured at the local, state and federal levels) correlated with support for government action to offset pollution.

A wide body of literature suggests trust is highly contextual, with the variables that it predicts or moderates varying widely from study to study (Critchley, 2008; Lubell, 2007; MacKeracher et al., 2018; Rousseau et al., 1998). For example, Australian public support for stem cell research was greater when people were asked about it in the context of a government-funded university as opposed to corporate-funded research because people trusted university scientists more than corporate scientists (Critchley, 2008).

A considerable body of research examines the role of trust in government and scientists in support for environment-related initiatives and emerging technologies. But as far as we are aware, there is not yet any empirical data on whether individuals' trust in government and scientists predicts support for the use of gene editing methods to control non-native species. We were also unable to find research examining the relationship between these trust variables and support for the use of poison as a control method. In the present study we examine the role of trust in predicting support for these types control methods.

Hypotheses and research questions

Previous studies have linked trust in scientists and the government to support for emerging technologies (Critchley, 2008; Lang & Hallman, 2005; Lee et al., 2005) and programs to address environmental issues (Konisky et al., 2008). We therefore pose the following hypotheses:

> H1a: Individuals with greater levels of trust in scientists will indicate greater support for non-native species control methods.

> H1b: Individuals with greater levels of trust in government will indicate greater levels of support for non-native species control methods.

Previous research suggests that metaphors and framing that present a natural threat in militaristic terms or lend agency to a natural entity may increase perceived risk and support for action (Flusberg et al., 2017; Hart & Larson, 2014; Matlock et al., 2017). However, previous research also suggests that the influence of militaristic metaphoric language may be context specific (Flusberg et al., 2017; Hauser & Schwarz, 2019). We therefore pose the following research question:

> RQ1: Will individuals in the condition using the "invasives" metaphor indicate greater support for control methods?

Poison is a common, but also an especially disfavored method of controlling non-native species among the lay public (Barr et al., 2002; Dunn et al., 2018; Gordon et al., 2014; Jetter & Paine, 2004). Some propose genetic engineering could provide a more humane and publicly acceptable alternative (Marris, 2018; Temple, 1990). However, while poison tends to elicit strong opposition, it is unclear whether members of the lay public would prefer gene editing methods as an alternative. We therefore pose the following research question:

> RQ2: Will individuals indicate greater support for control methods using gene editing than control methods using poison?

Given that individuals tend to prefer non-lethal methods over lethal methods of controlling non-native species (Arthur, 1981; Lute & Attari, 2017), we expect that respondents will favor gene editing control methods that disrupt reproduction over gene editing control methods that reduce survival fitness. We therefore propose that:

> H2: Individuals will indicate greater support for gene-editing control methods that disrupt reproduction (a non-lethal method) than gene-editing methods that reduce survival (a lethal method).

Methods

Participants

This study employed a nationally representative sample of United States residents ($N = 1{,}042$) for an online survey with an embedded experiment. The survey was conducted in cooperation with the professional market research firm Kelton Global. U.S. residents age 18+ (with Census based, interacting quotas for gender, age groups, ethnicity, and region) were recruited from a market research panel provided by the professional sampling agency Toluna. Regional quotas sampled participants from the U.S. Northeast (18%), Midwest (20%), South (39%), and West (23%). Ethnic quotas included white/ Caucasian (66%), Hispanic or Latino (15%), Black or African American (12%), Asian (2%), native American (1%) and other (12%). The final sample was 52% female, with an average age of 47. The survey was fielded from 8–12 February 2019, and the questions relevant for this paper were part of a larger questionnaire that covered other topics.

Experimental design

To test the influence of invasive as a metaphor on support for control methods, we employed a between-subjects experimental design. In the study we asked participants about their support for different types of possible methods for controlling non-native animal species, while manipulating whether the questions were asked using the word "invasive" to describe non-native species. The manipulation of interest in this study was that of non-native vs. invasive species.

Within scientific circles, the term invasive has definitional meaning beyond its metaphoric use. However, different definitions prevail among ecologists (Boonman-Berson, Turnhout, & van Tatenhove, 2014). Some only categorize non-native species as invasive when they also have damaging impacts (Davis & Thompson, 2001; Evans, Wilkie, & Burkhardt, 2008). Meanwhile, others consider a species' origin (native or non-native) a sufficient criterion for categorizing spreading species as invasive, arguing that evaluating impact is too subjective (Daehler, 2001; Richardson et al., 2000).

