LETTER

Communicating About Invasive Species: How "Driver" and "Passenger" Models Influence Public Willingness to Take Action

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Keywords
Attribution of responsibility; conservation management; invasive species; public action; risk perception.

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Received
12 September 2013
Accepted
14 April 2014

doi: 10.1111/conl.12109

Abstract

Invasive species may be viewed as "passengers" that spread in response to environmental changes rather than "drivers" of ecological impacts. To date, however, there has been no examination of how these alternative models affect public risk perception, sense of responsibility, and willingness to take action. We report on an experimental study of how these models affected respondents' ($N = 456$) willingness to take action to address two invasive species: tamarisk and garlic mustard. We found that the traditional driver model, compared to the passenger model, increased perception of risk to humans and the environment, both of which contributed to willingness to take action. The driver model, however, also decreased personal causal responsibility, though only when human responsibility for introduction was not mentioned. Our findings suggest that these alternative models create trade-offs for communication that necessitate contextual framing that attends to audience sense of risk and responsibility.

Introduction

Ecologists increasingly recognize that invasive species may be understood as "passengers" that spread in response to concurrent environmental changes, rather than "drivers" that directly cause ecological impacts (Didham *et al*. 2005; Macdougall & Turkington 2005; Wilson & Pinno 2013). Ecologists also debate whether the origin of species (native vs. non-native) is pertinent for judging them or whether we should instead focus on their impacts (Davis *et al*. 2011; Simberloff 2011). To date, however, there has been no examination of how these alternative models affect the public's risk perception of invasive species or their attribution of personal responsibility, both of which may affect willingness to take action. Yet if the public's willingness to take action is affected, it has critical implications for conservation management efforts because the recruitment and retention of volunteers is an important tool in monitoring and managing invasive species (Cohn 2008; Crall *et al*. 2011; Beirne & Lambin 2013).

To examine this issue, we draw on theory from the field of science communication. When science communicators design public outreach materials they offer interpretive packages that give meaning to an issue by presenting "a central organizing idea . . . for making sense of relevant events, suggesting what is at issue" (Gamson & Modigliani 1989). These choices "frame" an issue and "promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (Entman 1993). Scholars increasingly recognize the effects of framing in environmental management (Allan 2007; Larson 2011; Moore & Moore 2013), and in the case of climate change, there is now evidence that alternative frames can shift public perception and willingness to take action (Nisbet 2009; Hart & Nisbet 2012). It has been proposed that different models of invasive species will have similar effects (Larson 2005; Keulartz & van der Weele 2008), although we are unaware of any empirical tests of these propositions. To help fill this research gap, we report on an experimental study of how the driver and passenger models affect citizen perceptions

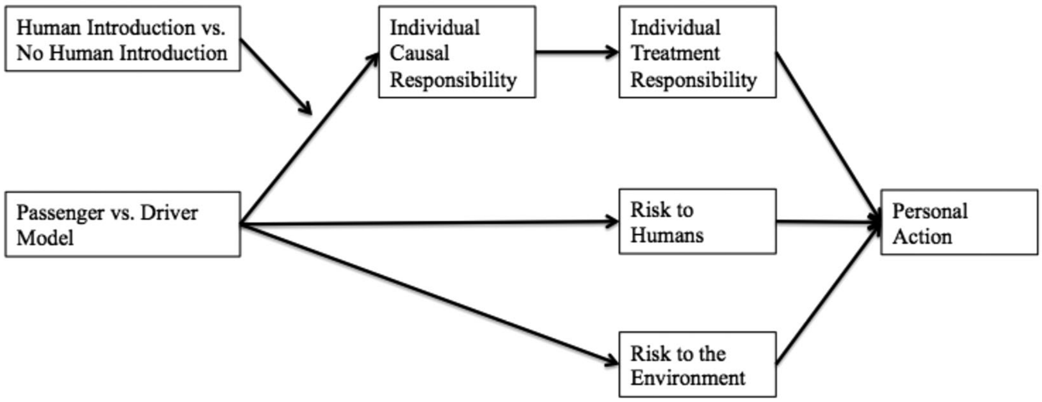

Figure 1 Conceptual framework for testing.

and willingness to take action to address invasive species.

