Revivifying, Repurposing, Reimagining: From Commodification to Kinship in 21st-Century De-Extinction and Xenotransplantation Narratives

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

De-extinction and xenotransplantation represent two key 21st-century biotechnological developments, both of which aim to use genetic engineering to address ecological and medical crises. This dissertation investigates the representation of de-extinction and xenotransplantation by scientific corporations, in the media, and in fiction. In particular, I draw on critical posthumanist theory to investigate how techno-optimistic and transhumanist rhetoric has influenced de-extinction and xenotransplantation narratives; how narratives respond to key issues in bioethics and environmental ethics; the implications that these narratives suggest for how biotechnology is shaping human and nonhuman identity; and the way that they explore possibilities for multispecies care, kinship, and entanglement. My analysis in Part I shows that de-extinction is frequently framed in terms of the biomedical and human health benefits that it can offer. While this biomedical framing is reflected in the *Jurassic World* films (2015, 2018, 2022) and the novels *Ghost Species* (2020) and *The Neanderthal's Aunt* (2014), these narratives focus on the risks arising from the exploitation and commodification of genetic material. In my analysis of xenotransplantation narratives in Part II, I observed that pigs are frequently framed as an abundant supply of organs that can solve the organ shortage crisis. In contrast, the novel *Pig-Heart Boy* (1997) and the film *We Ate the Children Last* (2011) focus on the bioethical risks faced by the first patients to undergo xenotransplantation, such as their vulnerability and the risk of discrimination, while the novels *Oryx and Crake* (2003) and *Chromosome 6* (1998) counter the frame of abundance by depicting the potential for detrimental environmental, political, and economic impacts. Lastly, my analysis in Part III of the short story "The Birdsong Fossil" (2021) and the novel *Pighearted* (2021) reveals that these narratives prioritize care, kinship, and entanglement, providing possibilities for reimagining the animals created by biotechnology beyond the hype of charismatic megafauna and the spare parts metaphor in de-extinction and xenotransplantation discourse. By drawing on multispecies environmental ethics and posthumanist bioethics, I conclude that these narratives can allow us to envision more ethical applications of biotechnology, which can thereby shape the future of de-extinction and xenotransplantation.

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Introduction: De-Extinction and Xenotransplantation Narratives

In March 2025, an image of a scientist holding genetically modified mice was shared across news media. While genetically modified mice are nothing new—mice are one of the most commonly used lab animals[1]—these particular mice are unique: with seven modified genes,[2] their most visually striking feature is their fluffy orange fur. The mice were not designed just as a cute experiment, though. Headlines framed these mice as a key development in resurrecting the extinct woolly mammoth. For example, a headline in *Discover Magazine* declared that "With Bushy Hair, This Engineered Woolly Mouse Could Help Revive the Woolly Mammoth."[3] These mice provide evidence of the power of biotechnology to alter life in increasingly visible ways. With their orange fur, the woolly mice are a dramatic example of the possibility for unanticipated outcomes to emerge from 21st-century biotechnology, as genetic engineering blurs species boundaries in ways that public audiences might not expect. And while public audiences were charmed by the woolly mice, only one month later this news was rapidly eclipsed by an even more sensational development: in April 2025, Colossal Laboratories & Biosciences—a biotechnology company that aims to "be the first company to use CRISPR technology successfully in the de-extinction of previously lost species"[4]—claimed to have resurrected the long-extinct "dire wolves" by genetically modifying grey wolves to make them

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[1] David Grimm, "How Many Mice and Rats Are Used in U.S. Labs? Controversial Study Says More than 100 Million," *Science*, January 12, 2021, https://www.science.org/content/article/how-many-mice-and-rats-are-used-us-labs-controversial-study-says-more-100-million. Ajay Gattani et al., "A Comprehensive Analysis of Use of Small Laboratory Animals in Preclinical Research: A Five-Year Quantitative Descriptive Analysis," *Journal of Pharmacology and Pharmacotherapeutics* 16, no. 2 (June 1, 2025): 193–201, https://doi.org/10.1177/0976500X241299162.

[2] Ewen Callaway, "Meet the 'Woolly Mouse': Why Scientists Doubt It's a Big Step towards Recreating Mammoths," *Nature* 639, no. 8054 (March 4, 2025): 284–85, https://doi.org/10.1038/d41586-025-00684-1.

[3] Paul Smaglik, "With Bushy Hair, This Engineered Woolly Mouse Could Help Revive the Woolly Mammoth," *Discover Magazine*, March 4, 2025, https://www.discovermagazine.com/the-sciences/with-bushy-hair-this-engineered-woolly-mouse-could-help-revive-the-woolly.

[4] Colossal Laboratories & Biosciences, "Company," August 6, 2021, https://colossal.com/company/.

appear more similar to the extinct species.[5] Featured on the cover of *TIME Magazine*, the story immediately gained international attention. As Colossal explains on its website, the project serves as "a groundbreaking conservation technology initiative," and they argue that "de-extinction can become a powerful, complementary tool in the global fight to preserve biodiversity."[6] According to Colossal, this development offers hope for conservation science, leading us towards a more ecologically resilient future through the power of biotechnology.

At the same time that woolly mice and dire wolves were captivating public audiences with the simultaneously adorable and awe-inspiring potentials of biotechnology, another breakthrough hit the headlines. In February 2025, it was announced that clinical trials of pig kidney transplants using genetically modified organs created by the company United Therapeutics have been approved by the FDA.[7] In the same month, the company eGenesis shared the news that they had successfully conducted the first of three pig kidney transplants approved under an "Expanded Access" program offered by the FDA.[8] In June 2025, *National Geographic*'s cover featured a piglet (which, like Colossal's mice, appears cradled in the hands of a glove-wearing scientist). The accompanying article, "This Pig Could Save Your Life,"[9] outlined developments in xenotransplantation research, focusing in particular on the work being done by eGenesis. As eGenesis explains on their website, pig kidney transplants could be vital in "potentially expanding access to life-saving transplants to address

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[5] Jeffrey Kluger, "The Return of the Dire Wolf," *TIME*, April 7, 2025, https://time.com/7274542/colossal-dire-wolf/.
[6] Colossal Laboratories & Biosciences, "Dire Wolf," accessed May 28, 2025, https://colossal.com/direwolf/.
[7] Tanya Lewis, "Animal-to-Human Organ Transplants Hit Long-Awaited Testing Milestone," *Scientific American*, February 13, 2025, https://www.scientificamerican.com/article/pig-to-human-organ-transplants-will-finally-begin-clinical-trials-this-year/.
[8] eGenesis, "eGenesis Announces Second Patient Successfully Transplanted with Genetically Engineered Porcine Kidney," accessed May 28, 2025, https://egenesisbio.com/press-releases/egenesis-announces-second-patient-successfully-transplanted-with-genetically-engineered-porcine-kidney/.
[9] Matthew Schaer, "This Pig Could Save Your Life," *National Geographic*, May 1, 2025, https://www.nationalgeographic.com/science/article/pig-organ-transplant-xenotransplantation.

the critical organ shortage."[10] The pig kidney therefore symbolizes the possibility that patients will no longer need to meet strict eligibility requirements to join endless transplant waitlists. Consequently, genetically modified pigs have become a new beacon of hope in transplant medicine.

These breakthroughs come in two distinct scientific fields that seek to address 21st-century ecological and medical problems. De-extinction, or the attempt to "re-create" or "resurrect" lost species, has gained momentum over the past few years. Companies like Colossal and Revive and Restore have been vocal about the possible ecological and environmental benefits of de-extinction, which offers a new, technological spin on conservation science. According to these companies, biotechnology promises to allow much more precise control over endangered and extinct species, meaning that endangered species can be cloned, thereby preventing their extinction (e.g., Revive & Restore's "genetic rescue" work on the black-footed ferret[11]), or that extant species can be altered to more closely resemble extinct species and thereby fill their ecological niche (e.g., Colossal's work on the woolly mammoth[12]). Xenotransplantation, on the other hand, aims to create a new supply of organs that can be transplanted into human patients. Biotechnological tools like CRISPR-Cas9 provide new levels of intervention into the genome: companies like United Therapeutics, eGenesis, and Qihan Biotech have each altered the pig genome in different ways, ranging from silencing existing genes to adding new genes.[13] Given the genetic changes making pig organs safer for human

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[10] eGenesis, "eGenesis Announces Second Patient."
[11] Revive & Restore, "Black-Footed Ferret Genetic Rescue," accessed June 25, 2025, https://reviverestore.org/projects/black-footed-ferret/.
[12] Colossal Laboratories & Biosciences, "The Mammoth," accessed June 25, 2025, https://colossal.com/mammoth/.
[13] United Therapeutics, "United Therapeutics Corporation Announces FDA Clearance of Its Investigational New Drug Application for the UKidney Xenotransplantation Clinical Trial," Press Release, accessed June 25, 2025, https://ir.unither.com/press-releases/2025/02-03-2025-120011819. eGenesis, "Our EGEN™ Platform," accessed June 25, 2025, https://egenesisbio.com/our-approach/. Qihan Biotech, "Qihan Biotech Publishes First Clinical Xenotransplantation Prototype, 'Pig 3.0', in Nature Biomedical Engineering," Press Release, September 2020, https://www.qihanbio.com/press/8.

patients, several prominent transplant surgeons in the United States, such as Dr. Robert Montgomery, have embraced xenotransplantation as a new medical tool that can give patients who would otherwise be ineligible for a transplant an alternative means to access organs.[14]

At the same time that these companies have been making headlines, popular novels, films, and short stories about de-extinction and xenotransplantation have also been engaging the public. For example, the *Jurassic Park* (1993) and *Jurassic World* films (2015, 2018, 2022, 2025), the novels *The Neanderthal's Aunt* (2014) and *Ghost Species* (2020), and the short story "The Birdsong Fossil" (2021) have explored a range of de-extinction candidates, ranging from insects to dinosaurs to Neanderthals, while the novels *Pig-Heart Boy* (1997), *Chromosome 6* (1997), *Oryx and Crake* (2003), and *Pighearted* (2021), along with the film *We Ate the Children Last* (2011), have depicted organs being transplanted from genetically modified pigs and primates into human patients. These examples span the 1990s to the 2020s, showing ongoing interest in the way that biotechnology could lead to new ways of conceptualizing the body and species boundaries. Notably, though, recent developments in de-extinction and xenotransplantation have prompted a return to two of the earliest-published stories on this list. Released on July 2, 2025, *Jurassic World Rebirth*, the latest installation in the *Jurassic* franchise—which began with Michael Crichton's novel *Jurassic Park* (1990)—brings de-extinction back in a dramatic new story. Meanwhile, in early 2025, Malorie Blackman's novel *Pig-Heart Boy* (1997) was adapted into a UK-based theatre performance. Both the theatre performance of *Pig-Heart Boy* and the summer blockbuster *Jurassic World Rebirth* are either revisiting or building on stories that began with bestselling or critically acclaimed novels from the 1990s. As these examples show, public interest in de-extinction and xenotransplantation has spanned

[14] NYU Langone News, "Dr. Robert Montgomery, Director of NYU Langone's Transplant Institute, on the Promise of Pig Organs," Fall 2024, https://nyulangone.org/news/dr-robert-montgomery-director-nyu-langones-transplant-institute-promise-pig-organs.

multiple decades, and recent real-world developments in the fields have propelled these stories to even greater success, reaching new audiences.

