

RESEARCH ARTICLE

Common approaches to introduced species management face widespread acceptance problems in the United States

Wade Simmons¹  | Darragh Hare^{1,2}  | Andrea Dávalos³  | Bernd Blossey¹ 

¹Department of Natural Resources and the Environment, Cornell University, Ithaca, New York, USA

²Wildlife Conservation Research Unit, Department of Biology, University of Oxford, Oxford, UK

³Department of Biological Sciences, SUNY Cortland, Cortland, New York, USA

Correspondence

Wade Simmons

Email: wps42@cornell.edu

Handling Editor: Alex Erwin

Abstract

1. Decisions on whether and how to manage introduced species can be controversial, but public attitudes towards introduced species management (ISM) are poorly understood. Despite the potential disruptive impacts of such controversies on public relations and conservation goals, decision-makers are currently left with little information on the social acceptability of different management alternatives.
2. To better understand the social acceptability of core features of ISM in the United States, we conducted an online experiment with vignettes describing hypothetical but realistic ISM scenarios, varying targeted taxon (insect or plant), control method (mechanical, chemical and biological), risk severity (low and high) and type of non-target risk (to humans or native species).
3. Not surprisingly, management with low risk was most acceptable, particularly for mechanical control. In high-risk scenarios, only mechanical control was acceptable, but only by a slim majority of respondents. Overall, chemical and biological controls showed low levels of acceptability.
4. Surprisingly, there was no significant difference in how respondents ranked risks to people and risks to native species.
5. Beyond differences in acceptability between management factors, we also find that the acceptability of management and attitudes towards risk were associated with respondents' demographic characteristics.
6. *Policy Implications.* Overall, our findings indicate that widespread acceptability of ISM should not be assumed. While management activities representing low-risk scenarios find some support in the public, our results highlight a disconnect between the effectiveness of common management methods and their social acceptability. Our findings highlight the need for evidence-guided ISM, which includes evidence of harmful impacts of introduced species, as well as risks and benefits of management activities, as one potential way to increase the social acceptability of non-native species management.

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2025 The Author(s). *People and Nature* published by John Wiley & Sons Ltd on behalf of British Ecological Society.

KEYWORDS

accountability, biological control, chemical control, experimental vignettes, introduced species, management, mechanical control, social acceptability

1 | INTRODUCTION

Non-native species in the United States (US) are frequently managed on public lands, with public money, and for public benefits, making the public key stakeholders. Management decisions without widespread public support may face opposition, delays, modifications or be abandoned altogether (Crowley et al., 2017; Estévez et al., 2015). Controversies in conservation, including over non-native species, often stem from conflicting values among individuals and stakeholder groups (Bruskotter et al., 2019; Estévez et al., 2015; Redpath et al., 2015). Such controversies can erode trust in management agencies (Crowley et al., 2017; Pomeranz et al., 2021) and undermine conservation goals. Yet social dimensions of non-native species management are under-studied (Estévez et al., 2015), limiting evidence-based decision-making that acknowledges both biological effectiveness and social acceptability.

Human-assisted biological invasions occur when species are transported (accidentally or purposefully) from their current range to a new environment where they are not native (Davis, 2009). This process unfolds in stages and species need to overcome multiple environmental and ecological filters (Figure 1). Most of the non-native

species that arrive in a new environment actually fail to establish, and of those that initially establish and grow, many fail to naturalize, that is, create self-sustaining, reproducing populations. Of those that naturalize, some thrive and expand their range from initial introduction areas, and they may become abundant in local ecosystems. Those non-native species that naturalize and become harmful by affecting native species, ecosystems, human well-being or the economy are considered invasive (Figure 1), but the distinction between introduced and invasive species has become blurred and scientists disagree on terminology (Richardson, 2011).

There is considerable scientific evidence that invasive species can be harmful to nature and nature's contribution to people (IPBES, 2023), but perceptions of invasive species, and of the language used to characterize non-native species, can vary widely (Shackleton et al., 2019), even within the scientific community (Davis et al., 2011; Guareschi et al., 2024; Sax et al., 2022; Soto et al., 2024). Part of the complexity that makes biological invasions a wicked problem (Woodford et al., 2016) is the enormous variation in introduced taxa (from microbes, to insects, to plants, to birds, to fish, to mammals, etc.) and their ecological niches (decomposers, herbivores, parasites, diseases, predators, etc.), causing a

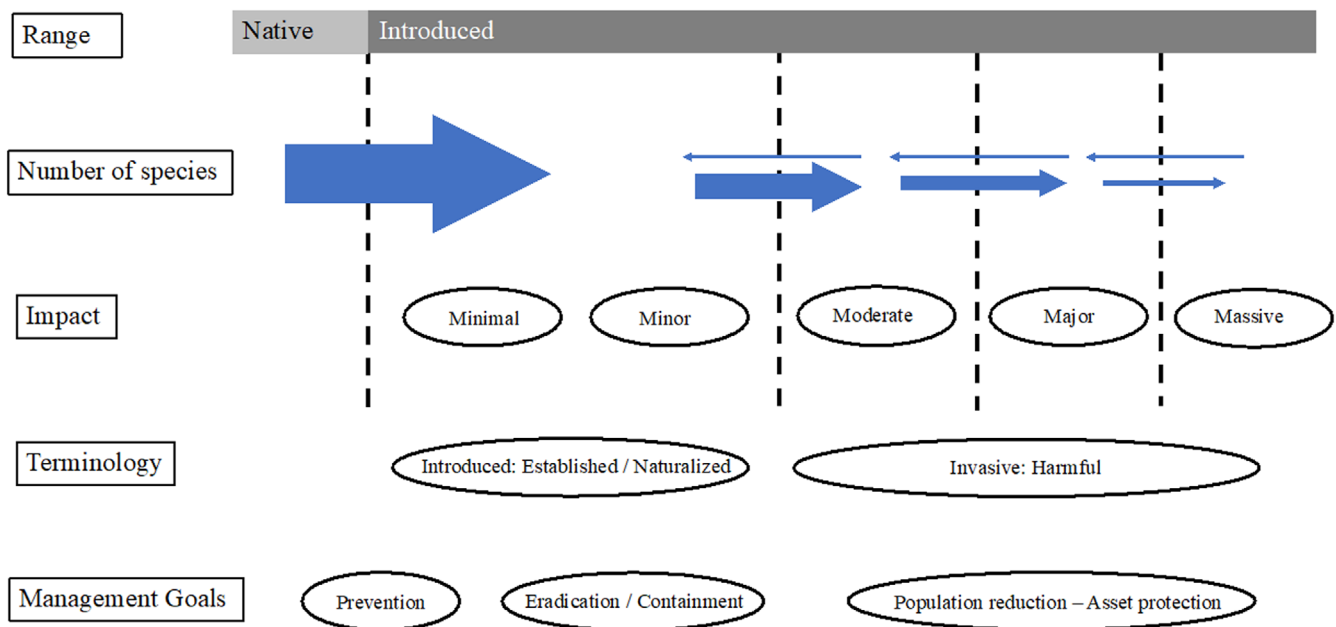


FIGURE 1 Key components describing introductions of non-native species, their impacts, terminology and management goals. Vertical dashed lines represent abiotic (climate, soils, etc.) and biotic (natural enemies, competitors, etc.) filters that reduce the numbers of species able to establish, naturalize, spread or achieve high abundance. Only a subset become 'invasive' requiring documentation of moderate, major or massive harmful negative impacts by some (IPBES, 2023), but not all (Richardson, 2011), classification schemes. Eradication is possible only in very early stages of invasion; once populations grow and ranges expand, management goals shift to containment, population reduction and asset protection. Some species pass through filters in reverse order, that is, their abundance and impacts become smaller over time, often associated with accumulation of natural enemies or diseases. Please note that we avoid problematic terminology, such as 'alien' in our description (Guareschi et al., 2024).

wide variation of potential and realized impacts. Impacts can vary according to how different stakeholders are affected and through time, reflecting a mix of scientific evidence and value judgements and creating intense disagreements about which non-native species should be managed and how (Bruskotter et al., 2019; Estévez et al., 2015; Redpath et al., 2015).

In the US, federal agencies are charged with preventing potentially harmful introductions and attempting early eradications, but as residence time and abundance of non-native species increase, state agencies, NGOs and individual landowners are mostly responsible for containment and abundance reductions (Figure 1). Introduced species management (ISM) aims to prevent or reduce harmful impacts of non-native species. Preventing introductions in the first place and then attempting eradications appears well justified following the precautionary principle (Minteer & Collins, 2005). However, engaging in ISM after a species is well established (Figure 1) reflects a belief that the non-native species is causing harm, and that risks associated with management are smaller compared to risks of not managing. Unfortunately, for the vast majority of non-native species we have extremely limited or no published evidence for their ecological impacts (Blossey, 1999; Davis et al., 2011; Simberloff et al., 2013; Vilà et al., 2024). Even for well-studied species, documented impacts can range from negative, to neutral, to beneficial (Tasker et al., 2022). Non-native species may cause harm, but the evidence base is extremely limited, and further complicating the issue is that some species decline over time after reaching high abundances, often in response to accumulating natural enemies (Blossey et al., 2021). Moreover, ISM often fails to document benefits to native species (Kettenring & Adams, 2011).