To assess the impact of the driver and passenger models on predisposition to take action, we draw from research identifying two primary causal pathways: the perception of risk and the attribution of personal responsibility (Figure 1; Story & Forsyth 2008). Selge *et al.* (2011), for example, found that people's perceptions of both the potential harm of an invasive species and human responsibility for its spread affect their preferred interventions. Both the Extended Parallel Process Model (Witte 1992) and Protection Motivation Theory (Maddux & Rogers 1983) hold that elevated risk perceptions can promote action to address a risk as long as individuals do not feel hopeless about a situation; multiple studies have confirmed this result in environmental contexts (Lévy-Leboyer *et al.* 1996; Hart *et al.* 2011). In addition, it is advisable to examine the perceived risks to humans and to the environment separately because they may differentially affect predispositions for behavior (Schultz 2000).

The passenger and driver models may also affect predispositions for action through the pathway of attribution of personal responsibility, which has two components: causal and treatment responsibility (Iyengar 1994; Stern *et al.* 1999). Causal responsibility refers to the belief that an individual is responsible for causing a problem, which may increase treatment responsibility, the belief that an individual is responsible for fixing a problem. Previous research has found a positive association between attribution of personal responsibility and willingness to take action across a variety of environmental issues (Story & Forsyth 2008).

Overall, we expect the driver model, compared to the passenger model, to increase risk perceptions and thus to strongly motivate action, because it emphasizes the agency of invasive species in causing ecological disruption. However, by the same token we expect that these aspects of agency in the driver model have the potential to lower the impetus to action by lowering attribution of personal responsibility. Accordingly, we expect the passenger model, which emphasizes the role of both humans and other actors in ecological disruption, to increase attribution of responsibility compared to the driver model, even as it lowers risk perception.

We also explore whether mentioning human introduction of an invasive species influences the relative effect of the driver and passenger models through attribution of responsibility. Human introduction suggests that humans are at fault for causing the problem, so we expect that mentioning it will lower the difference between the effect of adopting a driver or passenger model on perceived causal responsibility.

Method

Study design

We adopted a between-subject random assignment 2 (driver vs. passenger model) × 2 (mention of human introduction of invasive species vs. no mention of human introduction) experimental design to identify how these different models for invasive species may affect willingness to take personal action through the causal pathways of attribution of responsibility, perceived risk to humans, and perceived risk to the environment. To improve the generalizability of the study, each participant was asked about one of two invasive species, tamarisk/salt cedar (*Tamarix* species) or garlic mustard (*Alliaria petiolata*), both of which are amenable to descriptions under a passenger or driver model (see Stromberg *et al.* 2009; Davis *et al.* 2012, respectively). Thus, there were 8 conditions (four experimental conditions × two invasive species). Fifty-seven participants were randomly assigned to each condition for a total sample of 456. We recruited undergraduate students from a university in the northeastern United States for the study; such students are frequently recruited as volunteers for invasive species management programs (Krasny & Lee 2002; Cohn 2008; Delaney *et al.* 2008). Students were randomly recruited from multiple public areas on campus and then directed to a private area for the study. After listwise deletion of participants who did not complete the questionnaire, 436 participants remained for the analysis. APA ethical guidelines were followed and experimental participants did not receive compensation for completing the experiment.

After signing a consent form, participants were first provided with an information sheet that described one of the two invasive species under one of the varied conditions described above (full text of conditions is provided in Appendix 1). While the information sheets were constructed for the experiment, we consulted with ecologists to ensure their scientific accuracy. The driver model conditions focused on plant characteristics that cause ecological change whereas those for the passenger model focused on characteristics that allowed the plant to thrive under conditions of ecological change.

Independent control variables

Sociodemographics

Sociodemographics were measured by asking participants their age ($\bar{x} = 20.4$; SD = 2.77) and gender (Male = 0, Female = 1, $\bar{x} = 0.6$, SD = 0.5). There was little variance in age, so it was dropped from the analysis.

Core ecological beliefs

Participants were asked about their core ecological beliefs using the scale adopted by Stedman *et al.* (2004). The ecological core beliefs scale is a seven-item subset of the new environmental paradigm (NEP) scale developed by Dunlap & Van Liere (1978), and asks participants how much they agree with statements such as "The balance of nature is very delicate and easily upset by human activities." Answers were aggregated into a mean scale ($\bar{x} = 4.88$, SD = 1.05, Cronbach's $\alpha = 0.811$)

Invasive species type

A dummy variable was coded to indicate whether the participant was in a tamarisk or garlic mustard condition with garlic mustard as the reference group; this was then used to control for species type.

