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Purposefully Reborn: The Primordial Resurrection

The ground trembles as the large hooves strike the Earth. Reborn from extinction, the glorious mammoth grazes upon the arctic fields, restoring fragile ecosystems. De-extinction, a way of reviving an extinct species, is a chance to rewrite nature's history. With regulation and policy, it won't just be a scientific phenomenon but also a breakthrough in contemporary technology. De-extinction offers opportunities and opens many gateways, advancing biotechnology, broadening biodiversity within environments, and improving our daily lives with the lost wonders of nature. With the right approach, de-extinction could be a powerful tool for nature and humanity.

De-extinction has sparked debate among both the science and ethics communities. Some argue that revived species would disrupt ecosystem resource allocation and raise concerns about animal welfare. Lean Christopher Hunter, Ph.D, a professor of philosophy, states, "[P]ursuing de-extinction may ultimately lead to a reduction in overall species diversity due to resource allocation issues" (Hunter 573-574). Others argue that de-extinction could provide great environmental restoration from keystone species (an organism that helps shape ecosystems). Stewart Brand, the co-founder of Revive & Restore, states, "Some extinct species were important 'keystones' in their region. Restoring them would help restore a great deal of ecological richness" (Brand). Beyond ecological benefits, de-extinction could push the boundaries of biotechnology and contribute to conservation efforts to protect endangered animals, preventing future extinctions.

With both sides having many contradictions, a pragmatic solution would be to reinstate de-extinction because of benefits, but with carefully regulated and set rules and laws on how and when it could be used. Priority should be given to species that offer clear ecological function in ecosystems, scientific improvement in technology, or human ethics and benefits, ensuring that the technology does not disrupt ecosystems or cause inhumane damage to an animal's welfare. De-extinction provides many advantages, such as the possibility of reviving important lost species for the ultimate goal of biodiversity and ecological function.

The revival of keystone species could lead to prominent ecological restoration. Since keystone species play a critical role in ecosystem balance, they should be prioritized for de-extinction. Some examples of keystone species are apex predators and ecosystem engineers. Ferenc Jordán, a Hungarian biologist with an MSc in biology, describes ecosystem engineers as influential on their partners via biotic interactions. For example, decreasing the number of pollinators may harm the interaction of plant species they pollinate. Furthermore, he elaborates that another type of keystone species is a keystone predator, which shapes entire food webs and habitats. Without these keystone species, ecosystems can collapse or be unstable (Jordán). Ecosystems could regain their original ecological functions by restoring keystone species using de-extinction.

By restoring keystone species, ecosystems regain their original functions and rehabilitate further. For example, according to Ben J. Novak, the lead scientist at Revive & Restore, Passenger Pigeons, which went extinct in 1914, were nomadic ecosystem engineers who shaped forest landscapes and increased biodiversity. They would consume small seed-bearing plants and distribute the seeds as droppings falling from the sky, creating massive forest regeneration and fostering a higher level of biodiversity. They would also use canopy thinning (the breaking of branches from overcrowding each other) to allow sunlight to the forest's floor, allowing much vegetation and flowers to grow and attracting significant pollinators and herbivores (Novak). The passenger pigeon undoubtedly impacted the environment. With the loss of the passenger pigeon, forest regeneration and canopy thinning were significantly reduced. This impacted forest biodiversity because seeds could no longer be scattered through the pigeon's aerial droppings, and herbivores/pollinators would find it increasingly difficult to thrive because of the scarce vegetation. The passenger pigeon is one of many examples of how de-extinction of keystone species would greatly benefit the environment. It is crucial to have keystone species within our ecosystem; However, with regard to the powerful tool of de-extinction, certain regulations should be in place to prevent ecological disruptions.

