



The Ethics of Reviving Long Extinct Species

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Abstract: *There now appears to be a plausible pathway for reviving species that have been extinct for several decades, centuries, or even millennia. I conducted an ethical analysis of de-extinction of long extinct species. I assessed several possible ethical considerations in favor of pursuing de-extinction: that it is a matter of justice; that it would reestablish lost value; that it would create new value; and that society needs it as a conservation last resort. I also assessed several possible ethical arguments against pursuing de-extinction: that it is unnatural; that it could cause animal suffering; that it could be ecologically problematic or detrimental to human health; and that it is hubristic. There are reasons in favor of reviving long extinct species, and it can be ethically acceptable to do so. However, the reasons in favor of pursuing de-extinction do not have to do with its usefulness in species conservation; rather, they concern the status of revived species as scientific and technological achievements, and it would be ethically problematic to promote de-extinction as a significant conservation strategy, because it does not prevent species extinctions, does not address the causes of extinction, and could be detrimental to some species conservation efforts. Moreover, humanity does not have a responsibility or obligation to pursue de-extinction of long extinct species, and reviving them does not address any urgent problem. Therefore, legitimate ecological, political, animal welfare, legal, or human health concerns associated with a de-extinction (and reintroduction) must be thoroughly addressed for it to be ethically acceptable.*

Keywords: biotechnology, cloning, de-extinction, extinction, values

La Ética de Revivir Especies Extintas Hace Mucho Tiempo Sandler

Resumen: *Ahora parece ser plausible tener una vía para revivir especies que han estado extintas por varias décadas, siglos o incluso milenios. Llevé a cabo un análisis ético de la des-extinción de especies extintas hace mucho tiempo. Estudié diversas consideraciones éticas posibles a favor de buscar la des-extinción: que es un caso de justicia; que restablecería un valor perdido; que crearía un nuevo valor; y que la sociedad lo necesita como un último recurso de la conservación. También estudié varios argumentos éticos posibles en contra de la des-extinción: que no es natural; que podría causar sufrimiento animal; que podría ser ecológicamente problemático o dañino para la salud humana; y que es desmesurado. Hay razones a favor de revivir especies extintas hace mucho tiempo y puede ser éticamente aceptable hacerlo. Sin embargo, las razones a favor de buscar la des-extinción no tienen que ver con su utilidad en la conservación de especies, sino más bien con el estado de especies revividas como un logro tecnológico y científico, y sería un problema ético promover la des-extinción como una estrategia de conservación significativa ya que no previene la extinción de las especies, no aborda las causas de la extinción, y podría ser dañina para la conservación de algunas especies. Además de esto, la humanidad no tiene la responsabilidad ni la obligación de buscar la des-extinción de especies y revivirlas no es un problema urgente. Por esto, las preocupaciones legítimamente ecológicas, políticas, de bienestar animal, legales o de salud humana asociadas con la des-extinción (y reintroducción) deben ser abordadas a fondo para que sea éticamente aceptable.*

Palabras Clave: Biotecnología, clonación, des-extinción, extinción, valores

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Introduction

Cloning has been used with vulnerable and endangered animals and in attempts to revive species that have recently gone extinct (e.g., Lanza et al. 2000; Loi et al. 2001; Folch et al. 2009). Due to advances in genetics and synthetic biology, there now appears to be a plausible pathway for reviving species that have been extinct for several decades, centuries, or even millennia. This would be accomplished by reconstructing close approximations of the extinct species' genomes based on information found in preserved DNA (e.g., from fossils and museum specimens) and on genetic information from close living relatives and interspecies somatic cell nuclear transfer (cloning) (Church 2013; Lanza 2013; Novak 2013). Let us call this *deep de-extinction* in order to distinguish it from cloning more recently extinct species, such as the bucardo (*Capra pyrenaica pyrenaica*) and the gastric brooding frog (*Rheobatrachus silus*).