Prior to asking participants about their support for control methods, we explained to participants in each condition what we meant by [invasive/ non-native]. We gave participants a definition for invasive consistent with definitions emphasizing origin as a criteria (Daehler, 2001; Richardson et al., 2000), essentially treating invasive and non-native species as definitionally equivalent. Consequently, participants received the same definition regardless of whether they were in the invasives of non-native condition. In the definition we told participants that "A(n) [invasive/ non-native] animal species is one that wasn't originally found in this part of the world but was instead brought here by humans." And before asking participants about their support for control methods, we also explained that "Some think we should accept [invasive/ non-native] species even though many can threaten native wildlife. Others think we should remove them, even though it may be expensive or difficult to do so."

Dependent measures

Our analyses include three dependent variables indicating support for three methods of controlling non-native/ invasive species: (1) using poison; (2) using gene editing to reduce survival; and (3) using gene editing to disrupt reproduction. Support for each of these methods was measured on a seven-point scale reflecting agreement (1 = strongly disagree; 7 = strongly agree) with the following statements: "Overall, I support the use of poison to kill [invasive/ non-native] animals" (*M* = 3.06; SD = 1.95); "Overall, I support the use of gene editing [invasive/ non-native] animals to keep them from reproducing" (*M* = 3.88; SD = 1.99); "Overall, I support the use of gene editing [invasive/ non-native] animals to reduce their ability to survive" (*M* = 3.48; SD = 1.99). We presented each statement while using the word "invasive" for participants in the invasives condition, and while using the word "non-native" for participants in the non-native condition. We randomized the order in which we presented each statement to control for order effects.

Predictor variables

Trust in scientists and *trust in government* were each measured using single-item measures adapted from Pew Research surveys (Funk & Kennedy, 2018). Single-item measures asked participants how much they agree with the following statements: "I trust scientists to act in the interests of society" (*M* = 4.86; SD = 1.59) and "I trust the federal government to act in the interests of society" (*M* = 3.69; SD = 1.84). Responses were measured on a seven-point scale (1 = strongly disagree; 7 = strongly agree).

Invasive was a dichotomous variable based on the manipulation that each participant received, where −.5 = non-native condition and .5 = invasive condition. As control variables we included measures of age (*M* = 47.18; SD = 17.17), gender and education. Education was measured as a dichotomous variable (0, no college; 1, at least some college).

Analytical methods

We ran two types of analyses to test our hypotheses and research question. In our first set of analyses testing H1a, H1b and RQ1, we ran three linear regression models where variables were entered in blocks (demographics, trust and the experimental condition) to determine their relative explanatory power. In our second and final analysis testing RQ2 and H2, we estimated a linear-mixed effects model using the *lme4* package in R (Bates, Mächler, Bolker, & Walker, 2015). We estimated an LMEM for our final analysis because RQ2 and H2 involve within-subject data points and estimating a LMEM allowed us to account for the non-independence of the data. RQ2 and H2 involve non-independent data because they compare items (poison; gene editing to reduce survival; and gene editing to disrupt reproduction) evaluated by the same individual. Following the recommendations of Brauer and Curtin (2018), we included the maximal random effects structure called for by the design. Here, the design requires us to account for the non-independence introduced by subject with the random intercept and slope for subject.

In conducting our final analysis, we also used orthogonal contrast coding to create two variables, a contrast-coded variable representing RQ2 and a contrast-coded variable representing H2[1] (Abelson & Prentice, 1997; Judd, Kenny, & McClelland, 2001; West, Aiken, & Krull, 1996). Contrast code 1 resulted in a variable we label *GE methods v. poison*, which compares the mean support score for gene editing to reduce survival and gene editing to disrupt reproduction, with support for poison (RQ2). Contrast code 2 resulted in a variable we label *GE reproduce v. GE survival,* which compares support for gene editing to disrupt reproduction and support for gene editing to reduce survival fitness (H2). We then entered these two variables into our the LMEM while setting subject as a random factor to account for the non-independence of support scores provided by the same individual.

Results

Our three linear regression models provide partial support for Hypothesis 1a, as trust in scientists was positively related to support for two of the three invasive species control methods (Table 1). Greater trust in scientists predicted stronger support for the two control methods using gene editing, but did not predict support for removal methods using poison. Hypothesis 1b was fully supported,

Table 1. Regression predicting support for three methods of invasive/non-native species control: using gene editing to disrupt reproduction (GE reproduce); using gene editing to reduce survival (GE survival) and using poison to kill (poison).

