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Bringing Dinosaurs Back: The Moral & Legal Complications

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BRINGING DINOSAURS BACK: THE MORAL & LEGAL COMPLICATIONS

By
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From Hollywood blockbusters to your local natural history museums, dinosaurs have captured the attention and wonder of the public for decades. The possibility of bringing these long extinct creatures back, once a science-fiction fantasy, is now closer to reality than ever before through a process known as "de-extinction." This Article dives into the exploitative nature inherent in the de-extinction of dinosaurs, studying the University of Montana's Dr. Jack Horner's "dinochicken project" and the moral considerations implicated when conducting mass genetic engineering on sentient beings. The Article then centers itself on the ecological and legal complications likely to arise if a dinosaur de-extinction project, such as Dr. Horner's, is successful. Ultimately, although "bringing dinosaurs back" would certainly bring the dreams of many to life, the consequences in doing so suggest today's world would greatly benefit from leaving these prehistoric creatures in the past.

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I. Introduction

Dinosaurs once roamed the earth for about 165 million years, reigning as the supreme megafauna of a planet with an evolving cli-

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mate.[1] Dinosaurs primarily thrived throughout the Jurassic and Cretaceous periods, becoming especially dominant during the Cretaceous period.[2] The Jurassic period was filled with lush tropical forests from frequent rains, flooding, and a warm climate, with well-known dinosaurs like the Stegosaurus and Allosaurus roaming present-day Colorado and Utah.[3] The warm, wet climate of the Jurassic period continued into the Cretaceous period, introducing a steady ecosystem that supported magnolias, lilies, ants, butterflies, and termites, along with the Triceratops and the Tyrannosaurus Rex.[4] Dinosaurs frequently migrated due to active volcanic activity, earthquakes, and extreme heat, leading to many species' global presence.[5]

The dinosaur era ended sixty-five million years ago in a mass-extinction event, leaving only fossils of the massive creatures that once dominated the planet.[6] However, conversations regarding the 'resurrection' of the dinosaurs have been ongoing for decades, becoming a popular topic of public interest following the Hollywood blockbuster *Jurassic Park* in 1993.[7] Since *Jurassic Park* and its sequels portraying the revival of dinosaurs and the subsequent consequences hit theaters,[8] science and technology have made incredible advances—making the resurrection of extinct species not as far-fetched as it once seemed.[9] The process is known as *de-extinction*, and, in regards to dinosaurs, is some paleontologists' dream and some ecologists' worst nightmare.[10] Proponents of the de-extinction of dinosaurs argue mankind is under a "duty" to bring dinosaurs back if technology has suffi-

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1 *When Did Dinosaurs Become Extinct?*, USGS, https://perma.cc/V2YX-7AFQ (accessed Feb. 7, 2023); *What Was the Climate Like When Dinosaurs Lived*, ACT LIBR., https://perma.cc/C3C3-8QX3 (accessed Jan. 30, 2023); C. Wang et al., *An Unbroken Record of Climate During the Age of Dinosaurs*, EOS (May 17, 2021), https://perma.cc/MLL3-RVEV (accessed Feb. 24, 2023).

2 *What Was the Climate Like When Dinosaurs Lived*, *supra* note 1.

3 *Id*.

4 *Id*. Temperatures from the Northern to the Southern Hemisphere remained unchanged throughout the Cretaceous period, at approximately ten degrees higher than current temperatures today. Emily Osterloff, *Could Scientists Bring Dinosaurs Back to Life?*, NAT. HIST. MUSEUM, https://perma.cc/P99Y-DUFT (accessed Feb. 24, 2023).

5 *What Was the Climate Like When Dinosaurs Lived*, *supra* note 1; Osterloff, *supra* note 4.

6 *When Did Dinosaurs Become Extinct?*, *supra* note 1; Osterloff, *supra* note 4; *Extinction Events*, NAT'L PARK SERV., https://perma.cc/ERQ7-LFCY (last updated July 8, 2022) (accessed Feb. 24, 2023).

7 *See generally* Andrew Maynard, *Jurassic Park: The Rise of Resurrection Biology*, MEDIUM (Aug. 26, 2018), https://perma.cc/Z76Z-VT59 (accessed Jan. 30, 2023) (describing how *Jurassic Park* illustrates the field of de-extinction); JURASSIC PARK (Universal Pictures & Amblin Entertainment 1993).

8 JURASSIC PARK, *supra* note 7.

9 Maynard, *supra* note 7.

10 *Neuralink Cofounder: We Can Bring "Exotic" Dinosaurs Back to Life Now,* MIND MATTERS (Apr. 10, 2021), https://perma.cc/587Z-4YTL (accessed Jan. 29, 2023) [hereinafter *Neuralink Cofounder*].

ciently advanced to give us the ability to do so.[11] Further, proponents argue the re-existence of dinosaurs would positively influence and redefine the general population's "attitudes toward the natural world."[12] These changed attitudes could sway national governments to implement more environmental protections and policies toward the major environmental issues of today, such as animal welfare and climate change. Meanwhile, conservationists argue the re-introduction of a species long extinct like the dinosaurs would "functionally be the same as introducing a new invasive species to an ecosystem no longer equipped to support it."[13]

Dinosaurs existed millions of years ago, long past the date of scientifically recognized viable DNA for genetic engineering,[14] begging the question if "bringing the dinosaurs back" is even possible, much less relevant. In a recent panel, Dr. Jack Horner, the widely successful paleontologist who inspired *Jurassic Park*'s main character, Dr. Grant, stated that technology will be capable of resurrecting dinosaurs sometime between 2020 and 2025.[15] This Article explores the moral and legal implications of bringing dinosaurs back from extinction, and whether mankind should revive dinosaurs at all. Section II discusses the background science and progress made toward the de-extinction of dinosaurs. Section III then explores the morality behind de-extinction; Part A discusses the ethics behind the primary form of de-extinction, genetic modification, Part B focuses on the differences between the dinosaurs' and today's ecosystems, and Part C examines the potential effects dinosaurs would have on today's ecosystems. Section IV discusses dinosaurs' place in today's legal world, focusing on applicable environmental regulations, as well as patent law. This Article concludes that bringing dinosaurs back would be unnecessarily cruel and harmful to the dinosaurs, their parent species, and today's ecosystems.

II. Scientific Possibility or Science Fiction Fantasy?

As *Jurassic Park* depicts, scientists like Dr. Horner initially believed that the studying and cloning of dinosaur DNA would be the key to bringing dinosaurs back from extinction.[16] Scientists have tested the cloning of DNA for purposes of de-extinction with other extinct spe-

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[11] Vincent Billard, *Why Not Play God?*, *in* JURASSIC PARK AND PHILOSOPHY: THE TRUTH IS TERRIFYING 53, 60 (Nicolas Michaud & Jessica Watkins eds., 2014) ("Why on earth would technology give us the power of de-extinction, if it is not to be used?").

[12] *Id*. at 61.

[13] *Neuralink Cofounder*, *supra* note 10.

[14] Geraint Perry, *Jurassic World. Just How Impossible Is It?*, 37 BIOCHEMICAL SOC'Y 18, 18 (2015).

[15] Brandon Davis, *Dinosaurs Should Be Coming Back Between Now and 2025*, COMICBOOK (June 16, 2020, 6:37 PM), https://perma.cc/D7LN-UYW9 (accessed Jan. 26, 2023).