Both scientific and ethical evaluation of whether to pursue de-extinction of species such as the Passenger Pigeon (*Ectopistes migratorius*), thylacine (*Thylacinus cynocephalus*), mammoth (*Mammuthus primigenius*), and Shasta ground sloth (*Notbrotheriops shastensis*) are needed. Scientific evaluation involves determining whether it is technically feasible, identifying and quantifying possible risks, and assessing the scientific and conservation implications. Ethical evaluation involves determining whether deep de-extinction would promote or undermine significant values and whether it would conform to or violate operative norms and principles. I focused on ethical evaluation. I assessed possible ethical considerations in favor of pursuing deep de-extinction and assessed possible ethical considerations against pursuing deep de-extinction.

Ethical Arguments in Favor of Deep De-Extinction

Advocates of de-extinction have suggested several ethical considerations in favor of pursuing it: that it is a matter of justice; that it would reestablish lost value; that it would create new value; and that we need it as a conservation last resort.

Justice

Several of the species proposed for deep de-extinction, including the Passenger Pigeon and the thylacine, went extinct due to anthropogenic causes, such as hunting and habitat destruction. If we can develop the capacity to revive these species, perhaps, we have a responsibility to do so as a matter of justice—that is, as a way of making up for the wrong humans did in contributing to the ex-

tinctions (Crist 2008; Archer 2013; Brand 2013; Sherkow & Greely 2013).

It is part of the concept of restorative or restitutive justice that redress is owed from someone (or some group) to someone (or something) due to a harm or wrong done to them. However, it is not possible to harm or wrong a species because species do not have aims or welfares distinct from those of the organisms that comprise them. They do not have minds (so lack intentions, desires, or attitudes); they are not alive (so cannot be killed, sick, or injured); and they are not goal directed (so it is not possible to impair their capacity to achieve their ends) (Taylor 1986; Sober 2002). Therefore, they lack psychological, biological, and teleological interests. In contrast, individual organisms are goal directed, and many of them have intentions and desires. Therefore, gray wolves, black rhinoceroses, and human beings can be harmed or wronged, whereas *Canis lupis*, *Diceros bicornis*, and *Homo sapiens* cannot be (Sandler 2012). An implication of this is that species, such as *E. migratorius* and *T. cynocephalus*, cannot be owed a debt of restorative justice. Moreover, the individual organisms that were harmed and perhaps wronged during the extinction process are no longer alive. Nor are those who caused the extinctions. Therefore, it is not possible for a debt of restorative justice, even if there were one, to be paid by those who owe it to those who are due it.

Perhaps, the idea is that a wrong was done to the natural world by humanity in causing the extinctions, so humanity has a responsibility to make up for it by trying to bring back the species and reintroducing them if possible. However, like species, the natural world and ecosystems lack interests or welfares distinct from the individuals that constitute and populate them. They do not have minds or intentions; they are not alive; and they are not sufficiently internally organized and goal directed to have a good of their own (Sandler 2012). For these reasons, there is not an ethical responsibility, grounded in restorative justice, to engage in deep de-extinction.

The motivation behind the justice argument for de-extinction is that humanity has done something terribly wrong in causing so many species to go extinct. Therefore, we have a responsibility to make up for it in some way. However, the foregoing shows that restorative justice to the species or to nature is not the appropriate way to conceptualize this responsibility, and de-extinction is not the appropriate way to operationalize it. There are loose analogs to this situation in interpersonal ethics, cases in which terrible wrongs have occurred, but it is not possible to pay a debt of restorative justice to the victims (e.g., slavery and homicide). In such cases, "making up" for the wrongs involves acknowledgement of them, taking steps to ensure that they do not cause further (or compounding) harms to others (e.g., family or descendants),

and reforming individuals and institutions so that similar wrongs do not occur again in the future. This is a reparation and rehabilitation approach to making up for past wrongs, rather than a restorative or restitutive approach. Applying this to species extinctions, the appropriate way to make amends for past species extinctions is to mitigate the impact of species extinctions on ecological and human systems and to reform our practices and institutions so as to minimize future extinctions. However, I argue below (“A Conservation Last Resort”) that de-extinction can play only a very small role in these and may even be detrimental to them. Therefore, de-extinction is not well justified on restorative or reparative justice grounds.