	GE reproduction β	GE survival β	Poison β
Block 1: Demographics			
Age	.10	.03	−.12*
Gender (male)	.59***	.56***	.71***
Education	.21	.21	.41**
Inc. adjusted R^2 (%)	3.29***	3.32***	6.00***
Block 2: Trust			
Trust in scientists	.38***	.25***	.03
Trust in government	.31***	.55***	.67***
Inc. adjusted R^2 (%)	8.37***	12.60***	11.57***
Block 3: Experimental condition			
Invasive	.34***	.20	.36***
Inc. adjusted R^2 (%)	.63**	.18	.78***
Total adjusted R^2 (%)	12.40***	16.32***	18.89***

*$p < .05$; **$p < .01$; ***$p < .001$; support was measured on a seven-point scale where higher scores indicate greater support; all dichotomous variables are contrast-coded.

Table 2. Parameter estimates for the effect of type of control method on support.

	Support β
Fixed Effects	
(Intercept)	3.48***
GE methods v poison	.40***
GE reproduction v GE survival	.62***
Random Effects	
By-subject	
Intercept	1.65
$\text{Subject}_{\text{GE methods v. poison}}$	.51
$\text{Subject}_{\text{GE reproduction v. GE survival}}$	.97
Residual	.92

*$p < .05$; **$p < .01$; ***$p < .001$. *P*-values for fixed effects are computed via an approximate F-test with the Kenward-Roger method to compute the degrees of freedom (Kenward & Roger, 1997).

with trust in government positively related to greater support for all three control methods. In our exploration of Research Question 1, we found a significant influence of the experimental manipulation for two of the three control methods. Individuals in the invasive condition indicated greater support for using gene editing to disrupt reproduction and poison.

In our exploration of Research Question 2, we found significant results for *GE methods v. poison* (Table 2). The results show support was greater for the two gene editing control methods ($M = 3.68$; SD = 1.83) than for control methods using poison ($M = 3.06$; SD = 1.83). In testing Hypothesis 2, we also found significant results for *GE reproduction v. GE* survival. These results indicated that support was greater for gene editing control methods aimed at disrupting reproduction ($M = 3.88$; SD = 1.99) than gene editing control methods aimed at reducing survival fitness ($M = 3.48$; SD = 1.99).

Discussion

We initiated this study in response to debates about normative bias in the language of invasives species biology and to advances in genetic technologies that could change options for non-native species control. Several key takeaway points can be distilled from our results for practitioners working in conservation. First, our results suggest that, at least among members of the American public, adopting gene editing methods in place of poisons may lower social barriers for some non-native species removal programs, particularly when used to disrupt reproduction. Our results show respondent support favored non-native species control using gene editing methods over the use of poison. And between the two gene editing methods presented, respondents indicated greater support for gene editing used to disrupt reproduction than for gene editing used to reduce survival fitness.

Some limitations should be considered in interpreting these results. Thus far gene drives that could be used to control invasive species have only been tested in the lab, and the outcomes of trying to use gene drive are highly uncertain (Esvelt & Gemmell, 2017; NAS, 2016). In this study, we did not elaborate on the potential risks and uncertainties associated with using gene editing technologies to reduce or eliminate non-native species when we asked respondents to consider gene editing strategies. Future public opinion research on this topic should build on the results of this study, while providing survey respondents with more contextual detail about gene editing applications that might be used to address non-native species issues. Furthermore, similar studies ought to be replicated in other countries. Members of the U.S. public may respond differently to concerns related to various invasive species control methods than people living in other countries. The variations in support for control methods we observed may differ from the results that researchers might observe in countries where, for example, extinction rates are severe and tolerance of non-native species may be lower, such as Australia or New Zealand (Aguirre, 2019; Russell, 2014).

Beyond the type of control method used, our results suggest trust and language also have a role to play in influencing public support. As anticipated, trust predicted greater support for control methods. Several interesting patterns emerged in the influence of trust on support. Trust in scientists predicted support for the two gene editing methods, but not support for using poison as a control method. Perhaps this is related to a belief that there isn't anything particularly scientific about the use of poison. Although scientists may develop chemicals employed as poisons, we doubt that the typical person thinks of using poison as a particularly scientific endeavor. Meanwhile, gene editing is likely viewed as primarily a scientific endeavor. In that context, trust in scientists seems to provide a heuristic for forming an opinion on specific methods when little additional information has been provided.