[16] *Id.*; JURASSIC PARK, *supra* note 7.

cies, with the first test species becoming officially de-extinct in 2003.[17] The bucardo, a large wild goat that inhabited the mountain range between France and Spain, went extinct in 2000 due to over-hunting.[18] The last living bucardo was Cecilia, who scientists monitored in the wild until her death.[19] Following her death, scientists preserved her cells and injected them into 'empty' goat eggs, which researchers then implanted into fifty-seven surrogate goats.[20] Only seven of these goats became pregnant, with six ending in miscarriages and one goat carrying the pregnancy to term; Cecilia's clone was born in 2003, only to pass away ten minutes later due to internal organ complications.[21] The 're-birth' of the bucardo, albeit short-lived, marked the first species to come close to becoming de-extinct through scientific manipulation.[22]

In 2015, however, researchers ruled this path out for dinosaurs following the discovery of red blood cells inside a Cretaceous period dinosaur fossil.[23] After sectioning the cells and studying them, researchers determined there was no viable DNA within the cells.[24] The researchers concluded the presence of dinosaur DNA in fossils, or in a mosquito preserved in amber like in *Jurassic Park*, is incredibly unlikely due to its age and natural fragility.[25] Dinosaur DNA predates the oldest viable DNA discovered and used—mammoth DNA—by millions of years.[26]

In fact, dinosaur DNA would be sixty-six times older than the oldest DNA discovered, and twenty-two times older than the oldest viable DNA discovered.[27] Furthermore, DNA is naturally vulnerable to environmental forces, like water and sunlight, and deteriorates rapidly.[28] Even if viable dinosaur DNA was discovered, scientists noted that the DNA would likely be fragmented, meaning the amount would be insufficient to accurately replicate the genome, or the complete set of DNA, of a dinosaur.[29] Thus, following the 2015 study's results, researchers

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[17] Carl Zimmer, *Bringing Them Back to Life: The Revival of an Extinct Species is No Longer a Fantasy. But is It a Good Idea?*, NAT'L GEOGRAPHIC (Apr. 2013), https://perma.cc/72AA-WN5T (accessed Jan. 30, 2023).

[18] *Id*.

[19] *Id*.

[20] *Id*.

[21] *Id*.

[22] *Id*.

[23] Osterloff, *supra* note 4.

[24] *Id*.

[25] *Id.*; JURASSIC PARK, *supra* note 7.

[26] Perry, *supra* note 14, at 18.

[27] *Id*.; Osterloff, *supr*a note 4.

[28] Osterloff, *supra* note 4.

[29] *Id*. *See* Adele Ankers, *Possible Dinosaur DNA Discovered in 125-Million-Year-Old Fossil*, IGN (Oct. 27, 2021) https://perma.cc/QMQ5-ADXX (last updated Oct. 27, 2021) (accessed Feb. 3, 2023) (discussing results from a recent experiment that was conducted on an 125-year old dinosaur fossil where experts warned that the staining technique used was "not precise enough to indicate whether certain compounds are present").

concluded it would be extremely challenging to recreate dinosaurs using dinosaur DNA.[30]

Even though the initial and popular theory of resurrecting dinosaurs through DNA cloning is now scientifically recognized as likely impossible, scientists have continued to pursue alternative methods of dinosaur de-extinction. A newer method is "reverse engineering," or the process of manipulating the DNA of existing species with dinosaur ancestors.[31] Already successful with mice and flies, it is this same process that Dr. Horner and his team of researchers and paleontologists at the University of Montana are utilizing in their "dinochicken" project.[32] The dinochicken project is Dr. Horner's attempt to transform chickens, natural ancestors of dinosaurs, into dinosaurs through the reverse-engineering of chicken embryos.[33] Researchers are essentially re-programming chicken embryos to form teeth, forearms and a tail by altering the "levels of regulatory proteins that have evolved to suppress these characteristics in birds."[34] In 2015, Dr. Horner announced that his team had successfully transformed a chicken's beak into a dinosaur's mouth, complete with sharp teeth.[35] With both the hands and snout complete, the tail is the last component remaining for the dinochicken project's success, which Dr. Horner states is just a matter of funding, as researchers have nearly resolved the scientific technicalities.[36] The dinochicken project is now over fifty percent complete.[37]

However, the genetically modified dinochicken will only look like a dinosaur, likely lacking the behavioral and vocal characteristics of its dinosaur ancestors.[38] Dr. Horner posits that the anatomical changes to the dinochicken may, however, lead to the evolution of such similar behaviors and characteristics over time.[39] For example, adding a tail

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[30] Osterloff, *supra* note 4.

[31] Jennifer Viegas, *'Dinochicken' Scheme Puts Evolution in Reverse*, NBC NEWS (Mar. 5, 2009), https://perma.cc/9NMX-5VXJ (accessed Feb. 3, 2023).

[32] *Id*. *See also, The "Dino-Chicken" Project*, EVERYTHING DINOSAUR (Mar. 7, 2009), https://perma.cc/N2UL-RHZL (accessed Feb. 3, 2023) ("Project leader Jack Horner referring to the plan to reverse engineer a chicken embryo suggested that the American team would create a 'chickenosaurus' or perhaps a 'dinochicken.'").

[33] Viegas, *supra* note 31.

[34] *Id*.

[35] Jeff St. Clair, *How to Find the Dinosaur Lurking Inside Your Chicken*, IDEASTREAM PUB. MEDIA (Jan. 20, 2016, 1:31 PM), https://perma.cc/AVM9-NKZX (accessed Feb. 5, 2023). *Cf.* Bhart-Anjan S. Bhullar et al., *A Molecular Mechanism for the Origin of a Key Evolutionary Innovation, the Bird Beak and Palate, Revealed by an Integrative Approach to Major Transitions in Vertebrate History* 69 EVOLUTION 1665, 1668 (2015), https://perma.cc/PB3W-V7XB (accessed Feb. 5, 2023) (noting that the modified beak had some rudimentary teeth).

[36] *My "DinoChicken" Project Interview with Jack Horner*, DINOSAUR CULTURE, https://perma.cc/7L9U-KA3T (accessed Jan. 29, 2023) [hereinafter *Interview with Jack Horner*].

[37] Lauren Geggel, *Dino-chicken Gets One Step Closer*, LIVE SCI., https://perma.cc/WEC8-XMTM (last updated July 6, 2021) (accessed Jan. 29, 2023).

[38] *Interview with Jack Horner*, *supra* note 36.

[39] *Id*.

will could alter a chicken's sense of gravity, which would change the way the chicken naturally moves.[40] This will affect how high the chicken's head is from the ground, which would likely impact how the chicken hunts for prey.[41] Concerning vocalization, the dinochicken will evolve a new and different vocalization than that of a chicken, because sound travels differently through a beak than it would through a snout with teeth.[42] Ultimately though, Dr. Horner admits he has "no idea" what these genetic modifications will do to a chicken's behavior, but predicts the dinochicken will eventually look and act similar to a dinosaur like the Velociraptor, thus essentially bringing dinosaurs back to Earth.[43]

III. Morality – Unnecessarily Cruel or Ecological Duty?

Resurrecting a species that has been extinct for millions of years reveals several issues regarding morality. The scientific process of de-extinction raises welfare concerns and potential animal rights' violations for the 'parent' species undergoing genetic modification procedures.[44] However, the development and advancement of genetic modification has potential benefits in relation to medical science involving spinal cord birth defects.[45] Some paleontologists consider the de-extinction of dinosaurs to also be cruel to the dinosaurs themselves, whose ecosystems have long evolved since their existence,[46] with the alternative of placing dinosaurs in zoo-like enclosures triggering further welfare concerns.[47] Furthermore, the ramifications of reintroducing dinosaurs into today's ecosystems are massive, with the potential to negatively impact currently existing species, functionally acting as invasive species.[48] Others counterargue that the re-introduction of extinct species may potentially restore ecosystems.[49] Ultimately, the resurrection of dinosaurs is an immoral and cruel manipulation of science with multiple negative implications that outweigh any potential benefits.

