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A Duty to Cognitively Enhance Animals

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Abstract. In this paper I argue that humans have a pro-tanto duty to cognitively enhance some threatened animals. I will use as a case study a particular set of animals: smaller Australian marsupials. Many of these animals are at the brink of extinction thanks to the introduction of the fox and the domestic cat to the continent of Australia. Ecologists conjecture that these marsupials do not have the behavioral flexibility to cope with these novel predators. By introducing these predators, humans performed a wrong action because it led to the extinction of species and continues to threaten many marsupials species such as woylies, Gilbert's pototroos, numbats, and mountain pygmy possums (IUCN, 2016). This wrong action gives rise to an obligation to intervene to prevent further species loss. Traditional means of conservation do not seem sufficient to address this obligation; therefore, there is a duty to cognitively enhance these creatures as soon as the technology is sufficiently researched and safe.

Key words. Cognitive enhancement, conservation, species extinction, intrinsic value, genetic engineering.

1. Introduction. Alongside the growing literature on the ethics of cognitively enhancing humans (e.g. Buchanan, 2011; Persson and Savulescu, 2012; Sandel, 2007), there are also questions about the permissibility of enhancing non-human animals (e.g. Chan, 2009, Streiffer and Basl, 2013). In this paper, I will explore whether or not humans ever have a duty to cognitively enhance other animals, not merely for the benefit of humans, but for the preservation of species.

I will argue that humans have a pro tanto duty[1] to cognitively enhance certain animals to help avoid the loss of biodiversity, as soon as the technological capacity to do so is available. In this paper I will use as a case study a particular set of animals: smaller Australian marsupials, which, as I will explain in section two, are at grave risk of extinction thanks to the lose of habitat and the careless introduction of exotic predators:

[1] For the rest of the paper when I talk about an "obligation" to enhance I am referring to a pro tanto duty.

red foxes and feral domestic cats. These small marsupials do not have the cognitive flexibility to deal with these novel predators. In section three, I will argue that humans, by coopting habitat and introducing exotic predators, performed a wrong action by causing and threatening to cause extinction, and hence risking the loss of something intrinsically valuable—biodiversity. I will argue that this wrong gives rise to an obligation to intervene to try to prevent the loss of biodiversity. Ultimately, the main moral grounding for intervention is the loss of biodiversity; however, when preventing that loss, it is important to do so in ways that ideally do not cause suffering to individual animals or cause the most minimal amount of suffering possible. Another way to couch this caveat is in terms of flourishing. Biodiversity is valuable, but protecting biodiversity while promoting the flourishing of individuals is ideal. In section four, I will explain why a duty to prevent the loss of biodiversity while causing minimal suffering is exceedingly difficult to fulfill using traditional conservation practices. In section five, I will argue that, given that traditional practices cannot sufficiently address a duty to prevent the loss of biodiversity, cognitive enhancement might be a future solution—even cognitive enhancement by means of genetic modification. Finally, in section six, I respond to some potential objections to the idea that humans sometimes have a duty to cognitively enhance animals to prevent the loss of biodiversity.

2. The case study: foxes and cats vs. small Australian marsupials. After the arrival of Europeans in Australia in 1770, a host of new animals were introduced to the continent, including the red fox and the domestic cat. The introduction of these predators had many unintended negative consequences for the native fauna of Australia.

The IUCN Red List, the most comprehensive and authoritative global list of threatened[2] species, lists dozens of examples of mammals (the class that includes marsupials) threatened by non-native species—mostly foxes and cats (IUCN, 2016). In a recent review, Elizabeth Denny and Christopher Dickman note that, "The feral cat is linked to the early continental extinctions of up to seven species of mammals. They are also linked to island and regional extinctions of native mammals and birds and have caused the failure of reintroduction attempts aimed at re-establishing threatened species" (2010: 1). In Southwestern Australia, for example, the last record of the greater bilby, a marsupial with long ears weighing about three pounds, was around 5-12 years after the arrival of the red fox. (Abbott, 2001). While there are clearly other causes of the drastic decline or extinction of many Australian marsupials (e.g. drought, loss of habitat due to agriculture), these novel predators introduced by humans are clearly playing a significant role.

Ecologists conjecture that Australia's native fauna do not have the behavioral flexibility to cope with predators to which they are naïve (Davis, 2009). Lack of sophisticated cognition is indeed a hallmark of Australian marsupials. After all, the continent is notably arid and covered in nutrient-poor soil and brains are energetically expensive. As Australian ecologist Tim Flannery puts it, "it may indeed pay to be dumb in Australia. You save a lot of energy that way and if…the major predators are reptiles, great intelligence may not be needed to outwit them" (2002: 87). These animals just do not have the cognitive mechanisms to appropriately respond to these novel predators.

[2] In this paper, I use the catch-all term "threatened" to cover the IUCN categories of extinct in the wild, critically endangered, endangered, and vulnerable, as well as the Australian Environment Protection and Biodiversity Conservation Act categories of "Critically endangered, conservation dependant, extinct in the wild, endangered, and vulnerable" (EPBC Act List of Threatened Fauna, 2016).

