Ethical dilemma in conservation: a trolley problem thought experiment

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Abstract

Conservation decisions often need to integrate scientific predictions with societal values, ethical systems, and diverse perceptions that combine to form moral stances about conservation actions (e.g., trophy hunting or controlling invasive species). These can result in dilemmas and, if stakeholders hold different views on the morality of particular conservation actions, conflicts can arise. Here we adapt the well-known trolley problem thought experiment to a conservation context to offer a simplified, yet comprehensive framework enabling us to explore possible factors underlying differences in moral stances about such conflicts and better understand or predict them. Through the development of variations covering key concepts (asymmetry in numbers, victims and impacts; temporal and spatial asymmetry; uncertainty; causal relationships between actions and consequences), we provide a structured approach to elucidate moral conflicts in conservation. The trolley problem's versatility allows for the exploration of multiple scenarios deriving and combining these key concepts, facilitating a deeper understanding of the complexities inherent in conservation ethics. While acknowledging the need for contextualization and refinement, the conservation trolley problem also serves as a foundational step towards developing more nuanced thought experiments tailored to specific conservation contexts. The framework we present offers a systematic method to compare and analyse diverse ethical perspectives, fostering communication and facilitating informed decision-making in conservation practice. The integration of diverse metaphors offers avenues for enhancing dialogue between stakeholders, broadening perspectives, and advancing ethically sound conservation practices.

Keywords: Conservation, Ethics, Management, Metaphor, Thought experiment, Trolley problem

1. Different worldviews can motivate conservation decisions

Nature conservation aims to protect biodiversity, in particular populations and species threatened by anthropogenic activities. It also aims to ensure the sustainable use of nature. Conservation practitioners often have to make decisions in situations for which an action is believed to be beneficial for one entity of nature (*sensu* Lehnen et al. 2022; e.g., a group of individuals, populations, species, or ecosystems; see Box 1 for definitions), but may be detrimental for another entity, resulting in a trade-off. Moreover, some actions can lead to irreversible outcomes, in which case "wrong" decisions (or decisions with unintended or unforeseeable deleterious consequences) cannot be reversed. Such decisions are rarely straight-forward and the consequences of different actions or inaction are not always known, or can be perceived differently by stakeholders (Bennett 2016). Conservation decisions are influenced by a wide range of ecological and social factors, including economic, political, philosophical or psychological, amongst others (Bennett, 2016). Conservation must therefore account for values held by people and their relation with the environment (Ives and Kendal, 2014), and consider arguments beyond the scientific domain (in the sense of a hypothesis testing perspective), which would only predict the outcome of an action, not if it is right or wrong. It is important to include societal and ethical considerations, to decide how to prioritise different targets while accounting for the diversity of nature's values (IPBES, 2022).

A classical typology in the western conservation literature is composed of three main ethical perspectives. First, conservation approaches following a consequentialist ethics aim to reach a given target based on a range of values attributed to different entities of nature according to different ethical perspectives (here and in the following, we use ‘value’ in the sense of ‘assigned value’, i.e. a value attributed to something, in contrast to ‘held value’, i.e. life goals and principle; Box 1). These approaches include ecocentrism (species and ecosystems are attributed intrinsic value), biocentrism (living organisms are attributed intrinsic value), sentientism (sentient species that can experience consciousness beyond pain and pleasure are attributed intrinsic value) and anthropocentrism (only humans are attributed intrinsic value, and other species can be attributed instrumental value, i.e. only insofar as they benefit humans) (Latombe et al., 2022). These conservation approaches can aim for example to maximise native biodiversity (i.e. “coevolved, natural communities”; traditional conservation, Soulé 1985), maximise the benefits humans get from nature (new conservation, Kareiva and Marvier 2012 - but see Box 2 for a more nuanced description), or minimise animal suffering (conservation welfare, Beausoleil et al. 2018). By contrast, deontology considers actions under the perspective of duties and rights. Deontologists would therefore reject the killing of animals if they consider that animals have inalienable rights to life (Bichel and Hart, 2023; Korsgaard, 2018). Thirdly, virtue ethics advocates for actions that are driven by desirable human qualities, i.e. virtues (Hursthouse and Pettigrove, 2018), such as compassion for sentient animals (Wallach et al., 2018). Differences in ethical perspectives have led to multiple disagreements and disputes in the scientific literature (Box 2).

In addition to ethical perspectives, a wide range of subjective, cognitive and emotional factors can play a role in the stances people take on conservation issues. For example, temporal and spatial discounting, the preference for immediate rewards over long-term or distant costs, is a well-known psychological trait that is highly context-dependent

(Critchfield and Kollins, 2001; van der Wal et al., 2013) and has important implications for conservation (Swim et al., 2009). Other subjective or intersubjective considerations can influence decision making, including cultural preferences, species charisma, nativism, or any particular type of nature's contribution one would benefit from, i.e. individual relationships with entities of nature (Díaz et al., 2018; Lehnen et al., 2022). These considerations can be beneficial or detrimental for the implementation of conservation actions (Courchamp et al., 2018; Ducarme et al., 2013), for example the conservation of threatened species or the management of invasive species (Jarić et al., 2020).

The ethical views, subjective preferences and perceptions of a person interact to generate an opinion about the morality of an action in a given context. Differences in ethical views and cognitive or emotional preferences can lead to different stances about conservation actions, especially for complex ecological systems involving many entities of nature, potentially escalating towards conflicts between stakeholders (Crowley et al., 2017; Estévez et al., 2015; Redpath et al., 2013). The interplay between ethical views and subjective or intersubjective preferences can also generate personal dilemmas (internal conflicts), for example when different species considered morally equal are affected differently by conservation actions, or when a moral stance driven by ethical perspectives conflicts with a cognitive or emotional preference. Such external and internal conflicts can lead to a lack of decision making and inertia (Peterson et al., 2005). The fact that many disputes about appropriate conservation approaches have not been resolved despite multiple articles from all sides (Box 2) suggests that a tool that could allow systematically comparing positions for different situations is needed to promote communication and better identify points of divergence or agreement.

2. The trolley problem thought experiment as a tool to capture the diversity of conservation stances

Thought experiments can be used to simplify real, complex situations and explore how moral intuitions naturally emerge, or to elaborate more robust moral stances in different contexts, including conservation contexts (Haidt, 2001; Lakoff and Johnson, 1999; Singer, 2005). For example, thought experiments have been proposed to clarify the stance of compassionate conservationists for different complex situations (Rohwer and Marris, 2019). The trolley problem, first introduced by Foot (1967) and popularised under that name by Thomson (1976), is a well-known thought experiment to explore ethical dilemmas when both an action and an absence of action will necessarily lead to detrimental effects to humans. A general formulation is as follows: a carriage of a tram (called a trolley hereafter) is out of control and building up speed. It cannot be steered or slowed down. The trolley is heading towards five people who are somehow stuck to the track and so cannot escape. If the trolley hits the five people, it will kill them all. A bystander can pull a lever that will divert the trolley onto another track, where another person is stuck. The choice is therefore to act and save the five but kill (only) one (different) person, or do nothing and let the five people die but let the one other person live. Should the bystander pull the lever?

The trolley problem can easily be adapted for conservation by replacing humans by entities of nature on the tracks. The trolley is thus a metaphor for some environmental change that will cause harm to these entities (Figure 1a). In the following, we will consider individuals of natural populations on the tracks for simplicity, and depict them as such in figures, but the reasoning can be extended to consider different natural entities at different levels of organisation that are deemed of conservation value. While we acknowledge the metaphor is more far-fetched for conservation than for exploring ethics in a human-centred context (for which it has also been criticised; Bauman et al. 2014), and that more realistic depictions of environmental impacts will be needed for communication, we argue that the simplicity of the trolley problem makes it suitable to systematically explore and compare a wide variety of contexts in conservation and help transparent decision-making under moral dilemmas. In addition, the trolley problem captures some important features of conservation decisions. First, conservation actions usually impact more than one entity of an ecosystem. Second, conservation decisions are often time sensitive; postponing a decision or an action can have important and irreversible consequences for entities of nature (e.g., Naujokaitis-Lewis et al., 2018), as is the decision to pull the lever if the trolley is moving towards the junction.

