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What matters: Conservation values in invasion science

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Abstract
Invasive alien species (IAS) are globally considered major drivers of biodiversity loss. Because invasion science—the field studying IAS—informs policy and management, its normative underpinnings have become a subject of controversy. Historically, invasion science has aligned with traditional conservation, which is an ecocentric approach to conservation that recognises intrinsic value in natural collectives. This article examines debates surrounding the field's normative assumptions—focusing on the concepts of 'origin', 'harm' and 'naturalness'—and explores three alternative conservation approaches that challenge them: new conservation, convivial conservation and compassionate conservation. New conservation highlights the ecosystem services IAS may offer in novel ecosystems. Convivial conservation stresses the interconnectedness of humans and nature. Compassionate conservation focuses on individual animal welfare, regardless of native or invasive status. Each of these approaches questions rigid native-alien distinctions. They argue that invasion science's focus on nativeness and undisturbed environments overlooks contemporary ecological challenges, urging a re-evaluation of how these categories influence conservation decisions. Discussing these approaches highlights the interplay between scientific evidence and diverse value systems in IAS debates, and reveals controversies often stem from ingrained normative assumptions rather than purely scientific disagreements. The article argues that explicitly addressing these assumptions is crucial for managing the ethical and practical challenges of IAS effectively. It identifies potential convergence among different conservation approaches while acknowledging unavoidable incompatibilities. Accommodating various viewpoints involves recognising a plurality of legitimate concerns and values, promoting interdisciplinary collaboration and inclusive deliberation, balancing short-term actions with long-term objectives, and considering both human and non-human rights.

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Introduction

Human-dominated landscapes, climate change and the increased global transport of goods and people have altered species distributions, introducing alien species into new ecosystems. Invasive alien species (IAS) are alien species that impact their new environments, the economy or human health (McNeely, 2001). Recognised globally as major drivers of extinction (Clavero and García-Berthou, 2005) and biodiversity loss (Cuthbert et al., 2020; Pyšek and Richardson, 2010; Simberloff, 2005), IAS are considered 'a major and growing threat to nature, nature's contributions to people (NCP), with, in some cases, irreversible changes to biodiversity and ecosystems' (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], 2023). Nevertheless, management activities aimed at removing or eradicating IAS provoke critical responses that can primarily be attributed to diverging value systems (Estévez et al., 2015). The growing attention to IAS has led to several recurring debates regarding terminology, conceptual and theoretical problems and the assessment of impacts in invasion science (see, e.g. Boltovskoy et al., 2018; Cassini, 2020; Cuthbert et al., 2020; Guiasu and Tindale, 2018; Frank, 2019; Sagoff, 2020). These debates centre on two main issues that will be discussed in this article. First, critics contend that it is impossible to interpret and use core concepts like 'origin', 'harm' and 'naturalness' objectively, noting the use of these terms is necessarily value-laden (Sagoff, 2018, 2020; Warren, 2021). Second, the underlying values that guide the interpretation of these core concepts within the field are challenged. Critics argue that invasion science does not merely describe species' origins and distributions, but actively guides policies and management strategies, which becomes problematic when this is done without explicitly acknowledging the role of values in shaping these decisions (Warren, 2021). Although acknowledging that invasion science is value-laden is not inherently a criticism, critics find it problematic when these underlying values are not open to debate, particularly if their value systems do not align with the normative foundations of the field.

In response to these debates, many invasion scientists have defended the value and academic rigor of the field (Warren, 2021), dismissing criticism as 'invasive species denialism'. Such denialism involves rejecting or misrepresenting scientific facts (e.g. Ricciardi and Ryan, 2018; Richardson and Ricciardi, 2013; Russell and Blackburn, 2017). Some scholars defend invasion science by separating scientific aspects from the extra-scientific aspects related to public perception, political preferences and cultural beliefs. For example, Ricciardi and Ryan (2018) distinguish between value-laden rhetoric and ideology, and science, which is grounded in facts, noting that values are often expressed by social scientists and philosophers and in popular media. Additionally, attempts have been made to standardise terminology in the field to encourage objectivity in invasion science (e.g. Richardson et al., 2011; Valéry et al., 2008). Colautti and MacIsaac (2004) have attempted to formulate value-neutral terminology that they

argue should be used in scientific debates in order to separate these from ideological debates in the public domain. Whilst indicating a degree of responsiveness to criticisms, these efforts also highlight the remaining challenges in the field. If the influence of values is not acknowledged in attempts to increase objectivity, there is a risk that what is accepted as neutrality may merely reflect the prevailing consensus or dominant value system.

In this article, different perspectives on what values should guide conservation are categorised into four approaches: traditional conservation, new conservation, convivial conservation and compassionate conservation. These four approaches represent different value systems, including different entities in their moral consideration, emphasising instrumental, relational and intrinsic values differently. Although we will discuss these in more detail later, we briefly introduce them here. The traditional conservation approach is ecocentric, prioritising the protection of nature for its sake, targeting the diversity of species, wilderness and protected areas (Soulé, 1985). New conservation is an anthropocentric approach that emphasises the instrumental value of nature and endorses IAS when they increase ecosystem resilience and offer ecosystem benefits (Kareiva and Marvier, 2012). Convivial conservation prioritises relational values by focusing on the interconnectedness of humans and nature (Büscher and Fletcher, 2019). Compassionate conservation emphasises the moral consideration of individual non-human animals, regardless of their native, alien or invasive status (Ramp and Bekoff, 2015; Wallach et al., 2018). Each of the latter three approaches disputes some of the normative foundations of traditional conservation that inform invasion science, including the value of native species, the impacts that IAS have, and the human–nature relationship.

