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*Insight*

## A heuristic for innovative invasive species management actions and strategies

Yves Meinard<sup>1</sup>, Małgorzata Dereniowska<sup>2</sup>, Sandrine Glatron<sup>3</sup>, Virginie Maris<sup>4</sup>, Véronique Philippot<sup>5</sup> and Jean-Yves Georges<sup>6</sup> 

**ABSTRACT.** Conservation actions are notoriously difficult to design and implement in contexts of value pluralism. These difficulties are compounded in the case of biological invasion mitigation. Biological invasions are major threats to biodiversity and ecosystems. Preventing or mitigating biological invasions accordingly plays a key role in conservation policies. The relationship between human beings and invasive species is, however, complex, not unequivocal, and presents a variety of moral aspects. The practical and ethical reasons used to champion actions targeting populations of invasive species are questioned both in the literature and by actors and stakeholders in the field. The resulting debates between advocates and critics of biological invasion mitigation are doomed to remain sterile unless the whole diversity of points of view is considered and the relationships between human beings and non-human beings (i.e., plants and animals) are considered in their full complexity. As conservation biologists involved in invasion research, we argue that, instead of bemoaning such difficulties, conservation biologists should see the challenge to face this diversity as an opportunity to innovate. We present a heuristic, based on theories of deliberative democracy and multispecies anthropology, to help consider this pluralism and this complexity when identifying management options. This heuristic consists of identifying the spectrum of points of view of human and non-human beings concerned and assessing how acceptable the various actions are to all these points of view, until a course of action acceptable to all is found (if possible). We argue that by elaborating management options, which are arguably acceptable to all, including to members of the targeted invasive populations themselves, we can design more robust conservation solutions. We show how such an approach can be implemented in practice without paralyzing biological invasion mitigation.

**Key Words:** *decision making; deliberative democracy; invasive animals; invasive plants; multispecies anthropology; non-human agency; pluralism*

### INTRODUCTION

Environmental policies and conservation actions are notoriously difficult to design and implement due to the diversity of interests and the complexity of decision processes in societies increasingly characterized by value pluralism (Chapman et al. 2019). These difficulties are compounded in the case of biological invasion mitigation, which plays an increasingly important role in numerous conservation policies and strategies (Goodell et al. 2000, Perrings 2005, Mačić et al. 2018).

Invasive species are “alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health” (Beck et al. 2008:414). They are considered to be a major threat to biodiversity worldwide (Lambdon et al. 2008). Societies and ecosystems face a choice between mitigating biological invasions, or adapting to their mostly deleterious implications (Perrings 2005). Biological invasion mitigation plays a key role in numerous conservation action plans and environmental policies. For example, the European Union is equipped with a policy targeting invasive species (Beninde et al. 2015). In the Natura 2000 network (the main policy instrument devoted to conserve biodiversity in Europe), the presence and prevalence of invasive species are among the most important variables used to determine the conservation status of habitats (Evans and Arvela 2011). Similarly, numerous institutions funding environmental action plans have invasive species strategies, including requirements to control invasive species, conditioning their granting conservation funds (e.g., Concept cours d’eau SCOP and TERE0 2016).

All these policies and strategies are underpinned by moral premises converging toward the idea that we should mitigate the impact of invasive species, by preventing invasions or controlling populations of invasive species. Some of these moral premises are anthropocentric: we should control invasive species because they have direct and/or indirect impacts on human activities, health, and/or human well-being. Other premises are eco-centric: we should control invasive species because they harm ecosystem integrity or functioning, conceived as valuable in themselves. Other premises are species-centric: we should control invasive species because they harm other species, valuable in themselves, such as endemic and endangered species.

This convergence makes it look as though the idea that we should control invasive species is uncontroversial. However, the above anthropocentric, eco-centric, and species-centric arguments do not exhaust the range of possibly relevant arguments on this issue, and the justifiability of biological invasion mitigation can be questioned for a variety of reasons. Invasive species control implies physically interacting with, and often killing, living beings, which might be considered unacceptable by people motivated by biocentric values (i.e., people holding the moral view that we should not harm living beings), or by pathocentric values (i.e., people holding the moral view that we should not make sentient beings suffer), and concerned with the fact that controlling invasive animal species can imply that individuals might suffer or might be killed. Besides, numerous invasive species have been originally introduced because they are of particular interest to some people (Jarić et al. 2020): among myriads of examples, let us cite the cases of beautiful alien flowering plants introduced for

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horticultural reasons, or fast growing giant cane used over centuries for providing furniture. Moreover, a prominent reason why invasive species are now invasive is that we, human beings, have launched and are sustaining, rather than preventing, the intense circulation of goods and people on a global scale (Aguin-Pombo 2012, Epanchin-Niell et al. 2021). This problem is compounded by the effects of anthropogenic climate change, which intensify the circulation of species, with many species migrating to more favorable bioclimatic niches (Colautti et al. 2017, Cottier-Cook et al. 2017). Besides, vulnerability to biological invasions appears to be fostered by prior anthropogenic degradation (Martin et al. 2009). This can justifiably lead some people to argue that invasive species are scapegoats that we, human beings, blame whereas we are the true culprits of both biological invasions and more generally global change (Mach et al. 2014, IPCC 2018). Lastly, one can suspect that attempts at mitigating biological invasions are, at least in some cases, motivated by an ill-conceived, fixist perception of nature, ignoring that biological invasions have always played an important role in biogeographic changes and evolutionary processes. This diversity of attitudes toward invasive species reflects a diversity of values and representations among actors involved in and/or concerned by mitigation (Novoa et al. 2017, van Eeden et al. 2019).

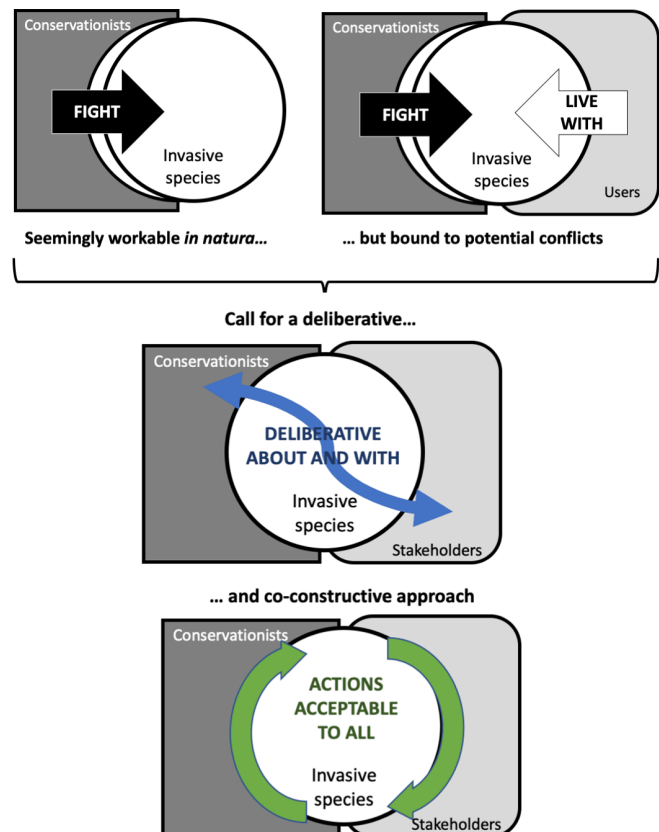
New paradigms recently introduced in the conservation literature echo this divergence between various existing attitudes with respect to invasive species. “Compassionate conservation” (Wallach et al. 2018:6), which aims “to safeguard Earth’s biological diversity while retaining a commitment to treating individuals with respect and concern for their well-being,” can suggest ruling out invasive species mitigation because it involves killing individuals. “New conservation” (Schilthuizen 2018), which argues that, instead of mourning pristine nature, we should embrace “new natures” and use them to support human development, can suggest that invasive species belong to these “new natures” to be valued and supported. In line with this argument, “novel ecosystems” rich in invasive species can be seen as valuable, just like natural ones (Hobbs et al. 2006). Such stances can occasionally be accompanied by the so-called “invasive denialism” (Russell and Blackburn 2017) that deny the seriousness of impacts of invasive species on ecosystems. Both the scientific literature and the strategies concerning invasive species are hence penetrated by unresolved ethical divergences, leading to harsh academic debates and deep conflicts among actors in the field (for a review of these conflicts, which falls beyond our scope, see, e.g., Pelé et al. 2021).

