ORIGINAL PAPER

The "IAS Management Attitude" scale: a tool for measuring consensus between experts and practitioners in invasion biology

Jacopo Cerri · Elisa Serra · Alberto Stefanuto · Emiliano Mori

Abstract Quantifying attitudes towards invasive alien species (IAS) is fundamental to understanding the extent to which conservation scientists agree and can collaborate in their management. We tested the IAS Management Attitude scale (IMA), a shortened version of the Pest Management Attitude Scale, originally invented to quantify attitudes towards pests in New Zealand, as a tool to quantify broader attitudes towards IAS among bioinvasion experts in Italy. We administered an online questionnaire to a sample of experts working on biological invasions in Italy. We collected 316 answers, both from conservation practitioners (26.6%) and researchers (73.4%), and we used structural equation modeling to test for the psychometric properties of the scale and compare attitude scores between groups. The scale showed both a good reliability (Cronbach's alpha = 0.7), validity (CFI = 0.99, TLI = 0.99, SRMR = 0.03, RMSE = 0.02) and measurement invariance, when comparing researchers and practitioners, as well as when comparing respondents working on different invasive taxa. Both researchers and practitioners, as well as respondents of a different age, had similar attitudes about IAS and their management. Our study shows that this shortened version of PMA scale, a simple scale originally conceived to measure attitudes towards invasive alien mammals, could indeed be used to quantify the attitudes of experts towards IAS, even in countries where the public debate about biological invasions is much more recent than in New Zealand. The scale could potentially be used both for large-scale and long-term research about the attitudes of experts about IAS.

Keywords Biological invasions · Attitudes · Structural equation models · Human dimensions · Questionnaire · Survey

J. Cerri (✉)
Dipartimento Di Medicina Veterinaria, Università Degli Studi Di Sassari, Via Vienna 2, 07100 Sassari, Italy
e-mail: jcerri@uniss.it

E. Serra
IMC Foundation - International Marine Centre, Loc. Sa Mardini, 09170 TorregrandeOristano, Italy

E. Serra
Dipartimento Di Scienze Della Vita E Dell'Ambiente, Università Degli Studi Di Cagliari, 09126 Cagliari, Italy

E. Serra · E. Mori
National Biodiversity Future Center, 90133 Palermo, Italy

A. Stefanuto
Associazione "Il Villaggio Degli Orsi", Loc. Stupizza, 33046 Pulfero, UD, Italy

E. Mori
Istituto Di Ricerca Sugli Ecosistemi Terrestri IRET, Consiglio Nazionale Delle Ricerche, Via Madonna del Piano 10, 50019 Sesto Fiorentino (Florence), Italy

Introduction

Invasive alien species (hereafter, IAS) are one the fundamental conservation threats worldwide, yet their management is complex, as it requires collaboration between different stakeholders (Liu and Cook 2015; Crowley et al. 2017; Shackleton et al. 2019). For instance, it often requires a sound agreement between experts, which can be researchers, practitioners or policymakers (Novoa et al. 2020; Vaz et al. 2017; Gbedomon et al. 2020; Shackleton et al. 2022). Like laypersons, experts agree, and eventually decide to collaborate about a certain issue, due to important and interdependent intrinsic factors, such as anthropomorphism, ideology, perceived moral obligations, value orientations or trust (Heeren et al. 2016; Bruskotter et al. 2019; van Eeden et al. 2019; Manfredo et al. 2020a, b; Schroeder et al. 2021), or because of extrinsic factors, such as their affiliation to different agencies and institutions.

Collaboration is also driven by individual thoughts about a specific issue. Explicit attitudes (hereafter, attitudes), are a parsimonious and clear approach to summarize these thoughts (Manfredo 2008). Attitudes are an association, in memory, of an evaluation with an object: if people have a positive evaluation when asked about a certain issue, we would say that they have a positive attitude towards it. Attitudes allow people (i) to understand if a certain object is consistent with their own goals, (ii) to express their own values and (iii) to facilitate social relationships, three scopes that are fundamental for collaboration (Manfredo 2008).

In research about personal networks, which can also be used to represent professional collaboration, attitudes are recognized as a key component of value homophily (McPherson et al. 2001). For example, research conducted in healthcare demonstrated that experts holding similar attitudes towards a certain issue have been found to be more willing to collaborate, even when they are from different backgrounds (Mascia et al. 2013, 2015). Therefore, in conservation biology developing reliable, and widely applicable, attitudinal scales is paramount for measuring a key driver of collaboration between experts over a specific topic (Dietsch et al. 2016; Gbedomon et al. 2020; Whitehouse-Tedd et al. 2021).