This article reviews the conceptual and ethical controversies surrounding invasion science. It first examines how key terms–origin, harm and naturalness–have traditionally been operationalized. Together, these concepts form the foundation for understanding, classifying and managing IAS in conservation and policy frameworks. This section discusses the epistemic and normative issues with these concepts. Next, this article examines the three alternative approaches to conservation that challenge one or multiple normative underpinnings of traditional conservation. Contextualising such critiques within alternative approaches will provide a better understanding of how disagreements emerge from different perspectives on concepts and prioritisation of values. This article argues that normativity in invasion science is both inevitable and not necessarily undesirable. Rather than seeking to identify the 'right' approach, our aim is to enhance understanding of how different normative assumptions can lead to varied interpretations and conclusions from the same ecological facts. By doing so, invasion science can more clearly articulate and defend its assumptions and values, whilst also fostering openness to a diversity of legitimate concerns within conservation.

Traditional conservation and invasion science

This section presents the normative postulates set forth by Michael Soulé (1985) that are exemplary of ecocentric perspectives in conservation science. In this article, conservation that aligns with these postulates is referred to as 'traditional conservation'. Next, it

critically examines how these normative underpinnings influence the understanding and application of the core concepts of 'origin', 'harm' and 'naturalness' in invasion science.

Soulé's first postulate stresses the value of biodiversity, arguing that the more diverse an ecosystem is in terms of species, the healthier and more robust it tends to be. The second postulate, 'ecological complexity is good', asserts that ecological complexity, marked by species interactions, leads to increased stability and resilience. His third postulate recognises evolution as an essential driving force behind biodiversity and adaptation and as crucial to a thriving ecosystem. Finally, the fourth postulate states that biodiversity has intrinsic value (Soulé 1985). This means it should be preserved for its own sake, regardless of its benefits to humans (Vucetich et al., 2015). Together, these postulates form the ecocentric and collectivist normative underpinnings that are commonly reflected in current conservation practices and research. It is often these ideas that are targeted when conservation faces criticism for being overly exclusionary and neglecting socio-economic factors, the dynamic nature of ecosystems and non-human lives. Consequently, this discussion does not aim to represent the current state of conservation science as a whole but serves to highlight the historical and ongoing influence of these foundational ideas, whilst setting the stage for the diverging viewpoints that challenge it. By formulating his postulates, Soulé underscored the inherently normative nature of conservation science and explicitly established conservation as a mission-driven undertaking with inherent ethical and moral dimensions.

In invasion science, these normative underpinnings are visible in the focus on preserving native biodiversity by reducing the disruptive impacts of IAS on species interactions and ecosystem stability. Whilst not entirely dismissing the instrumental values of nature, these efforts are primarily motivated by the intrinsic value placed on biodiversity and the preservation of ecosystems as ends in themselves. Despite the diversity of viewpoints inherent in any scientific discipline, there is notable agreement amongst invasion scientists on several fundamental concepts. A survey by Shackleton et al. (2022) found that 73% of professionals in the field challenge the notion that all forms of biodiversity should be valued regardless of origin. Additionally, there is overwhelming consensus that IAS pose a major global threat, with 89% identifying biological harm and 75% also pointing to harm to human well-being. These findings align with scientific and policy definitions which consistently include two primary components to categorise IAS: 'origin', indicating the non-native status of a species and 'harm', reflecting the potential negative impacts that qualify a species as invasive. Although there is some variability in accounting for the extent of human involvement in the introduction of species, this factor is often included in definitions of IAS to differentiate between natural and unnatural introduction pathways. The importance of this distinction is also demonstrated by 81% of respondents who perceive the human-mediated introduction of species as a phenomenon distinct from natural species dispersal (Shackleton et al., 2022).

Regardless of consensus within the field, the interpretation and application of foundational concepts in invasion science are not value-free. Although the desirability and attainability of objective value-free science are regularly questioned by philosophers of science, the 'value-free ideal' is still present in science. Elliot (2017) provides an overview of how values may influence science, noting that they can affect the choice of topics to study, the methods used for studying these topics, the aims of these studies in specific contexts, the responses to uncertainty, and the ways in which results are

described, framed, and communicated. The subsequent sections will explore the core concepts of origin, harm and naturalness in invasion science, illustrating the normative dimensions of these foundational concepts.

Origin

The emphasis on a species' biogeographic origin is motivated by the argument that it reflects its evolutionary journey and ecosystem interactions (Buckley and Catford, 2016; Richardson and Ricciardi, 2013; Simberloff et al., 2012). Alien species are significantly more likely to cause disturbance in local ecosystems (Buckley and Catford, 2016; Simberloff et al., 2012), and the degree of a species' 'alien-ness' to an ecosystem is a good predictor for its potential disruptiveness (Richardson and Ricciardi, 2013). Simply put, species lacking a shared evolutionary history with the recipient community are more likely to take advantage of an ecological niche or have traits the recipient community is not adapted to, causing problems for the native species in the area. Hence, many invasion biologists strongly assert that a species' geographical origin is an influential determinant of the potential ecological harm it can inflict.