ISM managers thus operate in an environment where information about the impacts of non-native species, how management affects non-target species, or whether management improves conditions for native species is highly uncertain. These uncertainties and perceptions of their associated risks may affect public attitudes regarding the three classes of interventions available to managers: mechanical (mowing, cutting and trapping), chemical (herbicides and insecticides) and biological (natural enemy enhancements or purposeful releases). Although biological and chemical controls require federal and state approval before they can be applied at all, their use remains controversial (Barratt et al., 2018; Crowley et al., 2017; Simberloff & Stiling, 1996). Concerns about non-target risks of chemicals are widespread as evidence of detrimental effects on species, food webs and human health continues to accumulate (Blossey, 2016; Gunstone et al., 2021; Mikulyuk et al., 2020; Schulz et al., 2021). Modern pesticides now widely used in ISM are promoted as more selective and less toxic than older versions, but this may be misguided (Schulz et al., 2021). Despite early successes in the early 20th century, enthusiasm for biocontrol has waned in the US, associated with some non-target effects of non-specific predators or herbivores, increased regulatory burdens and prolonged development times (Barratt et al., 2018; Schwarzländer et al., 2018; Simberloff & Stiling, 1996). Mechanical control often does not require federal

or state pre-approval except for place-based applications, such as in protected areas.

All management activities have inherent (but often unknown or undocumented) risks that may be perceived very differently by different individuals. To better understand social acceptability of ISM in the US, we conducted an online experiment investigating 24 realistic but hypothetical ISM scenarios varying targeted taxon (insect or plant), control method (mechanical, chemical and biological), risk severity (low and high) and non-target risk (to human well-being or native species). We restricted our experiment to non-native plants and insects. This allowed us to avoid confounding influences, such as the charisma of species or emotional triggers associated with birds or mammals that may affect the acceptability of their management (Jarić et al., 2020; Verbrugge et al., 2013). We were also purposefully general in our vignettes and did not specify particular species, places, habitats, specific threats by introduced species or specific risks of management. This allowed us to decouple our study from potential local effects, cultural differences (urban vs. rural) or other characteristics that can influence respondents' attitudes (Shackleton et al., 2019). We anticipate that our general assessments can form the basis of more advanced specific investigations probing how respondent's attitudes and behaviours are shaped by their specific life experiences. We expected acceptability to vary depending on target taxa (Lute & Attari, 2017), control method, risk severity and non-target risks. We expected management would be less acceptable in high- versus low-risk scenarios, and when non-target risk was to human well-being rather than native species. Lastly, we expected interactions among experimental variables, and between respondent's demographic characteristics and experimental variables, would help explain acceptability of management actions (Table 1, Table S1 provide a complete list of predictions).

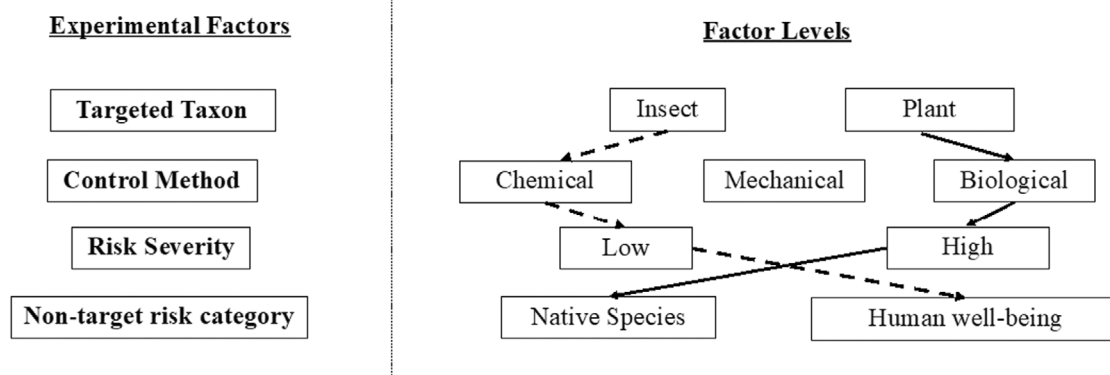
2 | METHODS

We constructed experimental vignettes (Atzmüller & Steiner, 2010)—short, plain-language, written descriptions of realistic invasion scenarios and proposed management actions. All vignettes shared a common structure and differed only in the four experimental factors (taxon, control method, risk severity and type of non-target risks). A full factorial design comprised 24 unique vignettes ($2_{\text{taxon}} \times 3_{\text{control method}} \times 2_{\text{risk severity}} \times 2_{\text{type of non-target risks}}$) (Figure 2, Table S2). Each vignette included a statement that managers believed a particular management action will improve the described situation. We measured respondents' agreement that it would be acceptable for managers to take a particular course of action (henceforth: acceptability) using a 7-point bipolar Likert scale ranging from 'strongly disagree' through 'neither agree nor disagree' to 'strongly agree' with an additional option of 'I do not know'. We described management actions using plain language instead of jargon (e.g. 'introducing a species of insect' instead of 'biocontrol'; 'applying chemicals' instead of 'chemical control') and avoided potentially emotive terms such as 'invasive.'

TABLE 1 List of predictions tested in the online experiment.

Tested experimental variables	Prediction
Taxon	Management of insects will be more acceptable than management of plants
Method	Mechanical control will be more acceptable than chemical control, and biological control will be least acceptable
Risk severity	Low risk will be more acceptable than high risk
Non-target risk	Risks to native species will be more acceptable than risks to human well-being
Risk severity × political score	High-risk management will be more acceptable to conservatives than liberals
Risk severity × land ownership	High-risk management will be more acceptable to individuals owning large tracts of land compared to those owning little or no land
Risk severity × Latin origin	High-risk management will be more acceptable to those not of Latin origin compared to those of Latin origin
Risk severity × childhood landscape	High-risk management will be more acceptable to individuals who grew up in rural settings than to those who grew up in urban settings
Risk severity × income	High-risk management will be more acceptable to wealthier individuals than to less wealthy individuals
Risk severity × age	High-risk management will be more acceptable to younger than older individuals
Risk severity × gender	High-risk management will be more acceptable to men than women
Risk severity × education	High-risk management will be more acceptable to individuals with less formal education than individuals with more formal education
Method × region score	Chemical and biological control will be more acceptable to individuals from the western US. compared to those from the eastern US
Method × education	Biological control will be more acceptable, whereas chemical control will be less acceptable for individuals with more formal education compared to individuals with less formal education
Method × political orientation	Chemical control will be more acceptable to conservatives than liberals
Non-target risk × political score	Risks to native species will be more acceptable to conservatives than liberals
Non-target risk × gender	Risks to human well-being will be more acceptable to men than women

Note: All predictions specified as main or interaction effects in the full model. For a list of references guiding our predictions, see the supplemental materials. Predictions supported by our results are highlighted in bold.



Example vignettes

--- An insect species has arrived in a place where it didn't previously exist and is causing negative effects on the environment. Local natural resource managers are confident that they can substantially improve the situation by applying chemicals to kill the problematic insects. There is a low risk that applying chemicals will harm human well-being in the local area.

— A plant species has arrived in a place where it didn't previously exist and is causing negative effects on the environment. Local natural resource managers are confident that they can substantially improve the situation by introducing a species of insect to kill the problematic plants. There is a high risk that releasing the additional insect will harm native species in the local area.

Response item: It would be acceptable for the managers to spray the chemical[release the insect]. Do you:

Strongly disagree, disagree, somewhat agree, neither agree nor disagree, somewhat agree, agree, strongly agree

FIGURE 2 Experimental design, illustrated by two example vignettes. Underlined sections of vignettes show where text was manipulated. All other text was standardized across all 24 vignettes (see Table S2 for a list of all vignettes).

We hired Qualtrics® to recruit 1234 adults (18+ years) living in the US, stratified to approximate the US population by age and region of residence (www.census.gov), and direct them to our online instrument (Table S3). We randomly pre-sorted vignettes into six groups of four and randomly assigned one group to each participant, generating 4936 responses. To prevent priming effects, we randomized the order of vignettes within each group. Before launching the study, we pre-tested the instrument with colleagues ($n=6$) and incorporated input into the final instrument. We used data on respondent completion times from a soft launch ($n=240$) to establish a minimum time threshold (<0.5 of the median time (min: 2 min; median 4 min)), which we then used to eliminate 'speeders' from our data set. For the final data set, we removed responses from two individuals because they reported not living in the US as well as all 'I do not know' responses to the response variable (total responses removed=209) leaving 4727 (95.7%) responses from 1212 respondents (98.2%) (Table S4). This research was approved by the Cornell University Institutional Review Board (protocol #2006009647), and all respondents provided informed written consent prior to completing the survey (Table S3).