Combinations of the different variations of the trolley problem developed hereafter will likely be required to approach real-world conservation issues (see Appendix S1). Reasonable analogues nonetheless exist for the original, simplest version. Let us consider a situation in which a lake is drying out (Figure 1b). This lake contains a large population of beavers, who will lose their habitat and die if the lake disappears (we assume there is no alternative habitat the beavers can move to). A hydrologist proposes diverting a nearby river to add water to the lake. Unfortunately, on the river lives a smaller population of beavers that will die if the river is diverted. Note that as individuals belong to the same species in this version, as in the baseline trolley problem, the value attributed to each individual on both tracks is considered identical or equivalent for the bystander. Thus a conservation action can be implemented to reduce the impact of an environmental change on one population of beavers, but this action will cause another population to be harmed. Importantly, in this version of the trolley problem, the environmental change is of the same nature as both populations would die due to the lack of water. That is, they are harmed by the same action, represented by the trolley as a metaphor in the thought experiment.

In the following, we develop variations of the trolley problem to guide our exploration of key concepts involved in different conservation contexts (Tables 1 and 2). Variations of the original, human-based trolley problem have been used to explore moral intuitions and opinions in situations potentially leading to dilemmas. Similarly, the variations we present hereafter can be used to break down conservation issues into core elements, by using a common, summarizing depiction, and explore moral intuitions in conservation contexts, to identify where conflicts between stakeholders or moral dilemmas may arise. The conservation trolley problem can thus be seen as a visual aid to generate a catalog of concepts that can affect moral judgment and play a role in conservation decisions through the different variations described hereafter. In particular, we develop variations covering three main concepts that are likely to influence conservation decisions: i) asymmetry between the tracks, ii) uncertainty in the outcome of an action and unforeseen consequences, and iii) causal effects and the implication and responsibility of stakeholders. Asymmetry between tracks is further divided into four types of asymmetry: a) asymmetry of numbers (when different numbers and ratio of entities of nature are affected), b) asymmetry of victims (typically when different species are affected), c) asymmetry of impacts, and d) temporal and spatial asymmetry.

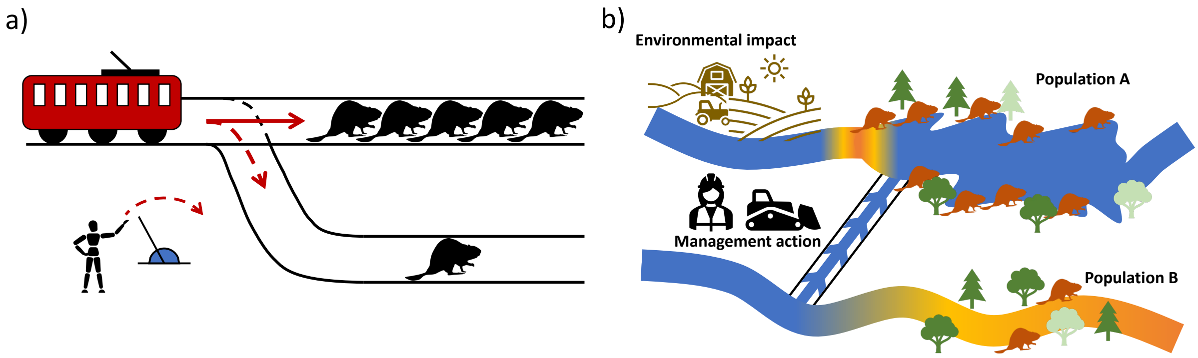

Figure 1. The trolley problem applied to conservation. a) In the original version, entities of nature are attributed the same intrinsic or instrumental value, here individuals of the same species. The tracks represent two conservation management options: the upper tracks are a *laissez-faire* option that will lead to many individuals being harmed, whereas the lower tracks represent the implementation of a management action that would lead to fewer individuals to be harmed, but those would not have been harmed without the action. Note that the individuals on the two tracks belong to different populations, and that the population on the second track is not a subset of the first one. b) A fictitious but realistic real-world situation that would closely correspond to the basic conservation trolley problem, considering two beaver populations of different size. The larger population is affected by anthropogenic activity that cannot be prevented. Diverting water from a nearby river would save them, but lead to the death of a distinct, smaller beaver population. Note that throughout the article we mostly consider situations with two options. This is done for simplicity, to clarify the concepts we are discussing, and better disentangle in which context dilemmas may appear. In practice, a range of options might need to be evaluated, and the false dichotomy fallacy avoided.

3. Variations of the conservation trolley problem involving asymmetry between conservation options

3.1. Asymmetry of numbers

The original trolley problem, and how it is most frequently presented in the scientific literature, pools one against five people. However, it has been shown that the ratio of the number of people on each track can influence people's decision (Nakamura, 2012), depending on variations of the trolley problem involving different causal relationships and stakeholder implication (see Section 5 for such variations). Different conservation issues will pool different population sizes against each other (Table 1). For example, trophy hunting (Section 5.2.1) typically pools one or few individuals to be killed by a wealthy hunter, to generate revenues that will contribute to save many other individuals. By contrast, the lethal control of the population of an invasive alien species is likely to result in the death of many more individuals, to save another native population. Differences in both absolute and relative numbers of entities of nature on each track should therefore be considered to examine dilemmas and conflicts in different conservation situations.

In addition, considering the absolute or relative size of the impacted populations compared to the global populations may be important. Biocentric and sentientist perspectives give intrinsic value to individuals. Under these perspectives, the absolute size of the impacted population is likely to determine if there is a dilemma. The ecocentric perspective gives intrinsic value to species and populations. Under this perspective, the relative size of the impacted population with respect to the total local or global population of the species, representing the threat on the population or species, is likely to determine if there is a dilemma.

3.2. Asymmetry of victims

Conservation actions will usually affect populations from different species, and these species can be attributed different intrinsic or instrumental values. Conflicts and dilemmas are likely to emerge when species are attributed different values, but differ in the size of the impacted population (Table 1). For example, trophy hunting (Section 5.2.1) targets charismatic species that are usually attributed high values. Species relocations (Section 5.2.4) will also target species of high value, and may have deleterious effects on other species. From a consequentialist perspective, considering values are additive, impacting a single, valuable individual could be considered equivalent to impacting many, less valuable individuals (Jarić et al., 2024; Latombe et al., 2022). This will depend on the different elements (ecological, ethical, or based on subjective preferences) that affect the value attributed to an entity of nature, including their sentience, rarity, charisma, cultural or economic importance, if they are native to the location, etc. (IPBES, 2022). It will also likely depend on how different these values are. Asymmetry of victims can be represented in the trolley problem by considering different species on the tracks.

3.3. Asymmetry of impacts

The impacts of a conservation decision need not be in terms of the death of individuals or population extirpation, but might appear as a deterioration of the physical state and wellbeing of individuals. Pollution (including light pollution) and changes in land-cover, food availability, water velocity and temperature have been shown to affect both the behaviour (e.g., sleep patterns, activity level, risk-taking, territory acquisition) and the physiology (e.g., metabolic rate, resting) of wild animals (Killen et al., 2013; Raap et al., 2015). In the trolley metaphor, non-lethal impacts can be represented by letting the trolley injure, but not kill, the individuals (Table 1). The dilemma arises if many individuals are suffering non-lethal impacts in one case, and few individuals would die or suffer a higher impact in the other.

3.4. Temporal and spatial asymmetry

Temporal and spatial discounting is a well-known cognitive trait that makes people underestimate the consequences of an action, a reward or a cost, when these consequences occur further in time or in space (Critchfield and Kollins, 2001; Green et al., 1997; Perrings and Hannon, 2001). Similarly, optimism bias is a cognitive bias under which people tend to underestimate future harm (Perrings and Hannon, 2001). The fact that delayed or remote consequences of environmental issues generate temporal and spatial discounting (regardless from uncertainty that can be associated with temporal considerations) and hinder the implementation of conservation actions is well-known in environmental sciences, including climate change (Baum and Easterling, 2010; Essl et al., 2018) and biodiversity loss through extinction debt (Essl et al., 2017; Kuussaari et al., 2009). On the other hand, it has been argued that the consequences of environmental risks can be so important from a moral perspective, that it may make them partly immune to temporal and spatial discounting. That is, differences in the timing of effects of different management actions or environmental impacts may not influence decision making by stakeholders (although this was observed in a thought experiment rather than a real situation; Böhm and Pfister 2005).