To date, various studies have developed psychometric scales to measure attitudes towards one or more IAS in specific circumstances, often within management or eradication programs (e.g., Siberian chipmunk *Eutamias sibiricus* in Northern Italy: Cerri et al. 2020; feral llamas *Llama glama* in Central Italy: Gargioni et al. 2021; see Kapitza et al. 2019 for a review). However, fewer tried to develop broadly-applicable attitudinal scales, to measure overall beliefs about IAS and their management, similarly to what has been done for other psychological constructs (e.g., wildlife value orientations, Manfredo et al. 2009). This gap needs to be addressed: biological invasions are one of the most important, and fastest-evolving, conservation issues globally (Bellard et al. 2016) and there is a growing need for studies mapping what conservation actors think about IAS across large spatial scales, and even how these thoughts evolved through time (Young and Larson 2011).

Aley et al. (2020) proposed the Pest Management Attitude (hereafter, PMA) scale as a reliable and valid tool to quantify attitudes towards pest species and their management, among the general public in New Zealand. The scale is based on the new ecological paradigm (hereafter, NEP) scale (Dunlap et al. 2000; Dunlap and Van Liere 2008) and on a literature review about pest management, and it was initially conceived for measuring support towards the control of pest vertebrate species in New Zealand (Russell et al. 2015). However, the scale, although initially conceived for the general public, covers many key issues related to the management of biological invasions and its application could become a valuable tool to measure attitudes about IAS and their control across experts in biological invasions worldwide.

In this study we provided the first application of a shortened version of PMA scale in a European country. Over the past few decades, awareness of the impact of alien and invasive species on conservation biology has significantly increased in Europe (Dehnen-Schmutz et al. 2018; Lipták et al. 2024). This rise in awareness can be attributed to the effectiveness of media communication, coupled with an increase in European projects, which have prioritized outreach as a key objective and a project milestone (Browne et al. 2009; La Morgia et al. 2017; Lioy et al. 2019). Europe hosts a unique native biodiversity and a number of biodiversity hotspots to be preserved (de Jong et al. 2014; Iannella et al. 2020; Trew and Maclean 2021). Thus, the substantial increase in alien and invasive species across the European continent occurred since

the early 2000s, together with the heightened public consciousness of the importance of native biodiversity, and the objectives of the EU Green New Deal have all contributed to making the issue of alien species even more pressing (Huang et al. 2011; Mormul et al. 2022; Menchetti et al. 2024). Among European countries, Italy—one of the most invaded (Haubrock et al. 2021)—has seen a steady increase in attention towards biological invasions, as well management initiatives and research since the approval of the first national legislative decree about IAS in 2017 (Legislative Decree no. 230/2017).

In this context, we administered the scale to a sample of experts (n=322) working on IAS in Italy and tested its reliability and validity, altogether with its measurement invariance between different groups of respondents. We compared the scores of researchers *versus* practitioners, as these two groups sometimes have different backgrounds and personal experiences that, sometimes, could lead them to diverge in their attitudes towards wildlife. We also compared respondents that had worked on a single taxonomic group of IAS, *versus* respondents that had worked on different taxonomic groups. This distinction was made because respondents working on a single group of IAS could have worked on the topic for a short period of time and therefore have evolved different attitudes, from people with prolonged professional experience of biological invasions. Then we also tested if the age of respondents, a potential antecedent of attitudes towards IAS, which are a relatively new topic in conservation biology (Campbell and Simberloff 2022), was associated with attitude scores. As conservation topics have a somewhat transient importance (de Oliveira et al. 2023; Jarić et al. 2023), and IAS are a relatively new topic for Italian conservationists, we hypothesized that younger respondents could have had higher scores than older ones.

Materials and methods

Experts were identified by (i) checking available studies carried out on IAS, since the early 2000s, (ii) identifying people involved in major conservation projects about IAS that were carried out in Italy (e.g., LIFE ASAP LIFE15 GIE/IT/001039; e.g., LIFE STOPVESPA, LIFE14/NAT/IT/001128; e.g., Interreg Maritime ALIEM https://interreg-maritime.eu/web/

aliem), (iii) from personal knowledge of authors of the study and (iv) by asking other researchers to nominate some colleagues. This led to a final list of 580 experts that included both people within the research community (which were classified as research-involved, hereafter "researchers''), as well as people working in private companies for environmental consulting and pest control, or in environmental agencies (classified as "practitioners"). In particular, we classified as "researchers'' only who have been involved in at least one scientific publication, thus including students and technicians.

Then, 525 experts were invited, between November and December 2020, to complete an online questionnaire on GoogleForms (see Appendix 1 in the Supplementary Information). The questionnaire was confidential and asked them 7 questions from the original PMA scale that had been selected as they were deemed to be suitable for measuring attitudes about IAS management in Italy (Table 1). Answers were based on 7-points bipolar scales, asking respondents to indicate the extent to which they agreed with a series of statements, from "totally disagree" to "totally agree".