Nonetheless, invasion scientists are often accused of nativism by critics (O'Brien, 2006; Peretti, 1998; Sagoff, 2018; Wallach et al., 2018). Nativism, in this context, refers to the prioritisation of native species over non-native ones, driven primarily by cultural preferences and xenophobic biases (Warren, 2021). Critics contend that accurately determining a species' origin, both temporally and spatially, presents significant challenges (Peretti, 1998; Warren, 2021). Because these critics argue nativeness cannot be objectively determined, they see xenophobia or other cultural biases as the underlying motivation for such preferences. Whilst others suggest that charges of these biases are unfounded (Hettinger, 2021; Simberloff, 2003), and invasion scientists generally recognise the epistemic uncertainties and methodological difficulties associated with using historical ecological data for conservation management, other values – such as biodiversity and naturalness – inevitably influence the decisions made in the face of these uncertainties. For example, even when a species' temporal and spatial development can be accurately determined, the choice of an appropriate historical baseline to define a species as native remains subjective (Woods and Moriarty, 2001). This decision can depend on ideas about the ideal state of an ecosystem and be influenced by pre-existing beliefs about what species 'belong' to an area. Similar choices arise when determining a species' range or when alternative understandings of species' nativeness, such as ecological fit are emphasised. A species' nativeness or alienness is not an inherent trait of a species but depends on its temporal and spatial context, which can be constructed in various ways (Boonman-Berson et al., 2014; Warren, 2007, 2021). Constant changes in ecosystems and species further blur these distinctions over time (Warren, 2021). Therefore, some critics argue that the native/non-native distinction holds no scientific value and should not be used as a guide for management (Davis et al., 2011). Nevertheless, completely dismissing the scientific validity of this concept is unwarranted. Despite the challenges in defining nativeness, the distinction can still offer meaningful insights for ecological research and conservation practices. These ambiguities do not prove that the focus on a species' origin is inherently informed by nativism (Hettinger,

2021), nor do they negate the existence of clear-cut cases where a population's origin is generally agreed upon.

Harm

Despite accusations of nativism, most invasion scientists do not consider all alien species to be harmful in principle (Bardgett and Simberloff, 2011; Buckley and Catford, 2016). The primary concern with alien species is their greater likelihood of causing negative environmental and socio-economic impacts compared to native species (Richardson and Ricciardi, 2013; Simberloff et al., 2012). Thus, alien species are generally defined as IAS when their abundance and impacts are perceived to cause harm (van der Wal et al., 2015). However, the definition of harm is routinely challenged, because perceptions of harm are often influenced by a species' origin and because harm is inherently a subjective concept.

First, it is widely acknowledged that most alien species do not thrive or cause problems when introduced into a new environment (Davis, 2009). Nevertheless, the potential for causing harm leads to a generally negative perception of all introduced species (Hettinger, 2021). This means that whilst most alien species are not harmful, in practice, their non-nativeness is perceived negatively based on the risk of them becoming invasive. This precautionary approach can lead to a generalised negative perception of all non-native species. Furthermore, Sagoff (2018) argues that when concepts such as 'biodiversity' and 'ecosystem integrity' exclude the presence of alien species by definition, alien species are seen as harmful. This creates circular reasoning because if harm is defined by the presence of alien species, and harm is used to define IAS, then all alien species could be categorised as IAS. Even though harm is not solely defined by these concepts, a non-native species may be viewed negatively, because its presence is perceived as disrupting the natural state of the ecosystem.

Second, whilst ecological changes due to alien species can be quantified, characterising these changes as degradation involves a value judgment (Sagoff, 2018; Tassin et al., 2017). There will be measurable declines in certain aspects, such as reductions in native species diversity or impacts on human well-being. However, the importance placed on these changes is influenced by societal values and priorities. These perceptions of harm are shaped by cultural values, economic priorities and social norms (Davis, 2009; Verbrugge et al., 2016; Warren, 2021). Additionally, Boltovskoy et al. (2018) suggest that selection bias might skew research towards studying alien species' negative impacts. Consequently, critics argue positive impacts are often understated, and positive and negative impacts can co-occur, sometimes in different domains (Vimercati et al., 2020). For instance, herbivores and livestock introduced for farming and hunting can threaten native species when no longer under human control (Spear and Chown, 2009), whilst continuing to be socially and culturally valuable and important resources for hunters.

Carneiro et al. (2024) counter such claims by arguing that despite some benefits, the overall negative impacts, including ecological disruption, loss of biodiversity and economic costs, far outweigh the benefits. Nevertheless, Boltovskoy et al. (2018) argue that providing examples of positive and mixed impacts does not necessarily constitute

science denialism nor counter the presumption that IAS generally have negative impacts. Establishing that biological invasions have more negative impacts overall does not prescribe a course of action in particular cases, because the impacts of introduced species may vary depending on the species involved and the context of their introduction. Even within invasion science, where its meaning is widely agreed upon, harm remains a subjective concept defined by what is considered valuable. The prioritisation of these values is far from universally accepted, with (short-term) economic benefits often taking precedence over biodiversity or community values.

Naturalness

In addition to their quantifiable ecological and socioeconomic impacts, alien species are often considered to devalue nature by diminishing the wildness or naturalness of ecosystems (Hettinger, 2021). Generally, IAS management reflects a commitment to maintain ecological processes and biodiversity as they existed before significant human intervention. In this context, invasion biologists assert that human-mediated dispersal differs from natural introduction (see, e.g. Cuthbert et al., 2020; Wilson et al., 2016). Human assistance increases the number and frequency of introduced individuals, the genetic diversity of introduced populations, the potential for simultaneous introduction with co-evolved species, and the duration of dispersal pathways being available, and changes in which species are moved, and when (Wilson et al., 2009). However, both critics and invasion scientists recognise that strictly distinguishing between human-mediated and natural introduction becomes increasingly complex when considering species movement driven by indirect human actions, such as climate change-induced changes in weather patterns, temperature and natural disasters (Bradley et al., 2024; Essl et al., 2019; Hettinger, 2021; Sagoff, 2018; Warren, 2021). To address this complexity, the concept of 'neo-natives' has been proposed to describe species that expand their ranges not through direct human transportation but as a result of anthropogenic environmental changes (Essl et al., 2019). This concept has sparked debate amongst invasion scientists. Whilst it is proposed as a useful framework for understanding species movements in the context of global change (Essl et al., 2019), some criticise it for potentially causing confusion and hindering conservation efforts (Wilson, 2020). Wilson (2020) argues that introducing new terms like 'neo-native' can blur the lines between native and non-native species, complicating management decisions and policy formulations. The inclusion of such species challenges the clear-cut differentiation between natural and human-mediated introductions and raises questions about how to classify and manage species whose movements are indirectly influenced by human-induced environmental changes.