The idea that Australian marsupials are not cognitively equipped to deal with novel predators really became concrete to me when I was fortunate enough to visit a conservation site in central Australia called Scotia. The Scotia Sanctuary is 250-square miles and includes two fifteen-square-mile fenced enclosures. In the two fenced enclosures all novel predators (cats and foxes) and other introduced animals (goats and rabbits) have been removed. The site contains bilbys, numbats and bridled nailtail wallabies—all animals that are in dire straights in the rest of the country, in large part because of novel predators. The then director of the site, Matthew Hayward, told me that some of the species of marsupials just did not react when approached by novel predators. They were easy pickings. Clearly, these animals have not evolved the appropriate cognitive capacities that would allow them to perceive and recognize foxes and cats as a threat and then behave appropriately. Hayward himself said he believed the only hope for some of these species was to become more intelligent.

What I learned about the Scotia Sanctuary is not something particular to that region; it is a continent-wide problem. Many reintroductions of marsupials have seen limited success because of the presence of exotic predators (e.g. Winnard & Coulson, 2008). In many reintroduction projects the ecologists have worked hard to try to teach the founding population that the exotic predators are dangerous (e.g. Griffin, 2000; McLean et al., 1996; McLean et al., 2000; Winnard and Coulson, 2008) often by associating negative experiences with the predators. Unfortunately, the less than successful results of many of these projects—mortality rates are generally very high—suggest that many of these animals would be able to survive and flourish only with bolstered cognition.

While this case study is a clear case, it is likely that there are other endangered species around the world who are under threat in part or in whole because their capacities (cognitive or physical) are not up to the challenge of dealing with novel predators or competitors, climate change, changed habitats, or other threats caused by humans.

3. A Wrong that Demands Correction.

In this section I will argue that the actions of coopting habitat and introducing free-ranging foxes and domestic cats to Australia constitutes a wrong action. It is a wrong action because it led to the extinction of species and the consequences of the action continue to threaten existing species. I will then argue that this wrong action requires correction; that is, it requires that we try to prevent the loss of biodiversity. I contend that biodiversity is intrinsically valuable and that intervening in the case of the small Australian marsupials will prevent the loss of something that is intrinsically valuable.

The idea that biodiversity is intrinsically valuable is not new. There are many environmental ethicists who believe that we have obligations to prevent species extinction based on the idea that nature is something of intrinsic value (e.g. Rolston, 1985; Callicot, 1986). Claiming that we have obligations to species is to claim that species have moral status. This claim is not based on sentience. Species are not sentient; they don't have interests—at least not in the way an individual has interests (Palmer, 2010). However, while sentience may be sufficient for moral status, it is not necessary (Warren, 1997). A species has moral status because it is where something of intrinsic value is located—namely biodiversity. For many, especially in fields like conservation biology, where it is a founding axiom of the field (Soule, 1985), this is so clearly true as

to be taken for granted. But others believe sentience is not only sufficient by also necessary for moral status (Singer, 1995). Here is a hypothetical case that supports the idea that biodiversity is something of intrinsic moral value.

Imagine you are a space surveyor with very sophisticated technology to intervene in far away quadrants in the galaxy. You detect a comet hurtling toward two planets. If you do nothing both planets will be destroyed along with all the life on those planets. You can only save one planet. Furthermore imagine that the planets contain an equal quantity of life and sentient creatures and that the capacities of the sentient creatures are the same. The only difference between the two planets it that one planet, Planet A, is inhabited by millions of species interacting in complex ways in hundreds of distinct ecosystems across the planet's surface and in its seas, while the other, Planet B, is inhabited by a single, photosynthetic, sentient species. Furthermore, imagine that humans will never be able to reach these planets, so there is no real instrumental value that can be gained from saving one over the other. The only knowledge you can gain is about the quantity of life, sentient creatures and the capacities of the sentient creatures. Surely you have an obligation to save one planet, but which one?

I don't think this is a case where you can flip a coin and either decision is morally permissible. Intuitively the correct action seems to be to save Planet A. However, the only difference between Planet A and Planet B is that Planet A is more biologically diverse. Furthermore, the case is built so as to exclude any meaningful instrumental value for either planet. Hence, the best explanation for the intuition that the morally correct action is to save planet A is that biodiversity is something of intrinsic value—it is valuable for what it is not what it gets you. Of course, in ordinary cases where humans

can interact and appreciate biodiversity, it is also instrumentally valuable. The point of the case is to try to support the idea that more good will exist in the universe if the biologically diverse planet is saved over the other.

As I said earlier, many environmental ethicists think that biodiversity is something of intrinsic value. For example, Holmes Rolston III believes that extinction is a great moral wrong, because it leads to a loss in biodiversity. He claims:

> "Extinction shuts down the generative process. The wrong that humans are doing, or allowing to happen through carelessness, is stopping the historical flow in which the vitality of life is laid. Every extinction is an incremental decay in stopping life processes—no small thing. Every extinction is a kind of superkilling. It kills forms (*species),* beyond individuals…It is not merely the loss of potential human information that is tragic, but the loss of biological information, present independently of instrumental human uses for it. (1985: 723).