Mediating variables

Attribution of responsibility

Attribution of personal causal responsibility was assessed by asking participants how responsible "individual people like me" are for causing the tamarisk/garlic mustard problem (not at all responsible = 1, very responsible = 7, $\bar{x} = 3.11$, SD = 1.87). Attribution of personal treatment responsibility was assessed by asking participants how responsible "individual people like me" are for addressing (fixing) the tamarisk/garlic mustard problem (not at all responsible = 1, very responsible = 7, $\bar{x} = 3.75$, SD = 1.83).

Risk perception

To assess respondents' perception of risk that tamarisk/garlic mustard poses to humans, we asked them to evaluate the severity of their threat to (a) "people like me," (b) "local communities near rivers that have tamarisk" (or "near woodlands that have garlic mustard"), and (c) "the United States as a whole." To assess their perception of risk that the species poses to the environment, we asked them to evaluate the severity of their threat to (a) "biodiversity," (b) rivers in the southwestern United States (or "woodlands in the northeastern United States"), (c) "plants," and (d) "the United States as a whole." For each item, respondents answered on a seven-point scale ranging from 1 (not at all a threat) to 7 (very serious threat); the answers to these questions were then aggregated into two mean scales (humans: $\bar{x} = 3.23$, SD = 1.46, Cronbach's $\alpha = 0.816$; environment: $\bar{x} = 4.72$, SD = 1.40, Cronbach's $\alpha = 0.769$).

Dependent variable

Willingness to address invasive species

To assess the participants' willingness to take action to address invasive species, we asked them the following question: "assuming you lived in a region where tamarisk/garlic mustard occurred, how likely would you be to participate in any of the following activities that could help remove tamarisk from along rivers" (or "garlic mustard from woodlands)?" The five activities were (a) attend a local public meeting, (b) contact a local public official, (c) volunteer with a local citizens' or environmental group, (d) participate on a local committee or task force, and (e) uproot it while hiking along a river" (or "in a woodland"). For each item, participants answered on a seven-point scale ranging from 1 (not at all likely) to 7 (very likely); answers were then aggregated into a single mean scale ($\bar{x} = 2.89$, SD = 1.55, Cronbach's $\alpha = 0.898$).

Data analysis

We first used ANOVA to investigate the representation of control variables for participants across conditions. We then used an ordinary least squares regression-based path analytic framework with the SPSS PROCESS macro developed by Hayes (2013) to examine the direct and indirect effect of these alternative models on willingness to take action through three causal pathways: (i) perception of risks to humans, (ii) perception of risks to the environment, and (iii) personal causal responsibility (see Figure 1).

The PROCESS macro generates a bootstrapped confidence interval for each of the three causal pathways while controlling for the control variables and other variables in the conceptual framework; the bootstrap analysis was conducted with 10,000 iterations and bias-corrected estimates, based on the recommendations of Hayes (2013). The bootstrapping approach toward indirect effects adopted here is generally considered superior to the Sobel test or causal steps approach (Hayes 2013). In addition, results from the PROCESS macro do not significantly differ from results of structural equation modeling (Preacher & Hayes 2008; Hayes 2013) and the inferential test process for coefficients adopted by the PROCESS macro, which is based on the *t* distribution, is more appropriate for smaller samples than the process typically adopted by SEM programs (Hayes 2013).

Table 1 Results from mediation analysis of the passenger and driver models through perception of risk to humans and perception of risk to the environment

Predictor	B
Equation predicting mediator 1 (risk to humans)	
Intercept	0.651*
Gender (female)	0.347*
Environmental values	0.193*
Causal responsibility	0.102*
Treatment responsibility	0.200***
Invasive species (garlic mustard)	0.176
Message condition (human introduction)	0.047
Message condition (driver model)	0.495***
Equation predicting mediator 2 (risk to environment)	
Intercept	2.05***
Gender (female)	0.243
Environmental values	0.309***
Causal responsibility	0.092*
Treatment responsibility	0.123**
Invasive species (garlic mustard)	0.157
Message condition (human introduction)	0.054
Message condition (driver model)	0.311*
Equation predicting dependent variable (willingness to take action)	
Intercept	−0.006
Gender (female)	0.062
Environmental values	0.301***
Causal responsibility	−0.012
Treatment responsibility	0.141**
Invasive species (garlic mustard)	−0.356**
Message condition (human introduction)	0.010
Message condition (driver model)	−0.198
Risk to environment	0.132*
Risk to humans	0.180**

Note: ***$P < 0.001$; **$P < 0.01$; *$P < 0.05$. Unstandardized coefficients are reported.