As conservation biologists, we argue that this predicament, which might look exasperating for colleagues concerned with mitigating the attested impacts of invasive species on biodiversity and ecosystems, should rather be seen as an opportunity to exert our creativity by inventing innovative actions and strategies, in the case of invasive mitigation actions, but also beyond. To substantiate this claim, we argue that instead of bemoaning the deplorable fact that there are deep moral disagreements on invasive species mitigation, conservation biologists should take it upon themselves to innovate by elaborating mitigation strategies and actions that, in addition to being scientifically robust, take diverging points of view decisively into account. The point is to foster our innovativeness to identify ever more robust courses of actions.

## A HEURISTIC FOR INNOVATIVE INVASIVE SPECIES MITIGATION ACTIONS AND STRATEGIES

Our aim is to propose a heuristic to support the work of people or groups of people who strive to elaborate and/or implement invasive species management actions and strategies in the field (Fig. 1). For brevity’s sake, we talk about “invasion experts.” Typically, those people come from varied disciplinary backgrounds and are entrusted by administrations or non-profit organizations with defining conservation strategies at various scales, in contrasted contexts (from natural protected to urban areas). They can be protected areas managers, conservation experts, researchers monitoring management projects (e.g., as part of scientific committees), or scientists implementing applied research projects.

**Fig. 1.** Conceptual schematization of our two-step approach: from the simplistic approach of academic conservationists (Manage = Fight) to a call for a deliberative co-constructed approach (Manage = Actions acceptable to all).



### Step 1: including other people’s point of view

When invasion experts strive to elaborate and/or implement invasive species mitigation actions and strategies in corresponding diversities of contexts, they all face a similar injunction: involve stakeholders in the process. This inclusion of stakeholders is championed by numerous prominent theoretical and practical management frameworks (e.g., Runge and McDonald-Madden 2018) and plays a key-role in numerous management blueprints (e.g., OFB 2017). Furthermore, it is mandated by many regulatory

frameworks, such as the European Directives structuring the Natura 2000 policy. This generalized call for participation echoes the moral ideal of deliberative democracy, according to which “the constraint-free force of the better argument” (Habermas 1992; that is, the attitude that consists in admitting that people holding different points of view should strive to convince others, not necessarily that their own vision is the right or the good one, but that it is acceptable to all) should regulate public decision making (Buchs et al. 2021).

Compelled as they are to frame their initiative in this participatory setting, invasion experts can endorse different attitudes. They can do everything they can to promote the invasive species mitigation actions and strategies they already have in mind, not only by arguing in favor of their preferred option, but also by silencing counterproposals and manipulating their audience to achieve their own goals. Alternatively, invasion experts can limit themselves to presenting purely scientific data to stakeholders and letting them decide the course of action to launch. These two alternative attitudes have been classically introduced by Pielke (2007), who calls them, respectively, “issue advocate” and “honest broker of policy alternatives.” Both attitudes are plagued by worrisome drawbacks. The attitude of the issue advocate can be criticized for being morally questionable (among other things because experts endorsing this attitude use their scientific authority to champion their own values), and it is liable to work only if the advocate is a skilled manipulator, which not all invasion experts are. When it comes to the honest broker, given the intertwinement of normative and scientific concepts in invasion biology, this attitude looks more like an unreachable ideal than a credible option. Besides, because they limit themselves to presenting purely scientific data, invasion experts who endorse this attitude compel themselves not to discuss the ethical reasons underlying invasive mitigation actions, which is arguably exceedingly self-restrictive. Beyond Pielke’s dichotomy, a third attitude can be for invasion experts to endorse the deliberative democracy’s quest for “the constraint-free force of the better argument.” This third attitude has two prominent merits. First, it can be value adding, in the sense that it can enrich actions and strategies by bringing in ideas and information that invasion experts might have initially lacked, and it can make decisions more likely to be understood and adhered to (Reed 2008, Johansson et al. 2018). Second, the implementation of this attitude is facilitated by the generalized call for citizens’ participation in societal and political decisions, which materializes in dedicated institutional settings, shared practices, well-trodden guidelines, and abundant conceptual resources and organizational tools to prevent, at least to some extent, possible drawbacks and manipulations of participatory mechanisms (Turnhout et al. 2010, 2020). We therefore claim that this third attitude is the best option for invasion experts to endorse.

Endorsing this attitude means, for invasion experts, to admit that people holding different points of view should strive to convince others, not necessarily that their own vision is the right or the good one, but that it is acceptable to all. Symmetrically, they should concede that others’ visions can be preferred if they are acceptable to all. This articulation, in terms of acceptability, of Habermas’s (1992) and Rawls’s (1999) seminal formulations of deliberative democracy is due to Estlund (2009). Diverging visions should hence be confronted, and their champions are expected to

hear the other side with respect, exchange arguments, provide each other with information, and refine their opinions. This process is expected to unfold until visions that prove not to be acceptable to all are identified and discarded, whereas visions that prove acceptable to all are retained because they can coexist in tolerance and can then be used to identify courses of actions that are acceptable to all. This acceptability test is a thought experiment aimed to see whether acceptance would be reached under ideal conditions (i.e., access to all the relevant information and unlimited time). These conditions are never fulfilled in real life, but give-and-take discussions are expected to approximate them.

In pluralist settings where contentious invasive mitigation actions are to be implemented, endorsing deliberative democracy’s core idea hence means for invasion experts that, instead of taking it to be self-evident that their point of view is the right one, they should develop a tolerant, open attitude toward other visions of biological invasions and respect the complexity of motivations and moral reasons behind different visions. This attitude does not amount to abandoning their own vision. It means that invasion experts should try to convince others that this vision is well-founded but accept at the same time that in some cases some people can remain unconvinced and/or can produce relevant counterarguments. Taking these people and their counterarguments seriously is the best available means invasion experts have to identify courses of action that have a chance to be implemented, owing to the fact that they can win the support of the various concerned points of view.

The notion of point of view deserves precise attention at this stage. Literally, to have a point of view, you need to have eyes, located at a point in space. This excludes, for example, that populations, but also institutions, communities, future generations, and blind people might have a point of view. Evidently enough, when we say that invasion experts should consider the point of view of others, we do not take the phrase in this absurdly restrictive sense. The notion of point of view is rather used, metaphorically, to refer to decentering efforts: taking the point of view of someone else means striving to consider him/her (his/her interests, values, opinions, rights, etc.) just as much as we consider ourselves. In this metaphorical sense, a blind person can have a point of view and so can institutions or abstract entities. For example, it makes sense to talk about the point of view of an NGO, the point of view of anglers, or the point of view of farmers, although the former is an institution, and the latter are abstract categories rather than concrete individuals.