Reestablishing Lost Value

Species possess many different types of value: ecological value to the systems in which they are located (e.g., performing ecosystem functions); instrumental values to people (e.g., providing ecosystem services); and intrinsic value (or final value) in themselves or for what they are (e.g., as distinctive forms of life) (Rolston 1986, 2003; Callicott 1989; Hunter 2001; Sandler 2012). As a result, species extinctions involve a loss of value from the world. This is one of the primary reasons that anthropogenic extinctions are wrong and ought to be avoided (Soulé 1985; Rolston 1995; Cafaro 2001). Perhaps, deep de-extinction can restore value that was lost. If so, this may justify pursuing it.

Many of the types of value that species possess are dependent upon their evolutionary and ecological relationships. This is the case on accounts that emphasize their natural-historical properties (Rolston 1986; Callicott 1989), their wildness or independence from humans (Elliott 1982, 1992; Soulé 1985; Katz 2000), and their ecological importance (Leopold 1968). Deep de-extinction, if successful, does not restore these relationships. It only results in organisms whose genetic makeup most resembles that of species that went extinct long ago. For this reason, on some conceptions of species, the organisms resulting from de-extinction may not even be conspecific with the species that went extinct. However, whether or not the organisms are of the same species, the contextual and relational bases for the lost value of the extinct species are not recreated through de-extinction. For instance, revived species will not be independent from humans in origin because we will have reconstructed their genome and cloned them. This does not imply that there is anything ethically problematic with them (as discussed below), but it does mean they will not have the same natural value as the extinct species (Mills 2006).

Moreover, for many de-extinction candidates, such as the mammoth, their ecological context no longer exists, and is not likely to be restored. For other candidates, such as the thylacine and Ivory-billed Woodpecker (*Campephilus principalis*), there are spaces that resem-

ble the species’ prior ecological context. In these cases, there may be ecological value to de-extinction and reintroduction. However, de-extinction itself is not sufficient for reestablishing the value. The revived species must also be restored to a close approximation of its former ecological context. This may prove technically difficult, given a lack of genetic diversity and the absence of behavioral models, for example (National Geographic 2013). There may also be economic, social, and ecological challenges associated with potentially contentious reintroductions (Rubenstein et al. 2006; Switek 2013).

Because the ecological, intrinsic, and instrumental value of species is relational and context sensitive, deep de-extinction alone is insufficient to reestablish it. Revived species might have value (discussed below), but it would not be same value the species had before it went extinct (with possible exceptions for the ecological or instrumental value of more recently extinct species that can be successfully reintroduced into their former habitats). Therefore, de-extinction of long extinct species is not justified on the grounds that it would reestablish lost value (except in very rare cases).

Creating Value

Even if deep de-extinction cannot replace lost values, it may nevertheless create value. Deep de-extinction would be a tremendous scientific and technological achievement. Accomplishing it would require advances in genetics and synthetic biology, among other fields. It would likely spin off further research programs, technologies, and applications. Scientific knowledge would also be gained from studying the development, traits, and behaviors of the animals and their descendants. For these reasons, there is scientific value in de-extinction (National Geographic 2013; Sherkow & Greely 2013).

Moreover, many people would find it wondrous and awesome to see a living ivory-billed woodpecker, thylacine, or mammoth, even if only in a zoo or wildlife park. Some revived species may also have significant cultural value (e.g., value for what they represent or for how they relate to cultural history or practice). This may be the case for the thylacine or passenger pigeon, for example. When revived species are valued by people in these and other ways, and so desired by them, then those de-extinctions have value for that reason (Sandler 2012; Brand 2013; Greely 2013). Wonderousness and cultural significance can also be the basis for economic value because some people are likely to spend resources to see or own individuals of revived species.

An additional way in which deep de-extinction might be valuable is by providing a hopeful counternarrative to the dominant conservation situation: elevated and accelerating rates of species extinctions and biodiversity loss (Magurran & Dornelas 2010; Barnosky et al. 2011). Deep de-extinction may offer an optimistic and creative

research agenda in comparison with what some see as the currently primary conservation biology activities of mitigating, managing, and documenting loss (Donlan et al. 2006; Brand 2013; Novak 2013).