Extinct species (especially long-extinct species) would not all fit into modern environments as they once did. Climate change, habitat destruction, and human expansion have altered ecosystems. It would pose a risk to put an extinct species (especially a recreated/altered one) in an environment where scientists are unsure they would be able to thrive and provide ecological benefits. Matthew H. Slater, Ph.D, a professor of philosophy at Bucknell University describes some pragmatic solutions of what questions scientists should ask when reviving an extinct species: “The question of whether a cloned mammoth is a *genuine* mammoth would in this context depend on whether it plays a sufficiently similar ecological role as did the extinct species” (Slater). After all, the species might not be a one-to-one replica. The woolly mammoth could be completely different and could pose a risk in modern environments, restricting ecological function. These are the pressing dilemmas about the debate, which should ultimately be answered with policy and regulation.

If scientists ensured that the replicas of the species could provide the same function as they once did, they should be revived. Dolly Jørgensen, Ph.D, a professor of history specializing in environmental humanities, has a viewpoint on reintroduction and de-extinction. Reintroduction science provides guidelines for existing species on whether they would successfully be reintroduced in an environment. Candidates of de-extinction should follow these guidelines. A potential candidate can be found by using background studies between the species’ habitat requirements, reintroduction projects of similar species, and the evaluation of present potential sites, and only if the original causes of extinction are removed. These guidelines highlight the benefits of de-extinction and ensure the candidates have a clear ecological role and a suitable habitat to return to without endangering the ecosystem or other species (Jørgensen). The time since a species' extinction should be considered when determining its viability as a candidate. If the species went extinct millions of years ago, there would be conflicts within the modern environment and their ability to adapt. Regulation to only bring species in recent decades would prevent reintroduction conflicts, raising the chance of a species thriving in their environments. Additionally, the guidelines and policy of de-extinction should benefit humans to create value for the species.

The revival of extinct species leads to increased biodiversity; However, scientists should not just randomly revive species because they meet safety guidelines. There must be some kind of benefit to human societies to create value for the species. A prominent advantage of de-extinction is the potential to mitigate climate change and restore ecosystems. Species with these traits should be prime candidates and absolutely be revived. An example of this is the woolly mammoth. Assume the mammoth passed the safety guidelines and was considered a safe species to be revived. Doctor George Church, Ph.D, a geneticist and professor of health sciences and technology at Harvard University, predicts that a woolly mammoth-sized mammal could knock down trees and shrubs within tundras and taigas, allowing the air to cool permafrost (any ground that is completely frozen for two years straight). This trait would help store carbon and methane emissions within the ice, slowing climate change. Furthermore, grazing would remove new seed droppings and compact snow cover, reducing heat-trapping (Church). Melting snow within the Arctic is a great factor in producing $CO2$ emissions, which is increasing climate change. Allowing woolly mammoths (or similar species) to graze and walk in the Arctic could slow climate change, benefiting humans and other animals by providing clean air. De-extinction offers more benefits to humanity than slowing down climate change. It could also be used as a research tool to prevent further extinctions and advance medical or genetic technology.

With the possibility of de-extinction comes promising benefits for medical and genetic advancements. The means of de-extinction uses various methods. Lucia Martinelli, a senior researcher at the MUSE-Science Museum, lists prominent strategies in de-extinction methods as cross-species cloning and genetic engineering (Martinelli). These groundbreaking technologies can potentially revolutionize contemporary medicines, specifically, genetic disorders, advancing regenerative medicine, and combating disease through insights and data gained from extinct species. By harnessing de-extinction as a tool with the strive for human benefit, scientists could improve human lives significantly with medical technology. Not only can de-extinction improve contemporary medical technologies, but it can also advance agricultural opportunities.