Because biological invasion mitigation actions can be questioned by individuals speaking in their own names and by people speaking on behalf of broader categories, they see themselves as representing individuals’ and abstract entities’ points of view; both deserve to be considered.

A first step of a heuristic to create successful invasive mitigation actions is hence to identify the spectrum of points of view to be considered and to assess which courses of action are acceptable, through thought experiments and, as much as possible, through discussions with representatives of these points of view. Although there is no guarantee that solutions acceptable to all will be identifiable in all cases, striving to identify such solutions remains worthwhile nonetheless.

## **Step 2: including the point of view of members of invasive species (and other concerned non-humans)**

We argue that the logic underlying our first step should be followed by a second step, inspired by a relatively recent trend in environmental humanities: multispecies thinking (Haraway 2008, Kirksey and Helmreich 2010, Kohn 2013, Kopnina 2017). This trend questions the asymmetry that consists in considering only the point of view of human beings, however diverse. We argue that, far from undermining the deliberative approach, this trend paves the way to widen its logic by including the point of view of non-human beings. We claim here neither to produce a representative review of this immense literature nor to do justice to the subtlety of its numerous contributions. Our point is to take advantage of major ideas structuring this literature, which could advantageously improve invasive species science and practice.

Whereas anthropology is the study of human beings and cultures, multispecies anthropology attempts to include other species and relations between species as topics for anthropological inquiries. When traditional anthropology includes non-human species in its topic, it conceives of them as objects of human representations and usages (Descola 2013). By contrast, multispecies anthropology attempts to attenuate this asymmetry by seeing human beings and members of non-human species as constitutive of both sides of the relation. Multispecies anthropology hence reveals that members of non-human species are not simply passive items onto which various people project their representations: they are constitutive, active parts of these relationships (Kohn 2013).

This idea suggests that our first step should be complemented by a second expansion of attitude. Based on the above-mentioned deliberative processes that lead people to a shared understanding of what is acceptable to all, we propose that members of invasive species, because they are constitutive elements of the various relationships humans and non-humans have, should similarly be included in the collective work aimed at developing solutions acceptable to all humans and non-humans.

Our idea, according to which an approach in line with theories of deliberative democracy should be complemented in a way that echoes multispecies thinking, will undoubtedly sound disruptive to some theoreticians. Indeed, most approaches designed to include the points of view of other stakeholders in collective decision making are deliberative or participatory tools, anchored in anthropocentric philosophical approaches (political liberalism and theories of deliberative democracy). By contrast, the above anthropological insights present themselves as radically non-anthropocentric. Historically, there is a tight link between the idea of acceptability and anthropocentrism because deliberative procedures are rooted in rationality and discourse, which are privileged human modes of cognition and communication. However, this historical link may be set aside at a practical level to revisit the notion of acceptability in a broader meaning and to combine it with a multispecies perspective.

In line with the multispecies trend, numerous recent contributions to anthropology, designed to rethink the very intellectual foundations of the discipline and strip it from remnants of anthropocentrism, explore how the point of view of non-human beings is sometimes integrated in collective actions and decision making. For example, Latour (1999) explored the construction

and functioning of collectives involving both human and non-human beings. Kohn (2013) made the point that many non-human life-forms engage in processes of representation and meaning giving. Using numerous examples mainly from South America and South-east Asia, Descola (2013) showed that many collectives, in non-western contexts, consider that members of some non-human species should take part in collective decisions whereas some human beings should be excluded from them. Morizot (2016) investigated how members of human and non-human species can cohabitate through “diplomatic” relationships. This line of thought also echoes the work of geographers highlighting the importance of non-human agency in “more-than-human social life” (Lawrence 2022, Argüelles and March 2022:44) and pointing out that the invasive entities are not non-human species, but rather networks of human and non-human actors (Robbins 2004). Echoing Kohn (2013), Atchison (2015) goes as far as talking about a reflexive learning with non-humans in the design and implementation of biocontrol management.

Although they are based on an abundant empirical material, these contributions are mainly descriptive and analytical, rather than action-oriented. They develop illuminating explanations of the diversity of relationships between diverse species in domains (collective actions and decisions) that are usually considered to be the prerogative of human beings. But they do not address the question of how the inclusion of members of non-human species in collective actions and decisions can be orchestrated when a decision that concerns both humans and non-humans has to be made. Latour’s (2018:47) notion of a “parliament of things” tellingly illustrates the limitations of such contributions in their application to issues of biological invasions. Latour (2018:53) argued that the two senses in which the verb “represent” is used when talking, on the one hand, about politicians “representing” their constituencies, and on the other hand, about scientists “representing” reality using scientific theories and arguments, are much closer than one might think at first sight. This leads him to claim that discussion and decision forums involving both political representatives and scientists constitute “parliaments” of sorts, in which both human and non-human beings are represented. However, as recalled in the introduction, when biological invasions are discussed, most scientists typically champion mitigation (and often eradication) actions, thereby representing invasive species in a sense that is unmistakably very different from the sense in which political representatives represent citizens. This difficulty shows that the question of how to include non-human beings in collective decisions and actions is largely untouched by this literature.

Similarly, multispecies anthropological studies applied to invasive species management (e.g., Mougnot and Roussel 2006, Méchin 2007, Blair 2017) are *ex post* observations that do not develop recommendations concerning decisions to be made regarding populations of these species. From the point of view of conservation practitioners and action-oriented conservation biologists, this literature is hence of little direct usefulness. This lack of action-oriented insights in the literature is problematic because whereas saying that conservation biologists should deliberate with other people about invasive species looks reasonable (leaving aside all the practical difficulties that the vast literature on participation and deliberation addresses, see e.g., Turnhout et al. 2020), the very idea that members of invasive

species could take part in discussions and deliberation may look fanciful. More precisely, the extension of the logic of acceptability to non-human beings faces two problems: first, non-human beings cannot speak, and therefore cannot discuss; second, if we set out to include the point of view of non-human beings, the question of who is to be included, unavoidably arises.

These are serious challenges, but we have good reason to think that they are not insurmountable. The main reason is that standard deliberative processes do work, despite the fact that they are also plagued by these two problems, albeit in a milder form. Indeed, typically, newborns, severely disabled people, future generations, and legal persons are literally incapable of partaking in discussions in deliberative settings. But, the latter owe part of their legitimacy and legitimating force to the fact that they manage to consider the point of view of these agents (Dereniowska 2017). This is done through an effort to represent the point of view of those who cannot participate themselves (Kulha et al. 2021). Similarly, the question of whose point of view should be represented also already arises in standard deliberative settings, where it is generally answered by claiming that all those concerned by the decision to be made and its foreseeable consequences should be included in deliberation (Daniell et al. 2010).

We claim that these classical answers to the milder forms of these problems should also be used to solve the more serious versions arising when enlarging the circle of discussions. As Caillon et al. (2017) recalled, the extension of representation to non-human beings already plays an important role in numerous recent environmental initiatives: just like representatives such as lawyers “can speak for corporations or municipalities, they can do the same for nature”. Representation is never an easy task, and the more different represented and representatives are, the more tentative the representation is. Representing non-human beings in decision processes concerning biological invasion mitigation is accordingly bound to be difficult and tentative, but this is no reason not to try.