A Conservation Last Resort

It has been suggested that conservation cloning needs to be developed and embraced as a last resort or “insurance policy” (Crist 2008; Kumar 2012; Brand 2013; Clarke 2013). If all other conservation efforts for a species fail, then at least the species’ DNA can be preserved so that it can be revived later, when the threats to it are mitigated, habitat is reestablished, or it will be useful to us. Therefore, there is an ethical responsibility, grounded in the responsibility to forestall anthropogenic species extinctions, to develop the capacity for de-extinction. Deep de-extinction would enable extending this responsibility to already long extinct species.

The technologies and techniques involved in de-extinction may prove useful to conservation biologists in efforts to preserve some endangered species (e.g., Ryder 2002; Mills 2006; National Geographic 2013). However, deep de-extinction is not itself a significant species conservation strategy because it does not prevent species from going extinct. Nor does it address the causes of extinctions, for example, habitat destruction, climate change, pollution, and extraction. Moreover, it typically will not involve restoring species to their coevolved ecological contexts because those contexts no longer exist, the ecological risks are too high, or the revived populations will not be independently viable (due to a lack of genetic diversity or behavioral plasticity, for example) (Ehrenfeld 2013; Jabr 2013; Pimm 2013).

Furthermore, deep de-extinction will not fully revive lost species because the organisms will be genetic hybrids, will live in different contexts, and may develop and behave differently. Successful deep de-extinctions will result in organisms with high genetic similarity to members of long extinct species, but for many species, species membership depends on more than just genotype (Crane & Sandler 2011). Moreover, species are typically valued for reasons that go well beyond their genetics. It is polar bears roaming the arctic, salmon spawning in the rivers, and Passenger Pigeons in mass migration that people value and (if they still remain) want to conserve (Rolston 1995).

In addition, conservation cloning will not scale to the extinction crisis that we currently face because it focuses on individual species and will likely be comparatively expensive. Therefore, it is crucial that the possibility of de-extinction does not reduce the urgency with which we address the causes of extinction and that it not divert resources from efforts to conserve currently existing species (Yule 2002; Ehrenfeld 2013; Pimm 2013). (However, it also should not be immediately assumed that con-

servation cloning and de-extinction will compete with more traditional conservation approaches for resources [Yule 2002; Holt et al. 2004; Sherkow & Greely 2013]). The last resort argument would be detrimental from the perspective of species conservation, and contrary to reparative justice, if it promotes the idea that so long as we save species’ DNA, we can always revive them later or that we can reduce them to very small populations because we have cloning as an insurance policy (Crist 2008; Sherkow & Greely 2013).

Ethical Concerns about Deep De-Extinction

Several ethical concerns have been suggested regarding deep de-extinction: that it is unnatural; that it could cause animal suffering; that it could be ecologically problematic or detrimental to human health; and that it is hubristic or akin to playing God.

Unnaturalness

The process of deep de-extinction would involve engineering life and creating organisms with genetic material from multiple species. Therefore, some may object to it, as they have to other transgenic biotechnologies, on the grounds that it is unnatural (OTA 1987; Program on International Policy Attitudes 2003).

The viability of the unnaturalness objection to transgenic biotechnology (including deep de-extinction) depends upon species boundaries having ethical significance, such that creating transgenics somehow violates them (Sandler 2012). However, species delineations are not always clear, and interspecific genetic hybridization is common in nature. Therefore, the mere existence of transgenic organisms is neither unusual nor ethically problematic.

Transgenic biotechnology (including deep de-extinction) does involve mixing genomic material between individuals of species that could not have bred or hybridized without human intervention. As a result, engineered organisms do not have as much natural value as do organisms whose origins are independent from humans. However, that something (including living things) could not have come to exist without human intervention or is low in natural value does not make it ethically problematic (Sandler & Simon 2012). If it did, then vaccines and low-fat yogurt would be ethically problematic. Moreover, people have been intentionally engineering organisms, including interspecific ones, since the beginning of agriculture. It is now routinely done and accepted in biomedical contexts as well.