Along with the news stories about woolly mice, dire wolves, and chimeric pigs, these fictional stories about dinosaurs and pig heart transplants are setting the stage for how public audiences will understand new developments in de-extinction and xenotransplantation. Given the rapid developments in de-extinction and xenotransplantation technology during the 2020s, the renewed interest in early texts like *Jurassic Park* and *Pig-Heart Boy* offers new opportunities to consider the ethical implications of these fields. In a trailer featuring numerous shots of the *T. rex* alongside speculation on the biomedical value of dinosaur DNA,[15] *Jurassic World Rebirth*'s depiction of de-extinction brings together the fear of uncontrollable scientific creations, along with techno-optimistic hope for new biomedical breakthroughs and commercial possibilities. Meanwhile, in a trailer that shows a boy grappling with the decision to undergo a pig heart transplant, the theatre performance of *Pig-Heart Boy* brings together xenotransplantation, fear of changes to the human body, and bioethical considerations about what transplanting pig organs means for human patients.[16] By raising questions about ethical scientific experimentation, about species boundaries, and about human identity in the face of far-reaching biotechnological experimentation, these narratives encourage public audiences to question the techno-optimistic rhetoric that characterizes de-extinction and xenotransplantation discourse, and to consider how developments in de-extinction and xenotransplantation will shape life in the 21st century.

The narratives emerging around de-extinction and xenotransplantation are the focus of this dissertation. While they have seemingly distinct aims and outcomes, they converge in several key

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[15] *Jurassic World Rebirth Official Trailer*, 2025, https://www.youtube.com/watch?v=jan5CFWs9ic.
[16] *Pig Heart Boy Trailer*, 2025, https://www.youtube.com/watch?v=6uUa4rIz2Ag.

ways. First, both fields draw on technosolutionistic and techno-optimistic rhetoric to promise hope for a better future. Secondly, both fields reflect the desire for stronger, more resilient bodies and ecosystems in response to medical and environmental crises. Finally, both fields raise profound ethical questions, both in terms of environmental ethics and bioethics. For example, if the goal is to create a biotechnological or biomedical product, what will the impacts of altering and commodifying biological material (genes, organs, entire bodies) be? How do these projects blur the lines between bodies and species, and what implications does this have for identity? What accountability should the creators of these new biotechnologies have with respect to the unanticipated consequences of their interventions into life? And are there opportunities for new forms of kinship across species boundaries to emerge from these projects?

By analyzing rhetorical and narrative responses to de-extinction and xenotransplantation in the media (news articles, podcasts, and science magazines), in industry (company websites and newsletters), and in fiction (novels, short stories, and films), I aim to identify the cultural and ethical implications of these emerging biotechnologies. Across three sections—Part I: Revivifying DNA, Part II: Repurposing Organs, and Part III: Reimagining Kinship—this dissertation investigates the wide range of ways that de-extinction and xenotransplantation have been framed: as solutions to environmental and medical problems, as examples of the exploitation of humans and animals in biotechnological and biomedical experimentation, and as opportunities to reconsider identity, species boundaries, and interspecies kinship. As I argue, techno-optimistic and technosolutionistic claims about how developments in these fields will create better futures for humans, animals, and the environment can obscure critical ethical considerations, and fiction provides an essential counternarrative to balance these claims. Ultimately, I hope to show that de-extinction and xenotransplantation narratives can highlight ethical concerns about *revivifying* and *repurposing*

biological material, while simultaneously *reimagining* biotechnology not as a tool that reinscribes human control over the biological world, but as a means of bringing humans, animals, ecosystems, and biotechnology into new entanglements.

0.1 Techno-Optimism and Technosolutionism in the Rhetoric of De-Extinction and Xenotransplantation

Optimism about the possibility to radically alter and improve human life has long characterized the discourse around biotechnology and biomedicine. This optimism is unsurprising since, as Martina Newell-McGloughlin and Edward Re note in their history of biotechnology, "the greatest and most notable impact of biotechnology has been in the medical and pharmaceutical arena,"[17] leading to significant human health outcomes. Biotechnological developments have therefore frequently been lauded as creating new "eras" or "ages" of human existence. For example, Lara Choksey refers to the decades in which the Human Genome Project was developed and completed as the "Age of the Genome,"[18] where genomics became a fundamental lens through which to view life. As Choksey explains, the human genome

> promised a blueprint that would tell us about biological complexity, and why human worlds seem so deeply complex in comparison to nonhuman ones: a code that could tell us not only what makes us human but how humanity is made and remade. Sequencing the human genome was to open up uncharted territory in the realm of human health and scientific understanding.[19]

While Choksey notes that the dreams of gaining new insights into human identity through genomics were unrealized, leading to new goals in the "so-called postgenomic era,"[20] this does not mean that

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[17] Martina Newell-McGloughlin and Edward Re, *The Evolution of Biotechnology: From Natufians to Nanotechnology* (Springer Netherlands, 2006), https://doi.org/10.1007/1-4020-5149-2. 8.
[18] Lara Choksey, *Narrative in the Age of the Genome: Genetic Worlds* (Bloomsbury Academic, 2021). 11.
[19] Choksey, *Age of the Genome*, 1.
[20] Choksey, *Age of the Genome*, 2.

researchers have lost hope in the powers of biotechnology. Indeed, new perspectives have emerged that frame biotechnology as a tool not simply to better *understand* biological systems and life, but instead to better *engineer* life in new ways. In an article titled "CRISPR-Cas Systems: Ushering in the New Genome Editing Era," Fernando Perez Rojo et al. suggest as much. They discuss the development of CRISPR-Cas genetic engineering systems, arguing that "[t]he discovery, characterization and development of CRISPR-Cas systems constitutes a major milestone for molecular biology in the 21st century."[21] They conclude that "[t]he current state of these systems, and furthermore their future potential as ever more easy-to-use variants are developed, promises to open many doors for genetic engineering – both in the areas of genome editing and non-genome editing."[22] If the Age of the Genome is over, then perhaps we are now in the "New Genome Editing Era" that Perez Rojo et al. describe, or the Age of CRISPR-Cas9. As genetic engineering becomes more precise, it offers new opportunities that the fields of de-extinction and xenotransplantation (among many others) can capitalize on.

The vision of genetic engineering as a biotechnological tool that can re-create extinct species to "restore" damaged ecosystems, or to bioengineer organs that can "solve" long transplant waitlists, is based on a techno-optimistic and technosolutionistic approach to environmental and medical crises. Techno-optimism and technosolutionism are closely linked but distinct philosophical stances. As John Danaher argues in his discussion of the former, it "holds that technology, defined here in largely material and instrumentalist terms, plays a key role in ensuring that the good does or will prevail over the bad."[23] "Technology" in this philosophical stance "has to be understood at a reasonably high level

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[21] Fernando Perez Rojo et al., "CRISPR-Cas Systems: Ushering in the New Genome Editing Era," *Bioengineered* 9, no. 1 (July 3, 2018): 214–21, https://doi.org/10.1080/21655979.2018.1470720. 219.
[22] Perez Rojo et al., "CRISPR-Cas Systems," 219.
[23] John Danaher, "Techno-Optimism: An Analysis, an Evaluation and a Modest Defence," *Philosophy & Technology* 35, no. 2 (June 1, 2022), https://doi.org/10.1007/s13347-022-00550-2. 11.

of abstraction — not just particular gadgets but the *totality of processes of technological production*."[24] De-extinction and xenotransplantation, then, while drawing on a range of biotechnological techniques and tools, can both be considered 21st-century "technologies."

In contrast to techno-optimism, technosolutionism, as Henrik Skaug Sætra explains, is "the idea that we can and should use technology to solve the challenges we happen to face."[25] From this perspective, technology is viewed as the most effective and efficient way to combat various problems, since "[i]t relates to the notion that everything is a nail to a person with a hammer, as most problems can be fixed with a more comprehensive application of technology for the most ardent techno-solutionists."[26] These two connected approaches—the optimistic belief in technology's potential to lead to "the good" and the solutionist belief that technology can fix humanity's problems—are evidently at play in de-extinction and xenotransplantation discourse. For example, these fields are frequently framed by proponents as offering possibilities for achieving the moral "good" by rectifying human-caused extinctions and expanding access to medical treatment. Both fields are also framed as solutions to critical problems, and genetic engineering becomes the so-called "hammer" that can fix the issues caused by climate change, habitat destruction, and biodiversity loss, while also solving medical crises like the shortage of transplantable organs.

Do the 2020s represent a new era of de-extinction and xenotransplantation? Proponents of these fields certainly seem to be crafting narratives around the possibility that de-extinction and xenotransplantation will offer solutions to important problems. However, there are other narratives worth considering. A variety of stories are being told about de-extinction and xenotransplantation in

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[24] Danaher, "Techno-Optimism," 11. Emphasis added.
[25] Henrik Skaug Sætra, "Introduction: The Promise and Pitfalls of Techno-Solutionism," in *Technology and Sustainable Development: The Promise and Pitfalls of Techno-Solutionism*, ed. Henrik Skaug Sætra (New York: Routledge, 2023). 2.
[26] Sætra, "Introduction," 2-3.

the media by science writers, in industry by scientists and medical doctors, and in fiction by speculative fiction (SF) authors and film directors. While some of these narratives embrace biotechnology as the key to environmental and medical crises, many more are critical of the way that de-extinction and xenotransplantation may alter human and animal bodies, exploit biological material in pursuit of valuable commodities, and contribute to environmental, economic, political, and medical problems rather than alleviating them. In the following sections, I will first outline theoretical frameworks that I draw on, before turning to the key fiction and nonfiction genres in my analysis of de-extinction and xenotransplantation narratives.