The question of whose point of view is to be included is a bit trickier. Indeed, although other people certainly have a point of view, and although the idea that a primate or other large animals can have a point of view obviously makes sense, one can doubt that invertebrates, or plants, or microbes have a point of view. Hence, in addition to the question of who, among those who have a point of view, should be included (the milder form of the question), the further question of who has a point of view, arises. To address this question, it is important to disentangle a false problem from a genuine one, which hides behind the phrase “point of view.”

The false problem stems from the above-discussed all-too literal understanding of this phrase. In the metaphorical sense in which the phrase “point of view” should be understood here, non-human beings, be they individuals of other species, or even other natural entities, can meaningfully be said to have a point of view. The false problem being evacuated, the real problem is that just like representation is all the more difficult with non-human beings, similarly, applying the standard inclusion criterion according to which the points of view of all those concerned should be included is a real challenge for beings that are so different from us, humans, that deciding if they are concerned or not is itself a challenge. But here again, this is no reason to give up.

Given the difficulties involved in deciding who is to be represented and in representing them, a natural suggestion might be to replace the notion of point of view by the one of interest. Whereas taking the point of view of, say, a snail, is doomed to be very difficult, trying to identify the snails’ interests might look easier and more objective. No doubt, for example, that the snail has an interest in finding food, some rest, and a sexual partner. However, this seeming advantage of the concept of interest over the one of point of view stems from an ambiguity. The term “interest” can be understood in at least two different senses. In a narrow sense, one has an interest in something if it improves one’s well-being. In that narrow sense, identifying the snail’s interests is arguably easier than taking its point of view. However, in this narrow sense, as standard deliberative settings unmistakably unveil, replacing points of view by interests is clearly reductive. Indeed, in such settings, some legitimate points of view can voice the idea that a given entity, such as for example a population of a rare species, should be preserved, even though its existence does not improve anyone’s well-being. Alternatively, the term “interest” can be redefined in a broad way, so as to encompass all the reasons why someone can be concerned by a decision. In this broad sense, however, identifying interests is just as challenging as taking others’ points of view into account. Replacing points of view by interests is therefore either reductive or useless, and in any case ambiguous.

At this stage, it can be tempting to oversimplify our proposal and to object that, if we take upon ourselves the requirement to consider the point of view of beings whose impacts we are concerned to mitigate, we are doomed to inaction. Take, for example, an ant that has just found its way into your kitchen. If you leave the ant be, the whole colony will flock into your kitchen in a couple of hours. So you may eliminate the ant. What if you strive to take the ant’s point of view into account? Isn’t it evident that killing the ant cannot be an acceptable solution from its own point of view? This situation and the application of our approach to it are more complex than this presentation makes it look. If we take the question of whose point of view should be represented in this case seriously, we should ask ourselves if the relevant point of view is the one of the single ant worker or the one of the entire colony. Because ant colonies are closer to super-organisms than to societies in the anthropocentric sense, the colony’s point of view is arguably more relevant. And, from this point of view, avoiding a full-scale war between you and the ant colony might justify the sacrifice of one single worker. This is just an example, but it illustrates that, in particular, thanks to the role of representation, the requirement to take points of view into account does not necessarily lead to inaction.

The multispecies literature hence invites us to take a second step for our heuristic to create successful invasive mitigation actions: striving to identify the spectrum of points of view of non-humans to consider, making sure that these points of view are represented, and assessing which courses of action the representatives of these points of view can deem acceptable, through discussions.

#### **A procedure and division of labor to implement the two-step heuristic**

Admitting that collective decisions on biological invasion mitigation should be based on arguments that are acceptable to all, one might think that implementing the two steps presented

unavoidably require concrete definitive criteria characterizing arguments that will be termed “acceptable to all,”— including to members of invasive species. Plausible candidates for such criteria could hold, for example, that arguments are acceptable to all if and only if they are scientifically sound, or if and only if they treat all the stakeholders involved fairly, etc. However, discussions in the deliberative democracy literature on acceptability, generally understood, suggest that it is hopeless to expect to be able to identify such criteria once and for all (see Meinard 2017 §2.3 for a presentation of this debate in a conservation context). Following a well-trodden approach in political philosophy, rather than implausibly pretending to identify definite, context-independent acceptability criteria, a more promising route is to define a procedure aiming to select arguments that are acceptable to all. Because, as explained above, the acceptability at issue here refers to unreachable ideal conditions of undistorted and unconstrained communication, the procedure will be no absolute guarantee that the arguments it selects will be acceptable to all. Its purpose is more modestly to organize our efforts to do our best to identify such arguments.

The procedure should organize how invasion experts will perform three tasks: (1) determining the variety of points of view that should be considered, (2) defining how these various points of view are to be represented, (3) discussing the various arguments for or against various proposed courses of action, expressed from different points of view, until a collective decision is made that considers all the relevant points of view, certainly imperfectly, but as much as it is feasible. These three tasks are not independent: decisions as part of one task can suggest revising what was done at another one. They should accordingly be performed iteratively rather than sequentially. As the procedure unfolds, if stakeholders question the very procedure, their criticisms will be considered and discussed as part of task three. During these discussions, criticisms and counterarguments are expected to emerge, which will propel the emergence of new counter-counterarguments and suggest the need to enlarge the circle of points of view considered, until no new argument emerges (such an argumentative dynamics is described by Meinard and Cailloux 2020, 2021). When the procedure closes, an unavoidably provisional identification of a course of action acceptable to all, at least in some fortunate cases, will be achieved.

Implementing such a procedure will involve doing things that are classically done and mastered by professionals of the collective elaboration of management plans, such as recruiting stakeholders and organizing concrete discussions of management actions, in a classical participatory approach (the details and specific challenges involved fall beyond our scope but are already discussed in a vast literature). However, our proposed procedure also involves radically novel, challenging endeavors. In its application to invasive species management, it requires determining if the point of view of members of invasive species potentially targeted in the conservation actions of concern is already represented by some of the stakeholders involved. If not, the procedure then involves at least one actor playing the devil’s advocate by striving to take and represent the point of view of members of this targeted invasive species, to identify arguments and counter-arguments that members of invasive species could put to the fore, and to determine whether or not the various arguments and counter-arguments mentioned in discussions are

acceptable to members of the invasive species at issue. Besides, as part of task three, if other non-human beings can be impacted by the decisions but are not already represented by some stakeholders (for example, a population of a local species that is threatened by the population of the targeted invasive species), at least one actor should similarly strive to take its point of view.

Future works should pursue our effort by clarifying concrete institutional mechanisms to sustain our suggested procedure and implement it. One such institutional mechanism could be the setting up of dedicated committees entrusted with the task of monitoring whether processes elaborating conservation action plans duly involve efforts to identify and represent non-human points of view. Concrete challenges will certainly emerge in the field as conservationists and consultants will strive to implement our proposed procedure for real. These are tasks for field actors to take charge of. In the meantime, the contribution that conservation biologists can make is to identify and clarify relevant arguments and counterarguments, which will provide part of the groundwork for the deployment of the procedure.