Rolston's words evoke many conservationists' conviction that biodiversity is something of intrinsic moral value[3] and that losing biodiversity is a great wrong and that we have obligations to try to prevent it (e.g. Soulé, 1985; Ghilarov, 2000; Vucetich et al., 2015). As the ecologist Alexei Ghilarov states, "Ecologists should not ignore the intrinsic value of biodiversity…Ecologists should describe [an ecosystem] not only as a machine for energy and matter processing, and not only as a natural factory producing different goods and services, but also as a living stage for a unique evolutionary play, and as an example of evolutionary heritage that is probably worth protection no less than the heritage of our culture" (2000: 411). Ghilarov admits that biodiversity is instrumentally valuable but,

[3] Though they may not uses this exact expression. It is usually an unspoken assumption underlying their work.

like Rolston III, he also thinks that it is also valuable for what it is not merely for what it can do for us.

Biodiveristy or a loss of biodiversity can be conceptualized in many different ways (DeLong, 1996). We might think of biodiversity as a global accounting of the distinct things that there are (DeLong, 1996). Conceived thusly, measuring biodiversity is essentially counting the different kinds that exist. Another way to think about biodiversity is to build on the previous concept and include not only the different kinds that exist, but also the functions and relationships those kinds engage in with other kinds; that is, we might think that 'biodiversity' refers not only to the things but also the relationships and functions that they perform within any given ecosystem (DeLong, 1996). In Don DeLong's (1996) heavily cited review of many different definitions of biodiversity, species were always present in all the definitions that he examined and, as he moved forward in time, ecologists started using the word to refer to not only units but the important functions and relationships between these units. For the rest of the paper I will be using this more robust notion of biodiversity that focuses on both the organisms and the relationships and functions that they perform in a greater ecosystem.

Regardless of how one likes to conceive of biodiversity, if an actual species goes extinct, there will be a loss of biodiversity. And if biodiversity is intrinsically valuable, then it is easy to understand why species extinction is a great wrong. In fact, many, if not most, conservation efforts, including particular actions for marsupial conservation discussed later in this paper are explicitly directed at fulfilling obligations to prevent species extinction.

Hence, the action of introducing exotic species to the continent of Australia was a morally wrong action because that action has led to a loss in the amount of biodiversity and continues to threaten existing biodiversity. This moral wrong entails a moral obligation to intervene on behalf of these marsupial species to try to prevent their extinction.

I will let my arguments rest on the obligations to species, but it is also the case that there are likely anthropocentric reasons to perform these actions as well. Humans value biodiversity for instrumental reason e.g. it is aesthetically pleasing, it is scientifically interesting, and, for many Australians it is a source of pride about their home country. Hence it is also in humanity's interest to prevent those extinctions.

Helping species sometimes means harming individuals. Trying to stop the loss of biodiversity has lead humans to privilege some species over others, as is routinely the case when conservationists kill exotic species that are threatening native species. For those who are more concerned with individual animal welfare than preserving biodiversity, our obligations to individuals may seem to trump our obligation to right the wrong of destruction of diversity. This is the position taken by Regan (1983). We shouldn't harm other sentient creatures for the benefit of species preservation. It is wrong to poison the rats on the island to save a species of seabirds. Indeed, it is often personally difficult for conservation biologists who have a hard time causing suffering to individual animals to protect species; however, they think that doing so will prevent a greater harm. And if a greater wrong can be avoided by neglecting or thwarting some individuals' interests then, and only then, is it permissible to harm an individual. I think that in the

case of losing biodiversity, we may sometimes justifiably thwart the interest of individuals.

For example, there have been many conservation efforts that have captured the last individuals of a species, taken them out of their habitat and put them in captive breeding programs, all for the sake of preventing species extinction. The case of the California condor is a well-known instance of this (Farnsworth, 2015). In the California condor case the conservation actions thwarted individual organisms interests for the benefit of the species—presumably since the condor would prefer to be soaring in the air rather than making do in captivity and the capture of these birds surely caused the individuals stress and suffering. In the case of the condor it seems like the right thing to do was to remove those birds from the wild—thereby saving the species. Furthermore, this action also led to future individuals flourishing in the wild. If capturing condors and starting a captive breeding program was the right action to take, then sometimes it is morally correct to thwart individual interests for the sake of the species.

Thwarting individual organisms' interests for the sake of the species is a difficult issue. Whether it is permissible is a tough question that has led to disputes between environmentalists and animal rights activists (Warren, 1996).[4] Mary Anne Warren, while thinking about what to do about feral pigs in Hawaii, writes that "Plant and animal species, once pushed to extinction do not return. If it is wrong for us to demolish the few remnants of original Hawaiian ecosystems, then it is wrong for us to permit feral pigs to demolish them. The pigs are a human-caused problem…there may be no feasible alternative to killing them. If so, then this course of action is justified…" (1996: 115).

[4] Some think that it is impossible to reconcile the views of environmentalist and animal rights activists (e.g. Sagoff, 1984). Others disagree (e.g. Callicott, 1988).

While I agree with Warren's assessment of the case of pigs in Hawaii, killing animals is not a particularly desirable result and should always be avoided if possible.

Unfortunately, lethal measures against individuals are often taken by ecologists to protect species. This is one of the reasons why I will propose cognitive enhancement as a way to try to satisfy the obligation to prevent species extinction, since I believe it will be the best way to preserve species while avoiding the hurting and killing of sentient creatures that live outside of their native range through no fault of their own.