We fitted a cumulative link mixed effects model in R (R Core Team, 2022) using the 'ordinal' package (Christensen, 2022) to determine which factors were significant ($p < 0.05$) in explaining acceptability of proposed management actions. In our global model, we included all four experimental factors and their possible two-way and three-way interactions. We also included main effects of all measured demographic variables (gender, age, Latin origin, income, education, political orientation, land ownership, childhood landscape; see demographic questionnaire, Table S3), and tested 13 two-way interactions between experimental factors and demographic variables for which we had specific predictions based on a range of existing evidence (Table 1, Table S1). For land ownership, we collapsed the two largest ownership categories into a single category due to the small number of respondents. We included a random effect to account for multiple responses from each respondent. We reduced models through sequential backward model elimination with pairwise comparisons, testing nested models against the full global model with likelihood ratio tests until no non-significant terms remained. We tested model terms for collinearity but could not validate all assumptions, including the proportional risk assumption, due to unreliability of methods for ordered logistic regression models with a random effect. We ran an ANODE (Type III) to evaluate effects of all main and interaction terms. We calculated and tested marginal means using 'emmeans' (Lenth, 2023) from the reduced model to explore differences in acceptability between levels of factors identified as significant by ANOVA.

3 | RESULTS

Acceptability of management actions varied across our 24 experimental conditions (Figures 3 and 4). In our best-fit model, each of the four experimental factors significantly predicted the acceptability of

management actions, though risk severity only became significant in interactions with demographic variables (Table 2, Table S5). Taxon, control method and non-target risks were involved in significant two- and three-way interactions.

Within control methods, non-target risk, risk-severity and targeted taxon affected acceptability most frequently for biological control (10/28, 10 significant differences of 28 pairs of comparison within biological control; see Table S6 for a list of all Tukey comparisons) and chemical control (10/28) and least frequently for mechanical control (7/28). Where differences were significant, they always involved high- versus low-risk scenarios, with low risk always having greater support.

Patterns of acceptability were not statistically different within high- or low-risk scenarios. Significant differences in acceptability only occurred in comparisons involving mechanical control, with mechanical control always being more acceptable than the alternative. Attitudes towards biological and chemical controls did not differ significantly from each other, regardless of taxon targeted or associated non-target risks.

Comparing within non-target impacts, acceptability was always significantly lower for biological and chemical relative to mechanical control, regardless of taxon targeted. Acceptability only separated for biological and chemical controls in comparisons to mechanical control across non-target impacts. When biocontrol targeted plants and involved risks to human well-being, acceptability was significantly lower than mechanical control of either plants or insects with risks to native species. In identical comparisons between chemical and mechanical control, acceptability did not differ.

All demographic predictors except residence by US Census Region were significant predictors of acceptability of ISM, and political orientation, land ownership, Latin identity, age, gender and education were involved in significant interactions with risk factors (Table 2, Table S5; Figure 5). In high-risk scenarios, acceptability of management declined significantly with age (Tukey test, difference -0.02 [SE] 0.003, $p < 0.0001$) and was lower for women than men (Tukey test, difference [SE] -0.55 [0.12]) and for non-Latin respondents relative to those with Latin origin (Tukey test, difference [SE] -0.55 , [0.18]; Figure 5). Respondents owning 10+ acres (~ 4.05 ha) found high-risk management significantly more acceptable than those who owned no land (Tukey test, difference [SE] 1.00 [0.24]) or less than an acre (Tukey test, difference [SE] 1.14, [0.23]), as did respondents who grew up 'very urban' compared to 'slightly rural' (Tukey test, difference [SE] 0.79 [0.21]; Figure 5). Contrasts between levels of education and political identity were only significant across risk severities, with lower acceptability for high-risk management. An additional significant interaction between non-target risks and gender also affected acceptability of management (Table S5). When risks were to human well-being, management was less acceptable to women than men (Tukey test, difference [SE]: -0.54 [0.11]) but when risks were to native species, there was no gender difference in acceptability. Women's acceptance of management with risks to native species was significantly greater than when risks were to human well-being (Tukey test, difference [SE]: 0.54 [0.08]), a difference that

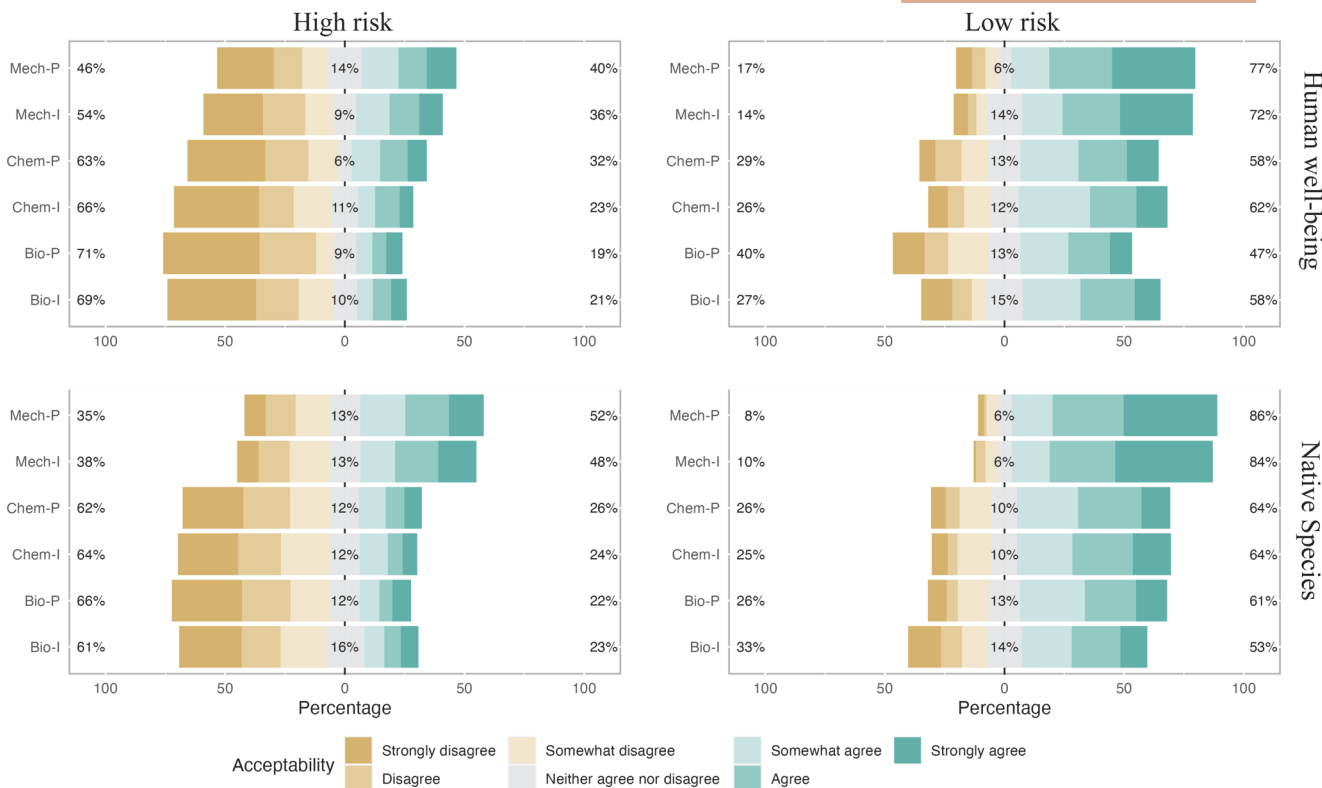


FIGURE 3 Acceptability of mechanical (Mech), chemical (Chem) and biological (Bio) control of non-native plants (P) and insects (I) affecting native species or human well-being in high- and low-risk scenarios. Each bar represents one of 24 experimental treatment combinations of managed taxon, control method, risk severity and non-target risk. Bars show distribution of responses and percentages coloured by disagreement (browns, left), indifference (grey, middle) and agreement (greens, right).