Trust in government predicted support for all three control methods, with trust in government becoming more predictive of support as a method becomes less humane (disrupting reproduction versus reducing survival fitness versus death by poison). This makes a certain amount of sense in light of the work of Rudolph and Evans (2005), who found that trust in government can lead people to support things they are otherwise ideologically opposed to. One might reasonably assume that many people oppose killing animals outside of a farming or hunting context. If that's the case, then people might be more likely to set aside their normal objections if they trust the government that would presumably be involved in any such action. We say presumably because while many non-native species control programs are carried out by government agencies, we did not provide respondents with information about either who has developed these methods or who would implement them.

Additional research could build on our study results by, for example, testing whether it might matter if people knew more about the scientists involved in developing gene editing. In other words, would it matter if respondents were told that gene editing was being developed in university, private, or government labs? And would it matter if respondents were told that a non-natives species program would be implemented by the government versus some other group?

Future research would also benefit from using more robust measures of trust. Due to space limitations we used single-item measures of trust in government and scientists. This poses two potential issues that are less problematic when using multi-item measures. First, using a multi-item measure can reduce random error, improving reliability. Second, a multi-item measure can often capture the underlying concept more adequately, improving content validity. We are less concerned with content validity, given that our measures are consistent with prior studies using single-item measures of trust in various actors, including studies using trust to predict attitudes toward emerging technologies (Akin et al., 2017; Critchley, 2008; Funk & Kennedy, 2018). With respect to reliability, because multi-item measures of trust would likely reduce random error, our findings may represent conservative estimates of the influence of trust. Taken as a whole, our findings related to trust add to a growing body of literature suggesting that trust is contextual. In just what context trust in a particular actor matters most will require additional research.

The results of this study also found a role for the use of metaphor in shaping support for control methods. Our research suggests that using the metaphor "invasive" can generate more support for action to control non-native species. We found that labeling non-native species as invasive resulted in more support for two of the three control methods we asked respondents about – control methods using poison and control methods using gene editing to reduce reproduction, with the introduction of the term invasive explaining slightly more variance in support for control using poison.

These results contribute to the broader literature on environmental and science communication in two ways. First, they contribute empirical evidence suggesting messages attributing agency to natural entities influence how we understand and respond to environmental issues (Hart & Larson, 2014; Liu et al., 2019; Matlock et al., 2017), in this case, generating support for action against non-native species. Second, our results suggest militaristic metaphoric language is viewed as applicable to the problem of non-native species issues and at least some control methods as a solution (Landau et al., 2018; Thibodeau & Durgin, 2011). The results of this study contrast with the results of a similar study in which militaristic metaphoric language failed to increase the likelihood that an individual said they would take preventive action in response to a cancer scare (Hauser & Schwarz, 2019). Perhaps this is explained by the fact that confronting cancer is primarily a solo endeavor, while confronting invasive species is a communal endeavor.

The influence of our experimental condition on support for control methods explained less than one percent of the variation observed. However, it should be noted we isolated our manipulation to a change in a single term, rather than the larger suite of terms often employed in militaristic metaphors in invasion biology. As noted earlier, militaristic metaphors are often expressed using clusters of interrelated terms (Larson, Nerlich, & Wallis, 2005). For example, invasive species are often said to "colonize" natural habitats and biologists are said to "eradicate," "wage war on" and "battle" invasive species.

Furthermore, this study represents just a single exposure, which is unlikely to adequately represent the long-term effects that may influence perceptions through repeated exposure to the term through news, online websites, signage at parks and elsewhere. While our narrow approach may have limited the influence of our manipulation, it also helped us rule out lexical effects. The limited effect sizes observed might also be explained in part by the fact that we compared use of the term invasive with the use of the term non-native as the alternative. We used the term non-native in condition one as an alternative to the invasive metaphor used in condition two as we believed it would be most familiar to our respondents. However, the word non-native may also carry normative baggage. In particular, some argue that "non-native" could be construed as xenophobic (O'Brien, 2006).

While metaphors are important and useful in helping both lay and expert members of the public communicate and understand complex environmental issues, many scientists and scholars have become sensitive to the possible consequences that may come with their use. Meanwhile, scientists working in the field appear to be gravitating toward the term invasive over other related terms, such as "non-native," "exotic species," and "non-indigenous species" (Larson et al., 2005). And limited scholarly and popular media analyses suggest there may be an overall upward trend in references to "invasive" species in scientific and popular articles (Larson et al., 2005; Pereyra, 2016). Meanwhile, some critics advocate the field of invasion biology move away from terms they argue may inappropriately suggest a dichotomy between native and non-native as "good or evil" (Chew & Laubichler, 2003; Lidström & West, 2017).