Temporal and spatial asymmetry can easily be represented using the trolley problem metaphor when entities are far away from the junction on the tracks (Table 1).

4. Uncertainty and unforeseen consequences

In the original trolley problem, and in the different variations above, the consequences of all actions are known to actors. However, this is rarely the case for conservation decisions, and any of these variations can incorporate some level of uncertainty, which would interact with asymmetry to potentially generate dilemmas or conflicts. This would especially be the case if there is a chance that the impacts in the alternative solution (when pulling the lever) have been overestimated, or when the impacts in the 'business as usual' scenario (not pulling the lever) have been underestimated. Uncertainty can easily be added to the trolley problem by adding a probabilistic branching on each track (Table 1). There is then a chance that the track normally impacting only one individual will impact many more individuals, and reciprocally, that the track normally impacting multiple individuals will eventually impact none.

Ethical decisions are more complex when the outcomes are uncertain, and uncertainty is inherent to conservation and hard to reduce (Canessa et al., 2016). Rationally, there are multiple ways of approaching risky dilemmas, e.g. take the action which ensures the least negative outcome, the best average outcome, or has the potential for the most positive outcome. However, agents tend to use different decision-making strategies under uncertainty than when outcomes are certain, resorting less on consequentialist or utilitarian approaches (Kortenk Amp and Moore, 2014). Uncertainty can indeed favour *status quo* even when it is the least favourable option from a consequentialist perspective, due to widespread risk aversion tendencies (Canessa et al., 2020). Uncertainty can also allow us to consider actions related to precautionary principles, for example for prevention of non-native species. Actions such as phytosanitary measures and border interceptions are routinely implemented, where non-native species are detected and killed even though it is uncertain if they would be able to establish and what impacts they would have had.

5. Variations of the conservation trolley problem involving causal effects and the implication and responsibility of stakeholders

Asymmetry and uncertainty variations capture important considerations met by conservation managers facing environmental issues. However, another ethical component that is often overlooked and seldom explicitly considered in such situations, is the issue of causal effects between the presence and death of the entities and the implication of the bystander. Interestingly, by contrast, the trolley problem has been widely used to examine how stakeholder implication and causality are important for ethical decisions involving humans, especially through the giant variations described hereafter. It is therefore crucial to examine variations including these concepts for conservation.

5.1. Giant variations of the original trolley problem

The trolley problem, while first published by Foot (1967), only became well-known after its most famous variation was presented by Thomson (1976). Commonly referred to as the "fat man variation" (e.g., Edmonds, 2013), here we will use the more neutral denomination "giant on a footbridge variation" to refer to this thought experiment (Figure 2a). In this variation, there is only one set of tracks, on which the five people are tied up. The bystander is on a footbridge, next to a giant person. The bystander realises that pushing the giant onto the tracks will stop the trolley and save the five people, but will kill the giant. Should the bystander push the giant?

In the original version of the trolley problem, most people (around 90% across multiple studies) tend to act in a utilitarian fashion (Box 1) and sacrifice the single person (Navarrete et al., 2012). By contrast, most people would refuse pushing the giant (Greene et al., 2001; Singer, 2005). The principle of double effect has been advanced to explain this difference in outcome. According to the principle of double effect, it is not morally acceptable to use a negative event as a means to achieve a positive outcome, i.e. to push and kill the giant as a means to save five people. On the other hand, it is morally more acceptable to act in a way that a negative event occurs as a consequence of trying to do a good deed; in the original trolley problem, the bystander intends to save five people, and the single individual dies as a consequence of the bystander's action, but their death is not what prevents the trolley to kill the other five (McIntyre, 2019). The following variation (called the "giant on a loop" variation hereafter) has nonetheless been proposed to refute this argument (Singer, 2005): the bystander can pull a lever that would divert the trolley to a loop on which the giant is attached, which will therefore stop the trolley, saving the five people, but kill the giant (Figure 2b). However, to our knowledge, there are no experimental results showing how people's decisions would differ between these two giant variations, and it is therefore difficult to conclude if the difference is meaningful and if it refutes the principle of double effect. Another argument for explaining the difference of decision between the original trolley problem and the giant on a footbridge variation is that people may have an emotional response to directly killing a person by physically pushing them vs. indirectly by pulling a lever, which has been observed using functional magnetic resonance imagery on subjects presented with the two thought experiments (Greene et al., 2001).

The importance of these two variations on the study of ethical decisions using the trolley problem indicates that causal relationships between the death and life of the different individuals and the direct implication and responsibility of the actors are crucial for decision-making processes involving ethical considerations. The difference between these two variations further suggests that small differences in the causal relationships and the implication of the stakeholders are also important. In conservation, actions involving the direct killing of animals, such as sanitary culling, lethal management of invasive alien species, or trophy hunting, often generate conflicts amongst stakeholders (Baynham-Herd et al., 2018). The combined relationship between the action of the stakeholders and the impact of the species being managed and the death or survival of other species will vary from case to case, and these differences may be crucial to explain different stances about conservation actions. In this section, we explore such variations of the conservation trolley problem in which there is some direct implication of stakeholders in the life or death of non-human individuals.

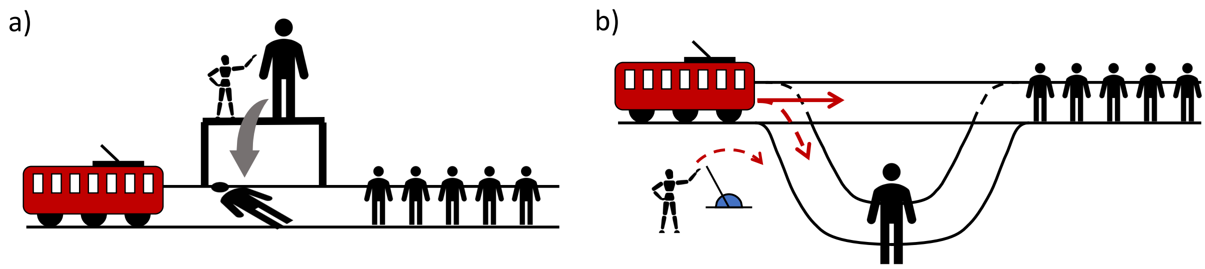

Figure 2. Two giant variations of the trolley problem, for which the implication of the bystander in the death of the victim, and the causal relationship between the death of the victim and the life of the others (means vs consequence) vary compared to the original version. a) The original giant on a footbridge variation from Thomson (1976), in which the bystander pushes the giant on the tracks from a footbridge. b) The giant on a loop variation, in which the giant is on a loop to which the trolley can be diverted (Singer 2005). In both cases, killing the giant is a means to prevent the death of the five people, but people may make a different decision in the two cases, refuting the principle of double effect.

5.2. Variations around direct implication and causality for conservation issues

In the following, we develop different variations of the trolley problem corresponding to different conservation issues. By doing so, we illustrate how they differ in terms of stakeholder implication and causal relationships between the stakeholder actions and the life of entities of nature. Using a common thought experiment, and removing other considerations linked to asymmetry and uncertainty (which will also vary across these conservation issues), it becomes possible to examine the potential role of causal relationships and stakeholder implication in conservation conflicts and dilemmas.

5.2.1. Trophy hunting

To illustrate how the giant variation can be adapted to conservation issues, imagine an animal being next to the bystander on the footbridge. The bystander can kill the animal, making it fall on the tracks, to save several animals of the same or of other species which are located further away on the tracks (Table 2). This footbridge conservation variation can be used to represent a (virtuous) version of trophy hunting, in which the hunting of charismatic animals is permitted for a high price, so that the money can be reinvested for conservation of entire populations. Another variation of the animal on a footbridge trolley problem that may be even more in line with trophy hunting would be that the bystander does not kill the animal themself, but allows someone else to do it, as it may decrease the impression of responsibility (plausible deniability) and potentially change the outcome (akin to the difference between the giant on a footbridge and the giant on a loop variation). In addition, one can incorporate further subtleties, such as the motivation of the person who would kill the animal (Macdonald et al., 2016), or the fact that the individual that is killed may have specific attributes considered charismatic, as is often the case for trophy hunting.