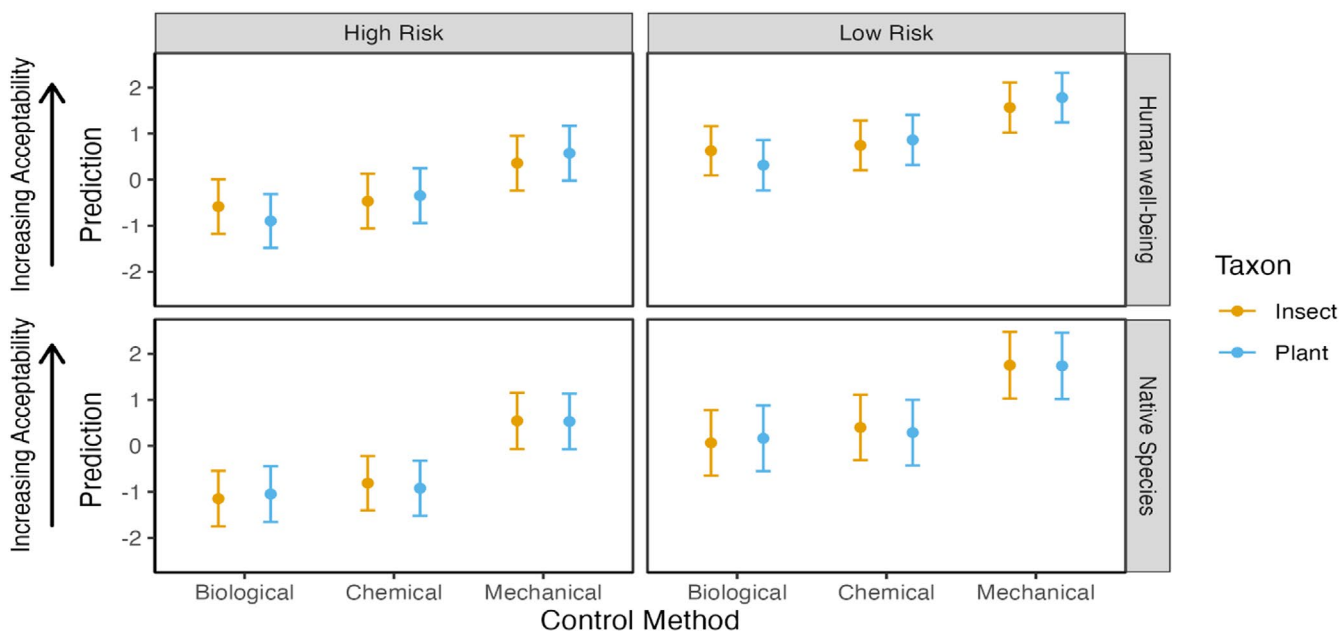


FIGURE 4 Predicted acceptability of introduced species management actions described in experimental vignettes. Each point represents one of 24 experimental treatment combinations of managed taxon, control method, risk severity and non-target risk. Data show parameter estimates (log-odds ratios) with 95% CI error bars from our reduced model. Larger y-values indicate greater acceptability.

TABLE 2 Analysis of deviance output of reduced ordinal mixed model for predicting social acceptability of introduced species management.

Variable	LR χ^2	DF	<i>p</i>
Taxon	-0.002	1	1.000
Method	-0.002	2	1.000
Non-target risk	-0.002	1	1.000
Risk severity	-0.002	1	1.000
Gender	-0.002	2	1.000
Age	-0.002	1	1.000
Latin identity	-0.002	1	1.000
Income	11.267	1	<0.001
Education	-0.002	4	1.000
Political identity	-0.002	7	1.000
Land ownership	-0.002	3	1.000
Childhood landscape	-0.002	7	1.000
Taxon \times method	-0.002	2	1.000
Taxon \times non-target risk	0.001	1	0.980
Method \times non-target risk	-0.001	2	1.000
Risk severity \times political identity	22.110	7	0.002
Risk severity \times land ownership	13.741	3	0.003
Risk severity \times Latin identity	9.374	1	0.002
Risk severity \times childhood landscape	19.909	7	0.006
Risk severity \times age	35.917	1	<0.001
Risk severity \times gender	8.774	2	0.012
Risk severity \times education	16.622	4	0.002
Non-target risk \times gender	12.138	2	0.002
Taxon \times method \times non-target risk	6.980	2	0.030

Note: Variables with bold text indicate statistical significance ($p < 0.05$).

was not significant for men (Tables S5 and S6 list complete model results).

4 | DISCUSSION

Our findings suggest that many current ISM practices have limited acceptability by the US public, even when risk levels are low. This low acceptability stands in stark contrast to claims that non-native species are a major driver for global biodiversity loss, creating harmful economic, ecological and human health impacts and negatively affecting nature's contribution to people globally (IPBES, 2023). Based on our results, public support for management actions targeting non-native species cannot be assumed. This raises fundamental questions about drivers shaping public attitudes regarding the management of non-native species, justifications for targeting certain taxa and choice of management options.

Traditional justifications for conservation using concepts of intrinsic value of species and nature have been criticized for an

'inattention to human well-being' (Kareiva & Marvier, 2012). The expectation of those championing a more human-centric argumentation is that an increased focus on ecosystem services, or nature's contributions to people, would result in increased public support for conservation (Kareiva & Marvier, 2012), but effectiveness of this approach has been questioned (Admiraal et al., 2017). Reported links between introduced species and risks to humans can drive news coverage and online searches (Woodworth et al., 2023), but we found that concerns of management potentially harming native species were equally strong as impacts affecting human well-being. Our results point to a greater societal concern for the fate of native species than generally acknowledged and may be consistent with evidence showing a shift from utilitarian value orientation to more ecocentric or mutualistic views of nature and wildlife in the US (Manfredo et al., 2021) affecting attitudes regarding management of non-native species (Minteer & Collins, 2005).

Concerns of the public over the well-being of non-native species appear amplified when mammals are targeted, for example, cats or horses (Marra & Santella, 2016; Scasta et al., 2020). However, this is not always the case, for example, when non-native mammal control is expected to benefit native mammals (Bremner & Park, 2007). We purposefully avoided lumping different non-native taxa in our vignettes because we expected attitudes to vary depending on whether the non-native targets were plants, invertebrates, fish, birds or mammals (Bremner & Park, 2007). We recognize that environmental value orientations of our respondents may influence their attitudes (Sharp et al., 2011), but we did not measure them, and future work would need to examine how such value orientations may affect support for management actions targeting different but specific taxa in specific locations. We acknowledge that demographic factors (age, gender, land ownership, Latin origin, etc.) can influence respondents' attitudes (but see Steele & Pienaar, 2021) and find support that these characteristics can mediate attitudes, but our data show that attitudes towards management also vary independently of these factors.

What we are left with is an astonishing gap between the discourse and emphasis in national and international bodies such as the US National Invasive Species Council (<https://www.doi.gov/invasivespecies>) or The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (IPBES, 2023) and what people are willing to accept to manage non-native species and their impacts. The non-native plant and insect targets, methods of management and risks we describe in our vignettes were intentionally general to allow sampling across the entire US, and it is likely that with increasing specificity participants may provide different answers. However, each management program takes place in a unique socio-ecological context, and details of what is being managed, why, how and where will likely be perceived differently by different (local) stakeholders. Our generalized and hypothetical management vignettes were not designed to capture such local dynamics, but rather to document baseline acceptability for the basic building blocks of management programs. 'Sharpening' vignettes to specific local conditions and being more detailed about impacts of

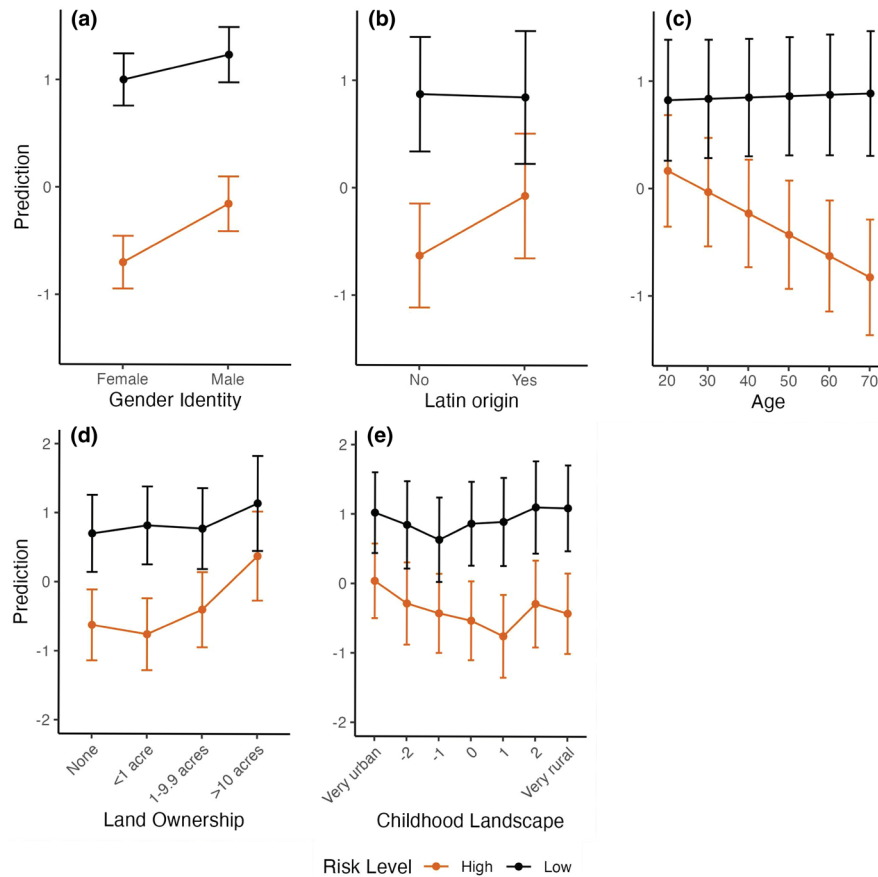


FIGURE 5 Acceptance of high- (red) and low- (black)-risk management as a function of (a) gender, (b) Latin origin, (c) age, (d) land ownership and (e) childhood landscape, which significantly interact with non-target risk level. Data are parameter estimates (log-odds ratio) from our reduced model, and error bars represent 95% CI. Larger y-values indicate greater acceptability.

the targeted introduced species, the means of control and specific ecological or human health outcomes may offer a powerful tool for further dissecting the complexities of public attitudes.