In closing, it should be noted that we have not weighed into the debate as to whether the invasion metaphor should be used but rather we have focused on what effect it has on support for particular methods of dealing with non-native species. To the extent one's goal is to promote public support for these methods, use of the metaphor does seem to be a way to move the needle. However, there is also the risk that use of the metaphor will strike the public as manipulative or as an attempt to politicize science. In light of the fact "the social contract underlying public support for science is a fragile one" (Priest, 2001, p. 108), one should proceed with caution. Simply put, we've answered the "does it work" question, but the "should we use it" question remains open.

Note

1. The contrast code values for Code 1 (GE methods v. poison) were: poison = −.667; GE survival = .333; GE reproduce = .333. The contrast code values for Code 2 (GE reproduce v. GE survival) were: poison = 0; GE survival = −.5; GE reproduce = .5.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Patrice A. Kohl http://orcid.org/0000-0002-9367-5116

References

Abelson, R. P., & Prentice, D. A. (1997). Contrast tests of interaction hypotheses. *Psychological Methods*, *2*(4), 315–328. doi:10.1037/1082-989x.2.4.315

Aguirre, J. C. (2019, April 28). The culling. *The New York Times*, p. 34.

Akin, H., Rose, K. M., Scheufele, D. A., Simis-Wilkinson, M., Brossard, D., Xenos, M. A., & Corley, E. A. (2017). Mapping the landscape of public attitudes on synthetic biology. *Bioscience*, *67*(3), 290–300. doi:10.1093/biosci/biw171

Arthur, L. M. (1981). Coyote control: The public response. *Rangeland Ecology & Management/Journal of Range Management Archives*, *34*(1), 14–15.

Barnes, M. E., Evans, E. M., Hazel, A., Brownell, S. E., & Nesse, R. M. (2017). Teleological reasoning, not acceptance of evolution, impacts students' ability to learn natural selection. *Evolution: Education and Outreach*, *10*(1), 7. doi:10.1186/s12052-017-0070-6

Barr, J. J., Lurz, P. W., Shirley, M. D., & Rushton, S. P. (2002). Evaluation of immunocontraception as a publicly acceptable form of vertebrate pest species control: The introduced grey squirrel in Britain as an example. *Environmental Management*, *30*(3), 342–351.

Barua, M. (2011). Mobilizing metaphors: The popular use of keystone, flagship and umbrella species concepts. *Biodiversity and Conservation*, *20*(7), 1427–1440.

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1), 1–48. doi:10.18637/jss.v067.i01

Boonman-Berson, S., Turnhout, E., & van Tatenhove, J. (2014). Invasive species: The categorization of wildlife in science, policy, and wildlife management. *Land Use Policy*, *38*, 204–212.

Borel, B. (2017, Summer). How genetically modified mice could one day save Island Birds. *Audubon*, *119*(2), 48–60. Retrieved from http://www.audubon.org/magazine/summer-2017/how-genetically-modified-mice-could-one-day-save.

Brauer, M., & Curtin, J. (2018). Linear mixed-effects models and the analysis of nonindependent data: A unified framework to analyze categorical and continuous independent variables that vary within-subjects and/or within-items. *Psychological Methods*, *23*(3), 389–411. doi:10.1037/met0000159

Brossard, D., & Nisbet, M. C. (2007). Deference to scientific authority among a low information public: Understanding US opinion on agricultural biotechnology. *International Journal of Public Opinion Research*, *19*(1), 24–52.

Cavalier, V. (2014, February 22). Protesters make noise over New York plan to kill off mute swans. *Reuters*. Retrieved from http://www.reuters.com/article/us-usa-swans-idUSBREA1L0BZ20140222.

Champer, J., Buchman, A., & Akbari, O. S. (2016). Cheating evolution: Engineering gene drives to manipulate the fate of wild populations. *Nature Reviews Genetics*, *17*(3), 146–159.

Chanley, V. A., Rudolph, T. J., & Rahn, W. M. (2000). The origins and consequences of public trust in government: A time series analysis. *Public Opinion Quarterly*, *64*(3), 239–256.

Chew, M. K., & Laubichler, M. D. (2003). Natural enemies–metaphor or misconception? *Science*, *301*(5629), 52–53.

Corlett, R. T. (2017). A bigger toolbox: Biotechnology in biodiversity conservation. *Trends in Biotechnology*, *35*(1), 55–65.

Corner, A., & Pidgeon, N. (2015). Like artificial trees? The effect of framing by natural analogy on public perceptions of geoengineering. *Climatic Change*, *130*(3), 425–438.