5.2.2. Invasive alien species

Invasive alien species (IAS) are one of the main threats to global biodiversity (Bellard et al., 2016; Maxwell et al., 2016; Roy et al., 2024). Their lethal control has been shown to be an efficient management measure not only in eradication programmes, when populations are still in the early stage of invasion and therefore at low abundance, but also to reduce population abundance and contain spread of IAS (Jones et al., 2016; Sankaran et al., 2024). However, lethal control of IAS has been criticised for being unethical when applied to sentient beings, particularly warm-blooded vertebrates (Wallach et al., 2020, 2018), and has led to conflicts between stakeholders (Crowley et al., 2017). Understanding the causes for such conflicts is often not straightforward, and may be due to the concepts of asymmetry and uncertainty developed above, but also to the fact that it implies the direct action of killing animals, for example by trapping, hunting or poison baiting (Crowley et al., 2017). The main difference with the trophy hunting variation (excluding the difference in number of individuals affected, as discussed above) is that the individuals or entities belonging to the IAS are threatening individuals of native species (or native entities of nature), which may die as a consequence. This difference therefore warrants a distinct variation, to examine if this may play a role in explaining differences in people's opposition to IAS lethal control compared to trophy hunting.

For a better understanding of the conflict, we here suggest two variations of the conservation trolley problem that represent this situation (Table 2). In both variations, an individual of the IAS is the reason why the trolley is running. The presence of the IAS entity in the trolley may be recorded from a weighing scale, which sets the trolley in motion. In the first variation, the bystander pulls the lever, which sends the trolley on a path that will kill the IAS individual inside it. This can be seen as the effect of managing the environment so that it benefits the native species but is detrimental to the IAS. In the second variation, the bystander can push a button that will directly kill the IAS entity, and stop the trolley. In addition, it is possible to distinguish multiple reasons for the IAS to be on the trolley, to reflect different pathways of introduction, from intentional (e.g. as game or pets) to unintentional (e.g. stowaway) (Hulme et al., 2008) and the role of stakeholders with different levels of knowledge about the consequences of such introductions (see APPENDIX S2 for a discussion on the involvement of stakeholders).

5.2.3. Species culling

Species culling is a conservation measure that has been advocated (and applied) to limit population sizes, for example for large herbivores in the absence of predators or for predators that have been reintroduced or for whom land use change increase predation efficiency , to prevent overconsumption of resources and starvation or stop the spread of epidemics (e.g., Hervieux et al. 2014; Martel et al. 2020; Nugent et al. 2011; VerCauteren et al. 2011; Wilson et al. 2015). Culling, even to avoid later suffering for the whole population (e.g. during an epidemic or food shortage), has nonetheless raised ethical concerns (Wallach et al., 2018), and has generated opposition by part of the public (e.g., ICMO2 2010; Nugent et al. 2011).

To conceptualise the issue, we propose two variations of the conservation trolley problem (Table 2). In these variations, as in the asymmetry of impact variation, we assumed that the trolley will not kill an individual upon impact, but will injure it greatly, inflicting high levels of suffering. In the first variation, the bystander has the opportunity to inject the individual with a lethal, non-painful poison. The individual will be killed instantly without suffering. This variation explores the morality of killing a living being, potentially sentient, to prevent their later suffering (e.g. during an epidemic or food shortages). In the second variation, the same trolley is heading towards a group of individuals. A bifurcation mechanism would send the trolley towards empty tracks, and is linked to the vitals of one of the individuals. The bystander can therefore inject the poison to the individual, killing it but preventing it and other individuals from suffering. The second variation is similar to a biological invasion situation when the presence of an IAS would not result in the death of native individuals, but would degrade the conditions of life of both native and invasive species, with the difference that for species culling, entities are indistinguishable from each other, whereas for IAS, it is the introduction of specific entities that generates suffering.

5.2.4. Assisted colonisation

Assisted colonisation, the translocation of endangered species outside their indigenous range to prevent their extinction, can be another contentious issue (Hoegh-Guldberg et al., 2008; Ricciardi and Simberloff, 2009). For example, a proposition to introduce endangered rhinoceros in Australia has faced opposition for the lack of knowledge on potential impacts and been qualified as “neocolonial” (Hayward et al., 2018). Assuming the translocated species would have negative impacts on native entities of nature (otherwise no dilemma would appear), we can use the trolley problem to examine this situation from an ethical perspective. Consider an individual is on a set of tracks and will be killed by the trolley (Table 2). A bystander can then move the individual from the tracks, but only onto another trolley. The trolley is conceived in such a way that the presence of the individual will set it in motion, leading to killing an individual of another species on the tracks. From a trolley problem perspective, assisted colonisation is similar to biological invasions as described above, with the difference that the IAS is not assumed to be endangered in its native range. However, since this is the case for some IAS (e.g. the Sea Lamprey *Petromyzon marinus*, Guo et al., 2017, and many other examples, Tedeschi et al. 2024), this variation could be used in such a context, to explore if this difference creates a difference in conflicts or dilemmas.

6. Discussion and conclusion

Conservation often involves multiple stakeholders and must address complex issues involving multiple entities of nature with different assigned values. It therefore faces inherent challenges, where divergent perspectives and ethical considerations often generate conflicts amongst stakeholders, or even internal dilemmas within a person. Understanding what drives support or rejection for different conservation actions across a range of issues and contexts is not straightforward. For example, why may some support trophy hunting but reject the lethal control of invasive species, or reciprocally? Recognising the utility of thought experiments as powerful tools for elucidating complex real-world problems, we adopted the well-known trolley problem thought experiment to explore how different aspects related to conservation issues can lead to value conflicts in decision-making. Doing so allows us to compare apparently very different situations whose comparison may seem to make little sense, but for which ethical considerations actually lie on the same foundations, to get a fundamental understanding of conservation.

The conservation trolley problem is used here as an illustrative thought experiment (*sensu* Brun, 2017), to provide a simpler description of complex situations and make them clearer, understandable and comparable. These conservation trolley problem variations can also be used in a heuristic fashion (*sensu* Brun, 2017) to identify the context that may create ethical dilemmas or conflicts between stakeholders (see Appendix S1). Trophy hunting and the lethal control of invasive alien species are seldom compared to each other, or not in a way that allows to explicitly disentangle their similarities and differences (e.g., Wallach et al., 2018). Using the trolley problem, we can see that i) they share a direct implication of stakeholders as, there is a lethal action in both cases, but they differ in the relationship between the individual(s) being killed and the other individuals; ii) they likely differ in the number of individuals that are killed, as trophy hunting targets small numbers of individuals per hunter, whereas the lethal control of invasive species will usually target an entire population; iii) they likely differ in the relative value of the entities of nature affected, as trophy hunting targets charismatic animals which may have a high, local cultural value, whereas it may vary for invasive species, some being more charismatic than others (Jarić et al., 2020). Using the trolley problem as a common depiction, it becomes possible to examine which of these variations in particular may lead to disagreements and dilemmas.

The trolley problem may also be used to examine conflicts and dilemmas for particular conservation issues, by developing variations with incremental levels of stakeholder involvement and causal relationships between entities of nature's existence and death, and combining these with asymmetry and uncertainty variations (see Appendix S1 for an example for invasive alien species). Using the trolley problem this way may prove especially useful for wicked problems including multiple elements interacting in a complex system and therefore difficult to solve (Game et al., 2014), although its simplicity may also limit its application for systems that are too complex to be simplified.

Finally, conservation actions will often also affect humans, either positively (e.g., by generating some earnings) or negatively (e.g., by preventing access to recreational areas).

As the value attributed to humans will likely be very different from that attributed to non-human entities of nature, and stakeholders might be differently affected and hold different values, it will be important to include affected stakeholders in thought experiments. In particular, the concepts of sacred vs. secular values (Box 1) can generate different types of choices and dilemmas, which sometimes may be even more difficult to resolve than when considering non-human entities of nature only (Daw et al. 2015; see Appendix S2 for more details).