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[40] *Id*.

[41] *Id*.

[42] *Id*.

[43] *Id*.; Davis, *supra* note 15.

[44] *See Biotechnology*, BBC, https://perma.cc/DCL6-AUPN (accessed Jan. 24, 2023) (describing the animal rights and welfare implications of genetic engineering).

[45] *Interview with Jack Horner*, *supra* note 36; Viegas, *supra* note 31.

[46] Steve Brusatte, *A Paleontologist Explains Why Bringing Back Dinosaurs is a Really Bad Idea*, SALON (June 24, 2018, 7:30 PM), https://perma.cc/KK66-Q7JG (accessed Jan. 30, 2023).

[47] *Animals for Entertainment*, BBC, https://perma.cc/XU4U-JARL (accessed Jan. 30, 2023).

[48] *Neuralink Cofounder*, *supra* note 10.

[49] Breanna Draxler, *5 Reasons to Bring Back Extinct Animals (And 5 Reasons Not To)*, DISCOVER MAG. (Apr. 4, 2013, 11:36 AM), https://perma.cc/V55L-UYPQ (accessed Jan. 30, 2023).

A. The Ethics of Genetic Modification

There are three primary methods of de-extinction: reverse engineering, genetic engineering, and cloning.[50] Reverse engineering, previously briefly discussed,[51] uses a "living species that is genetically similar to the extinct species [to] selectively breed it for traits of the now-extinct species."[52] Genetic engineering and cloning both require viable DNA or cell nuclei from the extinct species, which is likely nonexistent in the case of dinosaurs.[53] Thus, reverse engineering, which uses birds as the genetically similar living species, is the current primary method in researchers' attempts to resurrect dinosaurs.[54] Birds evolved from dinosaurs and still have similar DNA and behavioral traits to their prehistoric ancestors; birds, like dinosaurs, hunt with their talons, display extravagant feathers in mating practices, and rely on advanced senses of sight and smell to navigate their surroundings.[55] As Dr. Horner and other proponents of de-extinction argue, genetically modifying birds to resemble their dinosaur ancestors raises no more moral concerns than other types of genetic modification because "[b]irds are dinosaurs, so technically we're making a dinosaur out of a dinosaur."[56]

However, the process behind "making a dinosaur out of a dinosaur" is not as simple and painless as it sounds. Genetic modification experiments typically require a large amount of animal 'test subjects' to undergo incredibly invasive procedures.[57] Invasive surgical procedures, such as vasectomies and surgical embryo transfers, are common.[58] While the technology behind genetic engineering is advancing, these techniques are currently "relatively inefficient," causing an excessive amount of animals to undergo these procedures to effectuate a successful result.[59] For example, surrogate animals implanted with genetically engineered embryos typically do not result in a successful pregnancy, and if they do, less than a third of the offspring carry the desired genetic alteration.[60] Thus, invasive, and often harmful, genetic modification experiments are conducted on a vast number of animals

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[50] *Id*. Draxler uses the term "backbreeding" in place of reverse engineering, but the terms describe the same process. *Cf.* Viegas, *supra* note 31 (describing the process of reverse engineering to achieve de-extinction).

[51] *See* discussion *supra* Section II (discussing the science behind and the progress made toward the de-extinction of dinosaurs).

[52] Draxler, *supra* note 49.

[53] *Id*.

[54] Viegas, *supra* note 31.

[55] Brusatte, *supra* note 46.

[56] Viegas, *supra* note 31; Michael Casey, *Scientists Engineer Chickens with Dinosaur Snouts*, CBS NEWS (May 14, 2015, 4:47 PM), https://perma.cc/RTQ3-RNBS / (accessed Feb. 24, 2023).

[57] Elisabeth H. Ormandy et al., *Genetic Engineering of Animals: Ethical Issues, Including Welfare Concerns*, 52 CAN. VETERINARY J. 544, 546–47 (2011).

[58] *Id*. at 546.

[59] *Id*. at 547.

[60] *Id*.

in order to 'perfect' the technique and achieve the desired result, causing a mass exploitation of animals.[61]

Furthermore, these manipulative experiments for the benefit of human interests require a disregard of the intrinsic value of an animal and their rights.[62] The concept of the intrinsic values of living beings is not new: the early philosopher Aristotle defined it as "telos," or the ultimate reason, essence, and purpose for each living thing's natural existence.[63] Aristotle recognized that telos extends beyond humankind and applies to animals as well.[64] Bernard Rollin, an American philosopher and professor at Colorado State University,[65] describes telos in relation to animal ethics as "at root a moral notion, both because it is morally motivated and because it contains the notion of what about an animal we *ought* to at least try to respect and accommodate."[66] Interests thus "flow" from an animal's telos, such as maintaining the animal's integrity and dignity.[67]

The genetic modification of animals to serve purely human interests negatively affects an animal's telos and infringes upon an animal's inherent integrity and dignity.[68] This principle has been legally recognized by the Switzerland Constitution, which requires the "dignity of creation" to be respected in genetic engineering projects.[69] Disrespect to the dignity of creation can include any intervention in appearance, degradation, or excessive instrumentalization.[70] Thus, to genetically modify birds to possess dinosaur characteristics, such as an alligator

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61 *See id*. ("Although the technology is continually being refined, current genetic engineering techniques remain relatively inefficient, with many surplus animals being exposed to harmful procedures.").

62 *Biotechnology*, *supra* note 44.

63 Ormandy et al., *supra* note 57, at 548; Tad Brennan, *Telos*, ROUTLEDGE ENCYCLOPEDIA PHIL., https://perma.cc/FJ73-NLEE (accessed Jan. 28, 2023).

64 Michael Wilson, *How Did Aristotle Derive Ethics from Telos?*, RESTAURANT NORMAN (June 3, 2021), https://www.restaurantnorman.com/how-did-aristotle-derive-ethics-from-telos/ (accessed Jan. 28, 2023); David Grumett, *Aristotle's Ethics and Farm Animal Welfare*, 32 J. AGRIC. & ENV'T ETHICS 321, 321 (2019).

65 *Bernard Rollin*, COLO. STATE UNIV., https://perma.cc/Q3XL-UP7J (accessed Jan. 29, 2023).

66 Ormandy et al., *supra* note 57, at 548.

67 *Id*.

68 *See generally id.* (arguing that genetic modification of animals violates species' integrity and disregards their inherent value as animals).