Critchley, C. R. (2008). Public opinion and trust in scientists: The role of the research context, and the perceived motivation of stem cell researchers. *Public Understanding of Science*, *17*(3), 309–327.

Daehler, C. C. (2001). Two ways to be an invader, but one is more suitable for ecology. *Bulletin of the Ecological Society of America*, *82*(1), 101–102.

Dalton, R. J. (2005). The social transformation of trust in government. *International Review of Sociology*, *15*(1), 133–154.

Davenport, J. C., Frankel, A. K., & Parry, C. M. (2003). *Waves, wetlands, and watersheds: California Coastal Commission science activity guide*. San Francisco, CA: California Coastal Commission.

Davis, M. A., & Thompson, K. (2001). Invasion terminology: Should ecologists define their terms differently than others? No, not if we want to be of any help!. *Bulletin-Ecological Society of America*, *82*(3), 206–206.

Dunn, M., Marzano, M., Forster, J., & Gill, R. M. A. (2018). Public attitudes towards "pest" management: Perceptions on squirrel management strategies in the UK. *Biological Conservation*, *222*, 52–63. doi:10.1016/j.biocon.2018.03.020

Elton, C. S. (1958). *The ecology of invasions by animals and plants*. London: Methuen.

Esvelt, K. M., & Gemmell, N. J. (2017). Conservation demands safe gene drive. *PLoS Biology*, *15*(11), e2003850. doi:10.1371/journal.pbio.2003850

Evans, J. M., Wilkie, A. C., & Burkhardt, J. (2008). Adaptive management of nonnative species: Moving beyond the "either-or" through experimental pluralism. *Journal of Agricultural and Environmental Ethics*, *21*(6), 521–539.

Fairbrother, M. (2016). Trust and public support for environmental protection in diverse national contexts. *Sociological Science*, *3*, 359–382.

Fischer, A., Selge, S., van der Wal, R., & Larson, B. M. (2014). The public and professionals reason similarly about the management of non-native invasive species: A quantitative investigation of the relationship between beliefs and attitudes. *PloS One*, *9*(8), e105495.

Fiske, S. T., & Taylor, S. E. (1991). *Social cognition* (2nd ed.). New York: McGraw-Hill.

Flusberg, S. J., Matlock, T., & Thibodeau, P. H. (2017). Metaphors for the war (or race) against climate change. *Environmental Communication*, *11*(6), 769–783.

Funk, C., & Kennedy, B. (2018). Public confidence in scientists has remained stable for decades. *Pew Research Center*. Retrieved from https://www.pewresearch.org/fact-tank/2019/03/22/public-confidence-in-scientists-has-remained-stable-for-decades/

Gauchat, G. (2012). Politicization of science in the public sphere: A study of public trust in the United States, 1974 to 2010. *American Sociological Review*, *77*(2), 167–187.

Genovesi, P., & Bertolino, S. (2001). Human dimension aspects in invasive alien species issues: The case of the failure of the grey squirrel eradication project in Italy. In J. McNeely (Ed.), *The great reshuffling: Human dimensions of invasive alien species* (pp. 113–119). Gland: International Union for Conservation of Nature.

Gibbs, R. W. (1998). The fight over metaphor in thought and language. In A. N. Katz, C. Cacciari, R. W. Gibbs, Jr., & M. Turner (Eds.), *Figurative language and thought* (pp. 88–118). New York, NY: Oxford University Press.

Gordon, R., Brunson, M. W., & Shindler, B. (2014). Acceptance, acceptability, and trust for sagebrush restoration options in the Great Basin: A longitudinal perspective. *Rangeland Ecology & Management*, *67*(5), 573–583. doi:10.2111/REM-D-13-00016.1

Hart, P. S., & Larson, B. M. H. (2014). Communicating about invasive species: How "driver" and "passenger" models influence public willingness to take action. *Conservation Letters*, *7*(6), 545–552. doi:10.1111/conl.12109

Hauser, D. J., & Schwarz, N. (2019). The war on prevention II: Battle metaphors undermine cancer treatment and prevention and do not increase vigilance. *Health Communication*. doi:10.1080/10410236.2019.1663465

Jetter, K., & Paine, T. D. (2004). Consumer preferences and willingness to pay for biological control in the urban landscape. *Biological Control*, *30*(2), 312–322.

Johnson, J. T., & Taylor, S. E. (1981). The effect of metaphor on political attitudes. *Basic and Applied Social Psychology*, *2*(4), 305–316.

Judd, C. M., Kenny, D. A., & McClelland, G. H. (2001). Estimating and testing mediation and moderation in within-subject designs. *Psychological Methods*, *6*(2), 115–134.