Limited knowledge about the impacts of invasive species by the public may explain the low acceptability of ISM since the main justification for the control of introduced species is the expected negative impacts on the economy, human health or native species and ecosystems (Pyšek et al., 2020; IPBES, 2023; Figure 1). Yet, despite decades of research, quantitative evidence of invasive species impacts is equivocal and is focused on a biased subsample of introduced species (Blossey, 1999; Simberloff et al., 2013). For example, a 2024 review of field impacts of introduced plant species in Europe (Vilà et al., 2024) summarizes results from 266 publications reporting 4259 field studies on 104 invasive species in 29 European countries. This seems like an impressive accumulation of evidence, but a third of these publications focused on just five species, and significant negative impacts were documented in only 26% of the field studies. Furthermore, there are at least 5136 non-native plants in Europe (Haubrock et al., 2023), thus evidence of impacts is available for 2% of them, and harmful effects do not seem widespread (Vilà et al., 2024). Extrapolating from what we know and generalizing that non-native plants represent major threats seems problematic. Even the evidence we have

for well-studied species appears contradictory in different meta-analyses. For example, evidence of impacts for several non-native aquatic plant species on other plants, fish or invertebrates ranged from negative to neutral to beneficial (Tasker et al., 2022), far from claims of widespread negative impacts. We do not suggest that non-native plants do not have impacts, but published evidence for these impacts is equivocal and not as clear and strong as commonly suggested.

Misinterpretation of available evidence and a general lack of evidence limit managers' ability to convey the need for invasive species management. What we do not know is how detailed information on specific impacts of non-native species may affect responses to our vignettes. Other studies have documented that increased knowledge about harmful impacts increases willingness to endorse management activities and even participation (Seboko et al., 2024; Steele & Pienaar, 2021). However, we lack convincing evidence that awareness campaigns about harmful effects of non-native species can make a difference (Haley et al., 2023). Moreover, information transfer itself does not necessarily affect perceptions or change behaviours (Dawson et al., 2024; McLeod et al., 2015). It may be equally important to assess whether efforts to promote public support for ISM should emphasize a different framing (Guareschi et al., 2024). For example, Haley et al. (2023) advocate for the use of 'benchmarks'

or 'metrics' that include relevant biological information on population growth rates or abundance to emphasize outcomes. Providing ecocentric justifications, such as improvements in the well-being of native species, can increase acceptability even of lethal management (Bremner & Park, 2007; Dawson et al., 2024; Hare et al., 2021).

Unfortunately, a pervasive lack of outcome assessments after management of non-native species perpetuates the disparity between the extent of management and the uncertainty of what is being achieved, in terms of both suppressing target species and impacts on non-target organisms (Blossey, 1999; Kettenring & Adams, 2011; Rinella et al., 2009). In our view, this widespread uncertainty about impacts for the majority of non-native species, combined with a lack of evidence regarding assumed benefits of management, undermines the ability of the public and independent scientists to assess risks of non-native species and risks associated with different ISM management techniques (Blossey et al., 2018; Hoffmann et al., 2019), or potential trade-offs. More broadly, uncertainty associated with evidence gaps can contribute to misinformation, polarized social attitudes and misplaced conservation efforts (Ford et al., 2021), providing fertile ground for continued social controversies and may constitute a major problem for the lack of acceptability of ISM by the public we document. Further work is needed to evaluate whether and what types of evidence may be persuasive in changing public attitudes.

We do not consider it likely that people do not care about the protection of nature—plenty of other work has demonstrated that they do (Admiraal et al., 2017; Manfredo et al., 2021; van den Born et al., 2001). However, despite available academic and general information, people may not recognize, or be aware of, whether and how specific non-native species may affect their daily lives and livelihoods (Haley et al., 2023; Seboko et al., 2024; Steele & Pienaar, 2021). This limited ability of individuals to accurately perceive the impacts of non-native species, if they materialize, may also drive mismatches between their biodiversity preferences and the impact of those preferences on the need for, or tools chosen to manage. Our respondents' preferences could also indicate that they thought we should not interfere and manage the abundance of species at all (de Groot et al., 2011), but we did not include this option in our vignettes. Our investigation was not designed to capture these nuances, but it is also possible that for our respondents, perceived risks of available treatment options outweighed the negative impacts of non-native species.

We find greatest public support for mechanical control (Figures 3 and 4). Our findings are in line with others who reported similar preferences for, or least opposition to, mechanical control compared to chemical or biological control (Bremner & Park, 2007). Our vignettes did not specify the type of mechanical treatments, which may range from simple uprooting of plants to clipping, mowing, chainsaws, or even bulldozers (Figure 6). We would expect that different mechanical treatment options would elicit quite different responses based on levels of associated disturbances. For example, removal of street trees in urban quarantine zones to manage Asian long-horned beetle, *Anoplophora glabripennis* (Haack et al., 2010), is likely to elicit a different response compared to hand pulling of herbaceous plants

in an urban park. However, while widespread, mechanical control has a very limited ability to control populations of non-native species beyond early establishment phases, for example, in plants (Kettenring & Adams, 2011) or insects, where it is often combined with other chemical treatments (Liebhold et al., 2016; Mackenzie & Larson, 2010). Thus, benefits of mechanical control to native species largely remain speculative and unverified.

Application of chemicals to manage non-native insects and plants is the most preferred and widespread method managers deploy, and their use has increased substantially in the past decades (Köhler & Triebkorn, 2013). This popularity of chemicals may be partially explained by the success achieved in suppressing large, albeit local, populations of many species. However, such efforts need to be repeated frequently and may impose severe additional stress on native species that are rarely recognized (Kettenring & Adams, 2011). Chemical control can be used successfully in the eradication of small populations of non-native species in early establishment phases (Quirion et al., 2018). But even with repeated efforts, chemicals are often insufficient for managing widespread introduced species (Martin & Blossey, 2013). Our respondents show a general aversion to these treatments, a continued trend of social discomfort towards this method which first coalesced in US environmentalism of the 1960s following the publication of Rachel Carson's *Silent Spring* (Carson, 1962). The withdrawal of many products no longer deemed safe for humans or the environment and documentation of widespread negative impacts to wildlife and human health (Chagnon et al., 2015; Köhler & Triebkorn, 2013; Schulz et al., 2021) may explain our respondent's aversion towards chemical treatments. However, more specific work is needed to probe whether reduced toxicity, or documentation of benefits associated with treatments, can make a difference in the acceptability of chemical controls.

Biological control, introduction of natural enemies, can result in self-sustaining, cost-effective suppression for widespread invaders, yet public support for this method is narrow and limited to low-risk scenarios. Specifically, modern weed biocontrol programs have an enviable track record of extremely rare and minor non-target impacts (Blossey et al., 2018; Hinz et al., 2019), but the practice remains poorly understood by scientists and managers not involved in biocontrol. For example, among European researchers and managers working with non-native species, the perceived risk of biocontrol was greatest for those with 'little knowledge' of the topic (Marchante et al., 2023). Furthermore, successful biocontrol programs also fade from attention since there is no longer a need for constant intervention and populations of non-native species are greatly reduced. However, as in other ISM programs, biocontrol programs also rarely provide long-term outcome assessments, which may limit their favourability rating in our survey (but see Blossey et al., 2024).

Our work provides a snapshot of public attitudes towards ISM, but our survey was not designed to answer questions regarding how values of respondents are formed, or how risk perceptions of different species and risks associated with specific control methods are derived or influence respondent's attitudes. We also do not know whether improved collection and dissemination about