0.2 Liminality and Biotechnological Strays: Altered Genes and Modified Bodies

Central to my analysis of de-extinction and xenotransplantation are the ways that different narratives imagine the potential impacts that these fields could have on the body. To make sense of the way that biotechnological and biomedical developments result in altered bodies and new forms of life, Susan Squier proposes the term "liminal lives" to refer to the wide range of beings, materials, and byproducts created through biomedical experimentation, which "exist in that in-between or marginal zone."[27] In particular, Squier focuses on the interventions into different life stages and biological processes (including, for example, birth, aging, and death). Squier argues that the liminal lives created through biomedicine "demand our attention, because they are powerful and dangerous representatives of a transformation we are all undergoing as we become initiates in a new biomedical personhood mingling existence and nonexistence, organic and inorganic matter, life and death."[28] In

[27] Susan Merrill Squier, *Liminal Lives: Imagining the Human at the Frontiers of Biomedicine* (Duke University Press, 2004). 4.
[28] Squier, *Liminal Lives*, 5.

other words, it is not just the beings or materials created directly through biomedical experimentation that are liminal; instead, we *become liminal* through indirect daily contact with biomedicine, including the unseen interventions that biomedicine offers into biological processes. When it comes to de-extinction and xenotransplantation, representations of these fields in the media and in fiction can *make visible* the interventions that often go unseen, thereby shaping the way that audiences understand their relationship to biomedicine and biotechnology, particularly in the context of the changes these fields could pose to the human body.

Squier's term is particularly relevant to the analysis of the hybrid and chimeric species created through de-extinction and xenotransplantation. As I've described above, both areas are intervening in death (both by preventing the death of *individuals* via organ failure and by reversing the death of *species* via extinction), and both areas rely on biotechnological tools and techniques to alter and engineer bodies in the attempt to gain control over biological processes. This intervention involves the movement of genes and cells across bodies and species, resulting in the creation of new hybrid species (like "de-extinct" animals whose genomes are constructed from multiple sources) and chimeric species (like pigs that are genetically modified to be more similar to humans) in the process. In this dissertation, I investigate the depictions of the "liminal" nonhuman beings created in xenotransplantation and de-extinction research that cross boundaries between human/animal, biotic/abiotic, and natural/technological. These beings include those who confuse species boundaries and the lines between humans/animals: cloned or bioengineered Neanderthals, humans with transplanted animal organs, as well as genetically modified bonobos and chimeric pigs. They range from being never fully human, to no longer fully human, to no longer fully animal. They also include beings who blur the boundaries between natural/artificial and technological/biological, such as beings who are neither fully biotic nor abiotic, along with beings whose bodies are commodified, blurring

the boundaries between research subject and biomedical product. Their modified bodies create new categories of existence: they are the new "liminal lives" of the CRISPR-Cas9 era.

Another way to conceptualize the liminality of these beings is to consider their *displacement* across time, space, and species boundaries. Barbara Creed argues that the Anthropocene is resulting in the creation of "anthropogenic strays," where, due to issues like human-caused climate change, "the concept of the stray as an outsider, a homeless creature, has shifted in its meaning as the traditional notion of what constitutes 'home' is radically undermined."[29] The result is that "[t]he anthropogenic stray, human and nonhuman, has become an outsider, refugee and exile because of human activities, which have forced the stray into a different state of estrangement, one which may well become the norm."[30] According to Creed, as human activity continues to threaten ecosystems and result in the displacement of species, those species are being alienated. And while Creed focuses on the context of the Anthropocene, I contend that genetic engineering is creating *biotechnological* strays: the liminal beings who are created using biotechnology, who are displaced from any concrete sense of geographical or biological belonging, and who exist solely to provide value as biomedical products.

In de-extinction, biotechnological strays include the hybrid animals that are created to replace extinct species, often by intermixing the genetic material and biological process of multiple species. For example, in the case of Colossal's mammoth project, the company seeks to create "woolly mammoths" using at least three different species, since they plan to modify the genomes of Asian elephants with the genes of extinct woolly mammoths, then incubate these embryos in surrogate

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[29] Barbara Creed, *Stray: Human-Animal Ethics in the Anthropocene*, Power Polemics (Sydney, NSW, Australia: Power Publications, 2017). 167.
[30] Creed, *Stray*, 169.

African elephants.[31] Consequently, hybrid "cold-resistant elephants"[32] will be created that are not fully mammoth nor fully elephant: they will be estranged from their own genetic lineages. These animals are also estranged from the ecosystems in which both woolly mammoths and elephants adapted to live. Even if they are able to survive in arctic tundra environments, these habitats are not the same as the ecosystems where woolly mammoths lived thousands of years ago—and while Colossal proposes that the cold-resistant elephants could potentially help to *recreate* the lost grasslands of the mammoth steppe,[33] there is little certainty about the animals' futures in the arctic, particularly as the arctic itself continues to transform due to climate change. At the same time, the hybrid animals will likely not be able to live in the same habitat as either Asian or African elephants due to their increased cold tolerance. These cold-resistant elephants will be true biotechnological strays: genetically, geographically, and temporally displaced.

Similarly, the pigs created in xenotransplantation are genetically modified in multiple ways that alienate them from their species identity. Not only are some of these pigs altered to be *less like pigs* (through silencing or "knocking out" genes, such as the genes that code for the alpha-gal sugar that can trigger immune reactions in human patients[34]), but others are also altered to be *more like humans* (through the creation of interspecies chimeras using human and pig cells[35]). However, while these pigs cross species boundaries that blur the "human" and the "animal," they fail to gain any benefits or protections that are usually granted to species that are perceived as being more similar to humans. For example, Lesley A. Sharp notes that while primates like baboons are no longer used in

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[31] Colossal Laboratories & Biosciences, "The Mammoth."
[32] Colossal Laboratories & Biosciences, "The Mammoth."
[33] Colossal Laboratories & Biosciences, "The Mammoth."
[34] FDA, "FDA Approves First-of-Its-Kind Intentional Genomic Alteration in Line of Domestic Pigs for Both Human Food, Potential Therapeutic Uses" (FDA, December 14, 2020). Jiahui Xi et al., "Genetically Engineered Pigs for Xenotransplantation: Hopes and Challenges," *Frontiers in Cell and Developmental Biology* 10 (January 12, 2023): 1093534, https://doi.org/10.3389/fcell.2022.1093534.
[35] Xi et al., "Genetically Engineered Pigs."

xenotransplantation, pigs are frequently viewed as being less worthy of ethical or moral consideration, likely due to their status as agricultural animals.[36] Interestingly, Creed notes that agricultural animals are already strays who are "[e]ssentially homeless," because they "live out their lives in holding areas—pens, crates, stalls and cages."[37] While xenotransplantation's pigs may live in similar conditions to those of agricultural animals, they will be actively prevented from ever sharing habitats with other pigs. Due to the risks of disease transmission, the genetically modified or chimeric pigs will be housed in secure facilities, and will never be permitted to come into contact with other animals.[38] The pigs will then experience yet another level of estrangement when their organs are used in transplant medicine: the pig will die, but the organ will live on in a new (*human*) body. The chimeric pigs, then, are biotechnological strays who are estranged from their bodies, their species identity, and any moral consideration.

Whether considered through the lens of liminality or biotechnological strays, the altered beings that are created through xenotransplantation and de-extinction pose important challenges to concepts of identity that are based on autonomous and self-contained bodies. Liminal beings like these biotechnological strays create discomfort by troubling what Elaine L. Graham refers to as the "ontological hygiene" of humanity—i.e., the implied boundaries "separating human from non-human, nature from culture, organism from machine, binary pairings whose mutual purification is complicit in the discourses of modernity."[39] As Graham explains, these distinctions are culturally constructed, but are often treated as being core components in distinguishing between human and nonhuman

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[36] Lesley A. Sharp, "The Other Animal of Transplant's Future," *Hastings Center Report* 48, no. S4 (2018): S63–66, https://doi.org/10.1002/hast.959.
[37] Creed, *Stray*, 120.
[38] Revivicor, "GalSafe® Pigs Environmental Assessment," October 19, 2020.
[39] Elaine L. Graham, *Representations of the Post/Human: Monsters, Aliens and Others in Popular Culture*, Manchester Studies in Religion, Culture and Gender (Manchester: Manchester University Press, 2002). 35.

identity. Because liminality resists distinction, these beings can pose a threat to the construction of various binaries that are used to categorize life: in de-extinction and xenotransplantation, liminal figures like the woolly elephant or the genetically modified pig are hybrids that are neither fully "natural" nor "technological," they are also no longer fully elephant/pig, but nor are they recognized as mammoth/human.

Perhaps unsurprisingly, monstrosity is a crucial lens through which these liminal figures of biotechnology and biomedicine are often viewed. As Graham argues, monstrosity has often been used to categorize the nonhuman, since monstrous figures "serve both to mark the fault-lines but also, subversively, to signal the fragility of such boundaries. They are truly 'monstrous'—as in things shown and displayed—in their simultaneous demonstration and destabilization of the demarcations by which cultures have separated nature from artifice, human from non-human, normal from pathological."[40] The distinction between "normal" and "pathological" is particularly relevant, since it contributes to the belief in a "correct" form of existence, whether it's unaltered nature or unmodified bodies. Similarly, in Pramod K. Nayar's discussion of posthuman theory, he connects monstrosity and animality, noting that both have been used to reaffirm what is (and what is not) human.[41] As I discuss in Part I and Part II, narratives about de-extinction and xenotransplantation often draw on the fear of the nonhuman in the depiction of genetically modified animal species and in the depiction of humans and Neanderthals who are either created or modified through biotechnological interventions. As I show, this alignment of biotechnological intervention with being "unnatural," and the products of biotechnology and biomedicine as being "monstrous" or "animalistic," can lead to serious ethical

[40] Graham, *Representations of the Post/Human*, 12.
[41] Pramod K. Nayar, *Posthumanism*, Themes in Twentieth- and Twenty-First-Century Literature and Culture (Cambridge, UK: Polity, 2014).

concerns about the way that both humans and animals will be treated in the context of de-extinction and xenotransplantation.