Kenward, M. G., & Roger, J. H. (1997). Small sample inference for fixed effects from restricted maximum likelihood. *Biometrics*, *53*, 983–997.

Kirkpatrick, J. F., Lyda, R. O., & Frank, K. M. (2011). Contraceptive vaccines for wildlife: A review. *American Journal of Reproductive Immunology*, *66*(1), 40–50.

Kohl, P. A., Brossard, D., Scheufele, D. A., & Xenos, M. A. (2019). Public views about gene editing wildlife for conservation. *Conservation Biology*, *33*(6), 1286–1295. doi:10.1111/cobi.13310

Konisky, D. M., Milyo, J., & Richardson, L. E. (2008). Environmental policy attitudes: Issues, geographical scale, and political trust. *Social Science Quarterly*, *89*(5), 1066–1085.

Kueffer, C., & Larson, B. M. H. (2014). Responsible use of language in scientific writing and science communication. *Bioscience*, *64*(8), 719–724. doi:10.1093/biosci/biu084

Lakoff, G., & Johnson, M. (2003). *Metaphors we live by*. Chicago: University of Chicago press.

Landau, M. J., Arndt, J., & Cameron, L. D. (2018). Do metaphors in health messages work? Exploring emotional and cognitive factors. *Journal of Experimental Social Psychology*, *74*, 135–149.
Lang, J. T., & Hallman, W. K. (2005). Who does the public trust? The case of genetically modified food in the United States. *Risk Analysis: An International Journal*, *25*(5), 1241–1252.
Larson, B. M. H. (2005). The war of the roses: Demilitarizing invasion biology. *Frontiers in Ecology and the Environment*, *3*(9), 495–500. doi:10.2307/3868637
Larson, B. M., Nerlich, B., & Wallis, P. (2005). Metaphors and biorisks the war on infectious diseases and invasive species. *Science Communication*, *26*(3), 243–268.
Lee, C.-J., Scheufele, D. A., & Lewenstein, B. V. (2005). Public attitudes toward emerging technologies: Examining the interactive effects of cognitions and affect on public attitudes toward nanotechnology. *Science Communication*, *27* (2), 240–267.
Leuven, R. S., van der Velde, G., Baijens, I., Snijders, J., van der Zwart, C., Lenders, H. R., & bij de Vaate, A. (2009). The river Rhine: A global highway for dispersal of aquatic invasive species. *Biological Invasions*, *11*(9), 1989.
Lidström, S., & West, S. (2017). Changing our attitudes towards invasive "Alien" species. *PLoS Ecology Blog*. Retrieved from https://blogs.plos.org/ecology/2017/02/08/changing-our-attitudes-towards-invasive-alien-species/.
Liu, T., Geng, L., Ye, L., & Zhou, K. (2019). "Mother nature" enhances connectedness to nature and pro-environmental behavior. *Journal of Environmental Psychology*, *61*, 37–45.
Lubell, M. (2007). Familiarity breeds trust: Collective action in a policy domain. *The Journal of Politics*, *69*(1), 237–250.
Lute, M. L., & Attari, S. Z. (2017). Public preferences for species conservation: Choosing between lethal control, habitat protection and no action. *Environmental Conservation*, *44*(2), 139–147.
MacKeracher, T., Diedrich, A., Gurney, G. G., & Marshall, N. (2018). Who trusts whom in the Great Barrier Reef? Exploring trust and communication in natural resource management. *Environmental Science & Policy*, *88*, 24–31.
Marris, E. (2018, February 20). Process of elimination. *WIRED*. Retrieved from https://www.wired.com/story/crispr-eradicate-invasive-species/.
Marris, E. (2019). Drones unleashed against invasive rats in the Galapagos. *Nature*, *565*(7741), 543–544.
Matlock, T., Coe, C., & Westerling, A. L. (2017). Monster wildfires and metaphor in risk communication. *Metaphor and Symbol*, *32*(4), 250–261.
Moro, D., Byrne, M., Kennedy, M., Campbell, S., & Tizard, M. (2018). Identifying knowledge gaps for gene drive research to control invasive animal species: The next CRISPR step. *Global Ecology and Conservation*, *13*, e00363. doi:10.1016/j.gecco.2017.e00363
National Academies of Sciences Engineering and Medicine. (2016). *Gene drives on the horizon: Advancing science, navigating uncertainty, and aligning research with public values*. Washington, DC: National Academies Press. Retrieved from https://www.nap.edu/catalog/23405/gene-drives-on-the-horizon-advancing-science-navigating-uncertainty-and.
O'Brien, W. (2006). Exotic invasions, nativism, and ecological restoration: On the persistence of a contentious debate. *Ethics, Place and Environment*, *9*(1), 63–77.
O'Keefe, M., Perrault, S., Halpern, J., Ikemoto, L., Yarborough, M., Life, U. N. B. C. F., & Sciences, H. (2015). "Editing" genes: A case study about how language matters in bioethics. *The American Journal of Bioethics*, *15*(12), 3–10.
Paolucci, E. M., MacIsaac, H. J., & Ricciardi, A. (2013). Origin matters: Alien consumers inflict greater damage on prey populations than do native consumers. *Diversity and Distributions*, *19*(8), 988–995.
PBS (Writer). (2018). Battleground Evergaldes. In.
Pereyra, P. J. (2016). Revisiting the use of the invasive species concept: An empirical approach. *Austral Ecology*, *41*(5), 519–528.
Peters, H. P., Lang, J. T., Sawicka, M., & Hallman, W. K. (2007). Culture and technological innovation: Impact of institutional trust and appreciation of nature on attitudes towards food biotechnology in the USA and Germany. *International Journal of Public Opinion Research*, *19*(2), 191–220.
Pimentel, D., Zuniga, R., & Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics*, *52*(3), 273–288.
Priest, S. H. (2001). Misplaced faith: Communication variables as predictors of encouragement for biotechnology development. *Science Communication*, *23*(2), 97–110.
Regalado, A. (2017). First gene drive in mammals could aid vast New Zealand eradication plan. *MIT Technology Review*. Retrieved from https://www.technologyreview.com/s/603533/first-gene-drive-in-mammals-could-aid-vast-new-zealand-eradication-plan/?utm_campaign=add_this&utm_source=email&utm_medium=post.
Richardson, D. M., Pyšek, P., Rejmánek, M., Barbour, M. G., Panetta, F. D., & West, C. J. (2000). Naturalization and invasion of alien plants: Concepts and definitions. *Diversity and Distributions*, *6*(2), 93–107.
Rousseau, D. M., Sitkin, S. B., Burt, R. S., & Camerer, C. (1998). Not so different after all: A cross-discipline view of trust. *Academy of Management Review*, *23*(3), 393–404.
Rudolph, T. J., & Evans, J. (2005). Political trust, ideology, and public support for government spending. *American Journal of Political Science*, *49*(3), 660–671.
Russell, J. (2014). A comparison of attitudes towards introduced wildlife in New Zealand in 1994 and 2012. *Journal of the Royal Society of New Zealand*, *44*(4), 136–151.