While acknowledging the potential need for a more straightforward metaphor of environmental impact and a clearer connection to conservation, the trolley problem captures the ineluctability of future impacts of different conservation actions (or lack thereof). Its versatility allows generating a wide variety of scenarios combining the different variations presented here (and maybe others we have overlooked), providing a robust foundation for future exploration. How to combine variations to create such scenarios may be context-dependent. The trolley problem variations presented here could also serve as a starting point for the development of more nuanced and context-specific metaphors that may better align with local specificities of conservation, to explore and communicate on conservation management situations generating conflicts. As we move forward, the integration of diverse metaphors and thought experiments holds the potential to enhance communication, broaden perspectives, and ultimately contribute to better informed and ethically sound conservation practices.

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Box 1. Definitions

Anthropocentrism: Ethical perspective that considers humans to be the sole, or primary, holder of intrinsic value, and therefore the concern of direct moral obligations. Non-human species are considered only to the extent that they affect the satisfaction of felt preference of human individuals (Norton, 1984; Palmer et al., 2014; Rolston III, 2003).

Assigned value: a value attributed to something (here mostly entities of nature) by someone, hereby expressing the importance they give to it compared to other things (Seymour et al., 2010).

Biocentrism: Ethical perspective considering all living beings as having intrinsic value and therefore the concern of direct moral obligations (Palmer et al., 2014; Rolston III, 2003).

Community of moral agents: The group of beings considered to have moral responsibility in their actions (Talbert, 2019).

Community of moral patients: The group of beings considered to have intrinsic value, and towards which moral agents have moral obligations (Warren, 2000).

Consequentialism: Ethical perspective according to which an action morality is evaluated based on its consequences (but see Sinnott-Armstrong, 2023 for different types of consequentialism).

Deontology: A normative ethical theory considering that "choices are morally required, forbidden, or permitted" (Alexander and Moore, 2016).

Ecocentrism: Ethical perspective considering that species, their assemblages and their functions, as well as more broadly ecosystems, rather than individuals, have intrinsic value and are the concern of direct moral obligations (Palmer et al., 2014; Rolston III, 2003).

Entity of nature: "Any concrete or abstract part of nature, encompassing, for example species, landscapes, plants, animals, nature spirits and nature as a whole." (Lehnen et al., 2022).

Held values: concepts or principles that human individuals deem important to them, underlying personal behavior, environmental beliefs, attitudes and decisions (Seymour et al., 2010). Adhering to a specific ethical perspective is a held value.

Intrinsic value: value expressed independently of any reference to people as valuers. Entities of nature, including habitats or species having intrinsic value and are worth protecting as ends in and of themselves (IPBES, 2022).

Instrumental value: Value given to an entity (individual or collective) by humans, based on its utility and how it benefits humans. For example, dogs may have an instrumental value for herding sheep or as guard-dogs (IPBES, 2022).

Principle of double effect: Principle according to which it is permissible to cause a harm as a consequence of an action that achieves positive consequences, but it is not permissible to cause a harm as a means to achieve these positive consequences (McIntyre, 2019).

Sacred value: something has a sacred value when its loss cannot be compensated (Schwartz, 2021).

Secular value: something has a secular value when its loss can be compensated by something else also holding a secular value (Schwartz, 2021).

Sentientism: System considering sentient beings as the concern of direct moral obligations (Palmer et al., 2014; Rolston III, 2003).

Virtue ethics: Ethical perspective that emphasises the virtues, or moral character as the reason for action (Hursthouse and Pettigrove, 2018).

Box 2. Unresolved conflicts between conservation approaches

Traditional vs new conservation

Traditional conservation as defined by Soulé (1985) follows an ecocentric perspective, based on the following normative postulates: (i) diversity of organisms is good; (ii) ecological complexity is good; (iii) evolution is good; and (iv) biodiversity has intrinsic value. By contrast, new conservation argues that maximising biodiversity can only be achieved through a utilitarian perspective (Kareiva and Marvier, 2012). That is, even if they do not argue against the intrinsic value of biodiversity, proponents of new conservation consider that many stakeholders follow a utilitarian perspective, and that designing conservation actions aiming at preserving species with instrumental values is the most effective approach for conserving biodiversity. This position has been heavily criticised by some proponents of traditional conservation, and clarifications from new conservationists have not allowed to settle the argument (see e.g. Doak et al. 2015; Kareiva and Marvier 2012; Soulé 2014, for different perspectives).

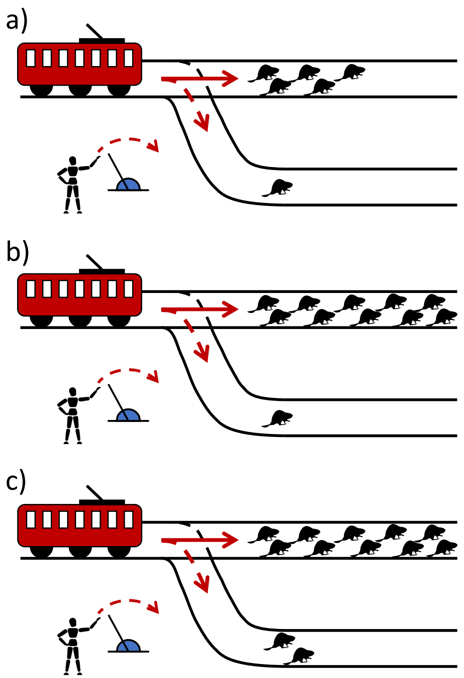
Traditional vs compassionate conservation

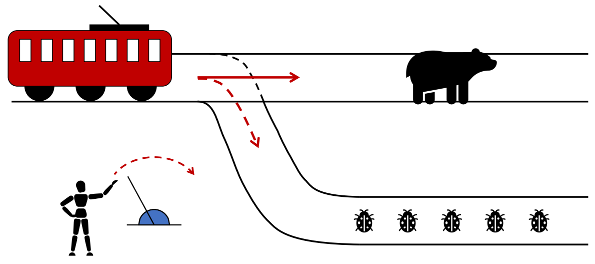
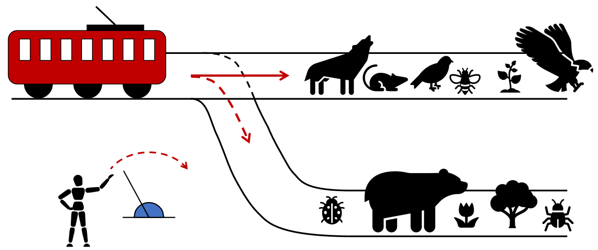
Compassionate conservation is a recent approach that is based on virtue ethics and promotes actions that stem from a compassionate attitude, following four tenets: i) do no harm; ii) individuals matter; iii) inclusivity (the value of an individual is independent from the context of the population, e.g. nativity, rarity, etc.); and iv) peaceful coexistence (Ramp and Bekoff, 2015; Wallach et al., 2018). Compassionate conservation opposes the killing of sentient animals regardless of context, e.g. when an invasive species or a native predator threaten other native species due to ecological imbalance resulting from anthropogenic change (Wallach et al., 2018). Compassionate conservation generated heated responses from traditional conservationists (e.g., Driscoll and Watson, 2019; Hampton et al., 2018; Oommen et al., 2019), and subsequent responses (e.g., Wallach et al., 2020) have not convinced opponents about the approach.

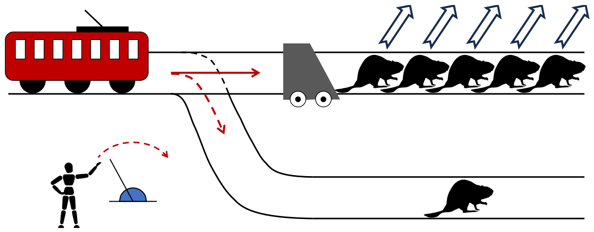
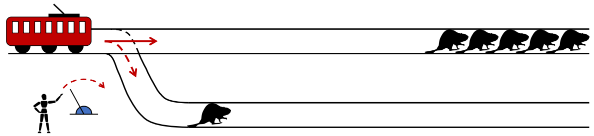
Compassionate conservation vs conservation welfare

Conservation welfare is a consequentialist approach that aims to minimise animal suffering in conservation (Beausoleil et al., 2018). It therefore shares a focus on animal sentience with compassionate conservation (although compassionate conservationists have contradicted themselves in the literature, mentioning both the importance of considering individuals' joy and pain, while at the same time advocating for considering all wildlife regardless of sentience; Wallach et al. 2018). Conservation welfare provides an objective criterion to determine the appropriateness of a conservation action (assuming suffering can be objectively measured). By contrast, compassionate conservation does not provide clear guidelines to determine what makes a conservation action guided by compassion beyond avoiding lethal actions, and how, for example, to resolve situations where lethal control would decrease overall suffering (Beausoleil, 2020). Thought experiments depicting specific but hypothetical ecological situations were described by Rohwer and Marris (2019) as a basis for clarifying the stance of compassionate conservationists, but obtained no response, to our knowledge.