69 *Bundesverfassung* [BV] [Constitution] Apr. 18, 1999, SR 101, art. 120, para. 2 (Switz.) ("The Federation adopts rules on the use of reproductive and genetic material of animals, plants, and other organisms. It takes thereby into account the dignity of the creature and the security of man, animal and environment, and protects the genetic multiplicity of animal and plant species."); Ethics Comm. for Animal Experimentation of the Swiss Acad. of Arts and Sci., THE DIGNITY OF ANIMALS AND THE EVALUATION OF INTERESTS IN THE SWISS ANIMAL PROTECTION ACT, 3 (2010) [hereinafter THE DIGNITY OF ANIMALS].

70 THE DIGNITY OF ANIMALS, *supra* note 69, at 7.

tail and sharp teeth, would conflict with birds' telos and disrespect their inherent value and dignity.[71]

Proponents of genetic modification and de-extinction, however, argue that any potential ethical complications are outweighed by the technological advancements, scientific knowledge, and benefits to the medical community such research provides.[72] De-extinction science offers insight into evolution and mass extinction events, which scientists say is needed in the face of climate change today, with extinction rates as high as those in the Cretaceous Period.[73] Further, dinosaur de-extinction projects, like the dinochicken project, provide valuable research into spinal cord growth and development, as genetically modifying a tail onto a chicken involves promoting the growth of the spinal cord.[74] Learning "what prompts and stops tail growth," scientists argue, could lead to medical advancements relating to spinal cord birth defects.[75] Proponents of dinosaur de-extinction believe the genetic modification of birds is "awaken[ing] the dinosaur within," while also providing significant knowledge and technological advancements to the scientific and medical communities.[76] However, in comparison to the cruel and harmful effects of genetic modification experiments, these benefits are minute.

B. Submersion into Today's Ecosystems

The reintroduction of dinosaurs into today's world raises significant moral questions about the potentially resurrected dinosaurs' well-being. Steve Brusatte, a paleontologist at the University of Edinburgh, believes bringing back dinosaurs would "simply be cruel."[77] If, in the future, technology sufficiently advanced to clone or genetically engineer dinosaurs like the Tyrannosaurus Rex or Triceratops, Brusatte argues these dinosaurs would be subjected to an unfamiliar and uninhabitable environment.[78] The dinosaurs lived in a constantly warming climate, where average global temperatures were 4° C higher than to-

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71 *See* Davis, *supra* note 15 (describing the dinochicken project to result in "a chicken with dinosaur teeth and an alligator tail").

72 *See generally* Draxler, *supra* note 49 (describing the benefits of genetic modification science). *See also* Viegas, *supra* note 31 (depicting the medical science benefits from dinosaur de-extinction projects).

73 Sherryn Groch, *'The De-Extinction Club': Could We Resurrect Mammoths, Tassie Tigers and Dinosaurs?*, SYDNEY MORNING HERALD (July 25, 2021), https://perma.cc/3K4P-943Z (accessed Jan. 26, 2023) (discussing how the world is experiencing a similar mass extinction event as in the dinosaur age, but because this extinction is anthropogenic, "extraordinary intervention" is needed beyond relying on nature to "fill[ ] the vacancies from a big extinction event like this." In the article, paleontologist Michael Archer argues that de-extinction science is the solution to conservation struggles and the climate crisis).

74 Viegas, *supra* note 31.

75 *Id*.

76 *Id*.

77 Brusatte, *supra* note 46.

78 *Id*.

day's global temperatures, and varied little between high and low latitudes.[79] Ice caps were nonexistent, oceans were stagnant and extended further onto land, and ocean temperatures averaged at 14° C higher than today's global ocean temperatures.[80]

Dinosaurs, Brusatte argues, would struggle to even breathe in the modern world.[81] The dinosaur age experienced rising oxygen levels in its atmosphere, reaching a peak of 30%.[82] In comparison, today's oxygen level is 21%.[83] Carbon dioxide levels during the dinosaur age were also considerably higher, over four times higher than today.[84] As a result, vegetation was also different, with grasslands and flowers just beginning to evolve.[85] Susannah Maidment, senior researcher at the Department of Earth Sciences at the Natural History Museum, argues the difference in vegetation would be detrimental to herbivores like the Stegosaurus, whose primary diet consisted of plants that went extinct "hundreds of millions of years ago."[86] Introducing dinosaurs into today's ecosystems would thrust them into unfamiliar habitats with a climate, atmosphere, and food chain unsuitable to support them.

The likely alternative would be to place cloned, or genetically modified species like the dinochicken, into zoo-like enclosures, as depicted in *Jurassic Park*,[87] which raises even more ethical concerns. Zoos strip animals of their natural habitats, often placing them in enclosures without adequate space, force animals to be consistently exposed to other species, and deprive many animals of their natural societal structure and necessary intraspecies companionship.[88] The unnatural captivity enshrined in zoos has led to many species developing "zoochosis," a mental illness causing captive animals to behave abnormally and, often times, to their own detriment.[89] Dinosaurs would

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[79] *Id.*; Charles Owen-Jackson, *Could Dinosaurs Live in Today's Environment?*, EARTHLY UNIVERSE (June 28, 2017), https://perma.cc/8FDD-RQQJ (accessed Jan. 26, 2023).

[80] Brusatte, *supra* note 46; Owen-Jackson, *supra* note 79.

[81] Brusatte, *supra* note 46.

[82] Owen-Jackson, *supra* note 79 (noting the high-oxygen level of the dinosaur age's atmosphere may have contributed to the massive size of some dinosaurs).

[83] Cheryl Hosmer, *How to Measure the Oxygen Level in the Air*, SCIENCING (Apr. 25, 2017), https://perma.cc/6D2G-GA9F (accessed Jan. 27, 2023).

[84] Owen-Jackson, *supra* note 79.

[85] Brusatte, *supra* note 46.

[86] Ed Browne, *Can Dinosaurs Be Brought Back to Life Via Cloning? Experts Explain*, NEWSWEEK (Aug. 6, 2021, 11:42 AM), https://perma.cc/3HXG-NUE8 (accessed Jan. 29, 2023).

[87] *See generally* Brusatte, *supra* note 46 (explaining that the habitat environments when dinosaurs lived naturally were different than today's environments); Alicia Pack, *Why Jurassic Park is a Terrible Zoo and Dangling Cows Like Tea Bags is a Bad Idea*, DAILY DRAGON (Sept. 3, 2022, 2:00 PM), https://perma.cc/LM9L-TERU (accessed Feb. 25, 2023) (listing the defective animal care and enclosures utilized for dinosaurs in the film).

[88] *Animals for Entertainment*, *supra* note 47.