Sinclair, K. (2018). Combatting lake invaders: A proposal for ballast water standards to save the great lakes from invasive species. *Ecology Law Quarterly*, *45*, 473.
Smith, S. (2015). 6 key takeaways about how Americans view their government. *Pew Research Center*. Retrieved from https://www.pewresearch.org/fact-tank/2015/11/23/6-key-takeaways-about-how-americans-view-their-government/
Temple, S. A. (1990). The nasty necessity: Eradicating exotics. *Conservation Biology*, *4*(2), 113–115.
Thibodeau, P. H., & Durgin, F. H. (2011). Metaphor aptness and conventionality: A processing fluency account. *Metaphor and Symbol*, *26*(3), 206–226.
Trumbo, C. W., & McComas, K. A. (2008). Institutional trust, information processing and perception of environmental cancer risk. *International Journal of Global Environmental Issues*, *8*(1-2), 61–76.
Venton, D. (2013). Forest management plans in a tangle: Conservation fight flares over invasive California eucalyptus. *Nature*, *501*(7465), 15–16.
Vitousek, P. M., D'antonio, C. M., Loope, L. L., Rejmanek, M., & Westbrooks, R. (1997). Introduced species: A significant component of human-caused global change. *New Zealand Journal of Ecology*, *21*(1), 1–16.
Warner, K. D. (2012). Fighting pathophobia: How to construct constructive public engagement with biocontrol for nature without augmenting public fears. *BioControl*, *57*(2), 307–317.
Warner, K. D., & Kinslow, F. (2013). Manipulating risk communication: Value predispositions shape public understandings of invasive species science in Hawaii. *Public Understanding of Science*, *22*(2), 203–218.
West, S. G., Aiken, L. S., & Krull, J. L. (1996). Experimental personality designs: Analyzing categorical by continuous variable interactions. *Journal of Personality*, *64*(1), 1–48.