0.3 Harvesting Mammoth Skin and Pig Kidneys: Biovalue, Commodification, and Capital

As biotechnology promises new interventions into the body, new *uses* of biological material begin to emerge. To return to Squier's term "liminal lives," she notes that these beings are often used for the benefit of others. For example, she discusses embryonic stem cells as a key example of the liminal lives created in biomedicine, noting that "though they partake of human qualities, they share with nonhuman life-forms the possibility of being harvested for a use that transcends their own life."[42] Research in both de-extinction and xenotransplantation requires the use of biological material that, like embryonic stem cells, has applications beyond its original context. In de-extinction, genetic material acquired from the bodies of long-dead animals (and indeed, members of long-extinct species) is used to create new, hybrid animals. For example, DNA has been extracted from frozen mammoth skin found in the arctic and from pickled thylacine remains stored in a museum collection, and these types of materials—ranging from hundreds to tens of thousands of years old—can now find new uses in the 21st century.[43] In xenotransplantation, meanwhile, pigs become temporary incubators to house organs, and when the pigs are sacrificed, the organs are extracted and transferred into the bodies of human patients. And human patients, too, can offer "a use that transcends their own life": as

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[42] Squier, *Liminal Lives*, 4.
[43] Giorgia Guglielmi, "First Fossil Chromosomes Discovered in Freeze-Dried Mammoth Skin," *Nature* 631, no. 8022 (July 11, 2024): 719–20, https://doi.org/10.1038/d41586-024-02253-4. Margherita Bassi, "A 110-Year-Old Pickled Thylacine Head Helped Build the Most Complete Ancient Genome to Date, Says 'De-Extinction' Company," *Smithsonian Magazine*, October 28, 2024, https://www.smithsonianmag.com/smart-news/a-110-year-old-pickled-thylacine-head-helped-build-the-most-complete-ancient-genome-to-date-says-de-extinction-company-180985308/.

I discuss in Part II, transplant patients who opt to receive pig organs frequently frame their decision in terms of the ongoing benefits it can provide to science and medicine. As these examples show, de-extinction and xenotransplantation both rely on the transferability of biological material into new contexts and new bodies. Importantly, though, the level of agency across these examples differs significantly: unlike the corpses of mammoths and thylacines and the living pigs from which genetic material and organs are harvested, humans can opt to participate in experimental medicine. As I discuss in Part II, however, even for patients who choose to participate in experimental medicine, there are still important ethical concerns about their vulnerability and ability to consent.

In my analysis of the narratives emerging around de-extinction and xenotransplantation, I focus in particular on the way that biological materials such as genes and organs are produced, extracted, transferred, revivified, and repurposed, often creating new sources of value and commodifiable products. Catherine Waldby's term "biovalue" is especially useful tool for tracing the way that biological materials in de-extinction and xenotransplantation are harvested for further use. According to Waldby, this type of value "is generated wherever the generative and transformative productivity of living entities can be instrumentalised along lines which make them useful for human projects – science, industry, medicine, agriculture or other arenas of technical culture."[44] As Waldby explains, biomedical research is particularly likely to produce new forms of biovalue as biological materials (such as DNA) are modified and altered to create new combinations that can be used as biomedical *products*. When it comes to de-extinction and xenotransplantation, both areas offer opportunities to discover (and engineer) new sources of biovalue as genetic modifications create organs and organisms whose added value stems from their ability to be revivified and repurposed in

[44] Catherine Waldby, *The Visible Human Project: Informatic Bodies and Posthuman Medicine* (Routledge, 2000). 33.

ever new ways. Typically, this commodification of biological material is deeply technosolutionistic, as these projects—and the new products they seek to create—are framed within the context of their ability to have widespread biomedical, environmental, and ecological benefits.

The creation of biovalue is not limited solely to disembodied biological material either: entire bodies can become sources of biovalue. For example, Waldby focuses her analysis on the Visible Human Project (VHP), which involved digitizing two human bodies to create an anatomical resource. These bodies provided a new source of medical knowledge created through the mapping of their interiors. However, Waldby notes that this use of the human body is not straightforward. While it "seems a testament to human mastery over the natural world," Waldby argues that "it throws open the human to multiple incursions, demonstrating the body's possibilities for commodification, for instrumentalisation."[45] By commodifying and instrumentalizing the human body, then, the VHP troubles the idea of biotechnology as a tool under human control. This is where another important concept comes in: Justin Omar Johnston's concept of "human capital." Johnston analyzes how fiction engages with the commodification of human bodies in the "biotech century," and highlights how new options for body modification or enhancement create the "transformation of the human (at the level of ideology) into a target, a goal, a score."[46] By casting a perfected version of "human" identity as an unreachable goal, the result is that "human [is] always in need of an upgrade: new skills, new capabilities, new ways of competing. This is the human that is always becoming human and is therefore never fully human. This is the human as human capital."[47] Sherryl Vint, like Johnston, explores the biopolitical implications of new technologies by drawing on 21st-century SF. Vint

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[45] Waldby, *Visible Human Project*, 8.
[46] Justin Omar Johnston, *Posthuman Capital and Biotechnology in Contemporary Novels*, Palgrave Studies in Literature, Science and Medicine (Cham, Switzerland: Palgrave Macmillan, 2019). 15.
[47] Johnston, *Posthuman Capital*, 15.

explores how biocapital is produced by bodies in four different ways, which she terms "biopolitical figurations."[48] These figurations, she argues, "capture new experiences of subjectification—in the Foucauldian sense of both producing subjectivity and doing so by being subjugated to power relations—in our contemporary world of epivitality."[49] These figurations comprise "the immortal vessel, the vital machine, the spare part, and the living tool,"[50] each representing different ways of mapping how the biological systems of bodies are used to produce value and vitality.

The concepts of biovalue, epivitality, and human capital provide useful frameworks for my analysis of the human and nonhuman figures in de-extinction and xenotransplantation narratives. As I discuss in Part I and Part II, even as these fields promise grand biotechnological and biomedical developments, the commodification of biological material and bodies extends to the overall category of the human as well, raising significant ethical, social, and political concerns. For example, in Part I, I investigate fictional characters (both *Homo sapiens* and Neanderthal) who were created using cloning or genetic engineering, and whose bodies are viewed as sources of potential biomedical value. These characters are seen as being less "human" due to their creation in a laboratory, and their bodies therefore become exploitable in the pursuit of further opportunities to capitalize on the value of their genetic material. In Part II, I focus on human characters whose bodies are altered through receiving pig organ transplants. These characters are both test subjects *and* customers, exploitable sources of medical knowledge *and* exploitable consumers of medical products. Meanwhile, animals are present across all three sections, not just in terms of the products created using their genetic material or organs, but also as *representations* of scientific advancement. In Part III in particular, I

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[48] Sherryl Vint, *Biopolitical Futures in Twenty-First-Century Speculative Fiction* (Cambridge University Press, 2021). 20.
[49] Vint, *Biopolitical Futures*, 20.
[50] Vint, *Biopolitical Futures*, 20.

show that animals have been rhetorically highlighted (to promote hype for the powers of de-extinction) or hidden (to reduce discomfort at the transfer of animal organs), and that fiction can play an important role in countering these processes with a more nuanced depiction of the relationships between humans and animals in the context of biotechnology.

0.4 Human Futures of De-Extinction and Xenotransplantation: Transhumanist Perspectives on Identity and Technology

Given the way that biological material is being repurposed in de-extinction and xenotransplantation, questions of identity—and especially about the impact of biotechnological modification on identity—are central to these projects. As genomes are modified and as genetic material and organs are transferred between bodies, biological boundaries become increasingly unstable, leading to uncertain distinctions between human/nonhuman. Two philosophical and theoretical approaches—transhumanism and critical posthumanism—provide crucial context for making sense of these questions. Both approaches explore the way that technology is impacting human bodies, identities, and societies, and both fields address the idea of "the posthuman" as a core concept. As transhumanist and posthumanist scholars have pointed out, these overlaps lead to transhumanism and posthumanism being mistaken for one another or being used interchangeably.[51] However, this does not mean that the lenses through which transhumanist and posthumanist theorists view identity are the same. Indeed, there are critical distinctions, particularly in the way the

[51] Francesca Ferrando, "Transhumanism/Posthumanism," in *Posthuman Glossary*, ed. Rosi Braidotti and Maria Hlavajova (Bloomsbury Academic, 2018). 439. Sherryl Vint, "Speculative Fiction," in After the Human: Culture, Theory, and Criticism in the 21st Century, ed. Sherryl Vint, After Series (Cambridge, United Kingdom; Cambridge University Press, 2020). 225-226. Max More and Natasha Vita-More, "Roots and Core Themes," in *The Transhumanist Reader: Classical and Contemporary Essays on the Science, Technology, and Philosophy of the Human Future*, ed. Max More and Natasha Vita-More (Wiley-Blackwell, 2013). 1.

movements engage with technology, how they conceptualize human (and "posthuman") identity, and the types of futures they envision for humanity. In this dissertation, I incorporate a critical posthumanist theoretical framework in my analysis of de-extinction and xenotransplantation. Given that, across Part I and Part II in particular, I critique the influence of techno-optimistic transhumanist philosophy on the discourse around de-extinction and xenotransplantation, I will begin by outlining the core aspects of a transhumanist approach to the body and identity.

To start with, transhumanism is both a philosophical field and a movement that seeks to change (or rather, to *enhance*) the human body by using scientific and technological tools. According to Max More and Natasha Vita-More, transhumanism "seeks the continued evolution of human life beyond its current human form as a result of science and technology guided by life-promoting principles and values."[52] In other words, transhumanist philosophy embraces technology as a tool that can be used to alter the body, leading to better possibilities for human existence. As More notes, continual development, rather than a static state of perfection, is the goal, since "[t]ranshumanists seek not utopia, but perpetual progress."[53] Or, as Nayar explains, transhumanist philosophy "sees a *telos* for humanity's future that is achieved almost exclusively through technology."[54] While transhumanists may take progress over perfection, the goal is to always move towards ideal or perfected states by using cutting-edge technologies to continually enhance and improve the body in new ways. Technosolutionism and techno-optimism are therefore deeply enmeshed in transhumanist philosophy: technology is seen as creating better forms of human existence, *and* as solving problems by overcoming the biological limitations of the body. Given the technosolutionistic and techno-

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[52] More and Vita-More, "Roots and Core Themes," 1.
[53] Max More, "The Philosophy of Transhumanism," in *The Transhumanist Reader: Classical and Contemporary Essays on the Science, Technology, and Philosophy of the Human Future*, ed. Max More and Natasha Vita-More (Wiley-Blackwell, 2013). 14.
[54] Nayar, *Posthumanism*, 7.

optimistic rhetoric in de-extinction and xenotransplantation, it is important to trace the influence of transhumanist theories on these two fields, in particular, how the idea of perpetual progress and improvement that defines transhuman theory has influenced depictions of de-extinction and xenotransplantation. As I discuss in Part I, de-extinction is certainly viewed as an opportunity for (and an example of) biotechnological progress. Across the media, industry, and in fiction, the genetic material of dinosaurs, mammoths, and Neanderthals are framed as offering insights into human genetics, and thereby creating opportunities for new biomedical products that can enhance *human* health and bodies.