Results

A one-way ANOVA found no differences between conditions for gender ($F_{7,429} = 0.679$, $P = 0.69$) or environmental values ($F_{7,429} = 1.445$, $P = 0.19$). The regression analysis found that individuals were more willing to take action to address tamarisk than garlic mustard (unstandardized regression coefficient $b = -0.356$, $P < 0.001$); tamarisk and garlic mustard conditions were combined for subsequent analysis with a dummy variable included to control for this difference.

Looking first to risk perceptions, the regression analysis found that the driver model increased perception of the risk that the invasive species posed to humans ($b = 0.495$, $P < 0.001$) and the perception of risk to humans had a positive influence on willingness to take action ($b = 0.180$, $P < 0.01$) (see Table 1).

The regression analysis also found that the driver model increased perception of the risk that the invasive species posed to the environment ($b = 0.311$, $P < 0.05$), which, in turn, increased willingness to take action ($b = 0.132$, $P < 0.05$) (see Table 1).

Looking next to attribution of personal responsibility, the analysis revealed that the effect of the driver model was conditional on whether or not human introduction of invasive species was mentioned. When human introduction was not mentioned, the driver model suppressed perceptions of causal responsibility compared to the passenger model ($b = -0.648$, $P < 0.01$), whereas when human introduction was mentioned, the influence of the driver model was similar to the passenger model on individual causal responsibility ($b = 0.139$, $P = 0.56$; see Table 2, Figure 2). Individual causal responsibility, in turn, had a positive influence on attribution of individual treatment responsibility ($b = 0.500$, $P < 0.001$), which had a positive influence on willingness to take action ($b = 0.140$, $P < 0.01$) (see Table 2).

The analysis of indirect effects through bootstrapped mediation tests corroborated the aforementioned results. If the lower (LCI) and upper (UCI) 95% confidence intervals for the indirect effects are either *both* above zero or *both* below zero there is a significant indirect effect through the mediator(s). The driver condition had a

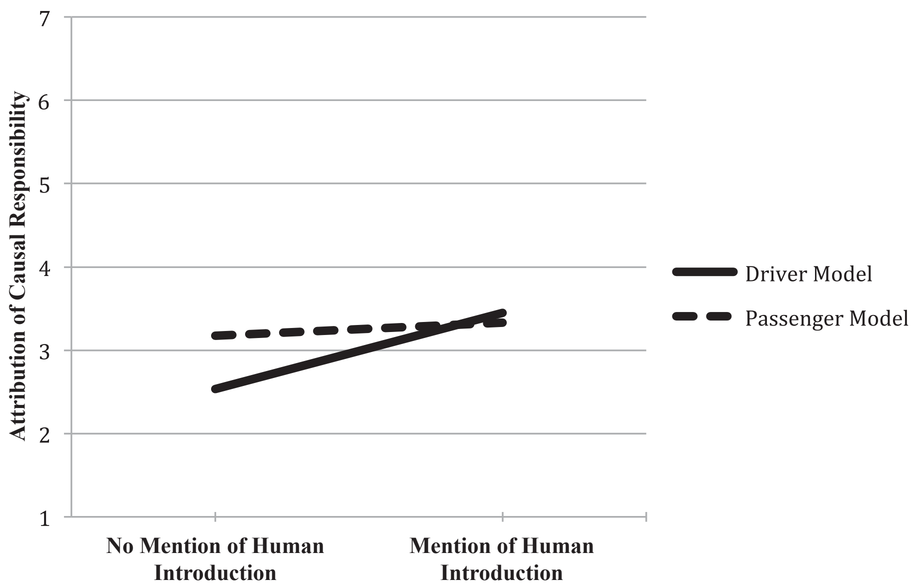

Figure 2 Driver model versus mention of human introduction on attribution of causal responsibility.
Note: Estimates in this figure are calculated with covariates set to their sample means.

significant positive mediated influence on willingness to take action through the perceived risk to humans (LCI = 0.023, UCI = 0.200) and through the perceived risk to the environment (LCI = 0.006, UCI = 0.113). When human introduction was not mentioned, the driver model had a significant negative mediated influence on willingness to take action through attribution of personal responsibility (LCI = –0.110, UCI = –0.011); this indirect influence did not appear, however, when human introduction was mentioned (LCI = –0.020, UCI = 0.060).