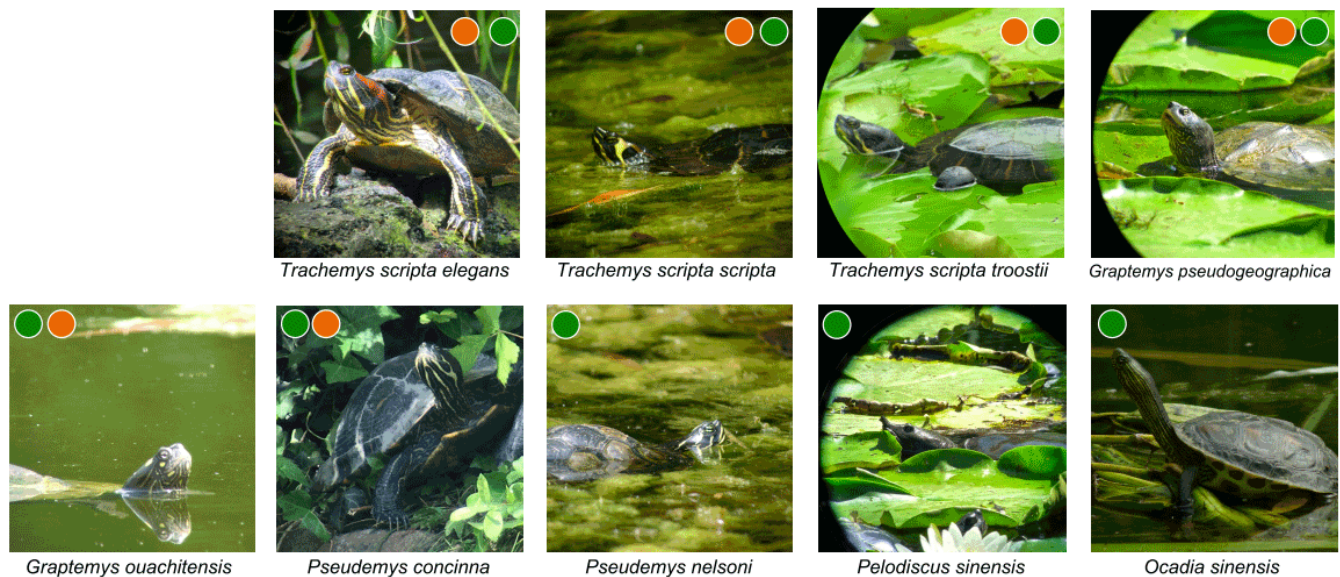
#### DISCUSSING WITH INVADERS: EXAMPLES

We explore a concrete case study to illustrate how invasion experts can use our heuristic to try to identify courses of action supported by arguments that are acceptable to all, including concerned members of invasive species. When exploring this case study, we do not aim to elaborate general solutions applicable to all situations. All the situations in which a decision has to be made concerning invasive species management should be handled on a case-by-case basis. We do not report real-life processes that would exemplify the unfolding of the procedure introduced. Rather, we limit ourselves to exploring how invasion experts should reason to identify arguments that are liable to be acceptable to all and that are accordingly likely to be selected by the procedure described, which should be orchestrated by actors in the field. Using this approach, we explore the case of invasive freshwater turtles in urban parks in Strasbourg, France.

Exotic freshwater turtles such as the red slider (*Trachemys scripta elegans*) count among the most invasive species (<https://www.nobanis.org/>), with potentially major impacts on native species in the wild (Cadi and Joly 2003, Díaz-Paniagua et al. 2011, Standfuss et al. 2016). They occur in European cities mainly as a result of citizens releasing their pets in neighboring urban parks (Teillac-Deschamps et al. 2009), where these pets contribute to relationships between citizens and nature (Teillac-Deschamps et al. 2008, Philippot et al. 2019). The case of invasive freshwater turtles in urban parks therefore offers an interesting setting to assess the credentials and usefulness of our approach.

In a former study focusing on freshwater turtles occurring in urban parks in Strasbourg (Philippot et al. 2019), we identified 80 freshwater turtle individuals belonging to 7 species, all exotic, among which 3 species are considered invasive in France (*Graptemys* spp., *Pseudemys* spp., and *Trachemys scripta elegans*, *T.s. scripta*, *T.s. troostii*; <https://www.legifrance.gouv.fr/eli/arrrete/2018/2/14/TREL1705136A/jo/texte>; Fig. 2). We also reported people expressing complex and subtle feelings, ranging from curiosity to indignation, most being satisfied by the presence of the turtles in the parks. Many people consider turtles as normal inhabitants, if not part of the parks, and as contributors in connecting them to nature. Consistently, although most people

**Fig. 2.** Exotic turtle species identified in the two urban parks in Strasbourg, France (Citadelle in green, Orangerie in orange) studied by Philippot et al. (2019).



are aware of their invasive potential, 60% of them consider a putative eradication of exotic turtles in urban parks in Strasbourg unacceptable.

This case study illustrates a common context for urban areas where some exotic species (albeit invasive in the wild) are maintained because they are structuring elements of citizens' lives and contribute to (re)-connecting people with some form of nature. It provides an interesting context to explore how our theoretical framework can contribute to choosing the most appropriate mitigation strategy in urban areas like Strasbourg, by asking the question: which possible courses of action would be acceptable to all, including the turtles themselves?

Let us therefore imagine an invasion expert who tries to answer this question as part of a collective project to manage populations of invasive turtles in Strasbourg parks. The information concerning people's relationships with turtles in the park, associated with ecological information concerning existing communities living in the park, provide the information needed for task 1, the identification of relevant points of view, which will, in this specific case, include the various categories of people presented by Philippot et al. (2019) and populations of invasive turtles. Task 2 then involves enjoining concerned people to participate in discussions directly, in person, or as representatives of other people or of members of invasive species. Lastly, task 3 will consist in discussing envisioned courses of action by invoking all the arguments, counterarguments, and criticisms that can emerge from the various points of view. Discussions at this stage could unfold based on arguments such as the ones that follow.

A voluminous literature claims that several of the turtle species present in these parks can cause damage to native biodiversity and natural and semi-natural areas. These arguments are so strong that even people whose relationship with these invasive turtles differs from those of invasion experts can be convinced that these

species should not occur in natural areas. Of course, when implementing the procedure for real, invasion experts should test whether their arguments are acceptable to all the people involved in the case at hand, and if necessary, find more understandable ways to articulate their argumentation or propose alternatives.

Supposing that everyone can be convinced that invasive turtles do not have their place in natural and semi-natural areas, this leaves an open question about what should be done with turtles already present in natural areas and with animals that could colonize natural areas (e.g., by escaping from urban parks). Killing all these animals would unlikely be acceptable to all because some people may deem that life is of the highest value, or that the main reason to value biodiversity is the value of life, or that invasive turtles are present because humans brought them here, or simply because the financial costs of such actions are prohibitive. Because eradication is not acceptable to all, we have to find an acceptable place for these invasive turtles to live. Urban parks are a prominent candidate. Urban parks are not natural areas where invasive turtles may deteriorate. They are rather artificialized systems already deeply impacted by human activities where native biodiversity typically does not occur anymore. Thus, the argument referring to the impact of invasive species on native biodiversity and natural areas does not hold in urban areas. Moreover, invasive turtles occurring in urban parks have been reported to be beneficial to citizens through (re)connection with nature (Philippot et al. 2019, Glatron et al. 2021). Seeing urban parks as a haven for invasive turtles and an arena for a diversity of people to deploy their multiple relationships with nature is hence a reasonable option supported by arguments acceptable to all people. The practicability of such a confinement of turtles in urban parks is illustrated by the case of the recovery center of red slider turtles in the Parc de la Tête d'Or in Lyon, France ([http://www.zoo.lyon.fr/zoo/sections/fr/missions/projet\\_nature/bassin\\_tortues/centre\\_tortues\\_floril/](http://www.zoo.lyon.fr/zoo/sections/fr/missions/projet_nature/bassin_tortues/centre_tortues_floril/)). Obviously, such a solution should be



implemented in urban parks disconnected from natural areas or where turtles are prevented from reaching surrounding wetlands (see Beever et al. 2019 for a discussion of a similar issue in the case of parrots).