Of course, if the project succeeds, many endangered species will become more difficult for foxes and cats to catch, and this could potentially cause the predators suffering. On balance, this suffering is likely to be quite minimal. Since these species are at the present moment quite rare, they actually make up a relatively small portion of the diet of these predators. Cats in Australia eat a lot of rabbits, which are also introduced. But they eat a little of everything. A review of 49 data sets on cat diet from around the continent descried cats as "an opportunistic, generalist carnivore capable of exploiting a diverse range of vertebrate and invertebrate prey" (Doherty et. al., 2015: 972). Indeed, they turned up 123 birds, 157 reptiles, 58 marsupials, 27 rodents, five bats, 21 frogs, nine medium-and large-sized exotic mammals, insects from 13 orders, as well as spiders, scorpions, centipedes and crustaceans on the cat dinner menu (Doherty et. al., 2015). Arthropods are actually the most common item they eat. If the Gilbert's pototroos suddenly learn how to steer clear of them, they will be fine. Foxes are similarly flexible. A study in the state of Victoria found them willing to hunt and eat 62 mammal species (48 native species and 14 introduced species), five kinds of birds, two kinds of reptiles, and eight species of insects, and a couple of crustaceans (Davis et. al., 2015).

Warren's comments on the case of the pigs in Hawaii brings up another interesting point, the idea that there is a stronger duty to save species that are threatened by human action then those that are threatened for other reasons. Context matters when we intervene in nature (Palmer, 2010; Palmer, 2012). That human actions are the cause of a wrong creates a stronger obligation to do something to fix that wrong.

4. Why our obligation to prevent species extinction with minimal suffering is so hard to fulfill in the case of Australian marsupials. Fulfilling obligations to prevent species extinction will often imply a duty to ecologically restore, since habitat loss is the greatest global threat to species (Kareiva and Marvier, 2011). However, merely creating more habitat will not satisfy an obligation to prevent the extinction of the small Australian marsupials since any newly created habitats will also be suitable for the novel predators. So, while there is surely a duty to restore habitat, performing this action alone does not seem sufficient to try to address the duty of extinction prevention. Similar difficulties face many endangered animals, whether from introduced predators, climate change or some other irrevocably changed feature of their existence that makes mere habitat restoration insufficient.

Control of problematic non-native species, an obvious and commonly used option to satisfy an obligation to prevent species extinction, can be surprisingly difficult and comes with its own ethical challenges, as mentioned above. Control of exotics is currently an ongoing endeavor in Australia. The practice of eradication has been successful on some islands. In 1980 domestic cats were successfully eradicated on Australia's Lord Howe Island, which paved the way for native seabirds to once again nest

on the island (see islandconservation.org for this and other examples). However, while there have been successes at eradicating exotic species on islands, there is no realistic prospect of eradicating the novel predators on the entire continent of Australia. Conservation reports or plans call for the "control" or "management" of these introduced species (Denny and Dickman, 2010) implying that eradication is not possible.

In her book "Rambunctious Garden", Emma Marris tells the story of invasive species eradication in central Australia at the Scotia Sanctuary. The sanctuary has two fifteen-square-mile fenced enclosures to protect a number of endangered marsupials from invasive species. After the fences were built, the areas needed to be rid of the harmful exotics before the endangered animals could be reintroduced. It took 5 years to get rid of the invasive species in the first enclosure. The second, with a new feral animal controller, took 18 months. The person in charge of the job said, "'the average in Australia is that it takes one hundred nights per cat'" (Marris, 2011: 11). The reason that these eradication efforts were successful was because the expensive fences essentially created an island in the middle of the continent.

Total eradication of feral cats and foxes on the Australian continent does not seem possible. However, by aggressively *controlling* the numbers of exotic predators in an area, there have been improved success rates for reintroduction, hence a betterment of the prospects of threatened species, even if the successes are short lived (Winnard and Coulson, 2008).[5] Most control actions involve hunting, trapping and poisoning exotic species. These measures are controversial, especially for individuals concerned with

[5] Another possible action aimed at helping these kinds of animals proposed by Wallach et al. (2015) and Johnson and Stinchcombe (2007) is to try to bolster apex predator populations—in the shape of dingoes, which might help limit populations of smaller predators, including foxes and cats. However, many questions, both ethical and empirical, remain about this potential strategy.

animal welfare. Many conservation biologists who use lethal controls are partially motivated by welfare interests—in particular they would like to minimize the amount of animal suffering *caused* by the novel predators. Controlling the exotics through lethal means avoids a greater amount of suffering that would have occurred if exotics had not been controlled because each predator kills many prey items (Australian Invasive Species Council, 2013). As Warren notes, "researchers have reported that in New South Wales feral cats kill about 400 million native mammals, birds and reptiles annually" (1997: 114). Of course the preservation of biodiversity is the primary motivator for conservation efforts in Australia. However, suffering is a great wrong too and if we can protect biodiversity while at the same time minimize the suffering of all animals involved this would be a more morally justifiable action.