Bodily modification through new technologies is viewed by transhumanists as an essential part of this continual progress. The right to this type of modification is referred to as "morphological freedom," which Anders Sandberg describes as "an extension of one's right to one's body, not just self-ownership but also the right to modify oneself according to one's desires."[55] The use of the word "freedom" is significant: it designates not just the right to modification, but also a belief that the body's biological limitations can be overcome through technological intervention. And like perpetual progress, morphological freedom is clearly at play in de-extinction and xenotransplantation discourse. Xenotransplantation, unsurprisingly, is frequently connected with the ability to modify one's body using biotechnology. As I discuss in Part II, the right to decide how one chooses to modify their bodies is certainly expressed by proponents of xenotransplantation, and some depictions of xenotransplantation explore the use of pig organs or skin in *elective* procedures, where xenotransplantation becomes an opportunity for self-expression and freedom from the limitations of the body. This transhumanist approach can create a system where, rather than focusing on lifesaving

[55] Anders Sandberg, "Morphological Freedom--Why We Not Just Want It, but Need It," in *The Transhumanist Reader: Classical and Contemporary Essays on the Science, Technology, and Philosophy of the Human Future*, ed. Max More and Natasha Vita-More (Wiley-Blackwell, 2013). 56

medical procedures for patients in need, biomedical corporations might instead focus on creating commodifiable products for consumers.

According to transhumanist scholars, morphological freedom, combined with the focus on ongoing progress, can lead to humans evolving into *posthumans*. For example, as More explains, "[b]ecoming posthuman means exceeding the limitations that define the less desirable aspects of the 'human condition.'"[56] These "less desirable aspects" of human existence, More explains, include "disease, aging, and inevitable death."[57] Beyond the physical changes to the body, transhumanists also view the posthuman as having "much greater cognitive capabilities, and more refined emotions"[58] than humans. In other words, transhumanists view the "posthuman" as a healthier, more resilient, more intelligent, and perhaps even immortal state of being that can be achieved through technological intervention. Along with the physical and cognitive enhancements that transhumanists hope for, both advocates and critics of transhumanism have noted that this change to the material body is frequently posed as a means of enhancing *identity* and *individuality* as well. As Sandberg notes, "morphological freedom is not going to eliminate humanity, but to express *what is truly human even further*."[59] But what does being "truly human" mean from a transhumanist perspective, and what problems could arise from this approach to human identity?

The identity that transhumanism seeks to enhance is based on a specific understanding that prioritizes certain characteristics as "human." For example, More highlights the role of "Enlightenment ideas and ideals" in transhumanism, which he argues includes "rationality and scientific method, individual rights, the possibility and desirability of progress, the overcoming of

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[56] More, "Philosophy of Transhumanism," 4.
[57] More, "Philosophy of Transhumanism," 4.
[58] More, "Philosophy of Transhumanism," 4.
[59] Sandberg, "Morphological Freedom," 63. Emphasis added.

superstition and authoritarianism, and the search for new forms of governance—while revising and refining them in the light of new knowledge."[60] In response, some scholars have noted that this combination of new technologies and Enlightenment ideals (especially regarding individuality) in pursuit of the enhancement of the human can reinforce an idea of identity that is based on the mind/body divide. Bruce Clarke and Manuela Rossini note that "[t]ranshumanist prostheses are *skeuomorphs of humanism*, vestiges of heroic aspirations that preserve rather than challenge the Cartesian mind-body split so definitive of Western modernity and the Eurocentric myth of progress as technoscientific development."[61] As they point out, it is evident that transhumanists see both technologies and the body as tools that can be used to better express the individuality of the human mind.

Part of the reason why transhumanism and posthumanism may be mistakenly conflated is because of what Pramod K. Nayar refers to as "popular posthumanism."[62] This understanding of posthumanism is based on popular representations of altered humans: as Vint explains, SF has played a significant role in encouraging audiences to view the "posthuman" as the human intensified or perfected through technological enhancements. Vint notes that "[i]n mainstream culture, the term posthuman will usually bring to mind some image from speculative fiction (sf)—a future of perfected embodiment through genetic modification that gives humans new morphologies and capabilities, or a future where we have left embodiment altogether to live at the speed of data as minds uploaded to networks, configuring our surroundings to suit our whims."[63] Both Nayar and Vint point out that

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[60] More, "The Philosophy of Transhumanism," 10.
[61] Bruce Clarke and Manuela Rossini, "Preface: Literature, Posthumanism, and the Posthuman," in *The Cambridge Companion to Literature and the Posthuman*, ed. Bruce Clarke and Manuela Rossini, Cambridge Companions to Literature (Cambridge, United Kingdom; Cambridge University Press, 2017). xiv. Emphasis added.
[62] Nayar, *Posthumanism*, 8.
[63] Vint, "Speculative Fiction," 220.

these views of a "posthuman"—meaning, in this case, a technologically enhanced and disembodied *human*—are much more in line with transhumanism than posthumanism. As Nayar explains, popular posthumanism is based on the idea that a core, foundational "human" identity can be reinforced through technological interventions; as he argues, this approach relies on "traditional views of the human."[64] Cary Wolfe, similarly, discusses the need for posthuman theorists to differentiate the two fields, noting that "[m]any of those who aspire to, or imagine the inevitability of, what is often called a 'posthuman' condition […] are, philosophically speaking, rather traditional humanists."[65]

The transhumanist approach to identity can raise several issues. For example, while morphological freedom is viewed as a core aspect of transhumanism that allows individuals to express their human identity in new ways, this can result in a never-ending cycle where further enhancements are always needed to maintain human identity. Or, as Johnston notes, the need to strive to be "human" means that one is not inherently already human, and instead, "neoliberal rationalities reimagine human belonging as an aspirational category always and structurally just out of reach."[66] The transhumanist approach to identity, as posthuman theorists have pointed out, can result in the reinforcement of exclusionary frameworks that have historically been used to limit who is considered fully "human." Vint, for example, argues that the "[i]nterest in human/machine couplings expressed in transhumanism […] is often seen as intensifying rather than ameliorating the hierarchical way of thinking that has characterized human exceptionalism."[67] Human exceptionalism, or the belief that status as "human" holds particular value, can lead to the privileging of certain approaches to the

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[64] Nayar, *Posthumanism*, 8.
[65] Cary Wolfe, "Posthumanism," in *Posthuman Glossary*, ed. Rosi Braidotti and Maria Hlavajova (Bloomsbury Academic, 2018). 356.
[66] Johnston, *Posthuman Capital*, 2.
[67] Sherryl Vint, "Introduction," in *After the Human: Culture, Theory, and Criticism in the 21st Century*, ed. Sherryl Vint, After Series (Cambridge, United Kingdom; Cambridge University Press, 2020). 5.

"human" over others, while also reinforcing the "superiority" of humans over nonhuman life, such as nonhuman animals.[68] As I discuss in both Part I and Part II, when biotechnological intervention is framed as a way to achieve an enhanced "human" identity, the result is that characters like cloned humans and Neanderthals, along with humans with pig organs, must continually try to reaffirm their identity as human.

In my analysis of the figures created in de-extinction and xenotransplantation, I will focus in particular on the bioethical risks arising from a transhumanist approach to biotechnological intervention. In its attempt to "apply technology to overcome limits imposed by our biological and genetic heritage,"[69] transhumanism's influence can be clearly traced in both de-extinction and xenotransplantation narratives. For example, as I discuss in Part I, de-extinction is promoted simultaneously as a means of rectifying environmental and ecological destruction while also offering potential genetic insights and biomedical benefits that can lead to revolutionary developments for human health. Meanwhile, as I discuss in Part II, xenotransplantation offers the possibility of radically changing current approaches to transplant medicine through a new supply of organs that can extend the lives of transplant patients in unprecedented ways. In both cases, technology is optimistically seen as offering possibilities to overcome death by extending the lifespans of humans, returning extinct species to existence, and protecting the environment in the process, leading to the type of "posthuman" existence that transhuman theorists describe. However, while concepts like morphological freedom and the ability to become more "human" through biotechnological enhancement are frequently explored in de-extinction and xenotransplantation narratives, so too is the

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[68] Other fields have, similarly, critiqued anthropocentrism and speciesism, such as the field of animal studies. For further discussion of how a critical posthumanist perspective can contribute to discussions of animal studies, see Wolfe, "Posthumanism."
[69] More, "The Philosophy of Transhumanism," 4.

potential for exploitation, and the possibility that the beings who are modified or created through biotechnological intervention will be excluded from being considered human despite (or because of) their bodily enhancements. A critical posthumanist approach, then, can help to identify and navigate the risks arising from a techno-optimistic, transhumanist approach to de-extinction and xenotransplantation.

0.5 Challenging Human Exceptionalism: Critical Posthumanism and Multispecies Studies

Unlike the reinforcement of enlightenment humanism associated with transhumanist theory, posthumanism involves tracing and critiquing the way that "human" identity is formed. Critical posthumanism is particularly relevant to the analysis of 21st-century biomedical and biotechnological developments. As Rosi Braidotti argues, the posthuman can be viewed as a "navigational tool," or "a working hypothesis about the kind of subjects we are becoming."[70] Braidotti's influential term "posthuman convergence" highlights three factors that are shaping human existence in the 21st century:

> First, at the social level we witness increasing structural injustices through the unequal distribution of wealth, prosperity and access to technology. Second, at the environmental level we are confronted with the devastation of species and a decaying planet, struck by climate crises and new epidemics. And third, at the technological level, the status and condition of the human is being redefined by the life sciences and genomics, neural sciences and robotics, nanotechnologies, and the new information technologies and the digital interconnections they afford us.[71]

According to Braidotti, these three factors "converge" to create a unique moment where to be "human" is to be impacted by capitalism and economic inequalities, climate change and

[70] Rosi Braidotti, *Posthuman Knowledge* (Cambridge, UK; Polity Press, 2019). 2.
[71] Rosi Braidotti, *Posthuman Feminism* (Polity, 2022). 3-4.

environmental crises, and the rapid development of new technological interventions. This posthuman convergence, according to Braidotti, is not the *end* of the human, but rather can allow for new configurations, since "it also affords huge opportunities for both humans and non-human agents, as well as for the Humanities, to reinvent themselves."[72] Across each section of this dissertation, I trace the ways that de-extinction and xenotransplantation are emerging in the context of the posthuman convergence. First, both fields embrace the technosolutionistic idea that biotechnology can enhance human life by solving environmental and medical crises; secondly, at the heart of both fields is the anthropocentric belief that humans can control the environment and exploit animals and natural resources, which has already contributed to climate change; and finally, both fields pose the possibility for ongoing commodification of biological material, which could result in further inequalities.