For these reasons, the fact that deep de-extinction involves intentionally creating organisms with genetic material from multiple sources does not make it unnatural in an ethically problematic sense. The views of those

who find transgenic biotechnology objectionable should be respected. For example, people should be informed when food contains genetically modified organisms so that they can make food choices according to their values (Streiffer & Rubel 2004). However, such respect does not require abandoning transgenic biotechnology or deep de-extinction, particularly because those who find it objectionable must also respect the views of those who do not (Sandler 2012).

Animal Welfare Concerns

Interspecific cloning has low success rates and often results in donors, surrogates, and offspring with health problems and abnormalities (Ryder 2002). These issues may be exacerbated with deep de-extinction due to greater likelihood of genetic imperfections and lower levels of information about the species. Thus, a possible concern regarding de-extinction is that it will cause animal suffering (Mills 2006; Crist 2008; Sherkow & Greely 2013).

Compared with the number of animals already used in research (estimated to be 10–25 million/year in the United States alone) and in animal agriculture (estimated to be 56 billion land animals/year globally), conservation cloning (let alone deep de-extinction) does not pose a special or very large animal welfare problem. Animal suffering is ethically significant (Singer 1989). Therefore, de-extinction research and implementation should be pursued in ways that cause as little suffering as possible, in accordance with all animal welfare laws and best practices and with appropriate research oversight. But the animal welfare concerns it raises do not significantly differentiate it from many other research and conservation practices involving animals (Harrington et al. 2013). Therefore, while animal welfare considerations must be addressed, they do not justify abandoning deep de-extinction.

Ecological and Health Concerns

Another concern that has been raised regarding deep de-extinction is that individuals of revived species could be released or could escape, and then become ecologically problematic or pose a threat to human health (Ehrenfeld 2006; Mills 2006; Sherkow & Greely 2013).

However, most of the species that have been proposed for de-extinction are unlikely to pose substantial ecological or health risks. Many revived species will be intended for research and exhibition, not release. Moreover, the fact that these species already have gone extinct once and will have low genetic diversity suggests that they will not be highly adaptive, fecund, and successful at evading attempts to control their numbers should they escape or be released. This is particularly so with respect to candidates with low reproductive rates (for example, the thylacine, Shasta sloth, and mammoth).

As with the animal welfare concern, the ecological concern regarding de-extinction has merit. It is certainly possible that there could be unintended negative ecological or human health impacts associated with deep de-extinction, particularly if the revived species are released. But it is also a challenge that is faced in other conservation contexts (e.g., breeding programs and relocations) and, as with the animal welfare concern, it is likely that it can be adequately addressed for many de-extinction candidates. It is even possible that some revived species—for example, the thylacine, Passenger Pigeon, or Ivory-billed Woodpecker—could be ecologically beneficial or increase support for protecting habitat (Crist 2008; Brand 2013; Sherkow & Greely 2013).

Hubris

A concern often raised regarding transgenic biotechnology is that it is hubristic or akin to “playing God” (Rifkin 1985; Comstock 2000; Plumwood 2002; Raffensperger 2002). Because deep de-extinction involves intensively engineering genomes, creating transgenic organisms, and using cloning for the purpose of bringing back long extinct forms of life, it is very likely to be subject to this concern.

There are actually several interrelated versions of the hubris concern. In one version, biotechnology is hubristic because researchers tend to overestimate their ability to predict and control the impacts of the technologies, particularly when they involve complex and dynamic systems (such as biological organisms and ecosystems). Hubris so construed is problematic because it can lead to detrimental outcomes. This version of the concern complements the ecological and health concern, and there is some merit to it, particularly in regards to introducing revived species into less controlled environments. However, as with the ecological concern, it applies differentially to de-extinction candidates and researchers. Some de-extinctions can be done in ecologically sensitive ways by researchers committed to addressing ecological risks (and who are willing to forgo the de-extinction or introduction if the risks cannot be adequately managed), while other projects and researchers might be hubristic (i.e., the risks might be unwarranted or those involved might not be adequately responsive to them).