[89] *See Experts Agree: Zoos Do More Harm Than Good*, IN DEF. ANIMALS (May 2021), https://perma.cc/5H7T-FS7J (accessed Jan. 30, 2023) (listing symptoms of zoochosis, which include self-harm, eating disorders, and heightened aggression).

likely experience the same fate if placed in captivity because of their ecologically similar social and behavioral patterns with today's zoo animals.[90]

In regard to adequate enclosure sizes, aviaries within zoos, for example, do not provide enough space for birds to fly for more than "a few seconds" at a time, or even at all.[91] Most species of birds, however, fly several miles a day; migratory birds typically fly anywhere from 15 to 600 miles in a day.[92] In comparison, studies of flying dinosaurs' fossils, like Pterosaurs, revealed flight ranges between 8,000 and 12,000 miles.[93] Thus, the "short bursts" of flight that aviaries provide is inadequate to support the range and amount of flights birds and flying dinosaurs inherently need.[94]

By being placed in zoos, some animals are also constantly exposed to their historical predators through sight, smell, and/or sound.[95] Constant exposure to historical predators leads to persistent stress in captive prey species, causing abnormal changes in behavior and physiology.[96] For example, prey species like rats, voles, spotted frogs, crayfish, beavers, hedgehogs, cotton-top tamarins, and elk can experience heightened plasma levels of stress hormones, higher blood pressure, more frequent defensive behavior, and long-term changes in anxiety-like behavior from consistent exposure to their respective historical predators' odors in captive conditions.[97] Similarly, dinosaur prey species like the Triceratops would likely be exposed to a potential historical predator, the Tyrannosaurus Rex, in a zoo-like system.[98] As a result, the Triceratops, much like beavers and rats, would likely experience heightened levels of stress and abnormal changes in behavior.[99]

The hindrance of natural herd behavior and social isolation in captive species also induces increased stress levels and detrimentally al-

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[90] *See generally* McGill University, *Retracing the Tracks of Dinosaurs Reveals Ecosystem the Size of a Continent*, SCI. DAILY (Apr. 22, 2010), https://perma.cc/5MZJ-JPM3 (accessed Jan. 30, 2023) (noting the ecological similarity of dinosaurs with mammals of today).

[91] CRAIG REDMON, BIRDS IN ZOOS IN ENGLAND: AN ASSESSMENT OF WELFARE, CONSERVATION AND EDUCATION IN 2013 43 (2015).

[92] Joe Lowe, *Five Fantastic Bird Migration Facts*, AM. BIRD CONSERVANCY (May 10, 2019), https://perma.cc/9Z3K-UWR8 (accessed Jan. 30, 2023).

[93] Reid R. Frazier, *Peerless Pterosaur Could Fly Long-Distance for Days*, NPR (Nov. 22, 2010, 12:01 AM), https://perma.cc/R79X-RVXZ (accessed Jan. 30, 2023).

[94] REDMON, *supra* note 91, at 43.

[95] Kathleen N. Morgan & Chris T. Tromborg, *Sources of Stress in Captivity*, 102 APPLIED ANIMAL BEHAV. SCI. 262, 267 (2007).

[96] *Id*.

[97] *Id*. at 271.

[98] *See* Natalie Wolchover, *What Did T. Rex Eat? Grazers? Rotting Meat? Itself?*, LIVE SCI. (Feb. 22, 2011), https://perma.cc/YR52-9YVD (accessed Jan. 23, 2023) (comparing the scientific theories that Tyrannosaurus Rexes were either hunters of "grazing species such as Triceratops" or were "opportunistic predators" like today's hyenas, eating carrion).

[99] Morgan & Tromborg, *supra* note 95, at 271.

ters animals' behaviors.[100] Elephants, for example, are a socially complex species that often exist in herds, and have been recorded to form social bonds, greet, and play with one another in the wild.[101] However, multiple zoos have been reported to split up captive elephant families, fail to maintain the minimum number of elephants required in an enclosure, or hold elephants in complete isolation.[102] As a result, captive elephants generally maintain shorter lifespans than their wild counterparts and experience severe psychological effects, like distress, repetitive behaviors, and increased aggression.[103] Captive dinosaurs with similar social needs and herding behaviors, like the Deinonychus, could experience similar effects if placed in zoos.[104] Thus, zoos are not an ethical alternative to introducing dinosaurs into today's ecosystems, and both would negatively impact dinosaurs' quality of life.

C. Affecting Existing Ecosystems

The reintroduction of dinosaurs, or genetically modified species resembling and behaving like dinosaurs, into today's ecosystems may negatively impact existing species and their environments.[105] There is a strong chance dinosaurs would act as invasive species, a prevalent issue in today's world already.[106] Invasive species are non-native species to a region that cause, or will likely cause, environmental harm.[107] Invasive species tend to overcome their host environment because they outcompete native species for food and lack natural predators in that environment.[108] For example, the bighead and silver carp are invasive fish species within the Missouri River that outcompete listed native fish species, like the paddlefish, for plankton due to their faster feeding cycle.[109] Another example is the brown tree snakes' invasion into

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[100] *Id*. at 284–85.

[101] Naomi D. Harvey et al., *Social Interactions in Two Groups of Zoo-Housed Adult Female Asian Elephants (Elephas maximus) that Differ in Relatedness*, 8 ANIMALS 132, 133 (2018).

[102] Katie Valentine, *Animal Welfare in Zoos: The 10 Worst Zoos for Elephants,* LADY FREETHINKER (Jan. 28, 2020), https://perma.cc/6Z5T-UEQE (accessed Jan. 23, 2023) (Both a New York and a San Diego Zoo have split up bonded elephants; meanwhile, a zoo in Utah has repeatedly failed to maintain its required minimum of three elephants per enclosure. A zoo in Virginia has also been reported to have held an elephant in isolation for nearly twenty years).

[103] *Elephants Live Longer in the Wild, Study Shows*, AFRICAN WILDLIFE FOUND. (Dec. 12, 2008), https://perma.cc/4BXS-47PK (accessed Jan. 23, 2023).

[104] *See* Kevin Padian, *Dinosaur*, BRITANNICA, https://perma.cc/32MW-6L7G (accessed Oct. 1, 2021) (describing evidence of social herds in dinosaurs).

[105] *Neuralink Cofounder*, *supra* note 10.

[106] *Id*. *See also Invasive Species*, NAT'L GEOGRAPHIC, https://perma.cc/EP7X-5ZZ5 (accessed Oct. 1, 2021) (citing how animals like pythons, invasive to Florida, outcompete other predators for food).

[107] Executive Order 13112-1(f), Invasive Species (U.S.D.A. 1999).

[108] *Invasive Species*, *supra* note 106.

[109] *Id*.; *American Paddlefish*, USFWS, https://perma.cc/PZZ3-AMPM (accessed Nov. 5, 2021).

Guam.[110] The snakes entered the island with no natural predators, causing the population to increase substantially without any form of control.[111] As a result, the snakes over-hunted Guam's native bird species, causing nine of the eleven forest-dwelling species of birds to go extinct.[112] Invasive species tend to not only threaten or completely eradicate native species, but also destroy local vegetation and habitat.[113] A prime example of this phenomenon is the nutria, invasive to North America, which have destroyed wetland ecosystems as a result of their extensive consumption of wetland grasses.[114]

If introduced into today's ecosystems, dinosaurs would likely act similarly to those invasive species. A Velociraptor—or a genetically modified and evolved animal similar to it, such as the dinochicken—could run at speeds of up to forty miles per hour, similar to speeds of today's hyena.[115] Hyenas reign as one of Africa's top predators with little competition due to their speed; excellent eyesight and hearing; and pack-hunting strategies.[116] Likewise, studies of Velociraptor fossils have concluded that Velociraptors, although only as tall as the modern-day turkey, thrived as small carnivores due to their speed, excellent senses of sight and smell, and pack-hunting strategies.[117] Due to these characteristics, a dinosaur like the Velociraptor would likely exist similarly to the hyena as a top predator in today's world, and may outcompete similar carnivores for food.[118] Further, a de-extinct Velociraptor could lead to the eradication of small prey species like the black-footed ferret and piping plover, species already threatened or endangered due, in part, to over-predation by coyotes.[119] Dinosaurs would likely become invasive species, rising to the top of the food chain in several of today's ecosystems, much like the Tyrannosaurus Rex did

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110 *Invasive Species*, *supra* note 106.