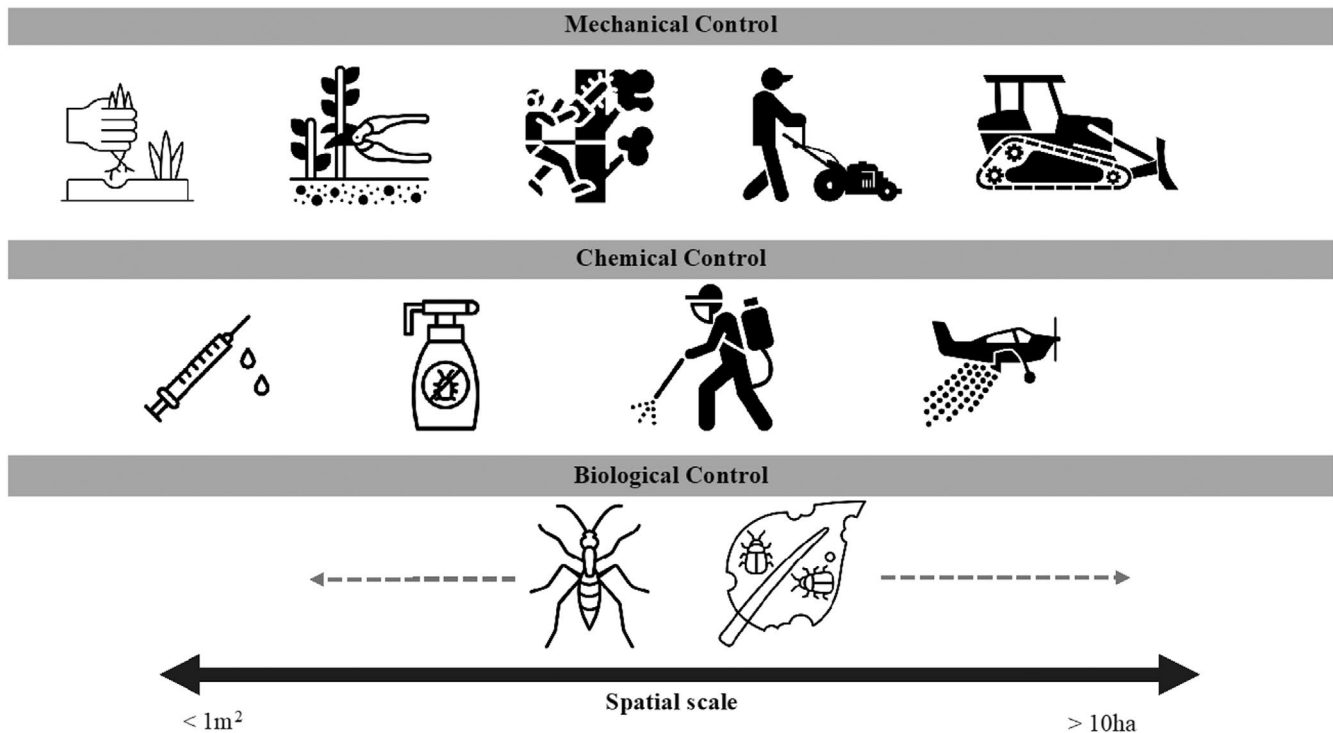


FIGURE 6 Possible range of tools deployed in mechanical, chemical or biological control targeting non-native plants or insects. The spatial scale of application for mechanical and chemical increases from very localized ($<1\text{m}^2$) to large treatment areas ($>10\text{ha}$). This is not applicable to biocontrol because insects that establish self-sustaining populations can reproduce and disperse from the original point of release. Artist credits of icons from thenounproject.com.: top rows (L-R): weeding (Akbar), pruning shears (Azam Ishaq), trimming trees (BSD studio), lawn mower (Sergi Delgado), bulldozer (kareemovic). middle row: syringe (SAM designs), insecticide (Kiselki), pesticide applicator and crop duster (Luis Prado). bottom row: ichneumon wasp (Icogenix), pests (Amethyst Studio).

impacts of non-native species or of outcomes of management activities on native species and human health may affect acceptance of management. We acknowledge that differences in how individuals and groups perceive personal and collective risks and benefits of introduced species and their management will depend not only on available information but also on how that information is framed, who delivers the message (Sauer et al., 2021), and whether specific management actions correspond with individuals values, attitudes, beliefs and perceived social norms (Kaplan et al., 2022; Kidd et al., 2019; Niemiec et al., 2016; Woodford et al., 2016). However, the status quo of choosing treatments without documentation of impacts of target non-native species, and documentation of benefits treatments may deliver seems impossible to retain given public opposition. We hypothesize that improved documentation and communication of ecological information on non-native species and their management may lead to shifts in social acceptability of ISM (Novoa et al., 2017). We encourage funders and managers to engage in the development of assessment methods to address evidence gaps and understanding of how public attitudes towards introduced species, their ecological risks and risk perceptions of different species and management practices are formed. A combined approach that includes work on ecological benchmarks and additional research on human dimensions of ISM, such as risk communication, message framing (Kidd et al., 2019) and embedding these ideas in human behaviour change research (Steele & Pienaar, 2021) may help managers

anticipate, plan for, avoid and/or respond to future controversies. Without this information, the ability to counter false preconceptions remains weak, with selective representation in the media, and a public discourse of controversy at times dominated by those with little factual knowledge (Light et al., 2022).

AUTHOR CONTRIBUTIONS

Wade Simmons and Darragh Hare conceived the ideas and designed methodology. Wade Simmons collected the data and analysed it with Andrea Dávalos and Darragh Hare. Bernd Blossey and Wade Simmons led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

ACKNOWLEDGEMENTS

We are grateful for the invaluable input from numerous colleagues, the editor and three peer reviewers, which greatly improved this project, and thank members of the Blossey Lab, Dr. Adam Hart, Erika Mudrak and Dr. Mildred Warner. We thank the New York Department of Environmental Conservation for funding.

CONFLICT OF INTEREST STATEMENT

The authors have no relevant financial conflicts of interest to disclose. Darragh Hare is an Associate Editor for *People and Nature* but was not involved in the peer review and decision-making process for this manuscript.

DATA AVAILABILITY STATEMENT

Data are archived with Dryad and available at <https://doi.org/10.5061/dryad.0rxwdbsc6>.

ORCID

Wade Simmons  <https://orcid.org/0000-0002-5619-3708>

Darragh Hare  <https://orcid.org/0000-0003-4418-9637>

Andrea Dávalos  <https://orcid.org/0000-0002-3590-4152>

Bernd Blossey  <https://orcid.org/0000-0001-7043-4435>

REFERENCES

- Admiraal, J. F., Born, R. J. G. V. D., Beringer, A., Bonaiuto, F., Cicero, L., Hiedanpää, J., Knights, P., Knippenberg, L. W. J., Molinario, E., Musters, C. J. M., Naukarinen, O., Polajnar, K., Popa, F., Smrekar, A., Soininen, T., Porras-Gomez, C., Soethe, N., Vivero-Pol, J.-L., & Groot, W. T. D. (2017). Motivations for committed nature conservation action in Europe. *Environmental Conservation*, 44(2), 148–157. <https://doi.org/10.1017/S037689291700008X>
- Atmüller, C., & Steiner, P. M. (2010). Experimental vignette studies in survey research. *Methodology*, 6, 128–138. <https://doi.org/10.1027/1614-2241/a000014>
- Barratt, B. I. P., Moran, V. C., Bigler, F., & van Lenteren, J. C. (2018). The status of biological control and recommendations for improving uptake for the future. *BioControl*, 63(1), 155–167. <https://doi.org/10.1007/s10526-017-9831-y>
- Blossey, B. (1999). Before, during and after: The need for long-term monitoring in invasive plant species management. *Biological Invasions*, 1(2–3), 301–311. <https://doi.org/10.1023/a:1010084724526>
- Blossey, B. (2016). The future of biological control: A proposal for fundamental reform. In R. Van Driesche, D. Simberloff, B. Blossey, C. Causton, M. Hoddle, C. Marks, K. Heinz, & D. Wagner (Eds.), *Integrating biological control into conservation practice* (pp. 314–328). Wiley.
- Blossey, B., Dávalos, A., Simmons, W., & Ding, J. (2018). A proposal to use plant demographic data to assess potential weed biological control agents impacts on non-target plant populations. *BioControl*, 63, 461–473. <https://doi.org/10.1007/s10526-018-9886-4>
- Blossey, B., Nuzzo, V., Dávalos, A., Mayer, M., Dunbar, R., Landis, D. A., Evans, J. A., & Minter, B. (2021). Residence time determines invasiveness and performance of garlic mustard (*Alliaria petiolata*) in North America. *Ecology Letters*, 24(2), 327–336. <https://doi.org/10.1111/ele.13649>
- Blossey, B., Nuzzo, V., & Endriss, S. B. (2024). From ecological menace to roadside attraction: 28 years of evidence support successful bio-control of purple loosestrife. *Ecosphere*, 15, e70089.
- Bremner, A., & Park, K. (2007). Public attitudes to the management of invasive non-native species in Scotland. *Biological Conservation*, 139(3–4), 306–314. <https://doi.org/10.1016/j.biocon.2007.07.005>
- Bruskotter, J. T., Vucetich, J. A., Dietsch, A., Slagle, K. M., Brooks, J. S., & Nelson, M. P. (2019). Conservationists' moral obligations toward wildlife: Values and identity promote conservation conflict. *Biological Conservation*, 240, 108296. <https://doi.org/10.1016/j.biocon.2019.108296>
- Carson, R. (1962). *Silent Spring*. Houghton-Mifflin.
- Chagnon, M., Kreuzweiser, D., Mitchell, E. A. D., Morrissey, C. A., Noome, D. A., & Van der Sluijs, J. P. (2015). Risks of large-scale use of systemic insecticides to ecosystem functioning and services. *Environmental Science and Pollution Research*, 22(1), 119–134. <https://doi.org/10.1007/s11356-014-3277-x>
- Christensen, R. G. B. (2022). ordinal—Regression models for ordinal data. <https://cran.r-project.org/package=ordinal>
- Crowley, S. L., Hinchliffe, S., & McDonald, R. A. (2017). Conflict in invasive species management. *Frontiers in Ecology and the Environment*, 15(3), 133–141. <https://doi.org/10.1002/fee.1471>
- Davis, M. (2009). *Invasion biology*. Oxford University Press.
- Davis, M. A., Chew, M. K., Hobbs, R. J., Lugo, A. E., Ewel, J. J., Vermeij, G. J., Brown, J. H., Rosenzweig, M. L., Gardener, M. R., Carroll, S. P., Thompson, K., Pickett, S. T. A., Stromberg, J. C., Del Tredici, P., Suding, K. N., Ehrenfeld, J. G., Grime, J. P., Mascaro, J., & Briggs, J. C. (2011). Don't judge species on their origins. *Nature*, 474(7350), 153–154. <https://doi.org/10.1038/474153a>
- Dawson, S., Dawson, C., Kennedy, M. S., Kreplins, T. L., Linnell, J. D. C., & Fleming, P. A. (2024). Knowledge and values drive acceptability of lethal control of kangaroos among the Australian public. *Biological Conservation*, 289, 110416. <https://doi.org/10.1016/j.biocon.2023.110416>
- de Groot, M., Drenthen, M., & de Groot, W. T. (2011). Public visions of the human/nature relationship and their implications for environmental ethics. *Environmental Ethics*, 33(1), 25–44. <https://doi.org/10.5840/enviroethics20113314>
- Estévez, R. A., Anderson, C. B., Pizarro, J. C., & Burgman, M. A. (2015). Clarifying values, risk perceptions, and attitudes to resolve or avoid social conflicts in invasive species management. *Conservation Biology*, 29(1), 19–30. <https://doi.org/10.1111/cobi.12359>
- Ford, A. T., Ali, A. H., Colla, S. R., Cooke, S. J., Lamb, C. T., Pittman, J., Shiffman, D. S., & Singh, N. J. (2021). Understanding and avoiding misplaced efforts in conservation. *Facets*, 6(1), 252–271. <https://doi.org/10.1139/FACETS-2020-0058>
- Guareschi, S., Mathers, K. L., South, J., Navarro, L. M., Renals, T., Hiley, A., Antonsich, M., Bolpagni, R., Bortolus, A., Genovesi, P., Jere, A., Madzivanzira, T. C., Phaka, F. M., Novoa, A., Olden, J. D., Saccó, M., Shackleton, R. T., Vilà, M., & Wood, P. J. (2024). Framing challenges and polarized issues in invasion science: Toward an interdisciplinary agenda. *Bioscience*, 74(12), biae084. <https://doi.org/10.1093/biosci/biae084>
- Gunstone, T., Cornelisse, T., Klein, K., Dubey, A., & Donley, N. (2021). Pesticides and soil invertebrates: A hazard assessment. *Frontiers in Environmental Science*, 9(May), 1–21. <https://doi.org/10.3389/fenvs.2021.643847>
- Haack, R. A., Hérard, F., Sun, J., & Turgeon, J. J. (2010). Managing invasive populations of Asian longhorned beetle and citrus longhorned beetle: A worldwide perspective. *Annual Review of Entomology*, 55(1), 521–546. <https://doi.org/10.1146/annurev-ento-112408-085427>
- Haley, A. L., Lemieux, T. A., Piczak, M. L., Karau, S., D'Addario, A., Irvine, R. L., Beaudoin, C., Bennett, J. R., & Cooke, S. J. (2023). On the effectiveness of public awareness campaigns for the management of invasive species. *Environmental Conservation*, 50(4), 202–211. <https://doi.org/10.1017/S037689292300019X>
- Hare, D., Daniels, M., & Blossey, B. (2021). Public perceptions of deer management in Scotland. *Frontiers in Conservation Science*, 2(December), 1–12. <https://doi.org/10.3389/fcsc.2021.781546>
- Haubrock, P. J., Balzani, P., Macêdo, R., & Tarkan, A. S. (2023). Is the number of non-native species in the European Union saturating? *Environmental Sciences Europe*, 35(1), 48. <https://doi.org/10.1186/s12302-023-00752-1>
- Hinz, H. L., Winston, R. L., & Schwarzländer, M. (2019). How safe is weed biological control? A global review of direct nontarget attack. *Quarterly Review of Biology*, 94(1), 1–27. <https://doi.org/10.1086/702340>
- Hoffmann, J. H., Moran, V. C., & Hill, M. P. (2019). Conceptualizing, categorizing and recording the outcomes of biological control of invasive plant species, at a population level. *Biological Control*, 133, 134–137. <https://doi.org/10.1016/j.biocontrol.2019.02.005>
- IPBES (2023). Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. In H. E. Roy, A. Pauchard, P. Stoett, & T. Renard Truong, (Eds.), *IPBES secretariat*. Bonn, Germany. <https://doi.org/10.5281/zenodo.7430682>