Some critics assert that distinguishing between human intervention and natural events is rooted in a problematic human–nature dualism (Sagoff, 2020). Therefore, they argue that any species movement, even those influenced by human actions, should be considered 'natural' given that humans are a part of nature (see, e.g. Brown and Sax, 2004; Sagoff, 2020). Botkin (2001) argues the idea that IAS are unnatural emerges from the traditional assumption that nature exists in a constant state of equilibrium when undisturbed. Consequently, introducing alien species is perceived as a disruption to this balance, meaning such species are seen as inherently undesirable. However, just

because ecosystems naturally exist in a certain state does not necessarily mean they ought to remain that way, nor that any human-induced changes are inherently bad. The assumption that 'natural' equates to 'good' is a value judgment rather than a scientific fact. Whilst contemporary scientific understanding refutes notions such as 'pristine nature', ecosystems that are relatively undisturbed are still generally preferred, and this presupposes that humans are, at least in some relevant ways, separate from nature. Cuthbert et al. (2020) counter this perspective, stating that including human influence in the IAS definition does not deny that humans are part of nature, but simply signifies human responsibility as human activities are an important factor in many invasions. It is not the involvement of humans that makes these invasions harmful, but the scale and magnitude of human-mediated invasions compared to natural species movements.

This section examined (criticisms of) the traditional understanding of the core concepts of invasion science. The emphasis on species' origin is anchored in the understanding that species with a shared evolutionary history are integral to ecosystem health and stability, having established complex interdependencies over time. Consequently, alien species, that lack this shared history, have the potential to undermine this ecological balance. The notion of harm in this context extends to the degradation of biodiversity and the disruption of what are perceived to be pristine ecosystems. Such changes are frequently attributed to human activities, which are contrasted with natural evolutionary processes. In conservation, different normative underpinnings can lead to varying interpretations of these concepts, reflecting diverse ethical and philosophical perspectives about our relationship with nature.

Alternatives to traditional conservation

This section provides an overview of three alternative approaches that challenge the normative underpinnings of traditional conservation: new conservation, convivial conservation and compassionate conservation. Each offers a distinct perspective on the interplay between humans, nature and IAS. How values affect the understanding of the core concepts of invasion science will be discussed in this context, along with an examination of the respective criticisms these approaches face.

New conservation

New conservation challenges traditional conservation for its focus on preserving wildness and maintaining ecosystems in a pristine, untouched state (Kareiva and Marvier, 2012). New conservationists argue these goals are unrealistic and disregard humanity's dependence on nature. Instead, they argue that conservation efforts must include human-altered landscapes (Kareiva and Marvier, 2012) and call for embracing novel ecosystems (Davis et al., 2011; Kareiva et al., 2012). Novel ecosystems emerge due to recent changes in species assemblages through human action, the introduction of species and climate change (Hobbs et al., 2009; Kareiva et al., 2012). New conservationists suggest that these ecosystems, having developed in the current changing climate may be more resilient to changes in the future (Hobbs et al., 2009), therefore requiring less intense management. This premise is challenged by Murcia et al. (2014) who note the increased

resilience of novel ecosystems is not proven, and it seems unlikely these will remain more stable than other ecosystems without human intervention to secure such resilience. New conservation argues that anthropogenically transformed nature can be as good, or even better than, traditional nature in a human-dominated world (Marris, 2011; Pearce, 2015). In this context, novel ecosystems can also fulfil traditional conservation goals that people value, such as biodiversity protection (Kareiva and Marvier, 2012).

This view extends to IAS, with many authors arguing for more recognition of their benefits in scientific debates and management (Vimercati et al., 2020). Schlaepfer et al. (2011) suggest that introducing certain species can contribute to human well-being and conservation goals. They claim that intentionally or unintentionally introduced species can have beneficial functions for conservation purposes, such as providing 'habitat, shelter and food for native species', as 'catalysts for restoration', 'ecosystem engineers' and 'providing ecosystem services' (p. 431). Furthermore, they argue that introduced species may fill ecological niches caused by species' extinctions (Schlaepfer et al., 2011). In 'The New Wild' (2015), Pearce takes this argument further, suggesting that IAS are helping rather than hindering nature, and IAS might even serve as 'nature's salvation'. He writes: '[…] when invaded by foreign species, ecosystems do not collapse. Often they prosper better than before. The success of aliens becomes a sign of nature's dynamism, not its enfeeblement' (Pearce, 2015, p. xiii). According to Pearce, the resilience, adaptability and competitiveness of IAS may be advantageous in a human-dominated world. However, these optimistic perspectives have been met with significant criticism for overstating the benefits provided by IAS and not adequately representing the drawbacks. Carneiro et al. (2024) show occasional benefits are outweighed by their substantial negative impacts on native biodiversity and ecosystem functions. The introduction of IAS is a leading cause of species extinctions and can lead to the homogenisation of global biota, reducing the uniqueness and resilience of ecosystems. Furthermore, the supposed benefits provided by IAS are frequently context-dependent and may not compensate for the irreversible ecological damage they cause. Therefore, they caution that overemphasising the benefits of IAS can undermine conservation efforts by downplaying the threats they pose to native species and ecosystems.