We used a shortened version of the Pest Management Attitude (PMA) scale, initially conceived as a 12- items scale and later refined to a final set of nine statements by Aley et al. (2020). The shortened version proposed in this study was firstly adapted to Italian context by translating it into Italian and by replacing the term "pest species" with "invasive alien species". Since the focus of our study was intended on IAS, such a change was necessary in order to avoid confusion in responses. Indeed "pests" term also includes native taxa, e.g., the wild boar, the starling and the magpie, which exert damages to crop and human wellness in general (e.g. Sorace 2001; Chiron and Julliard 2013; Brogi et al. 2020; Viviano et al. 2023). Furthermore, we avoided using the term "pest" for its negative connotation, which may bias people towards perception, hindering objective assessment of alien species impact. After piloting (N=8) the 9-items version of the scale with this adaptation, we further refined it by removing two of the nine items that sounded either unclear or ambiguous once translated in Italian and referred to the management of IAS in Italy, particularly those that were not mammals. Notably, we removed the statements: "Native species have greater rights than do pest species", and

Table 1 Overview of the main item of the shortened PMA scale

Code	Item
Nature conservation (NC)	Invasive alien species are a significant conservation problem. ("*Le specie aliene invasive sono una minaccia rilevante per la conservazione della natura*")
Costs and benefits (CB)	The benefit of invasive alien species control outweigh the risks to native species ("*I benefici derivanti dal controllo delle specie aliene invasive superano i danni che questo può comportare per le specie autoctone*")
Next generations (NG)	Investment in invasive alien species control is beneficial for future generations ("*Un investimento serio nel controllo delle specie aliene invasive andrebbe a vantaggio delle prossime generazioni*")
Not a priority (NP)	Invasive alien species control is less important than other conservation issues ("*Il controllo delle specie aliene invasive è meno urgente di altri problemi legati alla conservazione della natura*")
Collateral damages (CD)	Invasive alien species control has unknown side effects ("*Il controllo delle specie aliene invasive può avere effetti collaterali imprevedibili*")
Interference with nature (IN)	Invasive alien species control interferes with nature ("*Il controllo delle specie aliene invasive interferisce con la natura*")
Enough control (EC)	Not enough invasive alien species control is being done already ("*Fino ad oggi, non è stato fatto abbastanza per controllare le specie aliene invasive*")

Original items are from Aley et al. (2020), but the term "invasive alien species" is used instead of "pest". Translations in Italian language are in square brackets. The code of each item is used in Figs. 1 and 2

"Today's pest-control methods are NOT proven to be effective". To better identify the professional background of respondents, the questionnaire also asked participants to indicate whether they had worked on invasive alien mammals, birds, amphibians, reptiles, freshwater fish, freshwater invertebrates, terrestrial invertebrates, plants or marine organisms through a series of dichotomous questions. Finally, the questionnaires also asked respondents if they had participated in some specific conservation project for IAS. Questionnaires took about 5–7 min to complete. We also collected the age of each respondent based on publicly available information, or by directly asking through email.

We used Cronbach's alpha to measure the reliability of the scale, and confirmatory factor analysis to assess its validity. We tested if a solution with a single latent variable showed a good fit to the data, expressing overall attitudes towards IAS, as suggested by Aley et al. (2020), through modification indexes and chi-square testing of nested models (Beaujean 2014). Due to the non-normal distribution of item scores, we used a robust Satorra-Bentler estimator. Moreover, we also tested measurement invariance (configural, weak and strong invariance) to see whether the scale had the same structure between different groups of experts, and could be used to really compare attitudes between groups. Due to the low number of responses (see Results), it was not possible to compare experts

that had worked on different taxonomic groups (e.g. terrestrial vertebrates versus plants). Finally, we tested if the age of respondents affected their score through structural equation models.

Results

We collected answers from 316 respondents (60% response rate). Most respondents worked on invasive alien plants (52.7%), mammals (44.1%), terrestrial (38.8%) and freshwater invertebrates (34.8%), freshwater fish (32.3%), marine organisms (26.7%), birds (22.7%), reptiles (20.1%) and amphibians (15.8%). 73.4% respondents were researchers, while 26.6% of them worked as conservation practitioners in private companies or environmental agencies. Respondents had an age of 44.04 ± 12.97 years (mean ± s.d.).

The scale showed good reliability (Cronbach's alpha = 0.7). Confirmatory factor analysis also showed a good fit to the data, already when a basic model without groups was specified (CFI = 0.99, TLI = 0.99, SRMR = 0.03, RMSE = 0.02). Moreover, the scale showed strong measurement invariance, both when comparing researchers to conservation practitioners, and when comparing respondents that had worked on different taxa with respondents that had focused on one single taxonomic group. A model without constraints on its parameters performed just

as well as a model with constrained loadings between groups (weak invariance) and a model with constrained loadings and intercepts (strong invariance), both when we compared the difference in the T-statistics of nested models and when we compared alternative fitness indexes (see the Supplementary Information, Appendix 2).