- Jarić, I., Courchamp, F., Correia, R. A., Crowley, S. L., Essl, F., Fischer, A., González-Moreno, P., Kalinkat, G., Lambin, X., Lenzner, B., Meinard, Y., Mill, A., Musseau, C., Novoa, A., Pergl, J., Pyšek, P., Pyšková, K., Robertson, P., von Schmalensee, M., ... Jeschke, J. M. (2020). The role of species charisma in biological invasions. *Frontiers in Ecology and the Environment*, 18(6), 345–353. <https://doi.org/10.1002/fee.2195>
- Kaplan, H., Prahalad, V., & Kendal, D. (2022). Native for whom: A mixed-methods literature review and synthesis to conceptualise biotic nativeness for social research in the urban context. *People and Nature*, 4(1), 15–31. <https://doi.org/10.1002/pan3.10274>
- Kareiva, P., & Marvier, M. (2012). What is conservation science? *Bioscience*, 62(11), 962–969. <https://doi.org/10.1525/bio.2012.62.11.5>
- Kettenring, K. M., & Adams, C. R. (2011). Lessons learned from invasive plant control experiments: A systematic review and meta-analysis. *Journal of Applied Ecology*, 48(4), 970–979. <https://doi.org/10.1111/j.1365-2664.2011.01979.x>
- Kidd, L. R., Garrard, G. E., Bekessy, S. A., Mills, M., Camilleri, A. R., Fidler, F., Fielding, K. S., Gordon, A., Gregg, E. A., Kusmanoff, A. M., Louis, W., Moon, K., Robinson, J. A., Selinske, M. J., Shanahan, D., & Adams, V. M. (2019). Messaging matters: A systematic review of the conservation messaging literature. *Biological Conservation*, 236(April), 92–99. <https://doi.org/10.1016/j.biocon.2019.05.020>
- Köhler, H.-R., & Triebkorn, R. (2013). Wildlife ecotoxicology of pesticides: Can we track effects to the population level and beyond? *Science*, 341(6147), 759–765. <https://doi.org/10.1126/science.1237591>
- Lenth, R. (2023). *emmeans: Estimated marginal means, aka least-squares means*. (Version 1.8.4-1) [Computer software]. <https://CRAN.R-project.org/package=emmeans>
- Liebold, A. M., Berec, L., Brockerhoff, E. G., Epanchin-Niell, R. S., Hastings, A., Herms, D. A., Kean, J. M., McCullough, D. G., Suckling, D. M., Tobin, P. C., & Yamanaka, T. (2016). Eradication of invading insect populations: From concepts to applications. *Annual Review of Entomology*, 61, 335–352. <https://doi.org/10.1146/annurev-ento-010715-023809>
- Light, N., Fernbach, P. M., Rabb, N., Geana, M. V., & Sloman, S. A. (2022). Knowledge overconfidence is associated with anti-consensus views on controversial scientific issues. *Science Advances*, 8, 1–11.
- 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. <https://doi.org/10.1017/S037889291600045X>
- Mackenzie, B. F., & Larson, B. M. H. (2010). Participation under time constraints: Landowner perceptions of rapid response to the emerald ash borer. *Society and Natural Resources*, 23, 1013–1022. <https://doi.org/10.1080/08941920903339707>
- Manfredo, M. J., Teel, T. L., Berl, R. E. W., Bruskotter, J. T., & Kitayama, S. (2021). Social value shift in favour of biodiversity conservation in the United States. *Nature Sustainability*, 4(4), 323–330. <https://doi.org/10.1038/s41893-020-00655-6>
- Marchante, H., Marchante, E., Verbrugge, L., Lommen, S., & Shaw, R. (2023). Knowledge and perceptions of invasive plant biocontrol in Europe versus the rest of the world. *Journal of Environmental Management*, 327, 116896. <https://doi.org/10.1016/j.jenvman.2022.116896>
- Marra, P., & Santella, C. (2016). *Cat wars: The devastating consequences of a cuddly killer*. Princeton University Press.
- Martin, L. J., & Blossey, B. (2013). The runaway weed: Costs and failures of *Phragmites australis* management in the USA. *Estuaries and Coasts*, 36, 626–632. <https://doi.org/10.1007/s12237-013-9593-4>
- McLeod, L. J., Hine, D. W., Please, P. M., & Driver, A. B. (2015). Applying behavioral theories to invasive animal management: Towards an integrated framework. *Journal of Environmental Management*, 161, 63–71. <https://doi.org/10.1016/j.jenvman.2015.06.048>
- Mikulyuk, A., Kujawa, E., Nault, M. E., van Egeren, S., Wagner, K. I., Barton, M., Hauxwell, J., & Vander Zanden, M. J. (2020). Is the cure worse than the disease? Comparing the ecological effects of an invasive aquatic plant and the herbicide treatments used to control it. *Facets*, 5(1), 353–366. <https://doi.org/10.1139/FACET-S-2020-0002>
- Minteer, B. A., & Collins, J. P. (2005). Why we need an “ecological ethics”. *Frontiers in Ecology and the Environment*, 3(6), 332–337. <https://doi.org/10.2307/3868567>
- Niemiec, R. M., Ardoin, N. M., Wharton, C. B., & Asner, G. P. (2016). Motivating residents to combat invasive species on private lands: Social norms and community reciprocity. *Ecology and Society*, 21(2), art30. <https://doi.org/10.5751/ES-08362-210230>
- Novoa, A., Dehnen-Schmutz, K., Fried, J., & Vimercati, G. (2017). Does public awareness increase support for invasive species management? Promising evidence across taxa and landscape types. *Biological Invasions*, 19(12), 3691–3705. <https://doi.org/10.1007/s10530-017-1592-0>
- Pomeranz, E. F., Hare, D., Decker, D. J., Forstchen, A. B., Jacobson, C. A., Smith, C. A., & Schiavone, M. V. (2021). Successful wildlife conservation requires good governance. *Frontiers in Conservation Science*, 2, 1–7. <https://doi.org/10.3389/fcosc.2021.753289>
- Pyšek, P., Hulme, P. E., Simberloff, D., Bacher, S., Blackburn, T. M., Carlton, J. T., Dawson, W., Essl, F., Foxcroft, L. C., Genovesi, P., Jeschke, J. M., Kühn, I., Liebhold, A. M., Mandrak, N. E., Meyerson, L. A., Pauchard, A., Pergl, J., Roy, H. E., Seebens, H., ... Richardson, D. M. (2020). Scientists' warning on invasive alien species. *Biological Reviews*, 95(6), 1511–1534. <https://doi.org/10.1111/brv.12627>
- Quirion, B., Simek, Z., & Da, A. (2018). Management of invasive *Phragmites australis* in the Adirondacks: A cautionary tale about prospects of eradication. *Biological Invasions*, 20, 59–73. <https://doi.org/10.1007/s10530-017-1513-2>
- R Core Team. (2022). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://www.R-project.org>
- Redpath, S. M., Bhatia, S., & Young, J. (2015). Tilting at wildlife: Reconsidering human-wildlife conflict. *Oryx*, 49(2), 222–225. <https://doi.org/10.1017/S0030605314000799>
- Richardson, D. M. (2011). Invasion science. The roads travelled and the roads ahead. In *Fifty years of invasion ecology: The legacy of Charles Elton* (pp. 397–401). Blackwell Publishing.
- Rinella, M. J., Maxwell, B. D., Fay, P. K., Weaver, T., & Sheley, R. L. (2009). Control effort exacerbates invasive-species problem. *Ecological Applications*, 19(1), 155–162. <https://doi.org/10.1890/07-1482.1>
- Sauer, K. A., Capps, D. K., Jackson, D. F., & Capps, K. A. (2021). Six minutes to promote change: People, not facts, alter students' perceptions on climate change. *Ecology and Evolution*, 11(11), 1–13. <https://doi.org/10.1002/ece3.7553>
- Sax, D. F., Schlaepfer, M. A., & Olden, J. D. (2022). Valuing the contributions of non-native species to people and nature. *Trends in Ecology & Evolution*, 5050, 1–9. <https://doi.org/10.1016/j.tree.2022.08.005>
- Scasta, J. D., Adams, M., Gibbs, R., & Fleury, B. (2020). Free-ranging horse management in Australia, New Zealand and the United States: Socio-ecological dimensions of a protracted environmental conflict. *The Rangeland Journal*, 42(1), 27–43. <https://doi.org/10.1071/RJ19019>
- Schulz, R., Bub, S., Petschick, L. L., Stehle, S., & Wolfram, J. (2021). Applied pesticide toxicity shifts toward plants and invertebrates, even in GM crops. *Science*, 372(6537), 81–84. <https://doi.org/10.1126/science.abe1148>
- Schwarzländer, M., Hinz, H. L., Winston, R. L., & Day, M. D. (2018). Biological control of weeds: An analysis of introductions, rates of establishment and estimates of success, worldwide. *BioControl*, 63(3), 319–331. <https://doi.org/10.1007/s10526-018-9890-8>
- Seboko, T., Shackleton, C. M., & Ruwanza, S. (2024). Urban residents' knowledge of and attitudes and willingness to control woody invasive alien plants in their domestic gardens in South Africa. *People and Nature*, 6(5), 2077–2090. <https://doi.org/10.1002/pan3.10704>