Critical posthumanism is a useful framework for analyzing and addressing the depiction of exploitative and exclusionary frameworks by which identity is measured in de-extinction and xenotransplantation narratives. For example, Francesca Ferrando, in her discussion of existential posthumanism, defines this approach as "a path of self-enquiry and self-discovery, aimed at full existential awareness."[73] "Posthuman awareness" is, Ferrando argues, a key component of this approach, which "must comply with at least these three layers together: post-humanism, post-anthropocentrism, post-dualism."[74] In other words, posthuman awareness is the acknowledgement of how humanism, anthropocentrism, and dualism have each shaped understandings of human identity, and the ability to look beyond these to consider other possibilities for human existence. To do so,

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[72] Braidotti, *Posthuman Knowledge*, 4.
[73] Francesca Ferrando, *The Art of Being Posthuman: Who Are We in the 21st Century?* (Cambridge: Polity Press, 2024). 17.
[74] Ferrando, *The Art of Being Posthuman*, 28.

critical posthumanism often draws on or intersects with other theoretical approaches. For example, Braidotti traces the way that feminist theory has contributed to the formation of critical posthumanism, arguing that "[t]he posthuman turn is about the becoming-otherwise-human of feminist and critical theory."[75] Nayar similarly provides an important overview of the connections between critical posthumanism and fields like monster studies, animal studies, and disability studies, which he argues "all contribute to posthumanism because these redefine the boundaries of the human, and call into question the hierarchies of human/non-human, human/machine and human/inhuman."[76]

Through its critique of humanism, anthropocentrism, and dualism, critical posthumanism rethinks what it means to be "human." Nayar explains that critical posthumanism represents "a new *conceptualization* of the human. Posthumanism studies cultural representations, power relations and discourses that have historically situated the human *above* other life forms, and in control of them."[77] By decentering the "human" and questioning the construction of power over those considered "nonhuman," critical posthumanism offers opportunities to consider how *dehumanization* has been used to construct human identity. Vint argues that, in tracing *absences* in the historical construction of the "human," it "is not simply a case of bodies/subjects that have been left out of the humanist frame, but those who *actively have been excluded by a process of dehumanization*."[78] Indeed, Vint notes that an important connection across theorizations of posthumanism "is the recognition that 'the human' is always coproduced with an abjected nonhuman."[79] Certainly, this is the case in de-extinction and xenotransplantation narratives: cloned Neanderthals, genetically modified animals, humans with animal organs, and chimeric pigs all present versions of the monstrous or "abjected nonhuman"

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[75] Braidotti, *Posthuman Feminism*, 6.
[76] Nayar, *Posthumanism*, 4.
[77] Nayar, *Posthumanism*, 3.
[78] Vint, "Introduction," 6-7. Emphasis added.
[79] Vint, "Introduction," 6-7. Emphasis added.

against which "humanness" is measured. A critical posthumanist approach is valuable, then, in identifying the way that, even as biotechnology is promoted as the solution to environmental and medical problems, it is simultaneously used to construct the "nonhuman" and reinforce the "human."

One of the methods that Ferrando proposes in her discussion of existential posthumanism is "decluttering the notion of the human."[80] This *decluttering* can allow us to put aside the hierarchies, binaries, and restrictions that have long been central to the construction of "human" identity. As Ferrando argues, decluttering "is conducive to posthuman revelations and species renewal,"[81] since it "offers ways to make space from symbolic pollution (referring to biases and hidden agendas that may sustain the symbolic order of a notion), locating ourselves in the wider picture, without being trapped in self-inferred illusionary exceptionalisms and/or self-inflicted nihilistic paralyzations."[82] To declutter the human means identifying and challenging the hierarchies that have always shaped what it means to be "human." This process can result in better relationships with nonhuman animals and the environment. For example, in terms of de-extinction, the field is currently "cluttered" with both anthropocentrism and speciesism. Proponents center humanity in de-extinction discourse by arguing that by granting humans greater control over animals and ecosystems, de-extinction can allow us to rectify human-caused climate change and extinctions. Beyond that, as I will discuss in Part III, the animals selected as candidates for de-extinction, like Colossal's "dire wolves," are usually high in species hierarchies, where their biological and cultural proximity to humans establishes their value. To "declutter" de-extinction, therefore, requires us to think beyond anthropocentrism when selecting candidate species. Meanwhile, xenotransplantation is frequently framed as a hopeful solution to medical crises, but what often goes unaddressed is the fact that it would rely on the continued

[80] Ferrando, *The Art of Being Posthuman*, 30.
[81] Ferrando, *The Art of Being Posthuman*, 30.
[82] Ferrando, *The Art of Being Posthuman*, 31.

exploitation of nonhuman animals as a source of vitality and value. Decluttering xenotransplantation thus requires us to question the use of animals both in biomedicine and in agriculture. As I discuss in Part III, narratives can contribute to decluttering xenotransplantation by considering the possibilities for human-pig kinship to emerge from xenotransplantation, leading to new approaches to the organ shortage crises that do not rely on nonhuman animals.

Given the complications and misunderstandings that arise from the use of the term "posthuman," it is unsurprising that posthuman theorists have turned to other terms that can better differentiate their approaches to human-nonhuman entanglements. Graham, for example, discusses how her goal in analyzing depictions of technologically altered humans is not about identifying how humanity might evolve into something else, but rather to understand whose version of the "human" is being prioritized:

> What is at stake, supremely, in the debate about the implications of digital, genetic, cybernetic and biomedical technologies is precisely what (and who) will define authoritative notions of normative, exemplary, desirable humanity into the twenty-first century. […] It is not so much about the end of the human or the advent of the superhuman, therefore, as whose visions will fuel the technoscientific developments that contribute towards the realization of any such futures.[83]

To differentiate from the (transhumanist) idea of the posthuman as an enhanced "human," Graham opts to use the term "post/human," which she believes can "suggest a questioning both of the inevitability of a successor species and of there being any consensus surrounding the effects of technologies on the future of humanity."[84] Rather than the enhanced human of transhumanist theory, Graham's "post/human" aligns more with Braidotti's idea of the posthuman as a navigational tool, as Graham views it as a way of understanding the different influences (such as technological developments) that shape identity. This differentiation is crucial: as I highlight in my analysis of de-

[83] Graham, *Representations of the Post/Human*, 11.
[84] Graham, *Representations of the Post/Human*, 11.

extinction and xenotransplantation narratives, these stories often depict characters that align with the transhumanist idea of the "posthuman" as a modified or enhanced being, but whether these narratives encourage a more fundamental questioning of human identity, and whether they embrace a rejection of anthropocentrism, is not always initially clear. For example, across each section, I consider depictions of Neanderthals, cloned humans, and chimeric pigs, all of which represent the possible bodily modifications that could be made possible through biotechnology. However, many of these examples still frame these characters within the contexts of human essentialism, where "human" traits are prioritized.

Other alternatives to the "posthuman" have also been proposed as a way of better highlighting the interconnection between humans and other beings, particularly in the context of environmental concerns. For example, Donna Haraway has sought to differentiate her approach from that of posthuman theorists. Rather than Anthropocene, Haraway proposes the term "Chthulucene" to highlight the interconnections shared between species, since it suggests "a kind of timeplace for learning to stay with the trouble of living and dying in response-ability on a damaged earth."[85] Haraway's approach aligns with the work of scholars in multispecies studies, a field that, like critical posthumanism, seeks to highlight the way that identity is formed through relationships across species boundaries, often referred to as "assemblages."[86] Anna Tsing, for example, focuses on the concept of "precarity," and argues that it "is the condition of being vulnerable to others. Unpredictable encounters transform us; we are not in control, even of ourselves. Unable to rely on a stable structure

[85] Donna Haraway, *Staying With the Trouble: Making Kin in the Chthulucene* (Duke University Press, 2016). 2.
[86] Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton University Press, 2015), https://doi.org/10.2307/j.ctvc77bcc. 22-23. Thom van Dooren, Eben Kirksey, and Ursula Münster, "Multispecies Studies: Cultivating Arts of Attentiveness," *Environmental Humanities* 8, no. 1 (May 1, 2016): 1–23, https://doi.org/10.1215/22011919-3527695. 14.

of community, we are thrown into shifting assemblages, which remake us as well as our others."[87] If existence and identity are precarious, then there is no fundamental "human" identity that exists independently of the "unpredictable encounters" that Tsing describes.

The multispecies interactions that Haraway focuses on—especially with beings she refers to as the "chthonic ones"—prompt her to suggest an alternative to posthumanism: "The chthonic ones are not confined to a vanished past. They are a buzzing, stinging, sucking swarm now, and human beings are not in a separate compost pile. We are humus, not Homo, not anthropos; we are compost, not posthuman."[88] Haraway embraces the idea of multispecies "compost" as a productive means of rethinking the status of humans in the Chthulucene. And while Haraway acknowledges the "generative work" done by critical posthumanism,[89] she does not view her work as necessarily falling under that category, instead stating that "I am a compostist, not a posthumanist."[90] Haraway's multispecies, "compostist" approach to understanding the human condition—along with other work done in the field of multispecies studies—is particularly relevant for my analyses in Part III of de-extinction and xenotransplantation narratives that feature close relationships between humans and a variety of modified or engineered animals, such as chimeric pigs and robotic insects. While I draw on critical posthumanism, the idea of "compost" and the multispecies assemblages it suggests is a useful way of thinking through how humans, animals, and biotechnology are forming new and unanticipated entanglements through de-extinction and xenotransplantation.

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[87] Tsing, *Mushroom at the End of the World*, 20.
[88] Haraway, *Staying With the Trouble*, 55.
[89] Haraway, *Staying With the Trouble*, 32.
[90] Haraway, *Staying With the Trouble*, 101-102.