Perhaps a nonlethal way to control exotic numbers could be possible, for example by using sterilization and birth control. While this would be a better solution to shooting and poisoning the exotic predators, the feasibility of this solution takes it off the table. The fox and cat are well dispersed in Australia and very difficult to trap, and birth control rates must be near 100% for this strategy to be effective. It is widely regarded in the invasive species research community in Australia as impossible to try to stem their numbers by trapping and sterilizing or giving birth control to the exotics. Another potential approach would be using newer genetic technologies like the CRISPR-Cas9 system and gene drives to genetically alter the cats and foxes to be infertile or to only birth offspring of a single sex (Marris, forthcoming). These technologies are potentially very powerful, but also potentially dangerous. Were these alterations to escape Australia, they could mean the extinction of cats or foxes worldwide. Trading one extinction for

another seems like a poor solution to the problem. However, research on birth control and sterilization techniques, like research on cognitive enhancement, should certainly continue. Responding to the potential extinctions that loom over our world should entail research on multiple parallel approaches to have the best chance at success.

It might be thought that a better attempt to address the obligation of species preservation is to create more fenced-in sanctuaries like the ones at Scotia, from which non-native animals could be carefully relocated with minimal suffering. In the absence of other solutions, these small sanctuaries are certainly the best way of addressing a duty to prevent the loss of biodiversity caused by humans. Even if a one-time lethal purge of exotics is necessary to prepare the reserve, it certainly is morally superior to a plan of constant culling in an open area.

However, there are some major drawbacks to this conservation strategy, which makes me think it is not sufficient to address an obligation to prevent the loss of biodiversity while causing minimal suffering. One is that the animals' population numbers always increase to the point that they cannot be sustained on the fenced land of the reserve, which means either releasing some out of the reserve to be lunch for a hungry fox or supplementing their diets. Both strategies have been used at Scotia. Keeping these animals in fenced reserves is essentially keeping them in de facto zoos, which, in the end, are not completely safe. A failure in the fence or a gate left open could spell the death of a generation of marsupials or even the extinction of a species. The reserves are also vulnerable to fire, which could destroy entire populations, plunging the species into a genetic bottleneck. Such genetic contractions not only reduce the probability that the species will be saved, they represent a huge loss of genetic biodiversity. Another problem

for animals living in crowded reserves is that their living conditions are more stressful and the animals are more prone to parasites and diseases.

These problems arise because the fenced reserves are finite spaces that can't support the growing population of marsupials who are protected from the exotic predators. One solution to this would be to administer birth-control to the marsupials to control their numbers, thereby preserving the species and helping avoid the suffering that comes from overcrowding. While this might help slow the arrival of the problem, the problems still seem inevitable along with the suffering that comes from living in finite spaces.

But perhaps the biggest problem with these reserves is that the animals are being confronted with new selection pressures. There is very likely selection for animals that can thrive in zoo-like conditions, which includes selection for tamer animals. If there is selection for captive conditions then certainly this goes counter to addressing the duty of species preservation, since these traits would only create animals that are incapable of flourishing outside of the enclosure. In addition, it is problematic to take a wild animal and make it wholly reliant on human assistance, especially if other options would allow that animal to return to its habitat and engage in the ecological functions and relationships it had before the species almost went extinct. Here it is important to remember that the concept of biodiversity refers not only to the types but also to the relationships and functions those types perform within an ecosystem. Taming the marsupials could sever those relationships and eliminates those functions. Imagine a lineage of marsupials that has forgotten how to burrow for grubs after generations of being fed by humans. Even if they never forget their ecological roles, performing them only in tiny fenced areas means

they are not meaningfully present across the bulk of the Australian landscape. Again, the value of biodiversity and the obligation to preserve it speaks against these fenced reserves, when other possible conservation strategies are potentially on the horizon.

Ultimately, traditional means of conservation—restoration of habitat, controlling or eradicating predators, sterilization and contraception, and fenced reserves—simply do not seem like optimal responses to try to address a duty of preserving these marsupial species while causing minimal suffering and promoting flourishing. If we agree that the best way to preserve biodiversity is to have the marsupials living in the wild, on a large scale on large landscape areas, and, to the greatest extent possible, living the kind of life with all the relationships and ecological actions that were available to it before the introduction of foxes and feral cats, fenced enclosures are not the solution. Perhaps the best way to try to fulfill the duty of biodiversity preservation will be from an emerging and controversial technology: cognitive enhancement.

5. Smarter numbats. Recognizing that to best address the duty of biodiversity preservation is having them free in the wild—and that this wild is going to have foxes and cats in it—we come to see our pro-tanto obligation to make these animals smarter. That is, if the technology is available to cognitively enhance these animals so that the species will not go extinct, then there is a pro-tanto obligation to do so. Nick Bostrom and Anders Sandberg define cognitive enhancement as: "the amplification or extension of core capacities of the mind through improvement or augmentation of internal or external information processing systems" (2009: 311). They go on to note that:

> "Cognition can be defined as the processes an organism uses to organize information. This includes acquiring

> information (perception), selecting (attention), representing (understanding) and retaining (memory) information, and using it to guide behavior (reasoning and coordination of motor outputs). Interventions to improve cognitive function may be directed at any one of these core faculties" (2009: 312).