When we compared scores between groups, we did not notice differences between the attitudinal score of practitioners and that of researchers, nor between the score of experts that had worked on a single taxonomic group and those working on different taxonomic groups of IAS (Fig. 1).

This lack of difference was confirmed by the fact that multi-group CFA models were not significantly different from a basic CFA without groups, both in their t-statistics and their fitness indexes. Moreover, factor loadings of the various items were quite similar between groups (Fig. 2). Overall, beliefs about the importance of IAS control in conservation (NC), and the importance of IAS control as an action capable to benefit future generations (NG), were the items most strongly associated with the scores. Conversely, beliefs about the possibility of collateral damages from IAS control (CD) were the least predictive item (Fig. 2). Finally, age did not seem to affect attitude scores. A model where "age" predicted the scores was not better than the basic CFA model, and the slope of age in the SEM
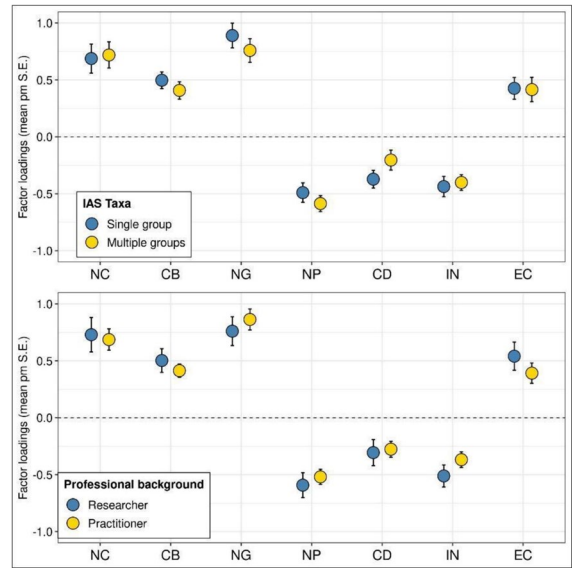
Fig. 2 Comparison of factor loadings. Upper panel: between respondents working on a single or on multiple taxonomic groups of IAS. Lower panel: between respondents with a different background, namely conservation practitioners and researchers. Acronyms are explained in Table 1

model had a small effect size (Appendix 2). Overall, participants supported the idea that managing IAS was important, as highlighted by Z-scores of the latent variables that were positive (Fig. 1). A
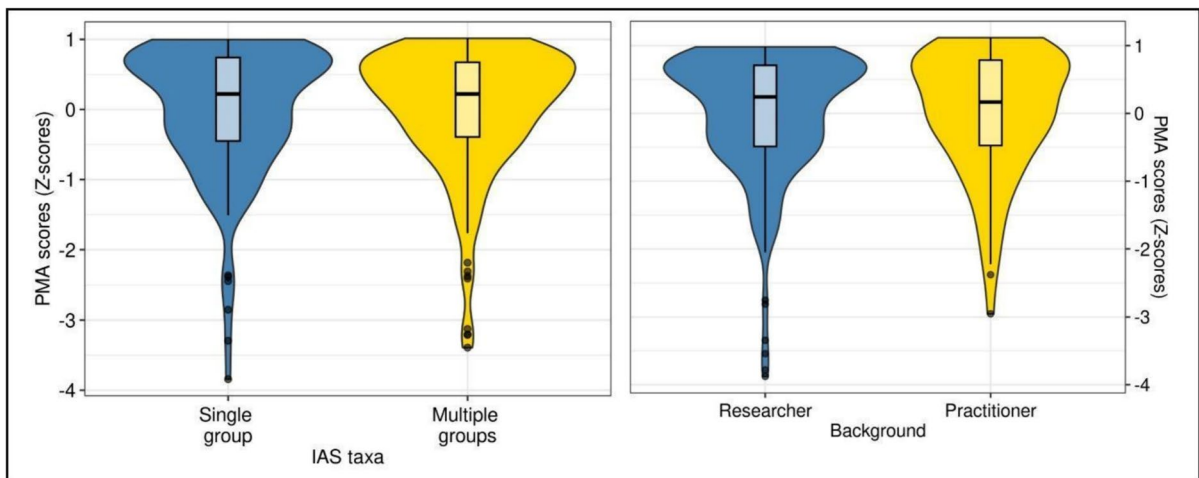
Fig. 1 Comparison of latent scores of the shortened version of PMA scale. Left: between respondents working on a single or on multiple taxonomic groups of IAS. Right: between respondents with a different background, namely conservation practitioners and researchers

complete overview of the distribution of answers to the various questions is available in Appendix 3.