The last question is whether this management option can be acceptable to invasive turtles themselves. At this stage, we have to try to take the point of view of these turtles and ask ourselves if we would find it acceptable being confined to urban parks. This management option involves that invasive turtles be denied access to natural ecosystems. This might sound unacceptable to these turtles because it excludes them from natural areas where they can live, and presumably live well, because they usually multiply in such natural areas. However, this exclusion is motivated by the fact that they demonstrably have major detrimental impacts on these ecosystems, which means that the benefits they get from these ecosystems will be short-lived at best. As a corollary of this exclusion from natural ecosystems, this management option offers these turtles the possibility to live in areas, urban parks, in which their lives are more respected and where they can become actors in relationships with a diversity of other species, including humans, in places where their presence is valued and valuable. All in all, it is not unreasonable to claim that, from the point of view of these invasive turtles, this management option is acceptable.

A plausible objection could be that our reasoning can be used to claim that certain people may be excluded from certain places, so long as one can argue that these people cause damage to these places or their inhabitants. We believe that this seemingly repugnant implication is acceptable (provided that the choice of area and people concerned is not biased by racial, ethical, cultural, or any other unacceptable prejudices): after all, excluding human people from certain areas due to their impacts on wildlife is the core justification of setting up strictly protected natural areas.

We hence propose that the management option consisting in confining exotic turtles to public parks to prevent invasions in natural areas while contributing to (re)connecting people with nature is acceptable to all, including invasive turtles themselves. By extension, the move of invasive turtles from natural areas to urban parks where they already occur should be envisaged as a reasonable option to thwart their expansion in the wild, when technically and financially feasible. We are aware that our conclusion is not applicable at all times to all situations and consider that the strength of the arguments and the chosen decision are tightly context dependent, provisional, and open to discussions that hopefully will inspire future cases-studies.

## CONCLUSIONS

We have introduced a heuristic tool for conservation biologists to explore innovative answers to a key question for the management of natural and semi-natural areas: what should be done with populations of invasive species? In the academic literature, answers tend to be a stereotypical “eliminate these populations, if technically and economically feasible.” We have argued that this univocal response denies the diversity and richness of the mutual relationships people share with members of invasive species. Considering this diversity and richness is morally required because we cannot admit without further ado that the relationship invasion experts have with invasive species is the right one. Moreover, if we fail to understand the diversity of relationships that people might have with members of invasive species, we are

bound to face resistance impairing the efficiency of mitigation actions. Thus, invasion experts should consider not only the point of view of people involved in the relationship with members of invasive species, but also the one of these beings themselves.

Although the approach we advocate is certainly less straightforward than the business-as-usual procedure, we have argued that it is implementable in practice, and that it could lead to substantial shared benefits. It directly addresses a fundamental moral conflict between invasive species mitigation actions and the respect for the moral status of living beings and offers a constructive approach for its resolution. In particular, this approach has a major potential to heal conflicts surrounding disputed invasive species management projects. Beyond the case of invasive species management, our approach may also be beneficial to reintroduction projects, considered to be a promising strategy to mitigate the erosion of biodiversity (Sarrazin and Barbault 1996), specifically when they are implemented in complex socioeconomic contexts such as suburban areas.

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## Data Availability:

*Data/code sharing is not applicable to this article because no data/code were analyzed in this study.*

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## LITERATURE CITED

- Aguin-Pombo, D. 2012. Biological invasions and global trade. Pages 83-99 in A. Mendonca, A. Cunha, and R. Chakrabarti, editors. *Natural resources, sustainability and humanity*. Springer, Dordrecht, The Netherlands. [https://doi.org/10.1007/978-94-007-1321-5\\_6](https://doi.org/10.1007/978-94-007-1321-5_6)
- Argüelles, L., and H. March. 2022. Weeds in action: vegetal political ecology of unwanted plants. *Progress in Human Geography* 46(1):44-66. <https://doi.org/10.1177/03091325211054966>
- Atchison, J. 2015. Experiments in co-existence: the science and practices of biocontrol in invasive species management. *Environment and Planning A* 47:1697-1712. <https://doi.org/10.1177/0308518X15597106>
- Beck, K. G., K. Zimmerman, J. D. Schardt, J. Stone, R. R. Lukens, S. Reichard, J. Randall, A. A. Cangelosi, D. Cooper, and J. P. Thompson. 2008. Invasive species defined in a policy context: recommendations from the Federal Invasive Species Advisory Committee. *Invasive Plant Science and Management* 1 (4):414-421. <https://doi.org/10.1614/IPSM-08-089.1>