Table 1. List of variations of the trolley problem accounting for issues of asymmetry and uncertainty in a conservation context, with the concepts they capture. Each depicted individual stands for an entity of nature that can represent a single individual or a population of fixed size, depending on the context.

Trolley problem variations for conservation	Description	Issue(s) raised
Asymmetry variations		
a) Asymmetry of numbers (different numbers and ratio of entities of nature are affected)		
	Conservation actions can affect different numbers of entities of nature. The absolute or relative number on each track can affect the decision of the bystander.	Is it more acceptable to sacrifice an individual to save ten than to save five? Is it more / less acceptable to sacrifice one individual to save five than to sacrifice two to save ten? Does the relative size of the impacted population compared to the global population matter?
b) Asymmetry of victims (different species are affected)		

	Entities of nature affected by the conservation action are attributed different (here lower) intrinsic or instrumental values to those affected by environmental change if nothing is done (e.g. if they belong to different orders, have different cognitive abilities, different charisma, etc.). Contrary to the original trolley problem, here we assume that an action aimed at conserving an valuable entity of nature will lead to the death of multiple, less valuable entities, but the populations can be inverted on the tracks.	Is an individual of one species valued the same as one of another species (intrinsic or instrumental value)? How to compare entities of nature with different values?
	Each track contains multiple different entities of nature with a wide range of values.	In reality, conservation actions affect whole communities or assemblages (although we rarely capture the whole assemblage complexity), involve multiple species with different values attributed by different stakeholders, and impact different numbers of individuals per species, making it more difficult to accurately weigh up the consequences.
c) Asymmetry of impacts		

	Conservation problem where impacts vary for the different options: the large population is suffering but individuals are not killed (represented by the fact that the trolley will push a device that will hit the individuals and expel them from the tracks, hurting them in the process), whereas the small population undergoes lethal impacts (or is hurt much more severely).	How is impact measured? How are different impacts (epecially lethal vs non-lethal) compared?
d) Spatial and temporal asymmetry		
	The consequences of pulling the lever will have an effect distant in time or in space, potentially generating discounting, i.e. an underestimation of these consequences (although it is often linked to uncertainty). In the metaphor, temporal and spatial remoteness are indissociable, as individuals further in space will be impacted further in time, but not necessarily in the real world.	Are impacts occurring in the far future or far away perceived as less important than the same impacts occurring in the immediate future or in the vicinity (discounting)?
Uncertainty and unforeseen consequences variation		

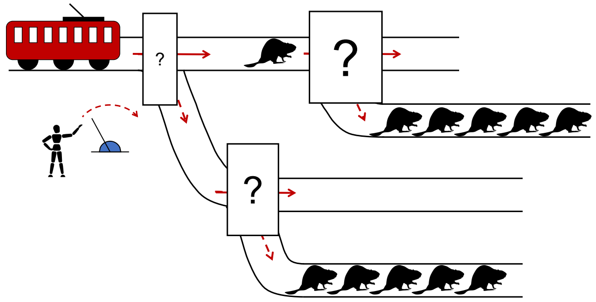
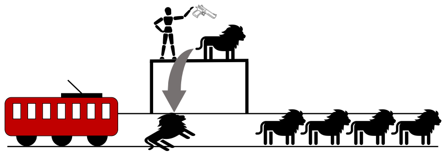
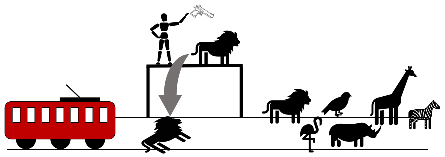
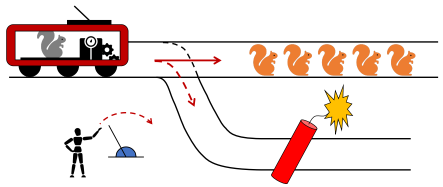
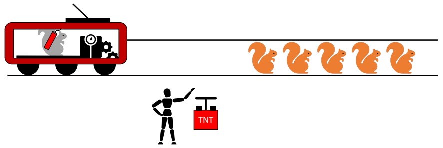
	Trolley problem accounting for uncertainty in impacts, which can be represented by probabilistic branching, making the path of the trolley towards one set of tracks or another uncertain. Plain arrows represent the expected path if the lever is not pulled. Boxes with question marks show that there is some level of uncertainty about the track the trolley will be sent to (the size of the boxes indicates the level of uncertainty). The branching depicted here illustrates a rather complex situation, and different branching configurations are possible based on the situation.	Does uncertainty change our incentive to act positively (precautionary principle) or negatively (fear of being wrong)?

Table 2. List of variations of the trolley problem for real-world conservation issues involving different relationships between the presence of an individual and the death of others, and different levels of involvement of stakeholders.

<table>
<tr><th>Trolley problem variations for conservation</th><th>Short description</th><th>Raised issue(s)</th><th>Real-world example</th></tr>
<tr><td colspan="4">Trophy hunting</td></tr>
<tr><td></td><td>Similar to the original “giant on a bridge” variation. Killing an individual will make it fall on the tracks and stop the trolley, preventing the death of others. The moral agent is therefore actively involved and thus takes personal responsibility in sacrificing a conservation target.</td><td rowspan="2">Is it acceptable to kill an individual to save others, although this individual is not involved in the future death of the others?</td><td rowspan="2">Trophy hunting is a widely used conservation approach in Africa, used in 23 countries (Lindsey et al., 2007). It generated many debates both in the philosophical realm and on social media (Bichel and Hart, 2023). A famous example of such debate surrounded the killing of Cecil the Lion (Nelson et al., 2016).</td></tr>
<tr><td></td><td>To be closer to a real-world application, the individuals saved may belong to multiple species.</td></tr>
<tr><td colspan="4">Biological invasions</td></tr>
</table>

<table>
<tr>
<td></td>
<td>The action of the bystander results in the death of the entity, but is not the direct cause. This is similar to the giant on a loop variation, but the difference is that the presence of the entity in the trolley leads to the death of other entities.</td>
<td rowspan="2">Is it acceptable to kill an individual to save others if this individual is the reason others will die?
Does the way an individual will die (as a consequence of an action or as a direct action as a means to save other individuals) and the implication of stakeholders in the lethal control of invasive species impacting native species affect the decision?
Does the reasons for the invasive species being in the trolley affect the decision of the bystander (e.g. if the bystander played a role in putting the species in the trolley)?</td>
<td rowspan="2">The grey squirrel (Sciurus carolinensis), native from North America, is invasive in Europe, where it threatens the native red squirrel (Sciurus vulgaris), but his lethal controlled has been challenged in some places by the general public, for example because of legal actions by animal right activists in Italy (Genovesi and Bertolino, 2001).</td>
</tr>
<tr>
<td>
</td>
<td>The action of the bystander directly kills the entity in the trolley. This is similar to the giant on a footbridge variation, but as above, the difference is that the presence of the entity in the trolley leads to the death of other entities.</td>
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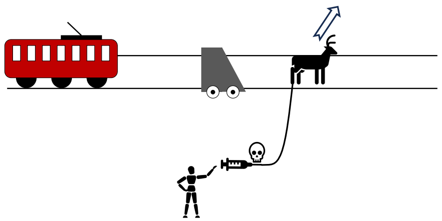
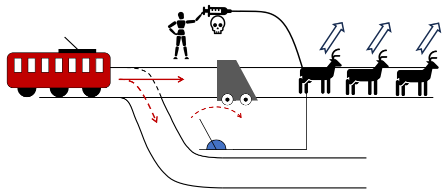
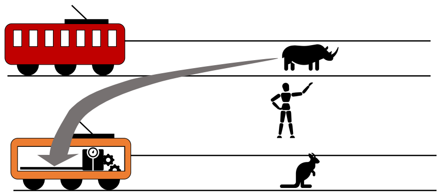
<tr>
<td colspan="4">Species culling</td>
</tr>
<tr>
<td></td>
<td>An individual will be hit by the trolley and suffer greatly but not necessarily die (or will die later). The bystander can inject a lethal and non-painful poison to kill the individual before it is hit by the trolley.</td>
<td>Is it acceptable to kill an individual to prevent its long-term suffering?
Are death and harm comparable?</td>
<td>Following the reintroduction of large herbivores in the Oostvaardersplassen nature reserve for rewilding purposes, culling was implemented to prevent individuals from dying or suffering from starvation in</td>
</tr>
</table>