Another argument from new conservation centres on the dependency of human lives on nature, highlighting the concept of ecosystem services (Kareiva and Marvier, 2012). Ecosystem services are the benefits humans derive from the natural environment, encompassing essentials like food, shelter, clean air and water, and pollination of crops (Millennium Ecosystem Assessment, 2005). New conservationists argue that, beyond nature's intrinsic value, there are pragmatic reasons to protect biodiversity, such as maintaining these vital ecosystem services. They advocate a shift in focus from protected areas to ecosystem services, promoting a more anthropocentric approach that emphasises aligning conservation goals with poverty reduction and economic development (Kareiva and Marvier, 2012). This increased focus on nature's instrumental value has led to the operationalization of the concept of ecosystem services within market-based instruments. New conservation suggests that by quantifying the economic value of ecosystem services, payment for nature conservation can be stimulated (Tallis et al., 2008). This approach becomes particularly relevant in the context of current political and economic systems, where financial incentives are powerful motivators. Practical applications of this

concept include methods such as payments for ecosystem services, biodiversity offsetting and ecotourism initiatives (Apostolopoulou et al., 2021).

Whilst conservation and economic development usually involve trade-offs, Kareiva and Marvier (2012) suggest that research and practice should focus on identifying the conditions necessary for win-win scenarios. This idea aligns with the convergence hypothesis, which posits that if human interests are intertwined with the interests of non-human life, anthropocentric and non-anthropocentric policies will eventually converge (Norton, 1986). Kareiva and Marvier (2012) argue that a few global corporations significantly influence resource and land use and consumer choices, effectively acting as 'keystone species' in global ecosystems. Acknowledging that their activities can harm the environment, they underscore the necessity of engaging with these businesses to improve their practices. Consequently, large corporations and private entities are increasingly involved in conservation efforts, motivated by the potential for economic gain.

Traditional conservationists Miller et al. (2014) argue that new conservation overstates the potential benefits of human-altered ecosystems, often based on flawed assumptions such as nature's resilience and the feasibility of constructing new ecosystems from non-native species. The concept of novel ecosystems has faced much criticism. Murcia et al. (2014) argue that embracing novel ecosystems could undermine restoration efforts by accepting degraded ecosystems as the new norm. They also point out that the concept lacks clear definitions and could be misused to legitimise harmful human impacts on ecosystems and challenge the notion that novel ecosystems are necessarily more resilient. Other critics argue that the ability to recover depends on the level and duration of disturbance, the type of system disturbed, and the possibility of alternative stable states (Miller et al., 2014). Whilst Doak et al. (2014) agree that pristine ecosystems do not exist, they defend the need to preserve relatively undisturbed natural areas, as these support more biodiversity than novel ecosystems. Miller et al. (2014) further emphasise the value of biodiversity, noting that a loss of species diversity diminishes ecosystem productivity, resilience and stability. Moreover, Neuteleers and Engelen (2015) argue that an emphasis on instrumental value risks overshadowing intrinsic motivations for conservation, potentially leading to unstable and self-interested conservation strategies. Miller et al. (2014) also warn that 'when economics can justify the existence of species with profit value, it can also justify the extinction of those interfering with profit' (p. 1). Finally, critics point out that when the potential benefits of IAS are overstated, significant ecological risks and financial costs involved when management is delayed are overlooked (Carneiro et al., 2024).

Convivial conservation

Convivial conservation offers a second alternative to traditional conservation. It questions the dualistic view inherent in traditional conservation, which presupposes a separation between humans and nature, and advocates recognising their interconnectedness instead (Büscher and Fletcher, 2019). Büscher and Fletcher (2020) contend that pristine nature, free from human touch, is a myth, as humans have always been part of natural ecosystems Accordingly, proponents propose a coexistence-based model emphasising living with nature rather than excluding humans from it (Massarella et al., 2022). In this model, humans and nature are seen as inseparable components of the same socio-

ecological system. These systems encompass the reciprocal relationships between ecological processes and human activities (IPBES, 2019).

Challenging the dualistic view of humans and nature, Büscher and Fletcher (2019) propose that the main goal of conservation should not be to protect nature from humans, but 'to promote nature for, to and by humans' (p. 286). This perspective underpins the concept of convivial conservation, which seeks to transform traditional conservation approaches by fostering a more integrated relationship between people and nature. In light of the persistence of colonial conservation practices and the dominance of Western science in conservation (Collins et al., 2021), convivial conservation emphasises the importance of understanding and addressing the inequalities of environmental damage, which disproportionately affect vulnerable and marginalised human populations, especially in the global South (Krauss, 2021). Domínguez and Luoma (2020) state traditional conservation often involves top-down governance systems that overlook and undermine local and Indigenous knowledge systems and forms of environmental stewardship. Therefore, convivial conservationists argue against protected areas, which are usually characterised by an exclusionary strategy (Massarella et al., 2022). These protected areas have often been criticised for overlooking human lives and livelihoods, exacerbating social injustices and failing to protect the rights of Indigenous peoples and local communities (Domínguez and Luoma, 2020; Krauss, 2021). In contrast, convivial conservation emphasises justice and interconnectedness, and it champions initiatives that are community-led, involve equitable resource distribution, and recognise diverse values and knowledge systems in conservation efforts (Krauss, 2021).