- Shackleton, R. T., Richardson, D. M., Shackleton, C. M., Bennett, B., Crowley, S. L., Dehnen-Schmutz, K., Estévez, R. A., Fischer, A., Kueffer, C., Kull, C. A., Marchante, E., Novoa, A., Potgieter, L. J., Vaas, J., Vaz, A. S., & Larson, B. M. H. (2019). Explaining people's perceptions of invasive alien species: A conceptual framework. *Journal of Environmental Management*, 229, 10–26. <https://doi.org/10.1016/j.jenvman.2018.04.045>
- Sharp, R. L., Larson, L. R., & Green, G. T. (2011). Factors influencing public preferences for invasive alien species management. *Biological Conservation*, 144(8), 2097–2104. <https://doi.org/10.1016/j.biocon.2011.04.032>
- Simberloff, D., Martin, J. L., Genovesi, P., Maris, V., Wardle, D. A., Aronson, J., Courchamp, F., Galil, B., García-Berthou, E., Pascal, M., Pyšek, P., Sousa, R., Tabacchi, E., & Vilà, M. (2013). Impacts of biological invasions: What's what and the way forward. *Trends in Ecology & Evolution*, 28(1), 58–66. <https://doi.org/10.1016/j.tree.2012.07.013>
- Simberloff, D., & Stiling, P. (1996). How risky is biological control? *Ecology*, 77(7), 1965–1974. <https://doi.org/10.2307/2265693>
- Soto, I., Balzani, P., Carneiro, L., Cuthbert, R. N., Macêdo, R., Serhan Tarkan, A., Ahmed, D. A., Bang, A., Bacela-Spychalska, K., Bailey, S. A., Baudry, T., Ballesteros-Mejia, L., Bortolus, A., Briski, E., Britton, J. R., Buřič, M., Camacho-Cervantes, M., Cano-Barbacid, C., Copilaș-Ciocianu, D., ... Haubrock, P. J. (2024). Taming the terminological tempest in invasion science. *Biological Reviews*, 99(4), 1357–1390. <https://doi.org/10.1111/brv.13071>
- Steele, Z. T., & Pienaar, E. F. (2021). Knowledge, reason and emotion: Using behavioral theories to understand people's support for invasive animal management. *Biological Invasions*, 23(11), 3513–3527. <https://doi.org/10.1007/s10530-021-02594-5>
- Tasker, S. J. L., Foggo, A., & Bilton, D. T. (2022). Quantifying the ecological impacts of alien aquatic macrophytes: A global meta-analysis of effects on fish, macroinvertebrate and macrophyte assemblages. *Freshwater Biology*, 67(11), 1847–1860. <https://doi.org/10.1111/fwb.13985>
- van den Born, R. J. G., Lenders, R. H. J., de Groot, W. T., & Huijsman, E. (2001). The new biophilia: An exploration of visions of nature in Western countries. *Environmental Conservation*, 28(1), 65–75. <https://doi.org/10.1017/S0376892901000066>
- Verbrugge, L. N. H., Van Den Born, R. J. G., & Lenders, H. J. R. (2013). Exploring public perception of non-native species from a visions of nature perspective. *Environmental Management*, 52(6), 1562–1573. <https://doi.org/10.1007/s00267-013-0170-1>
- Vilà, M., Trillo, A., Castro-Díez, P., Gallardo, B., & Bacher, S. (2024). Field studies of the ecological impacts of invasive plants in Europe. *NeoBiota*, 90, 139–159. <https://doi.org/10.3897/neobiota.90.112368>
- Woodford, D. J., Richardson, D. M., MacIsaac, H. J., Mandrak, N. E., van Wilgen, B. W., Wilson, J. R. U., & Weyl, O. L. F. (2016). Confronting the wicked problem of managing biological invasions. *NeoBiota*, 31, 63–86. <https://doi.org/10.3897/neobiota.31.10038>
- Woodworth, E., Tian, A., Blair, K., Pullen, J., Lefcheck, J. S., & Parker, J. D. (2023). Media myopia distorts public interest in US invasive plants. *Biological Invasions*, 25(10), 3193–3205. <https://doi.org/10.1007/s10530-023-03101-8>

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Table S1. List of predictions tested in management attitude surveys.

Table S2. Complete list of all 24 introduced species management vignettes.

Table S3. Full survey instrument.

Table S4. Descriptive statistics of respondents' demographics, compared against national demographics estimates from 2019 American Community Survey, where data is available.

Table S5. Parameter estimates for reduced model.

Table S6. Tukey test predicted differences in relative acceptability between all comparisons ($n=276$) of experimental factor interactions, accounting for effects of all other variables in reduced model.

How to cite this article: Simmons, W., Hare, D., Dávalos, A., & Blossey, B. (2025). Common approaches to introduced species management face widespread acceptance problems in the United States. *People and Nature*, 7, 1464–1476. <https://doi.org/10.1002/pan3.70053>