Discussion

Our study was the first one testing for the applicability of a general attitudinal scale to quantify attitudes towards IAS in a geographical context which is very different from the one where such scale was originally proposed (Aley et al. 2020).

The PMA scale was originally designed to measure attitudes towards IAS in New Zealand, a country where the control of invasive alien vertebrates is well-integrated into the political agenda (Russell et al. 2015). We showed that a shortened version of the PMA scale could also be used to measure attitudes towards IAS from experts in biological invasion research living in a European country, where the history of biological invasion management is much more recent, a finding that we deem both encouraging and important.

Our results indicated that the scale was both valid and reliable for our respondents. Even if our sample included experts in biological invasions, attitudes are often context-dependent and embedded into a certain culture and geographic context (Manfredo 2008; Heberlein 2012; Shackleton et al. 2022). Therefore, experts in IAS control working in Europe could well have had partially different beliefs from people in New Zealand: our results indicate that this does not seem to be the case. The various items of the scale were well-associated to overall attitude scores, a finding that was promising for future application of the scale, considering that experts worked on very different groups of IAS, each one characterized its own impacts, invasion history and control methods.

There were also no strong differences between respondents with different professional backgrounds, or different experience in biological invasion research: the scale worked equally well for conservation professionals and researchers, as well as for experts that had worked on one or more IAS. This second point was even more non-trivial, because attitudes are partially embedded into personal experience and differences in wildlife-related attitudes are a well-known cause of attrition between policymakers, professionals and researchers in areas such as wildlife management (Manfredo et al. 2008).

The use of a broadly applicable attitudinal scale, to measure beliefs about IAS and their control, paves the way for large-scale, and long-term, research about conservation experts working on biological invasions. For example, this management attitude scale could detect differences between conservationists working in different countries, or being characterized by different cultural backgrounds, similarly to other well-known scales (e.g., the wildlife value orientation scale, Manfredo et al. 2009). Studies of this kind can be extremely important to facilitate transboundary collaborations in IAS management, often a challenging issue (Prasanna et al. 2022). At the same time, it would be possible to test if constructs, such as social norms (Bicchieri 2016) or value orientations, affect attitudes towards IAS differently across cultures and countries, or to detect country-specific differences between stakeholders. Large-scale maps of attitudes towards IAS and their control can also be produced, similar to what has been done in North America for wildlife value orientations (Manfredo et al. 2020a), with the goal of identifying areas where attitudes and awareness of conservation stakeholders can be improved through tailored communication campaigns.

Moreover, a widely applicable attitudinal scale could also be used to measure how the perceived importance that conservation scientists attach to biological invasions can change through time. Topics in conservation biology are not static in time, but they also change with existing beliefs and paradigms (Anderson et al. 2021). Although over the last few decades researchers became increasingly aware of IAS and their impacts (Campbell and Simberloff 2020), as biotic communities become more homogenized it might happen that they would perceive IAS as part of invaded ecosystems (the "shifting baseline syndrome", Clavero 2014), with potentially important repercussions on their management.

Of course, our study was limited to experts working on bioinvasion research. Our sample was not representative of the whole Italian population and our findings cannot be compared to those of Aley et al. (2020). However, our psychometric scale showed some interesting properties, like invariance, validity and reliability, that were non trivial in a European context, as attitudes and values depend upon culture, and European countries, like Italy, have a much more recent history in biological invasions (Menchetti et al. 2024). If these

properties were confirmed in future studies with larger, and representative samples of European respondents, the IAS Management Attitude scale could become a valuable tool for research and management in biological invasion science. Therefore, future studies could either administer the IAS Management Attitude scale to other relevant conservation stakeholders (e.g., environmental agencies staff, policymakers) or to the resident population of Europe, and see if these properties still hold. Probably, at least in some European countries, public awareness of biological invasions might be significantly lower than in New Zealand, where public policies for bioinvasions date back to various decades ago. Nevertheless, comparing different European countries could be useful to design strategies for the large -scale outreach of biological invasions.

Conclusions

We found that the IAS Management Attitude scale, a shortened version of PMA scale, originally proposed to measure attitudes towards invasive pests in New Zealand, could also be used to measure attitudes towards IAS in a European country, at least among experts and practitioners working on biological invasions. This finding paves the way for large-scale, or long-term, quantification of attitudes towards invasive alien species and their management in Europe. Moreover, this study further encourages the application of the IAS Management Attitude scale in other countries, in an attempt to understand if it could be a broadly applicable tool for cross-cultural studies in the conservation social sciences.