In addition to being top-down and exclusionary, proposals like 'half earth', which aim to drastically expand protected areas, are also critiqued for their lack of transformative potential (Büscher and Fletcher, 2019, 2020). Büscher and Fletcher (2019) argue that whilst these proposals may seem ambitious, they do not fundamentally challenge the broader systemic issues that underlie biodiversity loss and ecological crises. Instead of merely expanding protected areas, a transformative approach would require addressing root causes such as unsustainable consumption patterns, economic inequalities and environmental injustices to create lasting change. This critique also extends to new conservation's emphasis on nature's services to humans and reliance on capitalism (Büscher and Fletcher, 2019, 2020). Market-based approaches to ecosystem services are criticised for commodifying nature, reducing its diverse ecological and relational values to monetary terms (Turnhout et al., 2013). Additionally, these instruments are seen as problematic, because they rely on the same capitalist frameworks that are major contributors to environmental degradation (Büscher and Fletcher, 2019, 2020; Krauss, 2021; Massarella et al., 2022). Whilst new conservation rejects problematic human–nature dualisms and attempts to integrate humans and nature, Büscher and Fletcher (2020) state that its trust in capitalist conservation reinforces more fundamental distinctions between human and non-human nature. Instead of focusing solely on ecosystem services, this approach aligns with the 'NCP' framework, which encompasses all the benefits that people derive from nature (Pascual et al., 2017). Although this framework originated from the ecosystem services concept, it extends beyond its focus on instrumental values by incorporating cultural, spiritual and non-material benefits alongside material ones.

Convivial conservation suggests that rigid adherence to historical baselines and rejecting any human influence in ecosystems are neither feasible nor desirable. However, this approach offers limited guidelines for dealing with specific cases such as IAS management because convivial conservation advocates fundamental structural change and rejects alienating technocratic, top-down approaches. Büscher and Fletcher (2020) argue that science is inherently political and cannot be the sole determinant of conservation action, emphasising that conservation is deeply embedded in daily life and must be context-specific. This perspective necessitates the recognition of local values and relationships and the advocacy for democratic decision-making tailored to local contexts. The integration of local knowledge and perspectives from the beginning is crucial (Caceres-Escobar et al., 2019), but Büscher and Fletcher (2020) also point out that conservation efforts must extend beyond community-based initiatives to address the pressures on biodiversity from extra-local actors.

From a traditional conservation perspective, convivial conservation's adoption of relational values is critiqued for remaining largely anthropocentric, with relational values being perceived as primarily instrumental, focusing more on the benefits to humans rather than on the intrinsic value of nature itself (Piccolo et al., 2022). This approach risks reinforcing the view that non-human organisms and ecosystems are merely means to human ends, which in the eyes of traditional conservationists is inadequate for true biodiversity protection (Kopnina et al., 2018). Traditional conservation advocates defend the need for protected areas to halt further biodiversity loss, and argue that recognising nature's intrinsic value can coexist with local community interests (Doak et al., 2014). They believe that conservation focused on biodiversity is compatible with community well-being, and more recent thinking about protected areas resists excluding local peoples from their land and aligns with the rejection of extractive capitalistic practices. Additionally, convivial conservation provides limited courses of action, as the application of key concepts, such as interconnectedness, is context-dependent. Similarly, whilst rejecting capitalism as an economic system may contribute to reducing future invasions, because many introduction pathways are related to international trade and colonial and extractive practices, it does not guide specific, more targeted, policies to prevent future invasions, nor does it guide the management of current IAS. Kopnina et al. (2018) also express concern that if all elements of nature are considered equally natural, it is difficult to strictly differentiate between harmonious coexistence and harmful human impacts. This makes it increasingly challenging to justify opposition to harmful human impacts. Furthermore, given our current population size and standards of living, living within nature without causing harm may not be feasible.

Compassionate conservation

Finally, compassionate conservation emerges as a distinct approach within the conservation discourse.[1] Guided by empathy and compassion, this approach centres on individual animals' intrinsic value and ethical treatment in conservation (Ramp and Bekoff, 2015; Vucetich and Nelson, 2013; Wallach et al., 2018). Proponents of compassionate conservation argue that the traditional approach towards IAS management tends to be overly aggressive towards non-human animals (Ramp and Bekoff, 2015). Compassionate

conservation criticises traditional conservation for reasons that differ from new and convivial conservation, whose foundations lie in the rejection of the human–nature dualism. Instead, compassionate conservation challenges tendencies of nativism, collectivism and instrumentalism that they argue serve as justification for indiscriminate and violent practices (Wallach et al., 2018). Nativism is criticised because it discriminates between animals based on their species membership and legitimises measures that compromise animal welfare against introduced populations. According to compassionate conservationists, this is based on ideals such as maintaining a 'pristine' nature, rather than their expected ecological impacts (Coghlan and Cardilini, 2022; Wallach et al., 2018, 2020). Wallach et al. (2018) argue that labelling animals as 'invasive' implies wrongful intent, and this demonisation of IAS as the cause of harm normalises the mass killing of these animals.

Collectivism is criticised for prioritising collectives, such as species, populations and ecosystems, over individual animals (Wallach et al., 2018). This conflict between collectivism and individualism arises because actions aimed at preserving ecological collectives often involve harm to individual animals. When conservation goals – such as maintaining biodiversity – conflict with the lives or well-being of individual non-human animals, the latter are often sacrificed to serve a perceived 'greater good'. This tension reflects a long-standing debate in environmental ethics and conservation biology over whether moral consideration should be primarily given to individual sentient beings or to larger ecological entities like species and ecosystems (Faria and Paez, 2019). Proponents of compassionate conservation argue that ethical obligations to individual animals should not be overridden by collective interests, challenging traditional approaches that justify individual harm for the benefit of the collective.