Cognitively enhancing these species to deal with the threats posed by foxes and feral cats not only seems like the best way to mitigate the loss of intrinsic value, but it also lacks some of the undesirable effects of the other conservation strategies. If done effectively, cognitive enhancement could mean that there could be an end to—or at least a great reduction in—the killing of exotics, thereby eliminating—or reducing the strength of—a major objection from people who view the killing of exotics as a wrongful infringement of animal rights (Regan, 1983). Also, enhancement should mean that the marsupials would no longer have to live in fenced reserves. This is desirable form the perspective of biodiversity but also animal welfare, since the marsupials could avoid the suffering of close proximity living. Hence, cognitive enhancement, along with the restoration of lost habitat, might be the best way to prevent the loss of a species all the while minimizing the suffering that would occur both to the marsupials and the exotics via the other conservation strategies. If this is the case, an obligation to protect species would imply that there is an obligation to cognitively enhance these marsupials, assuming that the technology is available and safe.

The focus of this paper is the many threatened or endangered marsupials of Australia; however, if I have successfully argued for this conservation strategy on moral grounds then the argument could be generalized. There are likely many other threatened species that could be saved by enhancement (cognitive or otherwise), from naïve island

birds dealing with invasive snakes on Guam to rhinos (notoriously dim creatures) that must outwit poachers to survive.

There are many possible ways to cognitively enhance. In the literature on cognitive enhancement of humans there has been much focus on drugs, neural implants or germ-line genetic modification, but perhaps the simplest way of cognitive enhancement is to just teach someone a new skill (Buchanan, 2011).

Cognitive enhancement attained by training has been tried out on certain Australian marsupials. Conservationists have had some success with training endangered species to fear and avoid exotic predators (McLean et. al., 1999; McLean et. al., 2000; Griffin and Evans, 2003) and toxic exotic prey such as cane toads (O'Donnell et. al., 2010). McLean et. al. (1996) were able to train rufous hare-wallabies to be more vigilant and hide from a model fox when presentation of the model was accompanied by either squirts from a squirt gun or wallaby alarm calls. Griffin and Evans (2003) trained tammar wallabies to fear foxes by presenting them a stuffed fox while simulating their capture by a human. The negative association made the wallabies more fearful of the model fox (as opposed to the control group, which alarmingly oriented *toward* the fox). Those that had received the training exhibited more alarm behavior (they were more prone to flee or preform a foot thumping alarm) when they encountered the model fox. When other wallabies were allowed to observe the trained group respond to model foxes they did spend more time looking at the potential threat. However, there have been some discouraging outcomes once trained animals are released into the wild.

Experiments at the Scotia preserve, run by Matt Hayward, showed that another kind of wallaby (bridled nailtail) could be trained to better avoid introduced predators. At

Scotia, they ran live dogs through the reserve as fox proxies to prepare the wallabies for release outside of the sanctuary's fences[6]. The wallabies soon responded appropriately to the fox proxy and upon release their survival rate was significantly higher than non-trained wallabies. However, despite their progress, eventually all the released wallabies were eaten, trained and non-trained. Hayward informed me that this result has been typical of these kinds of experiments. Furthermore, even if the adults are able to breed, the learned vigilance doesn't seem to be socially transferred to the young. This failure of the enhancement to be passed on through the generations is particularly troubling.

But these discouraging results do not mean that conservation should just fall back to the fenced reserve model; rather, it means that more drastic means of cognitive enhancement might need to be used to effectively address the duty. Genetic engineering may offer more permanent and generalized cognitive enhancement of animals, and these techniques are becoming a possibility (Anthes, 2013). Furthermore, in a recent study by Han et al. (2013), mice grafted with human glial progenitor cells showed enhancement in their learning, memory, and, perhaps most interestingly for the case under discussion, "contextual and tone fear conditioning" (342). In addition, technological innovations in genetic engineering have made the process more affordable (a constant challenge to conservation efforts), and more precise. The possibility of cognitively enhancing animals is fast becoming a reality. Admittedly, genetically modifying these marsupials so as to tweak their predator recognition capacities will take time, but given that it has the great potential to stop the loss of biodiversity, while reducing the amount of suffering for both marsupials and exotics, it seems like an optimal way of satisfying the duty to preserve biodiversity.

[6] I want to thank Matt Hayward who told me about this experiment. His research is not yet published.

One final advantage to the approach is its permanence. Culling of exotics and the maintenance of fenced enclosures are strategies that only work as long as there is the political will, the funding, and the human interest in keeping these species on the planet. A change in government or in human priorities could spell the end of these costly programs and the end of the mountain pygmy possum or the rufous hare-wallaby. But once the species has been altered to be able to recognize and evade these exotic predators, they will be able to make their own way in the world, with or without us. Their survival will not depend on our fickle attention. And they will be able to be wild in a way that many in captive and semi-captive conditions are not today.

6. Is there anything wrong with tinkering with animals' minds? I would now like to respond to some potential objections against the idea of genetically modifying animals for cognitive enhancement to save species. I will address six possible objections: unforeseen ecological consequences, the risk of reducing population through research-related mortality or infertility, suffering relating to the enhancement, a possible reduction in flourishing, the threat to the integrity of the species or dignity of the individual, and the idea that such alteration would be an instance of unacceptable human domination of other species.