Data availability statement

The preprint version is available at: https://ecoevorxiv. org/repository/view/6272/. Supplementary information, including Appendices 1, 2, and 3, and reproducible data and software code is available at: https://osf.io/yj8tp/.

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

References

Aley JP, Milfont TL, Russell JA (2020) The pest-management attitude (PMA) scale: a unidimensional and versatile assessment tool. Wildl Res 47:166. https://doi.org/10.1071/wr19094

Anderson SC, Elsen PR, Hughes BB, Tonietto RK, Bletz MC, Gill D, Holgerson MA, Kuebbing SE, MacKenzie CM, Meek MH, Veríssimo D (2021) Trends in ecology and conservation over eight decades. Front Ecol Environm 19:274–282. https://doi.org/10.1002/fee.2320

Beaujean AA (2014) Latent variable modeling using R: a step-by-step guide. Routledge Editions, London, UK

Bellard C, Cassey P, Blackburn TM (2016) Alien species as a driver of recent extinctions. Biol Lett 12:20150623. https://doi.org/10.1098/rsbl.2015.0623

Bicchieri C (2016) Norms in the Wild: How to diagnose, measure, and change social norms. Available online at this site: https://openlibrary.org/books/OL28616989M/Norms_in_the_Wild Accessed 24 Feb 2024

Brogi R, Grignolio S, Brivio F, Apollonio M (2020) Protected areas as refuges for pest species? The case of wild boar. Glob Ecol Conserv 22:e00969. https://doi.org/10.1016/j.gecco.2020.e00969

Browne M, Pagad S, De Poorter M (2009) The crucial role of information exchange and research for effective responses to biological invasions. Weed Res 49:6–18. https://doi.org/10.1111/j.1365-3180.2008.00676.x

Bruskotter JT, Vucetich JA, Dietsch AM, Slagle KM, Brooks J, Nelson MP (2019) Conservationists' moral obligations toward wildlife: Values and identity promote conservation conflict. Biol Conserv 240:108296. https://doi.org/10.1016/j.biocon.2019.108296

Campbell SE, Simberloff D (2022) Forty years of invasion research: more papers, more collaboration….bigger impact? NeoBiota 75:57–77. https://doi.org/10.3897/neobiota.75.86949

Cerri J, Mori E, Zozzoli R, Gigliotti A, Chirco A, Bertolino S (2020) Managing invasive Siberian chipmunks *Eutamias sibiricus* in Italy: a matter of attitudes and risk of dispersal. Biol Invasions 22:603–616. https://doi.org/10.1007/s10530-019-02115-5

Chiron F, Julliard R (2013) Assessing the effects of trapping on pest bird species at the country level. Biol Conserv 158:98–106. https://doi.org/10.1016/j.biocon.2012.08.001

Clavero M (2014) Shifting baselines and the conservation of non-native species. Conserv Biol 28:1434–1436. https://doi.org/10.1111/cobi.12266

Crowley SL, Hinchliffe S, McDonald RA (2017) Conflict in invasive species management. Front Ecol Environm 15:133–141. https://doi.org/10.1002/fee.1471

de Jong Y, Verbeek M, Michelsen V, de Place BP, Los W, Steeman F, Hagedorn G, Wetzel FT, Glöcker F, Kroupa A, Korb G, Hoffmann A, Häuser C, Kohlbecker A, Müller A, Güntsch A, Stoev P, Penev L (2014) Fauna Europaea– all European animal species on the web. Biodiv Data J 2:e4034. https://doi.org/10.3897/BDJ.2.e4034

De Oliveira CGH, Vardi R, Jarić I, Correia RA, Roll U, Veríssimo D (2023) Evaluating global interest in biodiversity and conservation. Conserv Biol 37:e14100. https://doi.org/10.1111/cobi.14100

Dehnen-Schmutz K, Boivin T, Essl F, Groom QJ, Harrison L, Touza JM, Bayliss H (2018) Alien futures: what is on the horizon for biological invasions? Divers Distrib 24:1149–1157. https://doi.org/10.1111/ddi.12755

Dietsch AM, Teel TL, Manfredo MJ (2016) Social values and biodiversity conservation in a dynamic world. Conserv Biol 30:1212–1221. https://doi.org/10.1111/cobi.12742

Dunlap RE, Van Liere KD (2008) The "New Environmental Paradigm." J Environm Educ 40:19–28. https://doi.org/10.3200/joee.40.1.19-28

Dunlap RE, Van Liere KD, Mertig AG, Jones RE (2000) Measuring endorsement of the new ecological paradigm: a revised NEP Scale. J Social Issues 56:425–442. https://doi.org/10.1111/0022-4537.00176

Gargioni C, Monaco A, Ficetola GF, Lazzeri L, Mori E (2021) From the Andes to the Apennines: rise and fall of a freeranging population of feral llamas. Animals 11:857. https://doi.org/10.3390/ani11030857