0.6 Posthuman Ethics, Bioethics, and Environmental Ethics

Bringing a critical posthumanist lens to the analysis of de-extinction and xenotransplantation narratives can provide an opportunity for expanded conceptions of identity, ethics, kinship, and care. The political and ethical potential of posthumanism is frequently invoked by posthumanist theorists, some of whom argue that critical posthumanism can create opportunities for expanded ethical theory *and* for tangible action. Ferrando, for example, argues that "[t]here is growing interest towards posthumanism, not only as a theoretical frame to understand our times, but as a *practical* one to act inspirationally in our lives."[91] Similarly, in the introduction to a collection on posthumanist theory (or theory "after the human"[92]), Vint notes that "the most important thing that unites the scholarship collected here is a sense that posthumanism is an ethical and political project—even if there is no consensus on precisely what its interventions should be."[93] As Vint notes, there is no single vision of what a posthumanist ethics would entail; instead, there are numerous different perspectives on the possible ethical and political application of critical posthumanism. Despite the broad range of possibilities for posthuman ethics, one key means through which new ethical approaches can be developed is by rethinking agency and autonomy in the context of the entanglements between humans, animals, biotechnologies, and environments. In particular, the influence of critical posthumanism on ethical theory can be seen in fields like medical humanities and bioethics, as well as environmental humanities and environmental ethics.

Recently, scholars have engaged with critical posthumanism as a means of thinking differently about the experience, care, and rights of medical patients. For example, in an edited collection on posthumanist bioethics, Danielle Sands argues that "the posthumanities can and should

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[91] Ferrando, *The Art of Being Posthuman*, 2. Emphasis added.
[92] Vint, "Introduction," 1.
[93] Vint, "Introduction," 7.

inform the conversations around life, subjectivity, human nature, responsibility, and interspecies relations that underpin bioethical decision-making."[94] And while, as Sands notes, the collection includes "sometimes discordant encounters"[95] between the two fields, it still works to reimagine bioethics by rejecting humanist conceptions of identity and bodily boundaries, since "a normative, universalist morality rooted in personhood cannot elucidate, for example, the rapidly changing account of the human necessitated by genome editing, or by increased knowledge of the microbiome."[96] In a chapter in the collection by Stefan Herbrechter, he compares transhumanist and posthumanist influences on bioethics. Herbrechter argues that an approach to bioethics informed by critical posthuman theory "would need to balance both the technological and the biological claims towards life by reconciling the deep ecological aspect of symbiogenesis with an acknowledgement of the originary technicity inscribed in life processes."[97] This approach that prioritizes an understanding of *both* "symbiogenesis" and "technicity" is important, he argues, because "[a]cknowledging this double (bio-technological) claim and its current context is the only adequate way to affirm and to come to terms with the material 'messiness' of 'our' time."[98] Posthumanist approaches to medical humanities and bioethics are critical to my investigation of the impacts of new biomedical developments on both humans and animals. Across Part I, Part II, and Part III, I look at the way that narratives grapple with the ethical problems arising from new biological-technological entanglements created through biotechnological experimentation. I consider how these narratives explore bioethics in the context of the influence of both transhumanism (especially in terms of attempts at achieving

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[94] *Danielle Sands*, "Introduction: Encounters Between Bioethics and the Posthumanities," in *Bioethics and the Posthumanities*, ed. Danielle Sands (Routledge, 2022). 1.
[95] Sands, "Introduction", 1.
[96] Sands, "Introduction," 5.
[97] Stefan Herbrechter, "Biohumanities," in *Bioethics and the Posthumanities*, ed. Danielle Sands (Routledge, 2022). 73.
[98] Herbrechter, "Biohumanities," 73.

"freedom" from genetic disease, organ failure, or bodily limitations in general) and posthumanism (especially in terms of recognizing how human-animal-biotechnology entanglements shape identity and embodiment). As de-extinction and xenotransplantation alter biology in unprecedented ways, creating new biological-technological forms of life, new approaches to bioethics that encompass these changes are crucial.

To better consider the new entanglements created through biotechnological and biomedical projects, it is important to consider how scholars in both bioethics and environmental ethics have explored alternative means of viewing the human body. To this end, and bringing together similar fields as do Sands and Herbrechter, Tana Jean Welch brings critical posthumanism into conversation with bioethics and medicine. Welch considers how a posthumanist perspective can encourage us to view patients differently, and argues that "[m]edical posthumanism views the patient as and within an assemblage and makes decisions designed to maximize the health of all."[99] As Welch argues, medical posthumanism shifts from focusing on the *autonomy* of individual patients to instead focus on what she refers to as the "mutual heteronomy"[100] of assemblages: "[a] posthuman subjectivity acknowledges the construction of subjectivity as always connected to the body's mutual relations with other living and nonliving substances, including our entangled engagements with biomedicine—from health care providers to the latest in life saving technologies and pharmaceuticals."[101] This medical posthumanism that Welch describes provides another perspective through which to consider the impact of biomedicine on patients. As I discuss in Part I and Part II, de-extinction and xenotransplantation narratives often depict fears that individuals will become less "human" and more

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[99] Tana Jean Welch, *Advancing Medical Posthumanism Through Twenty-First Century American Poetry*, Palgrave Studies in Literature, Science and Medicine (Palgrave Macmillan Cham, 2024), https://doi.org/10.1007/978-3-031-49888-6. 12.
[100] Welch, *Advancing Medical Posthumanism*, 15.
[101] Welch, *Advancing Medical Posthumanism*, 16.

"monstrous," either due to genetic modification or to receiving pig organs, and explore the potential exploitation, isolation, or discrimination that these patients may experience. However, these fears stem from the belief in human identity as individualistic and autonomous. If we consider identity as *always* being formed through the interactions taking place within and beyond bodies, and recognize mutual heteronomy rather than autonomy, then the integration of human/nonhuman becomes less threatening and more mundane.

The recognition of the body as a collection of interactions has long been a focus of environmental humanities and environmental ethics. In particular, theorists have called attention to how expanding our understanding of the body can also allow for better recognition of the influence of different systems and materials. Stacy Alaimo draws on new materialism and posthumanism as she calls for a "profound reconsideration of matter [that] needs to be at the root of a posthumanist environmental ethics."[102] Alaimo responds to conceptions of the body as individual and static, and argues that "[b]racketing the biological body, and thereby severing its evolutionary, historical, and ongoing interconnections with the material world, may not be ethically, politically, or theoretically desirable."[103] To reconsider matter without "bracketing the biological body," Alaimo introduces the concept of "transcorporeality," which highlights the interconnections between bodies and material environments, and "opens up a mobile space that acknowledges the often unpredictable and unwanted actions of human bodies, nonhuman creatures, ecological systems, chemical agents, and other actors."[104] Alaimo argues that the concept of transcorporeality can counteract this perceived separation of bodies from other materials and systems, and she explores several key examples to

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[102] Stacy Alaimo, *Bodily Natures: Science, Environment, and the Material Self* (Bloomington: Indiana University Press, 2010). 142.
[103] Alaimo, *Bodily Natures*, 3.
[104] Alaimo, *Bodily Natures*, 2.

show the interplay between human bodies, environments, genetics, and chemical contaminants, among other factors. Alaimo's transcorporeality provides a useful framework through which to consider the constant change experienced by the body. In terms of xenotransplantation and de-extinction, these fields do not create singular products isolated from their environments; instead, the altered organs, bodies, and species that emerge are always interacting with other materials and systems. As I discuss in Part II, a transcorporeal perspective on xenotransplantation can highlight the various political, economic, and agricultural systems that come into contact through biomedical experimentation. Meanwhile, in Part III I discuss how recognizing the interplay between species, genetic materials, and ecosystems can provide a foundation for de-extinction grounded in environmental and ecological ethics.

While these approaches to posthumanist bioethics and environmental ethics can provide important lenses through which to consider the societal implications of de-extinction and xenotransplantation, it is also important to trace individual instances of care in de-extinction and xenotransplantation narratives. Along with its influence on bioethics and environmental ethics, critical posthumanism provides a unique angle through which to consider relationships across species boundaries. In *More Posthuman Glossary*, Braidotti and Goda Klumbyte contextualize posthuman care as developing in relation to fields like ecofeminism, arguing that "[p]osthuman notions of care ethics build on these feminist genealogies and emphasize mutual trans-species interdependence and ontological relationality."[105] This approach is closely connected to multispecies studies concepts like "passionate immersion" [106] and "attentiveness,"[107] both of which frame paying attention to other

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[105] Rosi Braidotti and Goda Klumbyte, "Posthuman Care," in *More Posthuman Glossary*, ed. Rosi Braidotti, Emily Jones, and Goda Klumbyte (Bloomsbury Academic, 2023). 106.
[106] Anna Tsing, "Arts of Inclusion, or, How to Love a Mushroom," *Australian Humanities Review*, no. 50 (2011). 9.
[107] van Dooren et al., "Multispecies Studies," 17.

species as a critical step in encouraging compassion, interest, and care across species boundaries. For example, Thom van Dooren et al. argue that "the arts of attentiveness remind us that knowing and living are deeply entangled and that paying attention can and should be the basis for crafting better possibilities for shared life."[108] This type of attentiveness can lead to greater recognition of the need for ethical treatment of humans, nonhuman animals, plants, and other living beings. Amelia DeFalco outlines another approach to posthuman care that resonates with this ethos. As DeFalco argues, stories that depict care between human and nonhuman beings (such as robot companions) can encourage "an inclusive, enabling vision of care that makes room for the incredible range of affects, energies, behaviors, attachments, and dependencies (both visible and invisible) that produce and sustain life in more-than-human worlds."[109] Each of these approaches highlights the ability for care to cross species boundaries and biological/technological boundaries. Along with my analysis of the ethical considerations arising from de-extinction and xenotransplantation, in Part III I will also consider how de-extinction and xenotransplantation narratives can encourage relationships based on this type of posthuman and multispecies care, by depicting the entanglements that can form between humans and the animals created through biotechnology or biomedicine. The key takeaway that I want to emphasize is that theoretical perspectives like posthumanism (as well as other, related fields like multispecies studies) can offer critical opportunities to not just *theorize* about how to more ethically co-exist with the animals created through de-extinction and xenotransplantation, but also to *practically* act on this theory by prioritizing multispecies kinship and care.

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[108] van Dooren et al., "Multispecies Studies," 17.
[109] Amelia DeFalco, *Curious Kin in Fictions of Posthuman Care* (Oxford University Press, 2023), https://doi.org/10.1093/oso/9780192886125.001.0001. 26.