	The same trolley is heading towards multiple individuals, and will also injure them greatly. The bifurcation mechanism is linked to the vital rates of one individual. The bystander can inject the individual with the non-painful, lethal poison, to divert the trolley towards empty tracks.	Is it acceptable to actively kill an individual to save others, acknowledging this individual and the others would be harmed or killed otherwise, but by another process?	winter because of public pressure that deemed starvation unacceptable (ICMO2, 2010).
Species relocation			
	Saving an entity of nature sets a trolley in motion, leading to the death of another entity.	Should we save an entity if this entity will then cause the death of another individual, either directly or indirectly?	Species relocation has been advocated to conserve endangered species (Hoegh-Guldberg et al., 2008). These have raised some concerns given the risks to impact other species (Ricciardi and Simberloff, 2009).

Supplementary material for: “Ethical dilemma in conservation: a trolley problem thought experiment”

S1. Avenues to combine trolley problem variations and apply it to conservation issues

Conservation partners and stakeholders may disagree over a conservation action for different reasons, which can be difficult to pinpoint exactly, leading to further conflict and frustration. Here we suggest an approach to combine the different variations of the trolley problem presented in this paper in a systematic fashion, to explore which aspect of the action generates opposition. The trolley framing by itself will not solve conflicts, generate practical actions or create consensus; rather, it is meant as a diagnostic step to facilitate dialogue and clarify potential for conflict resolution. In addition, framing the issue using the trolley metaphor may present the issue to stakeholders in a different light, raise understanding of other stakeholders’ value systems, leading to a change in their stance or how strongly they feel about it. In addition, other combinations of variations may be appropriate for specific situations. Ideally, this process would be embedded in a broader structure for rational decision making, such as systematic conservation planning, structured decision making, or open standards for the practice of conservation (Schwartz et al., 2018).

Framing. The first step is to clearly define the action being discussed, as well as its spatial and temporal scale and scope. One should identify the decision makers, stakeholders and partners involved. The objective(s) of the action should be absolutely clear to all involved: these define what goes on the tracks of the trolley scenarios, that is, the entities being considered and how they are represented/quantified. A model of the system is necessary to fill in the problem with the different outcomes, that is, the individuals/entities that die in the different scenarios, and any other relevant objectives.

Variations. The original trolley problem is unlikely to capture the realistic conditions of the real-world problem at hand. Therefore, the group should develop a set of variations to explore the influence of different aspects. It is important here to strike a balance between realism and abstraction: overly complicated problems may become less and less informative as a diagnostic. If divergences or conflicts remain when the most complex version of one element is built, it indicates that other elements are important, and one can move to the next (for example, from involvement to uncertainty).

Involvement. Develop a set of trolley problem variations with increasing direct involvement of stakeholders in the death of the entity, until most elements from the real situation are captured (Figure S1a). The last variation of the phase 1 of the framework should be the closest to the concrete situation in terms of causal relationships between species’ life and death and of stakeholder involvement. For example, lethal management of invasive species is often recommended in early stages of invasion, when eradication is still possible (Pluess et al., 2012), usually implying active killing of individuals. In the context of invasive species management, one can therefore investigate if stakeholders have different stances about the indirect and direct killing of individuals, which would correspond to environmental

management vs. lethal approaches, and the impacts these individuals have on others (Figure S1a).
Asymmetry. To explore additional components, one should progressively add different species that may be affected by the choice and discussing their values (asymmetry of victims), different types of impacts including lethal and non-lethal (asymmetry of impacts), and different spatial and temporal scales at which impacts will be realized (spatio-temporal asymmetry) (Figure S1b). For example, will lethal trapping of invasive species incur by-catch of native species, including common or endangered ones? Would the removal of invasive species cause suffering in the immediate future, but avoid larger impacts in the longer term, or at a larger scale?
Uncertainty. Given the nature of conservation problems, capturing some level of uncertainty will likely always be necessary. In this case, the trolley representation might be modified to reflect a decision tree (Canessa et al., 2016), for example by choosing a small set of scenarios with possible (uncertain) outcomes to discuss, represented by different tracks (Figure S1b). This uncertainty should ideally come directly from the model of the system used to represent the outcomes of the action in the original problem description. For example, one could represent different velocities of spread by the target invasive (represented by different levels of impact on native species) or different levels of by catch by untested removal methods. The different scenarios can initially be described verbally, and if needed then associated with their different probability of occurrence.
Combining variations. Finally, if no change of opinion still arises, we recommend combining these variations in phase 3 (Figure S1c). How to combine these variations will likely be context dependent.

Discussion. Depending on the sensitivities, one may need to adopt different facilitation methods to lead stakeholders and groups through the process. Ideally, best practice methods for dealing with groups, including a careful composition of groups. To avoid dominance and power dynamics, as well as common heuristics such as anchoring, discussions should always allow adequate space for individual, anonymous judgments (Sutherland and Burgman, 2015). Note that the ultimate goal should be to clarify the causes of disagreements, not necessarily to achieve consensus, particularly where fundamental value differences exist.