Gbedomon RC, Salako VK, Schlaepfer MA (2020) Diverse views among scientists on non-native species. NeoBiota 54:49–69. https://doi.org/10.3897/neobiota.54.38741

Haubrock PJ, Cuthbert RN, Tricarico E, Diagne C, Courchamp F, Gozlan RE (2021) The recorded economic costs of alien invasive species in Italy. NeoBiota 67:247–266. https://doi.org/10.3897/neobiota.67.57747

Heberlein TA (2012) Navigating environmental attitudes. Oxford University Press, USA. https://global.oup.com/academic/product/navigating-environmental-attitudes-9780199773336?cc=de&lang=en. Accessed 24 Feb 2024

Heeren A, Karns GR, Bruskotter JT, Toman E, Wilson RS, Szarek HK (2016) Expert judgment and uncertainty regarding the protection of imperiled species. Conserv Biol 31:657–665. https://doi.org/10.1111/cobi.12838

Huang D, Haack RA, Zhang R (2011) Does global warming increase establishment rates of invasive alien species? A centurial time series analysis. PLoS ONE 6:e24733. https://doi.org/10.1371/journal.pone.0024733

Iannella M, Fiasca B, Di Lorenzo T, Biondi M, Di Cicco M, Galassi DM (2020) Jumping into the grids: mapping biodiversity hotspots in groundwater habitat types across Europe. Ecogr 43:1825–1841. https://doi.org/10.1111/ecog.05323

Jarić I, Correia RA, Bonaiuto M, Brook BW, Courchamp F, Firth JA, Gaston KJ, Heger T, Jeschke JM, Ladle RJ, Meinard Y, Roberts DL, Sherren K, Soga M, Redondo AS, Veríssimo D, Roll U (2023) Transience of public attention in conservation science. Front Ecol Environm 21:333–340. https://doi.org/10.1002/fee.2598

Kapitza K, Zimmermann H, Martín-López B, von Wehrden H (2019) Research on the social perception of invasive species: a systematic literature review. NeoBiota 43:47–68. https://doi.org/10.1016/j.biocon.2008.09.003

La Morgia V, Paoloni D, Genovesi P (2017) Eradicating the grey squirrel Sciurus carolinensis from urban areas: an innovative decision-making approach based on lessons learnt in Italy. Pest Manage Sci 73:354–363. https://doi.org/10.1002/ps.4352

Lioy S, Marsan A, Balduzzi A, Wauters LA, Martinoli A, Bertolino S (2019) The management of the introduced grey squirrel seen through the eyes of the media. Biol Invasions 21:3723–3733. https://doi.org/10.1007/s10530-019-02084-9

Lipták B, Kouba A, Patoka J, Paunović M, Prokop P (2024) Biological invasions and invasive species in freshwaters: perception of the general public. Hum Dim Wildl 29:48–63. https://doi.org/10.1080/10871209.2023.2177779

Liu S, Cook D (2015) Eradicate, contain, or live with it? Collaborating with stakeholders to evaluate responses to invasive species. Food Security 8:49–59. https://doi.org/10.1007/s12571-015-0525-y

Manfredo MJ, Teel TL, Henry KL (2009) Linking society and environment: a multilevel model of shifting wildlife value orientations in the Western United States*. Social Sci Quarterly 90:407–427. https://doi.org/10.1111/j.1540-6237.2009.00624.x

Manfredo MJ, Teel TL, Carlos AWD, Sullivan L, Bright AD, Dietsch AM, Bruskotter JT, Fulton DC (2020a) The changing sociocultural context of wildlife conservation. Conserv Biol 34:1549–1559. https://doi.org/10.1111/cobi.13493

Manfredo MJ, Urquiza-Haas EG, Carlos AWD, Bruskotter JT, Dietsch AM (2020b) How anthropomorphism is changing the social context of modern wildlife conservation. Biol

Cons 241:108297. https://doi.org/10.1016/j.biocon.2019.108297

Manfredo MJ (2008) Who cares about wildlife? Social science concepts for exploring human-wildlife relationships and conservation issues Springer eBooks, London and New York. https://doi.org/10.1007/978-0-387-77040-6

Mascia D, Cicchetti A, Damiani G (2013) "Us and Them": a social network analysis of physicians' professional networks and their attitudes towards EBM. BMC Health Serv Res 13:429. https://doi.org/10.1186/1472-6963-13-429

Mascia D, Di Vincenzo F, Iacopino V, Fantini MP, Cicchetti A (2015) Unfolding similarity in interphysician networks: the impact of institutional and professional homophily. BMC Health Serv Res 15:92. https://doi.org/10.1186/s12913-015-0748-9