Discussion

To the best of our knowledge, this is the first study to examine how the use of the driver or passenger models of invasive species in public outreach affects willingness to take action. As volunteers often serve a critical function in conservation efforts, this study encourages conservation practitioners to consider and to evaluate the public impact of framing outreach materials in different ways. Our results offer a nuanced view into how these two models may affect willingness to take action through the mediated causal pathways of public perceptions of risk and attribution of responsibility. The driver model, compared to the passenger model, encouraged willingness to take action to address invasive species by raising perceptions of the risk posed to humans and the environment. The driver model, however, also demonstrated the potential to suppress willingness to take action to address invasive species by lowering perceptions of individual responsibility, although this suppressive effect appears to be mitigated by the inclusion of a statement of human responsibility for introducing a species. We thus conclude that outreach materials will increase the predisposition to action when a driver model of invasive species is paired with an explicit statement about their human introduction.

Of course, this is only one study, and caution should be taken when generalizing. In particular, our study focused on predispositions to engage in behavior to address invasive species but did not measure actual behavior (cf. Prinbeck *et al*. 2011). In addition, while undergraduate students offer useful information for how potential student volunteers are likely to respond to information about invasive species, they are not representative of the general U.S. or even broader populations. Thus, future studies may build from this research to include observed behavioral responses among a more heterogeneous population; for example, personal characteristics may impact the mental models of both the lay public and scientists (e.g., ideology, disciplinary background, see Corley *et al*. 2009; Besley & Nisbet 2013) and affect whether they support or oppose alternative intervention strategies.

The unstandardized coefficients for the effects in our study were somewhat small. We suspect that this results from the use of a single exposure to the stimulus in our experiment, which provides a conservative estimate of effects that might occur with a more comprehensive communication campaign in which individuals are exposed to a message multiple times. The results may have also

Table 2 Results from moderated-mediation analysis of the passenger and driver models through attribution of causal and treatment responsibility

Predictor	b
Equation predicting mediator (causal responsibility)	
Intercept	2.012***
Gender (female)	−0.172
Environmental values	0.001
Threat to humans	0.290***
Threat to environment	0.135
Invasive species (garlic mustard)	−0.656***
Message condition (human introduction)	0.158
Message condition interaction (human intro × driver)	0.786*
Message condition (driver model)	
With no mention of human introduction	−0.648**
With mention of human introduction	0.139
Equation predicting mediator (treatment responsibility)	
Intercept	0.390
Gender (female)	−0.038
Environmental values	0.189**
Threat to humans	0.217***
Threat to environment	−0.055
Invasive species (garlic mustard)	−0.055
Message condition (human introduction)	−0.079
Message condition interaction (human intro × driver)	−0.094
Message condition (driver model)	0.061
Causal responsibility	0.500***
Equation predicting dependent variable (willingness to take action)	
Intercept	−0.020
Gender (female)	0.062
Environmental values	0.302***
Threat to humans	0.175**
Threat to environment	0.132*
Invasive species (garlic mustard)	−0.356**
Message condition (human introduction)	0.028
Message condition interaction (human intro × driver)	−0.038
Message condition (driver model)	−0.179
Causal responsibility	−0.012
Treatment responsibility	0.140**

Note: *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$. Unstandardized coefficients are reported. For the equation predicting the mediator *causal responsibility*, two driver model coefficients are provided to demonstrate how the impact of the driver model varies depending on the whether human introduction of species is mentioned or not. For the other equations in the table (predicting treatment responsibility and willingness to take action), there was no significant difference between the two versions of the coding for the human introduction variable, and the reported driver coefficient is with human introduction not mentioned.

been affected by the specific species and language adopted for the conditions in our study; we note, for example, that in general individuals were more willing to take action to address tamarisk than garlic mustard. Respondents may also have interpreted the "driver" model to have a more negative tone (Slovic *et al*. 2004), or they may have perceived other, unaccounted differences between conditions, which could have affected our results. While we used two different species to improve generalizability and reduce the chance that specific wording would overly affect the results, future studies may wish to examine the implications of language choices at a finer scale.