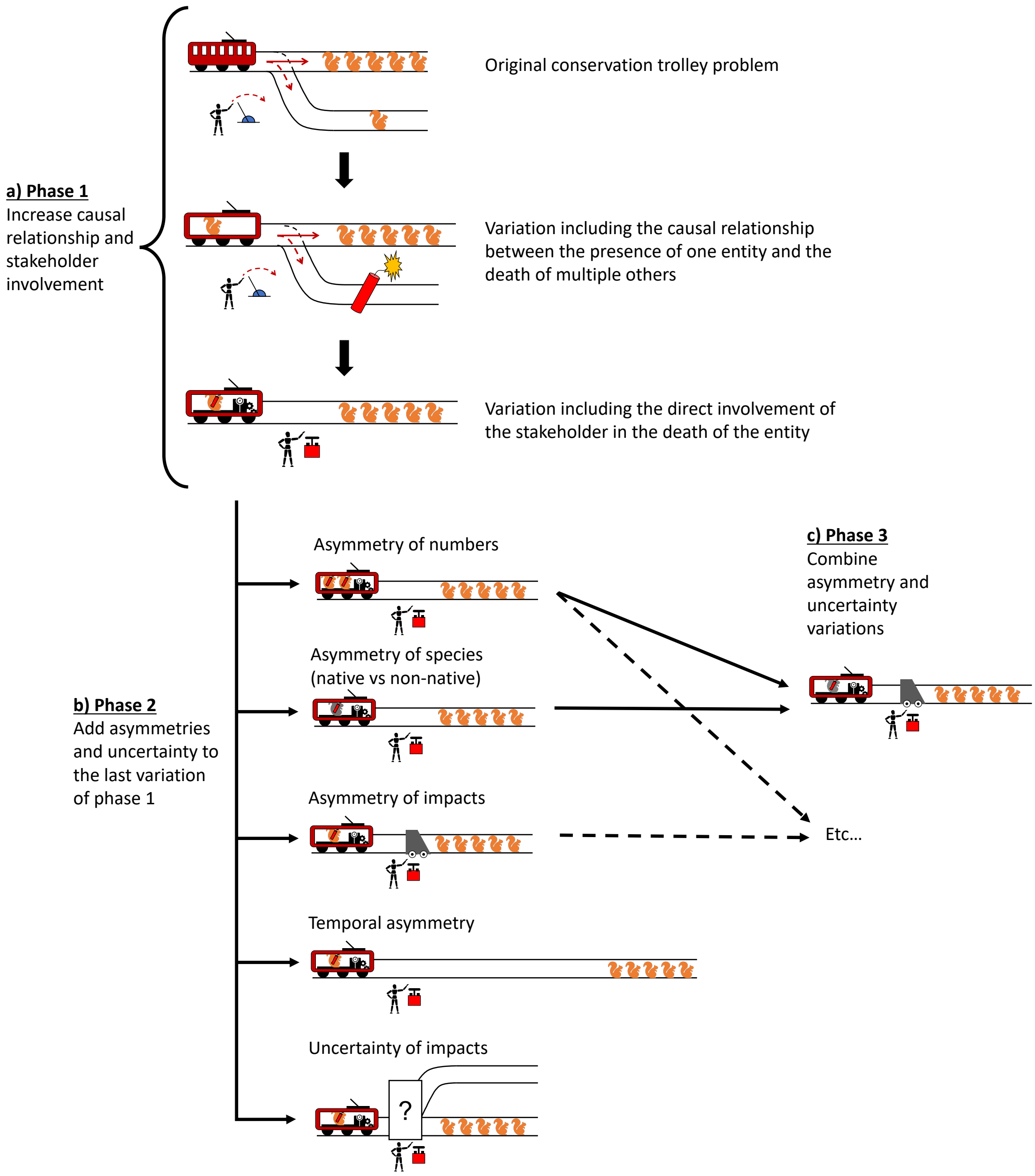


Figure S1. Three-phase framework for combining conservation trolley problem variations and detecting the source of conflicts of opinion or dilemma about conservation actions, using an invasion by the grey squirrel (*Sciurus carolinensis*), native to North America and introduced in various locations in Europe during the late nineteenth and the twentieth century, now threatening the native European red squirrel (*Sciurus vulgaris*) (Bertolino, 2008). a) Phase 1 starts with the original conservation trolley problem, and variations are then designed to consider the relationship between the presence of an individual and the death of other squirrels (here using the variations presented in the main text for invasive alien species). Note that at this stage, we do not differentiate between species, as the goal is to examine if causal relationships are at the origin of the conflicts, while excluding potential differences in value. In the figure, subsequent variations incorporate the fact that one individual is responsible for the death of others, and that it is killed as a side effect of saving the others (e.g. through the management of the environment - first variation), and that it is killed directly (lethal control - second variation). b) In phase 2, the last variation of phase 1 is used as a basis to incorporate different elements of asymmetry and uncertainty. c) In phase 3, the variations from phase 2 are combined iteratively.

S2. Stakeholders as part of the system

In the variations and examples above, we only compared choices where stakes were directed at non-human entities of nature. In practice, conservation decisions will often also affect human beings. For example, the introduction of non-native species is often linked to economic interests (directly when benefitting from the introduced species themselves or indirectly from general trade when non-native species are transported as stowaways or contaminants). Thus, preventing the introduction of non-native species may have economic impacts such as foregone revenue from harvesting the non-native species or from causing additional economic costs for biosecurity or reduced trade volume.

The inclusion of humans into these dilemmas (Figure S2) will likely affect decisions. The difference in intrinsic value that is attributed to humans vs non-humans is likely to be incommensurable for many people. Reciprocally, monetary benefits that may be drawn from some environmental change may be considered irrelevant compared to animal life. Tetlock et al. (2000) and Schwartz (2021) distinguish between sacred and secular values in conservation. For sacred assigned values, such as human life, compensation for their loss is impossible, while loss of secular assigned values could be compensated. If pitting entities with secular values against each other is a common issue in everyday life (‘regular choice’ hereafter), pitting entities with sacred and secular values (referred to as taboo trade-offs, or taboo choices) can be perceived as undercutting self-image and social identity as a moral being, and generate negative cognitive, emotional, and behavioral reactions from actors facing such decisions (Fiske and Tetlock, 1997). By contrast, “tragic choices” pitting entities with sacred values against each other and for which no option is satisfying, are deemed more acceptable than taboo choices, and even virtuous by people (Schoemaker and Tetlock, 2012). As the type of value (sacred or secular) attributed to different entities of nature can vary between people, different stakeholders may face regular, tragic or taboo choices, potentially leading to conflict.

When secular goals have a wider or long-term effect on entities with sacred values, taboo choices may be reframed as tragic choices, potentially facilitating discussion and exchange (Daw et al., 2015). For example, impacts on non-human species and the environment can be linked to current human livelihood and that of future generations. Finally, the fact that choices may impact decision makers themselves or not (Figure 3a,b) may add another level of complexity to the dilemma.

Environmental deterioration is often linked to economic benefits (e.g. mining activities typically have negative environmental impacts but generate jobs, resources, and profits). We have focused on choices between negative outcomes, which is naturally captured by the original trolley problem. Benefits (including offsets) could be easily incorporated in the conservation trolley problem by suggesting to receive money or another reward for rerouting the trolley towards an entity (Figure 3c). Assuming the reward has a secular value, the nature of the dilemma will then depend on if the non-human entities of nature that are being impacted have a secular value (regular choice) or a sacred one (taboo choice) for the decision-makers and stakeholders.

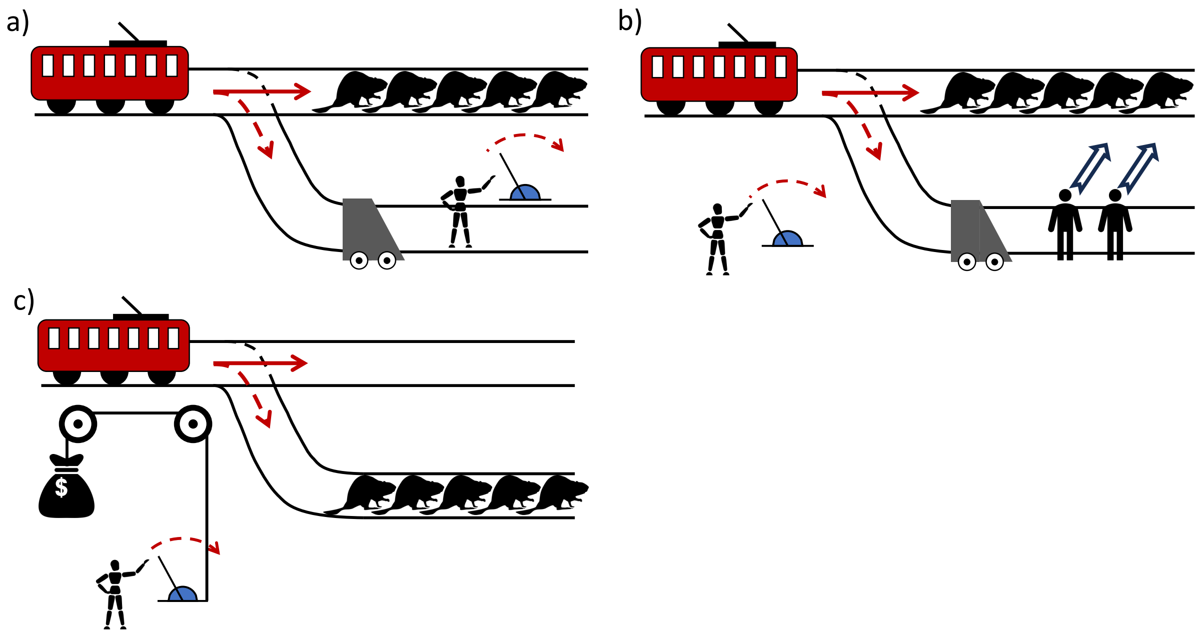


Figure S2. In some situations, management actions will affect stakeholders, negatively or positively. Negative impacts will usually not be lethal, and with some uncertainty, but may affect welfare, for example, when access to some areas is restricted. a) Decision makers can be directly affected by their decision. b) The decision may affect other stakeholders than the decision makers. c) There can be positive consequences, such as profits or other rewards, associated with negative impacts on non-human entities. Depending on how values attributed to non-human entities, stakeholders, and rewards may differ from one another (have a secular or sacred value), this can lead to regular, taboo or tragic choices.

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