- Beever, E. A., D. Simberloff, S. L. Crowley, R. Al-Chokhachy, H. A. Jackson, and S. L. Petersen. 2019. Social-ecological mismatches create conservation challenges in introduced species management. *Frontiers in Ecology and the Environment* 17(2):117-125. <https://doi.org/10.1002/fee.2000>
- Beninde, J., M. L. Fischer, A. Hochkirch, and A. Zink. 2015. Ambitious advances of the European Union in the legislation of invasive alien species. *Conservation Letters* 8(3):199-205. <https://doi.org/10.1111/conl.12150>
- Blair, J. J. A. 2017. Settler indigeneity and the eradication of the non-native: self-determination and biosecurity in the Falkland Islands (Malvinas). *Journal of the Royal Anthropological Institute* 23(3):580-602. <https://doi.org/10.1111/1467-9655.12653>
- Buchs, A., E. Hassenforder, and Y. Meinard. 2021. Adapting participatory processes to fine-tune conservation approaches in multiactor decision settings. *Conservation Biology* 35(3):804-815. <https://doi.org/10.1111/cobi.13654>
- Cadi, A., and P. Joly. 2003. Competition for basking places between the endangered European pond turtle (*Emys orbicularis galloitalica*) and the introduced red-eared slider (*Trachemys scripta elegans*). *Canadian Journal of Zoology* 81(8):1392-1398. <https://doi.org/10.1139/z03-108>
- Caillon, S., G. Cullman, B. Verschuuren, and E. J. Sterling. 2017. Moving beyond the human-nature dichotomy through biocultural approaches: including ecological well-being in resilience indicators. *Ecology and Society* 22(4):27. <https://doi.org/10.5751/ES-09746-220427>
- Chapman, M., T. Satterfield, and K. M. A. Chan. 2019. When value conflicts are barriers: can relational values help explain farmer participation in conservation incentives programs? *Land Use Policy* 82:464-475. <https://doi.org/10.1016/j.landusepol.2018.11.017>
- Colautti, R. I., J. Ågren, J. T. and Anderson. 2017. Phenological shifts of native and invasive species under climate change: insights from the Boechera-Lythrum model. *Philosophical Transactions of the Royal Society B: Biological Sciences* 372(1712):20160032. <https://doi.org/10.1098/rstb.2016.0032>
- Concept Cours d'eau SCOP and TERE0. 2016. Savoirs et savoir-faire sur les populations exotiques envahissantes végétales et animales et préconisations pour la mise en oeuvre des SDAGE. L'Agence de l'eau Rhône-Méditerranée Corse, Lyon, France. <https://www.documentation.eauetbiodiversite.fr/notice/savoirs-et-savoir-faire-sur-les-populations-d-especes-exotiques-envahissantes-vegetales-et-animales-0>
- Cottier-Cook, E. J., C. Beveridge, J. D. D. Bishop, J. Brodie, P. F. Clarke, G. Epstein, S. R. Jenkins, D. G. Johns, J. Loxton, A. MacLeod, C. Maggs, D. Minchin, F. Mineur, J. Sewell, and C. A. Wood. 2017. Non-native species: decadal review of the impacts of climate change on non-native species. Marine Climate Change Impacts Partnership, UK. [https://www.pure.ed.ac.uk/ws/portalfiles/portal/45400641/2017arc\\_sciencereview\\_005\\_nns.pdf](https://www.pure.ed.ac.uk/ws/portalfiles/portal/45400641/2017arc_sciencereview_005_nns.pdf)
- Daniell, K. A., I. White, N. Ferrand, I. S. Ribarova, P. Coad, J.-E. Rougier, M. Hare, N. A. Jones, A. Popova, D. Rollin, P. Perez, and S. Burn. 2010. Co-engineering participatory water management processes: theory and insights from Australian and Bulgarian interventions. *Ecology and Society* 15(4):11. <https://doi.org/10.5751/ES-03567-150411>
- Dereniowska, M. 2017. Positional analysis and practical ethics. Pages 104-127 in J. Brown, P. Söderbaum and M. Dereniowska, editors. Positional analysis for sustainable development: reconsidering policy, economics and accounting. Routledge, London, UK. <https://doi.org/10.4324/9781315206769-8>
- Descola, P. 2013. Beyond nature and culture. The University of Chicago Press, Chicago, Illinois, USA. <https://doi.org/10.7208/chicago/9780226145006.001.0001>
- Díaz-Paniagua, C., N. Pérez-Santigosa, J. Hidalgo-Vila, and M. Florencio. 2011. Does the exotic invader turtle, *Trachemys scripta elegans*, compete for food with coexisting native turtles? *Amphibia-Reptilia* 32(2):167-175. <https://doi.org/10.1163/01735-3710X552795>
- Epanchin-Niell, R., C. McAusland, A. Liebhold, P. Mwebaze, and M. R. Springborn. 2021. Biological invasions and international trade: managing a moving target. *Review of Environmental Economics and Policy* 15(1):180-190. <https://doi.org/10.1086/713025>
- Estlund, D. 2009. Democratic authority: a philosophical framework. Princeton University Press, Princeton, New Jersey, USA. <https://doi.org/10.1515/9781400831548>
- Evans, D., and M. Arvela. 2011. Assessment and reporting under Article 17 of the habitats directive - explanatory note and guidelines for the period 2007-2012. Final version. European Topic Centre on Biological Diversity, Paris, France. <https://circabc.europa.eu/sd/a/2c12cea2-f827-4bdb-bb56-3731c9fd8b40/Art17-Guidelines-final.pdf>
- Glatron, S., A. Hector, Y. Meinard, V. Philippot, and J.-Y. Georges. 2021. Réinterroger ce qu'est la nature en ville avec les tortues exotiques des parcs publics de Strasbourg. Pages 157-182 in J. Salomon Cavin and C. Granjou, editors. Quand l'écologie s'urbanise. UGA Editions, Saint-Martin-d'Hères, France.
- Goodell, K., I. M. Parker, and G. S. Gilbert. 2000. Biological impacts of species invasions: implications for policy makers. Pages 87-117 in Incorporating science, economics, and sociology in developing sanitary and phytosanitary standards in international trade: proceedings of a conference. National Academy Press, Washington, D.C., USA. <https://doi.org/10.17226/9868>
- Habermas J. 1992. Faktizität und Geltung: beiträge zur Diskurstheorie des Rechts und des demokratischen Rechtsstaats. Suhrkamp, Frankfurt am Main, Germany.
- Haraway, D. J. 2008. When species meet. University of Minnesota Press, Minneapolis, Minnesota, USA.
- Hobbs, R.J., S. Arico, J. Aronson, J. S. Baron, P. Bridgewater, V. A. Cramer, P. R. Epstein, J. J. Ewel, C. A. Klink, A. E. Lugo, D. Norton, D. Ojima, D. M. Richardson, E. W. Sanderson, F. Valladares, M. Vilá, R. Zamora, and M. Zobel. 2006. Novel ecosystems: theoretical and management aspects of the new ecological world order. *Global Ecology and Biogeography* 15(1):1-7. <https://doi.org/10.1111/j.1466-822X.2006.00212.x>