Rich opportunities for species to improve agriculture or even plant attributes with de-extinction. Giulia Albani Rocchet, Ph.D, a postdoctoral researcher at the Roma Tre University, was "spurred on by the knowledge that some seeds have the astonishing ability to survive adverse conditions and sprout after decades, even centuries" (Rocchet). By studying currently extinct plants, scientists can deduce why ancient seeds or crops became resilient in the first place, leading to enhancements of modern crops' resilience to diseases and stresses. This would lead to improvements in farms and longevity, ensuring increased harvests. In addition, the biodiversity created by plants could lead to ecosystem growth, which could even attract and promote pollinator populations, ensuring the continued success of crops. The Center for Biology Diversity, a nonprofit organization protecting endangered species, describes greater biodiversity within plants as being more resilient towards weather disturbances, enriching the population with more varieties of food, and improving soil health (CBD). Again, the more biodiversity, the more benefits in ecosystems. De-extinction plays a potentially huge role, and when considering plants or animals carefully, scientists can ensure safe revivals and strive to revolutionize food production and sustainability, making agriculture more adaptable to the ever-looming contemporary challenges like climate change. With regulations and policies, ethical considerations are necessary for successfully implementing de-extinction.

The ethical concerns of de-extinction revolve mainly around three points: the welfare of the revived species in an ecological system, their genetic well-being, and the broader impact on human societies. Building a strong ethical framework can ensure that de-extinction can successfully occur. Scientists should not avoid it completely because of ethical concerns. Adrian Burton, an independent researcher for the Ecological Society of America, describes the Pyrenean ibex. After going extinct because of the mass hunting the Ibex encountered, scientists attempted to revive the subspecies by fusing fibroblasts with the oocytes (the cell in the ovary) with a domestic goat. Although the surrogate mother was successfully able to give birth to a Pyrenean ibex, it died shortly from a lung defect within minutes of birth. This raised eyebrows on whether humanity should bring back extinct species if their quality of life couldn't be guaranteed. The technology scientists used was far from ready, and it was definitely possible to ensure that the species would have ethical living conditions through responsible safety practices. A species with a low success rate of living and maintaining a good quality of life should not be revived; However, the idea of de-extinction should not be relinquished completely. Scientists need to study their outlooks, whether in potential diseases or complications before a species is revived to ensure they can be cloned. Some practices during de-extinction should immediately be discarded: Ronald Sandler, Ph.D, a professor of philosophy and Director of the Ethics Institute at Northeastern University, describes that interspecific cloning has low success rates and often results in abnormal or unhealthy offspring. He suggests that these practices should be eliminated in de-extinction due to the likelihood of genetic imperfections (Sandler). Removing techniques that are considered significantly risky could limit the number of candidates, but is more viable ethically and considers the welfare of animals. Inbreeding is also a great ethical concern with small populations and should be considered.

De-extinct species would initially have small populations, risking genetic bottlenecks, which are events that Hongye Li, Ph.D, a professor of biotechnology at Zhejiang University, describes as " limit[ing] genetic variation in a population and result[ing] in founding populations that can lead to genetic drift." Scientists can prevent inbreeding and introduce genetic diversity by modifying DNA or crossbreeding with closely related species. With safer ethical measures in place, de-extinction can be pursued with the intent of causing as little suffering as possible and in accordance with current animal welfare laws. Not only would de-extinction standards allow for species to be safely revived, but humanity, from an ethical standpoint, has a responsibility to mitigate the damage they have caused to ecosystems.

Humanity must atone for the masses of species that went extinct because of our actions. Sandler suggests that de-extinction could serve as a form of ecological restitution. Many species involved in extinction were driven by human intervention. It is important to note that although it could be considered ethical to restore biodiversity and ecosystems using de-extinction, it should not be the sole substitute for conservation efforts (Sandler). The policy should extend ethical de-extinction efforts towards current species; If people believe that extinction is reversible, they may be less inclined to protect endangered species. Regulations should include using de-extinction as a last resort to revive species and ensure that resources are devoted to preserving species before they disappear. These policies would help the overall ethics concerning de-extinction. If policy and regulation of de-extinction is the right path to follow, there should be enforcement and regulations.