In addition to the direct effects examined here, framing effects have the potential to shape opinions through patterns of negotiated meaning that arise through interactions between various members of the public. We thus propose future research that examines additional dependent variables such as conversation dynamics to integrate the present research with literature examining how issue framing may impact discursive processes between scientists, journalists, managers, and the public (Price *et al*. 2005; Nisbet 2009; Nisbet & Scheufele 2009). Such inquiry would also touch more directly on broader ethical questions related to the form of communication and its implications for different audiences (e.g. Warner & Kinslow 2013).

Our study provides evidence that adopting different models for communicating about invasive species is likely to impact public perceptions and willingness to take action. However, we have analyzed "passenger" and "driver" as alternative communication models, when it may ultimately be a scientific question whether one or the other is appropriate in a given context. Thus, our findings are not intended as a prescription of how conservation practitioners ought to design messages about invasive species to reach out to the public and recruit volunteers, but instead seek to provide insight into the potential effects of alternative messages. It is likely that the insights from the present study are not limited to communicating about invasive species, but may apply in additional domains of environmental management.

Acknowledgments

We appreciate comments on the alternative descriptions of tamarisk and garlic mustard from Matt Chew and Mark Davis (respectively), and helpful comments from several anonymous reviewers and editors.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Appendix 1.

References

Allan, C. (2007) Exploring natural resource management with metaphor analysis. *Soc. Nat. Resour.*, **20**, 351-362.

Beirne, C. & Lambin, X. (2013) Understanding the determinants of volunteer retention through capture-recapture analysis: answering social science questions using a wildlife ecology toolkit. *Conserv. Lett.*, **6**, 391-401.

Besley, J.C. & Nisbet, M. (2013) How scientists view the public, the media and the political process. *Public Underst. Sci.*, **22**, 644-659.

Cohn, J.P. (2008) Citizen science: can volunteers do real research? *BioScience*, **58**, 192-197.

Corley, E.A., Scheufele, D.A. & Hu, Q. (2009) Of risks and regulations: how leading U.S. nanoscientists form policy stances about nanotechnology. *J. Nanoparticle Res.*, **11**, 1573-1585.

Crall, A.W., Newman, G.J., Stohlgren, T.J., Holfelder, K.A., Graham, J. & Waller, D.M. (2011) Assessing citizen science data quality: an invasive species case study. *Conserv. Lett.*, **4**, 433-442.

Davis, M.A., Chew, M.K., Hobbs, R.J. *et al.* (2011) Don't judge species on their origins. *Nature*, **474**, 153-154.

Davis, M.A., Colehour, A., Daney, J. *et al.* (2012) The population dynamics and ecological effects of garlic mustard, *Alliaria petiolata*, in a Minnesota oak woodland. *Am. Midl. Nat.*, **168**, 364-374.

Delaney, D.G., Sperling, C.D., Adams, C.S. & Leung, B. (2008) Marine invasive species: validation of citizen science and implications for national monitoring networks. *Biol. Invasions*, **10**, 117-128.

Didham, R.K., Tylianakis, J.M., Hutchison, M.A., Ewers, R.M. & Gemmell, N.J. (2005) Are invasive species the drivers of ecological change? *Trends Ecol. Evol.*, **20**, 470-474.

Dunlap, R.E. & Van Liere, K.D. (1978) The new environmental paradigm: a proposed measuring instrument and preliminary results. *J. Environ. Educ.*, **9**, 10-19.

Entman, R.M. (1993) Framing: towards clarification of a fractured paradigm. *J. Commun.*, **43**, 51-58.

Gamson, W.A. & Modigliani, A. (1989) Media discourse and public opinion on nuclear power: a constructionist approach. *Am. J. Sociol.*, **95**, 1-37.

Hart, P.S. & Nisbet, E.C. (2012) Boomerang effects in science communication: how motivated reasoning and identity cues amplify opinion polarization about climate mitigation policies. *Commun. Res.*, **39**, 701-723.

Hart, P.S., Nisbet, E.C. & Shanahan, J.E. (2011) Environmental values and the social amplification of risk: an examination of how environmental values and media use influence predispositions for public engagement in wildlife management decision making. *Soc. Nat. Resour.*, **24**, 276-291.

Hayes, A.F. (2013) *Introduction to mediation, moderation, and conditional process analysis: a regression-based approach*. The Guilford Press, New York.