6a. Unforeseen ecological consequences. The first objection might be that genetically modifying animals might have unintended and unforeseen results, and so it would be irresponsible to modify these organisms and release them into the wild. This is undeniably a legitimate concern. Our knowledge of the genetics is arguably more

advanced than our knowledge of ecology, and predicting the consequences of even subtle changes remains a challenge. Any enhancement program would have to be built on a rigorous program of captive observation and testing of enhanced marsupials before release. The first generations of altered animals can be engineered to express the changed genes but not to pass them on to any offspring (Esvelt et al., 2014). Tests would begin in sterile labs, then move to fenced reserves where ecological interactions could begin to be studied. Cognitive enhancement may be a moral obligation to address a duty of biodiversity preservation, but clearly that doesn't mean enhancing irresponsibly will be permissible. Relatedly, conservationists wishing to alter these populations will have to consult with and abide by the wishes of humans with a stake in the species and ecosystems involved. Spreading the enhancement throughout the entire species with a so-called "gene drive" would only occur after many years of testing, study, and societal conversations. As Kevin Esvelt and his colleagues write in their review on the promise of new technologies, including gene drives, "As self-propagating alterations of wild populations, RNA-guided gene drives will be capable of influencing entire ecosystems for good or for ill. As such, it is imperative that all research in this nascent field operate under conditions of full transparency, including independent scientific assessments of probable impacts and thoughtful, informed, and fully inclusive public discussions" (Esvelt et. al., 2014).

6b. Risk of reducing population through research-related mortality or infertility.

Another potential concern is that it is far too risky to try to cognitively enhance individuals of a particular species when the number of living individuals of that species is

already quite low. I don't think that small population sizes entails the moral impermissibility of experiments, especially if the experiments have a good potential to boost the number of individuals remaining while allowing them to return to their ecosystems and the relationships and functions they perform there. If numbers are exceptionally low, a project to build up numbers in fenced reserves or zoos may need to be undertaken before there are enough animals to safely enroll some into the research project.

6c. Suffering related to the enhancement. It is possible that some marsupials will suffer during the research and early phases of the enhancement project. Animals will have to be trapped and collected, then operated on to have their eggs (or other germline cells) altered. Even with anesthesia and painkillers, there is likely to be some distress and pain involved. Then they will likely spend the rest of their lives in a lab or a fenced enclosure. I believe that while it is important not to dismiss this suffering, that we balance it against the suffering of untold generations of their kind who would either die prematurely at the paws of a cat or fox, or live in the low-grade misery of a fenced enclosure. As in the condor case, the de minimus suffering of one or a few generations of animals makes possible the full, free, wild lives of hundreds of generations to come.

6d. A possible reduction in flourishing. Another potential objection is that changing the species will impede its flourishing. I am basing my argument for enhancement of these animals on the value of biodiversity, but I also believe we have obligations to the flourishing of individuals. Does changing them from their "normal" condition frustrate

their flourishing, if we use John O'Neill's definition: "A living thing can be said to flourish if it develops those characteristics which are normal to the species to which it belongs in the normal conditions for that species." (2006: 137)? First of all, they aren't leading "normal" lives in small enclosures. Inbreeding and lack of mate choices, looming threat of death by fire, increased stress, increased instances of parasites and disease, and selection for a more docile nature are not normal characteristics or normal conditions for these individuals. Secondly, one should not think that a cognitive enhancement necessarily equals a massive change in either physical or behavioral traits. The enhancement under discussion is minimal and the only change sought is an increased ability to recognize the exotic predators. This could potentially be achieved without massive behavioral changes for these animals, especially with the precision obtainable with new methods like CRISPR engineering (Esvelt et al., 2014; Marris, fothcoming). That increase in predator recognition will be a slight deviation from the norm of having poor exotic predator recognition abilities. However, this deviation should allow for a return to a closer approximation of normal habits before their environment contained the exotic predators. A small deviation from normal behavior, in other words, is plausibly permissible to prevent a greater deviation from normal behavior in future generations.

6e. A threat to the integrity of the species or dignity of the individual. I have grouped these objections because I think they are alike in that they see intervention in a linage of organisms as disrupting something of value that arises from their wholeness. Insofar as enhancement will change the genome of the bilby or numbat, it could be conceived as a threat to the "integrity" of their genomes, on par with what occurs when a species begins

hybridizing with a related non-native species. Yasha Rohwer and Emma Marris have argued that the genome itself is not a whole thing with clear boundaries (2015). The genome of any species is dynamic and multifarious by its very nature; that variety and changeability is in fact the engine of evolution. "Genetic integrity" is really a proxy for other things that are plausibly valuable: flourishing, biodiversity, and genetic diversity (Rohwer and Marris, 2015). In this case, the genetic alteration is conducted in defense of those very same values.

Some might think that even if the genetic manipulation is minimal and only results in a slight behavioral change, it is still wrong because it infringes on the animals' dignity. Dignity has been put forth as something with normative significance that goes beyond the mere welfare of an individual (e.g. Ortiz, 2004). Dignity is disrespected or compromised by preventing the individual organism from developing the functions that an individual of its species normally develops. Hence, to genetically modify the animal could be to change one of its "normal functions", even if that modification improves the overall welfare of the organism, and thus would compromise the dignity of the organism (Ortiz, 2004). In the case of the small Australian marsupials it is unclear that a genetic modification would prevent individuals from developing those normal functions. Perhaps it would just *add* another function or ability or increase a certain capability—predator detection. Conceived thusly, there is no loss of species-specific normal function, hence there would be no affront to dignity. However, it is possible to conceive of what is lost as the marsupials' characteristic inability to detect novel predators. Hence, the genetic modification would result in a loss of species-specific normal function. But, this loss doesn't seem problematic unless every species-specific normal function must be

preserved. And this certainly doesn't seem to be the case, especially if the function runs counter to the organisms' ability to develop the other species-specific normal functions.[7] It could indeed be argued that this intervention would increase the dignity of these species. Some are currently helpless wards of humankind, fed dog food and kept behind fences. Allow them a competitive amount of brainpower, and we can release them back into the wild to fend for themselves and write the own story of their lives. Enhancement will afford them the dignity of wildness.