Federal agencies should be the only organizations involved in reviving extinct species. Norman Carlin, an environmental attorney in the Holland & Knight's San Francisco office, suggests that ESA (the Endangered Species Act) policies should be in place to mitigate damage and enforce regulation. One of these policies listed is the obligation to help ensure the survival of listed endangered species. Another policy includes a mechanism by the ESA for reintroducing experimental/endangered populations, which can be utilized for revived species in the wild when the population becomes significant (Carlin 17). Numerous policies by the government could provide and regulate successful de-extinction. The jurisdiction of legislation for de-extinct candidates and species should fall into the hands of trusted biologists, philosophers, and federal organizations.

Transparency and public interest are crucial to consider in the de-extinction policy. It is quite conspicuous that de-extinction should follow transparency laws and be publicized with many aspects, including failures, ecosystem change, and laws; However, strict policies should be implemented to prevent de-extinct species from being used for profit in entertainment, tourism industries, and collections. De-extinct species should not be used like Jurassic Park attractions and cannot be commercialized. The European Patent Convention, an international organization within Europe, explains that "[P]atents shall not be granted for inventions where their 'commercial exploitation is against public order or morality." The law specifically mentions that inventions in biotechnology regarding the modification of and commercialization in patents that could cause suffering without any substantial medical benefit to man or animal cannot be patented (European Patent Convention 98/44 EC. Art 6(1), Art 6(2)). Although this suggests biotechnology, the law could also be applied to a policy in revived organisms where they should not be displayed among the public as an attraction or a way to be commercialized to make money. Despite significant evidence that de-extinction could succeed with good regulation and policies, critics still claim that de-extinction is a suboptimal idea.

Some critics claim that even with safety protocols and scientific benefits, resulting organisms wouldn't be identical to their ancestors, therefore creating less value in the species themselves in nature. Lean describes the concept of nature as a powerful teleological force. That power of nature causes the acts of control in nature to diminish in value (Lean). Furthermore, Helena Siipi, a University Lecturer of Philosophy at the University of Turku, describes that de-extinct populations could raise concerns as being inauthentic and, therefore, a result of diminished value to the original. She furthers her claim with an example: "If we found out an indiscernibl[e] identical piece of artwork was a forgery, we would value it less. The artwork needs to possess the right identity to be of value" (Siipi). Because of the resulting claims that the revived species would be valued less within the power of nature, the critics believe that when an ecosystem is restored, species will have its own trajectory in its environment. If people see ecological landscapes as having value derived from whether the landscape was made by humans or nature, then this argument could prove true. However, although a species may be inauthentic due to its de-extinct nature, function is one of the prime factors in deciding whether a species can be revived. Sandler disregards the fact that de-extinct species would be of less value. He claims that scientific and technological achievements would create value in de-extinction. Moreover, he explains that the majority of the population would find it wondrous to see a mammoth or thylacine (Sandler). So, although some critics claim that the population would value de-extinct creatures less because of their unnatural nature, the function of de-extinct species in restoring biodiversity and ecological function would create intrinsic value and ultimately be the same or even more valuable. This furthers the point that when reviving extinct species, they should have a function benefiting humans and creating value for the population. It should also be noted that the examples above (ie, the passenger pigeon) are significant examples of how a species could create and maintain value within humanity and ecosystems. De-extinction, despite some critics' remarks, is a completely viable option with regulations and policies.

De-extinction presents groundbreaking opportunities to restore ecosystems, advance biotechnology, and benefit human society overall. However, its success is crucially determined and dependent on the hinges of responsible safety and ethical concerns. With oversight by federal organizations of the government, composed of biologists, philosophers, and geneticists, who determine whether they are used for human benefit -- not a commercialized attraction -- de-extinction could become one of the most significant scientific advancements offering repairing damaged ecosystems and advancing technology, paving the way for a more sustainable future. It is imperative that de-extinction is used to our advantage with regulations and guidelines.

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