Iyengar, S. (1994) *Is anyone responsible? How television frames political issues*. University of Chicago Press, Chicago, IL.

Keulartz, J. & van der Weele, C. (2008) Framing and reframing in invasion biology. *Configurations*, **16**, 93-115.

Krasny, M.E. & Lee, S.-K. (2002) Social learning as an approach to environmental education: lessons from a program focusing on non-indigenous, invasive species. *Environ. Educ. Res.*, **8**, 101-119.

Larson, B.M.H. (2005) The war of the roses: demilitarizing invasion biology. *Front. Ecol. Environ.*, **3**, 495-500.

Larson, B. (2011) *Metaphors for environmental sustainability: redefining our relationship with nature*. Yale University Press, New Haven, CT.

Lévy-Leboyer, C., Bonnes, M., Chase, J., Ferreira-Marques, J. & Pawlik, K. (1996) Determinants of pro-environmental behaviors: a five-countries comparison. *Eur. Psychol.*, **1**, 123-129.

Macdougall, A.S. & Turkington, R. (2005) Are invasive species the drivers or passengers of change in degraded ecosystems? *Ecology*, **86**, 42-55.

Maddux, J.E. & Rogers, R.W. (1983) Protection motivation and self-efficacy: a revised theory of fear appeals and attitude change. *J. Exp. Soc. Psychol.*, **19**, 469-479.

Moore, K.D. & Moore, J.W. (2013) Ecological restoration and enabling behavior: a new metaphorical lens? *Conserv. Lett.*, **6**, 1-5.

Nisbet, M.C. (2009) Communicating climate change: why frames matter for public engagement. *Environ. Sci. Policy Sustain. Dev.*, **51**, 12-23.

Nisbet, M.C. & Scheufele, D.A. (2009) What's next for science communication? Promising directions and lingering distractions. *Am. J. Bot.*, **96**, 1767-1778.

Preacher, K.J. & Hayes, A.F. (2008) Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav. Res. Methods*, **40**, 879-891.

Price, V., Nir, L. & Cappella, J.N. (2005) Framing public discussion of gay civil unions. *Public Opin. Q.*, **69**, 179-212.

Prinbeck, G., Lach, D. & Chan, S. (2011) Exploring stakeholders' attitudes and beliefs regarding behaviors that prevent the spread of invasive species. *Environ. Educ. Res.*, **17**, 341-352.

Schultz, P.W. (2000) Empathizing with nature: the effects of perspective taking on concern for environmental issues. *J. Soc. Issues*, **56**, 391-406.

Selge, S., Fischer, A. & van der Wal, R. (2011) Public and professional views on invasive non-native species – a qualitative social scientific investigation. *Biol. Conserv.*, **144**, 3089-3097.

Simberloff, D. (2011) Non-natives: 141 scientists object. *Nature*, **475**, 153-154.

Slovic, P., Finucane, M., Peters, E. & MacGregor, D.G. (2004) Risk as analysis and risk as feelings: some thoughts about affect, reason, risk, and rationality. *Risk Anal.*, **24**, 311-322.

Stedman, R.C., Davidson, D.J. & Wellstead, A.M. (2004) Risk and climate change: perceptions of key policy actors in Canada. *Risk Anal.*, **24**, 1393-1404.

Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A. & Kalof, L. (1999) A value-belief-norm theory of support for social movements: the case of environmentalism. *Hum. Ecol. Rev.*, **6**, 81-98.

Story, P.A. & Forsyth, D.R. (2008) Watershed conservation and preservation: environmental engagement as helping behavior. *J. Environ. Psychol.*, **28**, 305-317.

Stromberg, J.C., Chew, M.K., Nagler, P.L. & Glenn, E.P. (2009) Changing perceptions of change: the role of scientists in *Tamarix* and river management. *Restor. Ecol.*, **17**, 177-186.

Warner, K.D. & Kinslow, F. (2013) Manipulating risk communication: value predispositions shape public understandings of invasive species science in Hawaii. *Public Underst. Sci.*, **22**, 203-218.

Wilson, S.D. & Pinno, B.D. (2013) Environmentally-contingent behaviour of invasive plants as drivers or passengers. *Oikos*, **122**, 129-135.

Witte, K. (1992) Putting the fear back into fear appeals: the extended parallel process model. *Commun. Monogr.*, **59**, 329-349.