Compassionate conservation recognises two understandings of instrumentalist tendencies in traditional conservation. The first views nature as a resource for human needs and is more easily recognisable in new conservation. The second interpretation bases the utility of individual animals in achieving conservation goals, such as maintaining biodiversity. This can legitimise conservation practices that harm individual animals to reach traditional conservation goals (Ramp and Bekoff, 2015; Vucetich and Nelson, 2013). Traditional conservation also recognises intrinsic value in non-human nature, although this value is typically ascribed to these collectives (Soulé, 1985), whilst individuals are valued primarily as members of their species instead of individuals (Ramp and Bekoff, 2015). Batavia and Nelson (2017) emphasise that recognising the intrinsic value of both individual and collective non-human entities is crucial for a compassionate approach to conservation, which respects the inherent worth of nature beyond its utility to humans and conservation objectives. In addition, compassionate conservationists argue this instrumental focus does not adequately protect elements of nature that do not provide direct or apparent benefits (Wallach et al., 2018).

Opposing these tendencies compassionate conservationists identify new and traditional conservation, compassionate conservation is centred around four tenets to guide conservation practices (Wallach et al., 2018). First, to minimise harm, proponents advocate against the intentional or indiscriminate harm or killing of sentient beings (Ramp and Bekoff, 2015). Second, compassionate conservationists urge recognition of the intrinsic value of individual animals (Batavia and Nelson, 2017; Vucetich et al., 2015). Third,

advocates posit that all animals, regardless of species, origin or ecological role, deserve equal consideration (Wallach et al., 2018). Fourth, compassionate conservation promotes the interconnectedness of humans and non-human nature (Wallach et al., 2018).

Compassionate conservation shares with new and convivial conservation the recognition of the potential value of IAS in novel ecosystems, albeit for different reasons. Whilst new and convivial conservationists value IAS for their contributions to ecosystem resilience, adaptability, or benefits to human-altered landscapes, compassionate conservationists focus on the ethical treatment and welfare of individual animals, including IAS. Adopting an inclusive stance towards IAS in novel ecosystems also addresses some challenges associated with eradication programs, as eradication programs often require continuous intervention (Norton, 2009), which means more animals are harmed by humans. The relevance of whether animals are harmed by human moral agents hinges on the concept of direct moral duties, which involve not causing unnecessary harm and suffering. However, many compassionate conservationists presuppose we are not indirectly morally responsible for the actions of other animals, even those introduced by humans. Therefore, the introduction of large predators is proposed as a compassionate IAS management alternative (Wallach et al., 2018), despite this being a lethal measure.

In the cases where eradication programs are the only feasible solution to save a species, the collectivist orientation of traditional conservation clashes with the concern for individuals found within compassionate conservation. Because compassionate conservation offers limited alternatives, strictly adhering to the 'do no harm' principle could result in a laissez-faire attitude towards nature management (Hayward et al., 2019). Interventions, particularly those that involve harm or culling, may therefore need to be minimised or avoided altogether, which may allow IAS to thrive at the expense of native species, potentially causing more suffering (Callen et al., 2020; Hayward et al., 2019). Additionally, the focus on individual welfare can conflict with broader conservation goals, ultimately harming collectives and biodiversity (Callen et al., 2020; Hayward et al., 2019), which are also crucial for the well-being of the animals that are part of these collectives. Other concerns relate to the lack of clarity about what exactly is considered harm, how compassion should be enacted when all courses of action potentially cause harm and how future suffering should be included in these considerations (Beausoleil, 2020). Finally, critics argue that compassionate conservation arbitrarily focuses on charismatic species like large predators and megaherbivores, paying insufficient attention to other, less charismatic species (Hayward et al., 2019).

In the previous sections, three alternatives to traditional conservation were presented. These varying perspectives represent distinct value systems that significantly influence how each approach interprets and applies the concepts of origin, harm and human intervention. New conservation dismisses the relevance of species' origin, arguing that whether or not a species is native is not relevant to its value, as long as it is able to contribute to ecosystem services. Convivial conservation does not address species origin explicitly but moves away from rigid boundaries and dichotomies dictated by science as top-down determiners for conservation action. Finally, compassionate conservation criticises the focus on origin as nativist and unjust, rejecting discrimination and harmful practices against animals based on their non-native status. Regarding harm,

new conservation emphasises the potential benefits of IAS for human well-being and ecosystem services, viewing harm in terms of the impact on people and their livelihoods. This approach advocates integration rather than eradication, supported by the belief that some IAS can enhance ecosystem resilience. Convivial conservation rejects standardised frameworks to measure and value impacts because these should be determined within their contexts instead. Compassionate conservation prioritises individual animals over ecological collectives, opposing practices that cause suffering. New conservation does not perceive human intervention as a devaluation of nature, arguing that introduced animals may be more resilient to further human-induced changes. Convivial conservation views humans as integral parts of nature and emphasises the interconnectedness of human and non-human communities. It also rejects human intervention as inherently negative, but aims to differentiate between positive and negative relationships between humans and their environment. Compassionate conservation exercises caution with human intervention, not because of a particular emphasis on naturalness, but due to the potential negative outcomes for animals.

Discussion

The discussion of the four approaches in the context of invasion science illuminates how debates over IAS can be understood as a reflection of deeper discussions about the values and concepts central to conservation. Each approach examined in the previous sections challenges the normative underpinnings of traditional conservation, as proposed by Soulé. These normative underpinnings are currently not sufficiently recognised and addressed within the discipline, yet they are guiding the management of IAS. This section highlights two key insights: the impossibility of a value-neutral viewpoint in the management of IAS and the need to navigate diverse positions and values within the field.