111 *Id*.

112 *Id*.

113 *Id*.

114 *See id*. (noting the importance of wetlands' tall grasses, which provide food, nesting sites, and shelter for many organisms, but are disappearing due to the nutria).

115 WANGTAO, *Top 10 Fastest Dinosaurs That Ever Lived (updated)*, ONLY DINOSAURS (July 24, 2021), https://perma.cc/ER6N-5DN4 (accessed Feb. 25, 2023); *Spotted Hyena*, SAN DIEGO ZOO WILDLIFE ALL., https://animals.sandiegozoo.org/animals/spotted-hyena (accessed Feb. 25, 2023).

116 *Hyena*, AFRICAN WILDLIFE FOUND., https://perma.cc/DHD3-4SSV (accessed Jan. 27, 2023); *What Do Hyenas Eat? Discover the Hyena Diet*, WILDLIFE TRIP (Nov. 23, 2021), https://perma.cc/DH8S-XQUS (accessed Jan. 27, 2023).

117 Amy Brannan, *Velociraptor: The Dinosaur Known Simply As "The Raptor,"* EXPLORING LIFE'S MYSTERIES (Nov. 1, 2021), https://perma.cc/MBE3-PFFD (accessed Jan. 24, 2023).

118 *See generally* Joseph Castro, *Velociraptor: Facts About the 'Speedy Thief,'* LIVE SCI. (Mar. 18, 2016), https://perma.cc/Q6Q7-HNZ7 (accessed Jan. 24, 2023) (noting Velociraptors' diets generally consisted of small mammals and other small dinosaurs).

119 Rick Tischaefer, WDM TECH. SERIES - COYOTES, USDA 2 (Nov. 2020), https://perma.cc/DT42-PYE7 (accessed Jan. 24, 2023).

in its time,[120] resulting in harm to current existing species and the environment.

As invasive species, dinosaurs would also pose the risk of carrying deadly diseases.[121] The introduction and spread of diseases by invasive species is common, as invasive species may carry unfamiliar viruses, bacteria, or other microorganisms, and serve as "vector species."[122] In the UK, for example, gray squirrels have become the predominant squirrel species, despite being invasive, because the species transmitted the deadly squirrel pox virus to the native, and once most-common, red squirrels.[123] Similarly, signal crayfish from North America have placed the UK's white-clawed crayfish at high risk of extinction due to the spread of crayfish plague, which is transmitted through the water and does not affect signal crayfish, but affects white-clawed crayfish.[124] Dinosaurs, as a de-extinct species, may carry or develop viruses or bacteria uncommon in today's environment and, following introduction into an ecosystem, may spread a disease to existing species that lack natural biological defenses to it.[125]

Proponents of de-extinction argue that the resurrection of extinct species could potentially help restore threatened or damaged ecosystems.[126] For example, bringing back mammoths—or mammoth-like creatures—to the Arctic tundra may help recreate the steppe ecosystem dwindling today.[127] The permafrost of the tundra, which stores massive amounts of carbon from dead vegetation, is melting at increasing rates due to climate change.[128] As such, the permafrost's carbon stores are at risk of releasing more than twice the current amount of carbon dioxide in the atmosphere.[129] The reintroduction of mammoths

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120 *See* Laura Geggel, *T.Rex Was Likely an Invasive Species*, SCI. AM. (Mar. 2, 2016), https://perma.cc/L3X8-K2Y2 (accessed Jan. 24, 2023) (discussing evidence of how the Tyrannosaurus Rex was an invasive species to North America, effectively outcompeting other predators and becoming the apex predator of the region).

121 *Id*. *See also* Jamie Bojko & Amy Burgess, *Invasive Species: Biggest Threat May Be the Most Uncertain – Disease*, THE CONVERSATION (Nov. 26, 2020), https://perma.cc/9XDC-8JV6 (accessed Jan. 29, 2023) (describing the diseases that invasive species often spread to native species).

122 Bojko & Burgess, *supra* note 121; *Human Health Impacts*, USDA NAT'L INVASIVE SPECIES INFO. CTR., https://perma.cc/7ASU-R8AJ (accessed Feb. 24, 2023). *See also Vector (Biology)*, SCI. DAILY, https://perma.cc/AZA8-B5X7 (accessed Jan. 29, 2023) (defining vector species as "an organism that does not cause disease itself but which spreads infection by conveying pathogens from one host to another").

123 Bojko & Burgess, *supra* note 121.

124 *Id*.; *Crayfish in Crisis*, BUGLIFE: INVERTEBRATE CONSERVATION TR. (May 2019), https://perma.cc/E72P-NNJW (accessed Jan. 29, 2023) (noting the UK's white-clawed crayfish will go extinct in most of their current range within the next twenty years).

125 *See* Bojko & Burgess, *supra* note 121 (describing the diseases that invasive species often spread to native species).

126 Draxler, *supra* note 49.

127 Paul Mann, *Can Bringing Back Mammoths Help Stop Climate Change?*, SMITHSONIAN MAG. (May 14, 2018), https://perma.cc/5AM4-DSFD (accessed Jan. 28, 2023).

128 Ted Schuur, *Permafrost and the Global Carbon Cycle*, NOAA ARCTIC PROGRAM (Nov. 22, 2019), https://perma.cc/M2NB-U7B6 (accessed Jan. 28, 2023).

129 Mann, *supra* note 127.

could potentially prevent the permafrost from melting, as the mammoths' trampling of mosses, shrubs, as well as snow cover and their uprooting of trees could insulate the permafrost and slow its thaw.[130] Dinosaurs could stand to potentially provide similar ecosystem services, as they functioned similarly to today's mammals in shaping and adapting to their environment.[131]

However, it is difficult to predict whether de-extinct species would resume their former roles in an ecosystem wholly foreign to them, as research on biological invasions notes the unpredictability of newly introduced species' impacts on the environment.[132] Ultimately, the negative effects of introducing extinct species like dinosaurs into today's ecosystems would likely outweigh any potential benefits, as dinosaurs would likely become invasive species and further harm existing species and the environment.

IV. Legal Implications

Bringing dinosaurs back from extinction also creates significant legal implications, including whether de-extinct dinosaur species would be listed as threatened or endangered under the Endangered Species Act (ESA).[133] The National Environment Policy Act (NEPA)[134] may also apply if de-extinction projects are considered major federal actions.[135] The resurrection of dinosaurs may even implicate patent law.[136] By re-entering the world, dinosaurs will necessarily have a presence in the legal system. The dinosaurs and the scientists behind their de-extinction will potentially require protections, and navigating these statutes will not be without difficulties.

The ESA establishes a regulatory protection scheme for species "in danger of extinction throughout all or a significant portion of its range," or that are "likely to become endangered within the foreseeable future."[137] Typically, this applies to existing species in order to prevent

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130 *Id*.

131 *See generally id*. (discussing species' roles as "natural geoengineers"). *See also* McGill University, *supra* note 90 (noting dinosaurs were ecologically very similar to mammals today).

132 Llester, *De-Extinction, a Risky Ecological Experiment*, ECOLOGICAL SOC'Y AM. (Feb. 19, 2016), https://perma.cc/WZ53-G2NK (accessed Jan. 24, 2023).