In the second version, biotechnologies are hubristic because they involve control-oriented fixes that treat the effects of problems, rather than address the social and behavioral causes of the problems. The hubris concern so construed complements the conservation concerns regarding de-extinction (i.e., that de-extinction does not address the causes of extinction and could undermine support for more robust and comprehensive conservation plans and approaches). However, as with the prior hubris concern, this one need not apply to all de-extinction research or projects. De-extinction pursued as

primarily a scientific challenge, with the goal of reviving a culturally valued long extinct species for exhibition would not be a hubristic approach to conservation because it would not be a conservation strategy. Nor would it be hubristic (in the sense at issue) to employ cloning as part of a comprehensive species conservation plan that addressed as well the causes of the species decline. What would be problematic is using de-extinction in lieu of alternative approaches (i.e., as a “techno-fix”) (Crist 2008).

In a third version of the hubris concern, transgenic biotechnology is hubristic because it treats living things as if they are mere genomic pieces or building blocks for us to use and suggests that we can design organisms better than nature can. It thereby expresses arrogance, promotes the idea that we should remake the world as we would like it to be (rather than accommodate ourselves to it), encourages viewing ecological systems as only existing to serve our needs and desires, and involves failing to see nonhuman value in the world. However, this version of the hubris concern assumes, without evidence, that those who engage in (or support) transgenic biotechnology have a highly reductionist view of living things or believe that we ought to remake biological and ecological systems according to our designs. This may be true of some biotechnologists, including some deep de-extinction proponents, but there is no reason to believe that it is true of all (or even most) of them. It is certainly possible to understand and appreciate species as ecologically situated forms of life (and not just genetic resources) and to value them independently from their usefulness to people, while also supporting or developing deep de-extinction. Many proponents of de-extinction emphasize the value of species and are motivated at least in part by wonder and a sense of responsibility toward extinct species (National Geographic 2013). Moreover, there is no evidence or reason to think that engaging in or supporting deep de-extinction will cause people to become reductionistic, less valuing of nature, or more apt to want to engineer ecological systems according to their designs.

For the reasons above, deep de-extinction is not necessarily hubristic. Whether it is depends upon the aims of the de-extinction, how it is pursued, and the motives, intentions, and character of those executing it (Sandler 2007; Crist 2008). If it is pursued as a tool to help design ecological systems as we would want them to be, as an alternative conservation strategy, or to realize our fantasies and assuage our guilt without adequate respect for the value of nature and species or appreciation and responsiveness to the risks involved, then it is hubristic. However, if it is responsibly pursued, motivated by wonder and scientific curiosity, and approached with ecological sensitivity, compassion for the animals involved, and proper perspective on what can be accomplished, then it need not be hubristic.

Deep De-Extinction as Luxury Conservation

Deep de-extinction does not address any pressing ecological or social problems, and it does not make up for past harms or wrongs. As a result, there is not a very strong ethical case (let alone an ethical imperative) for reviving long extinct species or developing the capacity for doing so. However, deep de-extinction is not intrinsically problematic. Moreover, it appears that de-extinction of at least some species could be pursued responsibly (and, in a small number of these cases, reintroduction may even be feasible and valuable). Furthermore, it is technically challenging and scientifically interesting, and there may be substantial social support for reviving some species. Thus, the considerations in favor of de-extinction are largely techno-science-oriented, not conservation-oriented.

Because the ethical case for deep de-extinction is not very strong, it is not urgent that the capacity for it be developed. Moreover, taking on significant costs and risks or funneling scarce resources to pursue it is not justified. Therefore, it is crucial that it not be prioritized over efforts to conserve existing species and that the ecological, animal welfare, conservation, legal, and health concerns regarding it (and associated introductions) are thoroughly addressed. Thus, from an ethical perspective, deep de-extinction is in many respects a luxury. It is fine to pursue if people want, so long as it does not interfere with or compromise ethically important things.

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