Value-ladenness

The discussion between traditional conservation and alternative approaches offers an illustration of what Sarewitz (2004) has called the 'scientization' of environmental disputes; a situation where disagreements about concepts, values and ethical norms are disguised as disputes over science and objectivity. Some proponents of invasion science perceive normative reflection on their practices as undermining objectivity and credibility. This response, however, is maladaptive since it obstructs the opportunity to openly and critically discuss and evaluate core assumptions (cf. Lahsen and Turnhout, 2021), ultimately obstructing constructive dialogue about the normative disagreement between diverse approaches to conservation. Value-ladenness is not an undesirable characteristic of science that can or should be avoided, rather it should be acknowledged and addressed to ensure the most (ethically) appropriate values influence science. When some invasion scientists comply with an illusory value-free ideal, science continues to be value-laden, but these values are not subject to debate. Such debates are crucial because they reflect the variety of values recognised in nature, the place of humans in nature, and the prioritisation of conservation goals.

The approaches discussed in this article showcase distinct perspectives on the interpretation of the concepts of origin, harm and human intervention, and place different emphasis on nature's intrinsic, instrumental, and relational values. The IPBES three-dimensional value system offers a framework for understanding and assessing the plurality of values of nature (Pascual et al., 2017). This system encompasses intrinsic values, recognising the inherent worth of nature irrespective of its utility to humans; instrumental values, referring to the utilitarian benefits that nature provides to humanity, such as ecosystem services quantified in economic terms; and relational values, which highlight the cultural, spiritual and social connections people have with the natural world. Traditional conservation is primarily aligned with intrinsic values, focusing on preserving nature for its sake, new conservation emphasises instrumental values by highlighting ecosystem services. Convivial conservation incorporates both relational and instrumental values, by shifting to a broader conception of nature's contributions to humans and compassionate conservation draws on intrinsic and relational values, stressing the ethical treatment of individual animals. Navigating this value pluralism requires recognising and integrating insights from diverse value dimensions into conservation policies and practices.

Navigating value pluralism

The alternative approaches presented share some important critiques in recognising the complexities of managing IAS in a human-dominated world. They predominantly highlight the insight that novel species assemblages are an increasingly integral and inevitable part of our world, and can be valued without abandoning conservation efforts. Similarly, all three alternative approaches discussed in this article question the tenability of the distinction between native and alien species. As these species persist and integrate into new environments, native and non-native species increasingly mix and become co-dependent, forming new ecological relationships and altering existing ones. Over time, some non-native species may become naturalised, establishing themselves as essential components of their new ecosystems (Hettinger, 2021). Habitat loss and climate change further complicate IAS management by causing shifts in species distributions, sometimes resulting in non-native species becoming endangered or extinct in their original habitats but thriving in new ones (Warren, 2021). These changes can mean that predicting if a species will be harmful or benign based on origin becomes increasingly challenging. Whilst these developments do not justify disregarding the relevance of these categories, in light of their far-reaching ethical implications, they do point to the need to continuously critically consider the tenability of these categories in a rapidly changing world.

Navigating the complexities arising from conflicting perspectives requires careful evaluation of the underlying values at stake within a particular context and recognising competing or overlooked viewpoints to foster an inclusive debate. Whilst these differences may sometimes complement each other, there are many instances where this is not the case. In such scenarios, the focus of deliberation should make sure to incorporate the fundamental values at play and their practical and ethical implications. Amongst the available approaches to conservation, some positions are indeed incompatible and their integration is not necessarily desirable. This is especially true when certain arguments are supported by biased interpretations of the available data, such as in cases where

positive examples are cherry-picked to emphasise the beneficial impacts of IAS. However, to effectively organise deliberation, it is crucial to understand that misrepresentation of data typically also supports pre-existing beliefs, underscoring the importance of considering values alongside scientific evidence when facing disagreements.

To move forward, invasion science must acknowledge the inseparable nature of scientific knowledge and values, recognising that cultural, ethical and societal factors necessarily shape its normative underpinnings and practices. Conservationists will inevitably continue to encounter complex social, cultural, economic and ecological challenges. These challenges introduce difficult ethical questions about conservation methods and objectives within the socio-ecological environment that must be addressed in ways that both recognise scientific evidence and engage the ethical and social dimensions of conservation and invasion science. Fostering interdisciplinary collaboration is crucial; by bringing together expertise from ecology, sociology, ethics and local knowledge, a more comprehensive understanding of the impacts and benefits of IAS can be developed, leading to more informed and effective management decisions (Boltovskoy et al., 2018; Guiasu and Tindale, 2018; Munro et al., 2019). Insights from local and Indigenous communities, social scientists, ethicists and others provide valuable contributions when integrated into a more inclusive approach that respects the legitimacy of different value systems in guiding conservation practices. Moreover, conservation does not need to be fully integrated into a unified approach. Conservation priorities can vary locally based on context-specific considerations, and whilst short-term actions are essential for urgent issues, they must be balanced with long-term ecological and societal objectives. Finally, it is crucial to address power dynamics and equity in conservation research and implementation to ensure that the values that guide it are as fair and inclusive as possible, taking into account the perspectives and rights of both human and non-human entities.

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Note

1. Compassionate conservation closely aligns with conservation welfare; both approaches advocate considering the well-being of individual wild animals within conservation practice and policy. However, they are based on different ethical foundations, leading to sometimes conflicting views on conservation activities. Compassionate conservation has pluralistic moral

foundations, that mainly include features of virtue and deontological ethics (Coghlan and Cardilini, 2022). In contrast, conservation welfare is consequentialist and seeks to balance the well-being of individual animals with broader conservation goals, deeming it acceptable to cause some harm if those harms are outweighed by expected benefits (Beausoleil, 2020). This approach is more closely aligned with traditional conservation, so to reflect a wide variety of values and critiques, compassionate conservation is discussed in this section.

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