McPherson M, Smith-Lovin L, Cook J (2001) Birds of a feather: homophily in social networks. Annual Rev Sociol 27:415–444. https://doi.org/10.1146/annurev.soc.27.1.415

Menchetti M, Schifani E, Alicata A, Cardador L, Sbrega E, Toro-Delgado E, Vila R (2024) Response to Genovesi et al.: Ant biosurveillance should come before invasion. Current Biol 34:51–52. https://doi.org/10.1016/j.cub.2023.11.055

Mormul RP, Vieira DS, Bailly D, Fidanza K, da Silva VFB, da Graça WJ, Pontara V, Bueno ML, Thomaz SM, Mendes RS (2022) Invasive alien species records are exponentially rising across the Earth. Biol Invasions 24:3249–3261. https://doi.org/10.1007/s10530-022-02843-1

Novoa A, Richardson DM, Pyšek P, Meyerson LA, Bacher S, Canavan S, Catford JA, Cuda J, Essl F, Foxcroft LC, Genovesi P, Hirsch H, Hui C, Jackson MC, Kueffer C, Le Roux JJ, Measey J, Mohanty NP, Moodley D, Muller-Scharer H, Packer JG, Pergl J, Robinson TB, Saul WC, Shackleton RT, Visser V, Weyl OLF, Yannelli FA, Wilson JR (2020) Invasion syndromes: a systematic approach for predicting biological invasions and facilitating effective management. Biol Invasions 22:1801–1820. https://doi.org/10.1007/s10530-020-02220-w

Prasanna BM, Carvajal-Yepes M, Kumar L, Kawarazuka N, Liu Y, Mulema AA, McCutcheon S, Ibabao X (2022) Sustainable management of transboundary pests requires holistic and inclusive solutions. Food Security 14:1449–1457. https://doi.org/10.1007/s12571-022-01301-z

Russell JC, Innes J, Brown PH, Byrom AE (2015) Predator-Free New Zealand: Conservation country. Bioscience 65:520–525. https://doi.org/10.1093/biosci/biv012

Schroeder SA, Landon AC, Fulton DC, McInenly LE (2021) Social identity, values, and trust in government: How stakeholder group, ideology, and wildlife value orientations relate to trust in a state agency for wildlife management. Biol Conserv 261:109285. https://doi.org/10.1016/j.biocon.2021.109285

Shackleton RT, Richardson DM, Shackleton CM, Bennett BM, Crowley SL, Dehnen-Schmutz K, Estévez RA, Fischer A, Kueffer C, Kull CA, Marchante E, Novoa A, Potgieter LJ, Vaas J, Vaz AS, Larson BMH (2019) Explaining people's perceptions of invasive alien species: a conceptual framework. J Environm Manage 229:10–26. https://doi.org/10.1016/j.jenvman.2018.04.045

Shackleton RT, Vimercati G, Probert AF, Bacher S, Kull CA, Novoa A (2022) Consensus and controversy in the discipline of invasion science. Conserv Biol 36:e13931. https://doi.org/10.1111/cobi.13931

Sorace A (2001) Value to wildlife of urban-agricultural parks: a case study from Rome urban area. Environm Manage 28:547–560. https://doi.org/10.1007/s002670010243

Trew BT, Maclean IM (2021) Vulnerability of global biodiversity hotspots to climate change. Glob Ecol Biogeogr 30:768–783. https://doi.org/10.1111/geb.13272

Van Eeden LM, Newsome TM, Crowther MS, Dickman CR, Bruskotter JT (2019) Social identity shapes support for management of wildlife and pests. Biol Cons 231:167–173. https://doi.org/10.1016/j.biocon.2019.01.012

Vaz AS, Kueffer C, Kull CA, Richardson DM, Schindler S, Muñoz-Pajares AJ, Vicente JR, Martins J, Hui C, Kühn I, Honrado JP (2017) The progress of interdisciplinarity in invasion science. Ambio 46:428–442. https://doi.org/10.1007/s13280-017-0897-7

Viviano A, Mori E, Manzini J, Paoletti E, Hoshika Y, Cotrozzi L, Pisuttu C, Risoli S, Materassi A, Moura BB (2023) The magpie and the grapes: increasing ozone exposure impacts fruit consumption by a common corvid in a suburban environment. Pest Manage Sci. https://doi.org/10.1002/ps.7819

Whitehouse-Tedd K, Abell J, Dunn AK (2021) Evaluation of the use of psychometric scales in human–wildlife interaction research to determine attitudes and tolerance toward wildlife. Conserv Biol 35:533–547. https://doi.org/10.1111/cobi.13599

Young AM, Larson BM (2011) Clarifying debates in invasion biology: a survey of invasion biologists. Environm Res 111:893–898. https://doi.org/10.1016/j.envres.2011.06.006