133 *See* Endangered Species Act of 1973, 16 U.S.C. §§ 1531–1544 (2021) (establishing protections for endangered and threatened species).

134 *See* National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321–4347 (2020) (requiring federal agencies to prepare a detailed statement with respect to major federal actions significantly affecting the environment).

135 *See* 40 C.F.R. § 1508.1 (2022) (defining what constitutes "major federal actions").

136 Brian Hausman, *Will De-Extinct Animals be Patent Eligible in the US?,* LIFE SCI. INTELL. PROP. REV. (May 1, 2023), https://perma.cc/6V36-QLVZ (accessed Feb. 2, 2023); Linda Kesselring, *Recognizing 35 U.S.C 101, 102, and 112 in Jurassic Park*, EMORY TECH. TRANSFER BLOG (Dec. 7, 2020), https://perma.cc/NWJ2-8QWQ (accessed Feb. 25, 2023).

137 16 U.S.C. § 1532(6), (20).

their extinction;[138] on its face, the ESA does not appear to apply to resurrected species like dinosaurs. However, the ESA includes a provision for reintroducing eradicated, endangered species to a region,[139] which could potentially apply to resurrected species.[140] Under this provision, "experimental populations" of species may be released if the Secretary of the Interior determines that the respective population is necessary for the conservation of the species.[141] The Secretary may also deem an experimental population "essential" to the continued existence of the species.[142] If deemed essential, the species is then listed as "threatened" under the ESA and afforded protection from "takes" and major federal actions that may significantly jeopardize the species' existence or adversely modify their critical habitat.[143] This ESA provision could be applied to dinosaurs because dinosaurs would be the "sole representatives" of an extinct species and "essential" to the continued existence of the species.[144] However, if genetically modified dinosaurs like the dinochicken are considered members of a living species modified to resemble an extinct relative—in the dinochicken's case, the living species would be a chicken—the species may be considered non-essential for the existing species' survival and consequently not afforded ESA protection.[145] It is unclear whether a modified dinosaur like the dinochicken would actually be afforded any protection under the ESA.

NEPA applies to major federal actions "significantly affecting the quality of the human environment," and requires extensive environmental analyses of the action to take a "hard look" at the environmental impacts of the action.[146] If a federal agency determines an action will have a significant environmental impact, the agency must complete an Environmental Impact Statement (EIS).[147] An EIS is a detailed report that includes any unavoidable adverse effects, available alternatives, a comparison between the short-term environmental usage and long-term productivity, and any "irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."[148] As such, "NEPA review would be

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138 *See generally* 16 U.S.C. §§ 1531–1532 (declaring the value of species "in danger" of extinction and defining a purpose of conserving those species until such danger no longer exists).

139 16 U.S.C. § 1539(j).

140 Norman F. Carlin et al., *How to Permit Your Mammoth: Some Legal Implications of "De-Extinction,"* 33 STAN. ENV'T L. J. 3, 19 (2013).

141 16 U.S.C. § 1539(j)(2)(A).

142 16 U.S.C. § 1539(j)(2)(B).

143 16 U.S.C. § 1539(j)(2)(C). *See also* 16 U.S.C. § 1538 (describing prohibited acts under the ESA); 16 U.S.C. § 1533(d) (applying the prohibitions to threatened species).

144 Carlin et al., *supra* note 140, at 20.

145 *Id.*; 16 U.S.C. § 1539(j)(2)(C)(i).

146 42 U.S.C. § 4332(C). *See also* 40 C.F.R. § 1508.1(s) (2023) (detailing what mitigation measures CEQ considers when implementing NEPA).

147 42 U.S.C. § 4332(C).

148 *Id.*

required for a de-extinction project that is federally funded, undertaken at a federal laboratory or breeding facility, or is intended to release and attempt reestablishment of the species on federal land."[149]

However, the application of NEPA to de-extinction projects presents significant issues due to the unpredictable implications of reintroducing a long-extinct species.[150] Accurately predicting potential impacts of resurrecting an extinct species requires significant knowledge on the characteristics, behavior, and background of the extinct species when it existed.[151] The best information available about the characteristics and behaviors of species that went extinct within the last century, like the passenger pigeon, is lacking and likely insufficient, especially in comparison to what is known about more recently dwindling species, like the condor.[152] Considering this, it is unlikely that scientists possess adequate information about dinosaurs, who went extinct millions of years ago, to accurately predict the impact of their resurrection.[153] De-extinct species that are recreated through genetic modification, like the dinochicken, are not true replications of the extinct species scientists have studied, but are instead a wholly new species.[154] Completing an EIS for such a de-extinction project would be incredibly difficult because of the lack of accurate information available on the resurrected species' behavior, its interactions with other species, and how it may impact the ecosystem.[155]

Scientists involved in de-extinction projects may also be interested in patenting their recreations in order to gain "exclusive rights to exhibit resurrected species" and recover expenses to potentially fund more de-extinction projects.[156] However, applying patent law to the resurrection of dinosaurs is challenging because the ability to patent becomes dependent on whether a resurrected dinosaur is considered a "natural phenomenon" or a "nonnaturally occurring manufacture."[157] Patents may be granted whenever an individual invents or discovers "any new and useful process, machine, manufacture, or composition of

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149 Carlin et al., *supra* note 140, at 31.

150 *Id*. at 41.

151 *Id*.

152 *See id*. (noting the best information available for passenger pigeons is "not even close" to what is known about existing species that have been reintroduced to the wild through conservation efforts, like wolves and condors).

153 *When Did Dinosaurs Become Extinct?*, *supra* note 1.

154 Carlin et al., *supra* note 140, at 41.

155 *Id*. at 41, 43. An EIS would not be impossible to complete because NEPA has a "carve-out" for necessary information that is unknown and difficult to obtain. Instead, NEPA requires that the EIS include 1) a statement that information is incomplete or unavailable, 2) an explanation of the ways in which it would be relevant to evaluate reasonably foreseeable significant impacts, 3) a "summary of existing credible scientific evidence," and 4) "the agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community." *Id*.

156 *Id*. at 48.

157 Diamond v. Chakrabarty, 447 U.S. 303, 309–10 (1980); Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576, 577 (2013).

matter, or any new and useful improvement thereof."[158] The U.S. Supreme Court has found explicit congressional intent that patent law possesses a broad scope, with the potential to patent "anything under the sun that is made by man."[159] The Court has recognized genetically engineered bacteria to be patentable,[160] as well as scientifically modified gene sequences.[161] Additionally, the Court has exempted creating a new product from a naturally occurring material in a lab from being classified as "a product of nature."[162] The Court has also stated that naturally occurring gene sequences, and their natural derivative products, are not patentable.[163]

Applying these patent law principles to the resurrection of dinosaurs, it is unclear whether scientists could patent their de-extinct dinosaurs. On one hand, dinosaurs were "products of nature" with "naturally occurring" gene sequences.[164] Dinosaurs were a group of animals belonging to the taxonomical group classification, Archosaurs, which today's crocodiles and birds also belong.[165] Thus, the resurrection of dinosaurs could be considered a "natural [ ] product" and therefore unpatentable.[166] On the other hand, de-extinction projects like the dinochicken involve artificially modifying gene sequences to create an animal resembling a dinosaur.[167]

Following this logic, the final product of a dinosaur de-extinction project could be considered a wholly new species that is a "product of human ingenuity."[168] The resurrected dinosaurs could be considered new creations in a lab, thereby exempting them from the classification as "product[s] of nature."[169] If this is the case, scientists could patent dinosaurs resulting from their de-extinction projects. Whether scientists could patent resurrected dinosaurs ultimately involves a determination of whether de-extinct dinosaurs are natural living beings, or the product of laboratory experiments, a difficult decision that potentially objectifies animals further in a legal system that has historically re-

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158 35 U.S.C. § 101 (1952).