- International Panel on Climate Change (IPCC). 2018. Summary for policymakers. Pages 3-24 in V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Cambridge University Press, Cambridge, UK and New York, New York, USA. <https://doi.org/10.1017/9781009157940.001>
- Jarić, I., F. Courchamp, R. A. Correia, S. L. Crowley, F. Essl, A. Fischer, P. González-Moreno, G. Kalinkat, X. Lambin, B. Lenzner, Y. Meinard, A. Mill, C. Musseau, A. Novoa, J. Pergl, P. Pyšek, K. Pyšková, P. Robertson, M. von Schmalensee, and J. M. Jeschke. 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>
- Johansson, J., C. Sandström, and T. Lundmark. 2018. Inspired by structured decision making: a collaborative approach to the governance of multiple forest values. *Ecology and Society* 23 (4):16. <https://doi.org/10.5751/ES-10347-230416>
- Kirksey, S. E., and S. Helmreich. 2010. The emergence of multispecies ethnography. *Cultural Anthropology* 25(4):545-576. <https://doi.org/10.1111/j.1548-1360.2010.01069.x>
- Kohn, E. 2013. *How forests think: toward an anthropology beyond the human*. University of California Press, Berkeley, California, USA. <https://doi.org/10.1525/9780520956865>
- Kopnina, H. 2017. Beyond multispecies ethnography: engaging with violence and animal rights in anthropology. *Critique of Anthropology* 37(3):333-357. <https://doi.org/10.1177/0308275X17723973>
- Kulha, K., M. Leino, M. Setälä, M. Jäske, and S. Himmelroos. 2021. For the sake of the future: can democratic deliberation help thinking and caring about future generations? *Sustainability* 13 (10):5487. <https://doi.org/10.3390/su13105487>
- Lambdon, P. W., P. Pyšek, C. Basnou, M. Hejda, M. Arianoutsou, F. Essl, V. Jarošík, J. Pergl, M. Winter, P. Anastasiu, P. Andriopoulos, I. Bazos, G. Brundu, L. Celesti-Grapow, P. Chassot, P. Delipetrou, M. Josefsson, S. Kark, S. Klotz, Y. Kokkoris, I. Kühn, H. Marchante, I. Perglová, J. Pino, M. Vilà, A. Zikos, D. Roy, and P. E. Hulme. 2008. Alien flora of Europe: Species diversity, temporal trends, geographical patterns and research needs. *Preslia* 80(2):101-149. <https://www.preslia.cz/P082Lam.pdf>
- Latour, B. 1999. *Pandora's hope: essays on the reality of science studies*. Harvard University Press, Cambridge, Massachusetts, USA.
- Latour, B. 2018. Esquisse d'un parlement des choses. *Écologie et politique* 56:47-64. <https://doi.org/10.3917/ecopo1.056.0047>
- Lawrence, A. M. 2022. Listening to plants: conversations between critical plant studies and vegetal geography. *Progress in Human Geography* 46:629-651. <https://doi.org/10.1177/03091325211062167>
- Mach, K. J., S. Planton, and C. von Stechow. 2014. IPCC SYR AR5 (Report), Annex II glossary. IPCC, Geneva, Switzerland. [https://www.ipcc.ch/site/assets/uploads/2018/02/AR5\\_SYR\\_FIN-AL\\_Annexes.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FIN-AL_Annexes.pdf)
- Mačić, V., P. G. Albano, V. Almpantidou, J. Claudet, X. Corrales, F. Essl, A. Evagelopoulos, I. Giovos, C. Jimenez, S. Kark, O. Marković, A. D. Mazaris, G. A. Ólafsdóttir, M. Panayotova, S. Petović, W. Rabitsch, M. Ramdani, G. Rilov, E. Tricarico, T. V. Fernández, M. Sini, V. Trygonis, and S. Katsanevakis. 2018. Biological invasions in conservation planning: a global systematic review. *Frontiers in Marine Science* 5. <https://doi.org/10.3389/fmars.2018.00178>
- Martin, P. H., C. D. Canham, and P. L. Marks. 2009. Why forests appear resistant to exotic plant invasions: intentional introductions, stand dynamics, and the role of shade tolerance. *Frontiers in Ecology and the Environment* 7(3):142-149. <https://doi.org/10.1890/070096>
- Méchin, C. 2007. Une espèce jugée invasive dans l'espace français: le grand cormoran (*Phalacrocorax carbo* L.). *Anthropozoologica* 42(1):105-120.
- Meinard, Y. 2017. What is a legitimate conservation policy? *Biological Conservation* 213 (Part A):115-123. <https://doi.org/10.1016/j.biocon.2017.06.042>
- Meinard, Y., and O. Cailloux. 2020. On justifying the norms underlying decision support. *European Journal of Operational Research* 285(3):1002-1010. <https://doi.org/10.1016/j.ejor.2020.02.022>
- Meinard, Y., and O. Cailloux. 2021. Deliberation in valuation and decision making: a conceptual clarification. *Oeconomia* 11-4:623-637. <https://doi.org/10.4000/oeconomia.11669>
- Morizot, B. 2016. *Les diplomates: cohabiter avec les loups sur une autre carte du vivant*. Wildproject, Marseille, France. <https://www.wildproject.org/diplomates>
- Mougenot, C., and L. Roussel. 2006. Peut-on vivre avec le ragondin? Les représentations sociales reliées à un animal envahissant. *Natures Sciences Sociétés* 14:S22-S31. <https://doi.org/10.1051/nss:2006051>
- Novoa, A., J. J. Le Roux, D. M. Richardson, and J. R. U. Wilson. 2017. Level of environmental threat posed by horticultural trade in Cactaceae. *Conservation Biology* 31:1066-1075. <https://doi.org/10.1111/cobi.12892>
- Office Français de la Biodiversité (OFB). 2017. *Guide d'élaboration des plans de gestion des espaces naturels*. OFB, Vincennes, France. <http://ct88.espaces-naturels.fr/>
- Pelé, M., J.-Y. Georges, T. Matsuzawa, and C. Sueur. 2021. Editorial: perceptions of human-animal relationships and their impacts on animal ethics, law and research. *Frontiers in Psychology* 11:631238. <https://doi.org/10.3389/fpsyg.2020.631238>
- Perrings, C. 2005. Mitigation and adaptation strategies for the control of biological invasions. *Ecological Economics* 52 (3):315-325. <https://doi.org/10.1016/j.ecolecon.2004.08.001>
- Philippot, V., S. Glatron, A. Hector, Y. Meinard, and J.-Y. Georges. 2019. Des tortues exotiques en ville: évaluation,

- perceptions et propositions de gestion à Strasbourg, France. *VertigO - la revue électronique en sciences de l'environnement* 19 (2). <https://doi.org/10.4000/vertigo.26449>
- Pielke, R. A. 2007. *The honest broker*. Cambridge University Press, Cambridge, UK. <https://doi.org/10.1017/CBO9780511818110>
- Rawls, J. 1999. *Political liberalism*. Columbia University Press, New York, New York, USA.
- Reed, M. S. 2008. Stakeholder participation for environmental management: a literature review. *Biological Conservation* 141 (10):2417- 2431. <https://doi.org/10.1016/j.biocon.2008.07.014>
- Robbins, P. F. 2004. Comparing invasive networks: cultural and political biographies of invasive species. *Geographical Review* 94 (2):139-156. <https://doi.org/10.1111/j.1931-0846.2004.tb00164.x>
- Runge, M. C., and E. McDonald-Madden. 2018. Navigating the field of decision analysis. *Decision Point* 107:4-11.
- Russell, J. C., and T. M. Blackburn. 2017. Invasive alien species: denialism, disagreement, definitions, and dialogue. *Trends in Ecology and Evolution* 32(5):312-314. <https://doi.org/10.1016/j.tree.2017.02.005>
- Sarrazin, F., and R. Barbault. 1996. Reintroduction: challenges and lessons for basic ecology. *Trends in Ecology and Evolution* 11(11):474-478. [https://doi.org/10.1016/0169-5347\(96\)20092-8](https://doi.org/10.1016/0169-5347(96)20092-8)
- Schilthuizen, M. 2018. *Darwin comes to town: how the urban jungle drives evolution*. Quercus Picador, London, UK.
- Standfuss, B., G. Lipovšek, U. Fritz, and M. Vamberger. 2016. Threat or fiction: is the pond slider (*Trachemys scripta*) really invasive in Central Europe? A case study from Slovenia. *Conservation Genetics* 17(3):557-563. <https://doi.org/10.1007/s10592-015-0805-2>
- Teillac-Deschamps, P., V. Delmas, R. Lorrillière, V. Servais, A. Cadi, and A.-C. Prévot-Julliard. 2008. Red-eared slider turtles (*Trachemy scripta elegans*) introduced to French urban wetlands: an integrated research and conservation program. *Herpetological Conservation* 3:535-537. <https://orbi.uliege.be/handle/2268/28797>
- Teillac-Deschamps, P., R. Lorrillière, V. Servais, V. Delmas, A. Cadi, and A.-C. Prévot-Julliard. 2009. Management strategies in urban green spaces: models based on an introduced exotic pet turtle. *Biological Conservation* 142(10):2258-2269. <https://doi.org/10.1016/j.biocon.2009.05.004>
- Turnhout, E., T. Metze, C. Wyborn, N. Klenk, and E. Louder. 2020. The politics of co-production: participation, power, and transformation. *Current Opinion in Environmental Sustainability* 42:15-21. <https://doi.org/10.1016/j.cosust.2019.11.009>
- Turnhout, E., S. Van Bommel, and N. Aarts. 2010. How participation creates citizens: participatory governance as performative practice. *Ecology and Society* 15(4):26. <https://doi.org/10.5751/ES-03701-150426>
- van Eeden, L. M., T. M. Newsome, M. S. Crowther, C. R. Dickman, and J. Bruskotter. 2019. Social identity shapes support for management of wildlife and pests. *Biological Conservation* 231:16-173. <https://doi.org/10.1016/j.biocon.2019.01.012>
- Wallach, A. D., M. Bekoff, C. Batavia, M. P. Nelson, and D. Ramp. 2018. Summoning compassion to address the challenges of conservation. *Conservation Biology* 32(6):1255-1265. <https://doi.org/10.1111/cobi.13126>