6f. An instance of unacceptable human domination of other species. A different kind of potential objection to cognitively enhancing animals is that doing so is an act of human domination of nature too extreme to be permissible, let alone obligatory. This objection is inspired by Katz who thinks that nature ought to "be free, to pursue its own independent course of development" (2003: 396). Katz is not alone. There is a dominant trend in conservation biology and environmental ethics, which claims what we need is less of humanity's influence on nature (e.g. Bradley, 2013; Hettinger, 2014). Many believe that true conservation is hands-off, since wilderness or nature is that which is free of humanity's touch. But while it is true that humans have had a very negative impact on nature in the past, this doesn't entail that no intervention should ever be done, especially when intervening will prevent a great wrong like species extinction.

There are many famous examples of morally justifiable human interventions to help endangered species. Take, for example, the case of the Florida panther, an endangered subspecies of the cougar. Florida panthers need a large range of habitat.

[7] It is worth noting that "dignity" is not a concept that everyone is ready to apply to all animals. Federico Zuolo makes a compelling case that we would do well to look elsewhere for our reasons to consider animals as morally considerable (2016).

However, the loss of habitat in Florida, brought on by humans, reduced the population to about 26 individuals (Biello, 2010). That small population suffered from inbreeding and exhibited obvious inherited defects, including heat problems, missing testicles, and kinked tails (Roelke et. al., 1993). In this case, the actions that led to the threat of extinction also caused a fair amount of suffering to the existing individuals of the subspecies. As is often the case when species are threatened, individuals suffer. To try to prevent the extinction of the subspecies and avoid further suffering due to genetic defects, panther reserves were created and conservation biologists transplanted eight female panthers from nearby Texas, which helped alleviate the genetic bottleneck and allowed the population to rebound (Biello, 2010). This human intervention ensured that the individual panthers in Florida did not have to mate with relatives and also that new panthers that were born did not have the defects that the 26 remaining panthers did. This action not only helps save a subspecies, but it also alleviated suffering and promoted flourishing. Thus, at least sometimes, human intervention is justifiable.

While I have claimed that the case of the Florida panther shows that human intervention in order to prevent species loss and harm to individuals can be morally justifiable, there were some people who thought that this intervention was not permissible because it altered the genetics of the future individuals, and brought in genes from outside the subspecies. Humans, under this view, should not be meddling with the genetics of animals. Since I have advocated germ-line enhancement of animals to avoid species loss and minimize the suffering of the individuals involved, I must show that, at least on occasion, these kinds of genetic interventions are permissible.

I think that a simple thought experiment can show that genetic modification of

organisms can sometimes be a morally permissible conservation practice. Imagine there is a species of animals that is not coping well with global warming. Its summer coat is much too thick and soon there will be extinction because the future individuals will die from heat stress unless the lineage can somehow evolve a thinner summer coat. Conservation biologists determine that the needed variation is just not present in the population's gene pool. Furthermore, assume that it has been shown that the animal can be genetically modified to have a thinner summer coat by inserting one or two amino acids into the genome, with no adverse effects on the modified animals, other organisms, or the greater ecosystem. So the choice is either to let those future individuals that make up the species die, resulting in the extinction of the species or to modify some present individuals genetically. Given that the next generation of individuals will suffer untimely deaths because of human activity (global warming), and that suffering to individuals and species extinction can be avoided by modifying present generations, intuitively, the right course of action is modification. If biodiversity is something of intrinsic value, it is hard to think that a small genetic manipulation that would prevent the loss of a species and preserve its relationships with other species and ecological functions would be morally wrong.

7. Conclusion. We will not be releasing smarter wollies or wallabies into the Australian bush any day soon. But as genetic technologies advance, we would do well to be ready with well considered ethical arguments about when and how they should be used in the "wild" natural world. I believe that if the price of a world with the diverse and astonishing lineages of Australian mammals is a bit of genetic tweaking, then we would do well to at least begin researching how to do so safely. I would like to end by

mentioning that although I am arguing here for a potential technological fix to meet obligations of preserving biodiversity, I don't want to leave the impression that I believe that technology can or will be able to fix or restore everything. Often future technology is held up as the potential solution to all present and future problems. So many crises in biodiversity can and should be primarily addressed through the basic tools of habitat preservation and restoration and carefully limiting human exploitation of rare species. To believe that technology will fix everything is folly. However, I think the converse of it is just as problematic: that technology can never be a solution to present and future problems. If we can agree that species extinction is wrong and that using some technology might be the best way to try to prevent that wrong (in certain circumstances), then, as I have argued, a pro-tanto obligation to use said technology likely exists. The obligation is blind to the methods by which it is achieved, and we must learn to at least be open-minded about every possible tool to save the great diversity of life on Earth—especially the beautiful, striped numbats, who deserve many more millennia of eating termites in the sun.

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