159 *Diamond*, 447 U.S. at 308–09 (citing S. Rep. No. 1979, at 5 (1952); H.R. Rep. No. 1923, at 6 (1952)).

160 *See id*. at 309–10 (stating that genetically-modified bacteria is a "nonnaturally occurring manufacture or composition of matter—a product of human ingenuity 'having a distinctive name, character, [and] use'").

161 *Myriad Genetics*, 569 U.S. at 580.

162 *Id*. at 595.

163 *See id*. at 591, 593–94 (finding new plant breeds eligible for patents, but not isolated DNA). *See also Diamond*, 447 U.S. at 309 (stating the statute's scope does not include "laws of nature, physical phenomena, and abstract ideas").

164 *See Diamond*, 447 U.S. at 313 (distinguishing products of nature from human-made interventions). *See also Myriad Genetics*, 569 U.S. at 580 (stating that a "naturally occurring DNA segment" is a product of nature and not patent eligible).

165 Josh Davis, *Where Did Dinosaurs Come From?*, NAT. HISTORY MUSEUM, https://perma.cc/HP3K-6R8R (accessed Nov. 8, 2021).

166 *Myriad Genetics*, 569 U.S. at 580.

167 Viegas, *supra* note 31.

168 *Diamond*, 447 U.S. at 309–10.

169 *Myriad Genetics*, 569 U.S. at 580.

fused to recognize the inherent value, rights, and 'personhood' of animals.[170] The de-extinction of dinosaurs creates complications in several bodies of law, in large part due to a general uncertainty of what these de-extinct dinosaurs 'are' and how they will act.

V. Conclusion

The dinosaurs who dominated the planet millions of years ago have captured the world in awe for centuries: their fossils grandly exhibited in museums and their presence cemented in popular culture with iconic movies like the *Jurassic Park* franchise.[171]

Dinosaurs fascinate children and adults alike, often serving as many children's introduction into the world of science.[172] Just because these 'larger-than-life' prehistoric creatures remain central to a collective human interest does not mean they should be revived into today's world. Although dinosaur de-extinction projects like Dr. Horner's dinochicken project may have potential benefits toward increasing public interest in science and advancing medical science,[173] the consequences of such projects are more harmful than beneficial.

Modifying existing species, like chickens, to resemble long-extinct dinosaurs involves a mass exploitation of animals, subjecting them to invasive and harmful procedures that often violate their inherent value and integrity.[174] In the alternative, if a genetic cloning project is successful in reviving dinosaurs, there is no suitable environment in today's world for them, regardless of whether they are placed into existing ecosystems[175] or zoos.[176]

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[170] *See, e.g.*, Matter of Nonhuman Rights Project, Inc. v. Lavery, 152 A.D.3d 73, 76 (N.Y. App. Div. 2017) (holding chimpanzees are not entitled to habeas relief); Cetacean Community v. Bush, 386 F.3d 1169, 1179 (9th Cir. 2004) (holding cetaceans lacked standing to sue government agencies). *But see Press Release: Animals Recognized as Legal Persons for the First Time in U.S. Court,* ALDF (Oct. 20, 2021), https://perma.cc/6DLB-SAN8 (accessed Jan. 27, 2023) (recently, a U.S. court recognized animals as "legal persons" for the first time).

[171] Riley Black, *Dinosaur Culture*, NAT'L GEOGRAPHIC (Mar. 24, 2014), https://perma.cc/R23W-WTL8 (accessed Jan. 27, 2023).

[172] *Experts Explain Why Dinosaurs Fascinate Kids and Adults*, PRIME TIME ZONE (Feb. 16, 2021), https://primetimezone.com/world/experts-explain-why-dinosaurs-fascinate-kids-and-adults/ (accessed Jan. 29, 2022); Gwen Dewar, *Paleontology and Dinosaurs for Kids: Tips for Getting Children Hooked on Science*, PARENTING SCI., https://perma.cc/BWE6-N7VF (accessed Feb. 25, 2023).

[173] Viegas, *supra* note 31. *See also Building a Chicken that Bites*, MONT. STATE UNIV. (Oct. 13, 2013), https://perma.cc/PG8A-RWTF (accessed Feb. 25, 2023) ("And, last, but not least, [the dinochicken project] will produce cool looking animals that kids will like.").

[174] *Biotechnology*, *supra* note 44; *see supra* Section III, Part A (discussing the ethics of genetic modification of animals and dinosaurs).

[175] Brusatte, *supra* note 46; *see supra* Section III, Part B (discussing the dangers of attempting to reintroduce dinosaurs into today's ecosystem).

[176] *See supra* Section III, Part B (discussing the dangers of holding dinosaurs in zoos); *Animals for Entertainment*, *supra* note 47.

Genetically modified species, like the dinochicken, have no place in today's ecosystems, where they would likely become domineering invasive species, rather than peacefully assimilating into existing ecosystems.[177] De-extinct species' place in the legal world is even more unclear, due to issues regarding whether protection can be afforded to them under the ESA, difficulties in completing necessary NEPA analyses, and the possible objectification of these living beings under patent law.[178]

Although dinosaurs' re-emergence into the world would fulfill the dreams of many, museums, books, movies, and our minds is where they should remain. The world the dinosaurs knew has vastly evolved since the time they roamed the Earth,[179] and the survival of today's ecosystems depends upon the stability of existing species' populations, which de-extinct dinosaurs would further damage.[180] As we witness the sixth mass extinction event rapidly wiping out between 11,000 to 58,000 species annually,[181] consequently making modern ecosystems even more fragile, the 'need' to revive dinosaurs becomes even more hollow. Although the study of dinosaurs provides useful information in developing an active response to climate change and its rapid rates of extinction,[182] the revival of dinosaurs takes science in an unnecessary and cruel direction. As Dr. Malcom in *Jurassic Park* stated as a forewarning to the chaos bringing dinosaurs back ultimately ensued: "Just because you can, doesn't mean that you should."[183]

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177 *Neuralink Cofounder*, *supra* note 10. *See supra* Section III, Part C (describing the potential for dinosaurs to be invasive species).

178 *See supra* Section IV (describing the potential legal issues associated with dinosaur re-emergence).

179 Brusatte, *supra* note 46. *See supra* Section III, Part B (discussing how today's ecosystem varies from the ecosystem when dinosaurs lived).

180 *See supra* Section III, Part C (describing the potential dangers of reintroducing dinosaurs into today's ecosystem).

181 Kristiina Joon, *Is the 6th Mass Extinction Here?*, OXFORD CLIMATE SOC'Y (Apr. 25, 2020), https://perma.cc/4KKP-KNF7 (accessed Jan. 30, 2023).

182 Groch, *supra* note 73.

183 Osterloff, *supra* note 4.