0.7 Genres and Modalities

In my analysis of the narratives emerging around de-extinction and xenotransplantation, I draw on both literary and rhetorical analysis. To consider the different ways that these developments have been imagined, I analyze a wide range of materials, which have different intended goals and audiences. In the following sections, I outline the key genres of fiction (speculative fiction, climate fiction, solarpunk, medical thriller, and young adult fiction), as well as the types of nonfiction sources (science magazines, news articles, podcasts, company websites, etc.) that I incorporate in this dissertation's analysis of de-extinction and xenotransplantation narratives. The intended purposes of these texts differ widely, but they all encourage audiences to consider the impacts of new scientific developments. Bringing together this range of nonfiction and fiction reveals the diverse, though overlapping, rhetorical strategies, narrative themes, and other cultural trends emerging around these biotechnological developments.

0.7.1 Speculative Fiction (SF)

Each chapter incorporates a close literary analysis of one or more speculative texts, which include novels, short stories, and films. SF is, unsurprisingly, a key genre in my analysis of de-extinction and xenotransplantation narratives. Many of the scholars already mentioned draw on SF: for example, Vint and Johnston have each explored the genre's engagement with biopolitical issues through a posthumanist lens, while Squier and Choksey have investigated SF's role in depicting biomedical and biotechnological developments, and Alaimo has explored transcorporeality and environmental issues through analyzing SF. As a genre that focuses closely on scientific developments, SF offers unique possibilities for interdisciplinary analysis. For example, Gary Westfahl discusses SF from the perspective of the "two cultures" of humanities and science. He notes

that given its rising popularity, "the genre now seems poised to make a significant contribution to society—such as, perhaps, helping to bring together the still-dueling factions of the sciences and the humanities, to break down stereotypical preconceptions which hinder communication, and to achieve some measure of reconciliation and commonality between these two disparate cultures."[110] Along with its interdisciplinarity, SF is also closely connected to critical posthumanism: as Vint argues, SF "offers a deep archive of ways of thinking about different embodiment, nonhuman agency, and diverse futures, often at scales far beyond a human lifetime, at times beyond the lifetime of our species."[111] As she explains, these features make SF a particularly important genre for posthumanist analysis.

In my analysis, I incorporate SF novels and films that envision societies where biotechnological advancements have made xenotransplantation and de-extinction possible. For example, Margaret Atwood's novel *Oryx and Crake* (2003) and the short film *We Ate the Children Last* (2011) both depict industries emerging around pig organ transplants and explore the potential societal impact of developments in xenotransplantation. Meanwhile, Gina DeMarco's novel *The Neanderthal's Aunt* (2014) and the *Jurassic World* films (2015, 2018, 2022) explore different possibilities for de-extinction, ranging from the creation of a Neanderthal baby to the widespread resurrection of dinosaurs. These examples demonstrate the wide spectrum of SF: while the society depicted in Atwood's novel's is characterized by highly futuristic biotechnologies and the widespread, commercial availability of pig organs for xenotransplantation, DeMarco's novel envisions a relatively unchanged society, where an attempt at creating a Neanderthal baby is the

[110] Gary Westfahl, "Introduction: Science Fiction at the Crossroads of Two Cultures," in *Science Fiction and the Two Cultures: Essays on Bridging the Gap Between Sciences and the Humanities*, ed. Gary Westfahl and George Slusser (McFarland & Company, Inc., 2009). 2.
[111] Vint, "Speculative Fiction," 232.

primary futuristic development. These examples also share important similarities, as each of them draws on fears about the potentially monstrous consequences of scientific experimentation, both in terms of the threat to human life, and the threat to human identity. SF narratives, then, offer opportunities to consider both cultural anxieties and potential ethical concerns about de-extinction and xenotransplantation.

0.7.2 Environmental Fiction

The other novels and short stories that I draw on are also speculative but can be characterized according to distinct genre (or subgenre) categories. Two genres that explore issues related to the environment and sustainability are particularly relevant: climate fiction (sometimes referred to as cli-fi) and solarpunk. Climate fiction, as Gregers Andersen explains, is a genre that explores the relationship between humans and the environment, particularly in relation to human-caused climate change: he notes that one feature that is "common to all climate fictions is that they use the scientific paradigm of anthropogenic global warming in their world-making."[112] Andersen identifies five common tropes in climate fiction, which he terms "The Social Collapse," "The Judgement," "The Conspiracy," "The Loss of Wilderness," and "The Sphere."[113] These tropes, as the names suggest, focus on topics such as the collapse of human society as a result of climate change, the environment enacting retribution on humans for human-caused environmental destruction, and humans engineering new environments in which to survive.

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[112] Gregers Andersen, *Climate Fiction and Cultural Analysis: A New Perspective on Life in the Anthropocene* (New York: Routledge, 2020). 5.
[113] Andersen, *Climate Fiction*, 11-12.

Meanwhile, the genre of solarpunk is closely related to climate fiction but has some key distinctions. First, while solarpunk, like climate fiction, prioritizes environmental concerns, it explores this from a much more hopeful and action-based perspective: as a genre that, in Olga Thierbach-McLean's words, "has undertaken to reclaim the future through radical hopefulness,"[114] it envisions new ways for humans to exist sustainably, and to cultivate closer relationships to the environment through technology. Or, as Juan David Reina-Rozo puts it, "[s]olarpunk is a movement in speculative fiction, art, fashion, and activism that seeks to answer and embody the question 'what does a sustainable civilization look like, and how can we get there?'"[115] Climate fiction like James Bradley's *Ghost Species* (2020) and solarpunk like D.K. Mok's "The Birdsong Fossil" (2021) envision the environmental and ecological impacts of human activity, and explore the potential role of de-extinction science in addressing anthropogenic environmental destruction, extinctions, and biodiversity loss. While the perspectives on de-extinction (and its ability to "solve" environmental crises) offered by these two stories differ, they both provide important opportunities to consider de-extinction in the context of climate change and sustainability.

0.7.3 Medical Fiction and Young Adult SF

Narratives that focus on medicine and healthcare can provide important insights into the bioethical issues arising from new medical treatments. These narratives can include the medical thriller genre along with SF that explores potential biomedical or pharmaceutical developments. The

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[114] Olga Thierbach-McLean, "Uncanceling the Future: Cyberpunk, Solarpunk, and the Rebellion of Eco-Optimism," in *Eco-Consciousness in American Culture: Imperatives in the Age of the Anthropocene*, ed. Adina Ciugureanu and Eduard Vlad (Peter Lang, 2023). 263-264.
[115] Juan David Reina-Rozo, "Art, Energy and Technology: The Solarpunk Movement," *International Journal of Engineering, Social Justice, and Peace* 8, no. 1 (March 5, 2021): 55–68, https://doi.org/10.24908/ijesjp.v8i1.14292. 54.

genre of the medical thriller, as Jean-Pierre Charpy explains, brings together medical topics and suspense. Charpy argues that "[a]lthough it is true that most medical thrillers share the same characteristics as thrillers—namely, fast-paced action, intensity of emotions, tension and excitement—they also have their own specific features, which are closely related to the medical knowledge or expertise of their authors and the professional environment in which they are embedded."[116] While, as Charpy notes, these novels are geared towards public audiences, their authors are often medical professionals. Consequently, medical thrillers often draw on real medical scenarios and incorporate varying levels of medical information. In my analysis, I incorporate Robin Cook's medical thriller *Chromosome 6* (1998), which explores xenotransplantation on a global scale in the context of exploitative systems like transplant tourism.

In contrast to medical thrillers, SF that focuses on biomedical developments is perhaps less likely to be grounded in real medicine. However, scholars have called for the significance of SF within the field of medical humanities. For example, Gavin Miller and Anna McFarlane's introduction to a special issue on "Science Fiction and Medical Humanities" outlines the ways that critical analysis of SF can contribute to the field: "[t]he task for studies of science fiction within the medical humanities is to articulate interpretative frameworks that do justice to medical thematics within the genre. This means challenging horizons of expectations that encourage unduly narrow readings of science fiction."[117] Young adult (YA) SF that focuses on medical topics can provide insights into the way that procedures like xenotransplantation are envisioned for young audiences. Two examples that I analyze in this dissertation, Malorie Blackman's YA novel *Pig-Heart Boy*

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[116] Jean-Pierre Charpy, "Medical Thrillers: Doctored Fiction for Future Doctors?," *Journal of Medical Humanities* 35, no. 4 (December 1, 2014): 423–34, https://doi.org/10.1007/s10912-014-9305-5. 424.
[117] Gavin Miller and Anna McFarlane, "Science Fiction and the Medical Humanities," *Medical Humanities* 42 (December 1, 2016): 213–18, https://doi.org/10.1136/medhum-2016-011144. 1.

(1997) and Alex Perry's YA novel *Pighearted* (2021), explore the experience of undergoing pig heart transplants from the perspective of children, which creates opportunities to consider the perceived social ramifications of these transplants (both in terms of human and nonhuman relationships).

0.7.4 Science Magazines and News Articles

In addition to these fictional sources, I also draw on a range of nonfiction sources intended for public audiences, including articles published online by newspapers and science magazines. The goal of these sources is typically to share scientific developments with the public. Science magazines are multimodal, and scholars have analyzed both the visual components of science magazines (such as their covers) and the textual elements (such as the use of metaphor).[118] Along with providing updates on current scientific developments, science magazines have a variety of other goals. In Carolyn M. Glasshoff's analysis of science magazine covers, she notes that "[d]epending on audience expectations, the magazine's primary purpose may be to inform, to persuade, to entertain, or a combination."[119] As Glasshoff explains, the goal of the science magazine will therefore influence the rhetorical choices made. This is further complicated by the need to navigate two competing goals, which, as Katarzyna Molek-Kozakowska outlines, are attracting/engaging audiences and providing credible information. Molek-Kozakowska discusses three strategies used by science journalists to engage audiences, which she terms the attentional turn (which emphasizes the "newsworthiness" of scientific information), the affective turn (which focuses on the emotional investment of the

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[118] Carolyn M. Glasshoff, "Why Should I Listen?: The Ethos of Science Magazine Covers," in *2012 IEEE International Professional Communication Conference*, 2012, 1–7, https://doi.org/10.1109/IPCC.2012.6408609. Niklas Pramling and Roger Säljö, "Scientific Knowledge, Popularisation, and the Use of Metaphors: Modern Genetics in Popular Science Magazines," *Scandinavian Journal of Educational Research* 51, no. 3 (2007): 275–95, https://doi.org/10.1080/00313830701356133.

[119] Glasshoff, "Why Should I Listen?," 2.

audiences), and the narrative turn (which focuses on using storytelling techniques to immerse audiences in a particular perspective).[120] While these methods can effectively catch the attention of audiences, Molek-Kozakowska argues that they can also detract from the stories, since "[w]hen taken to the extreme, their combined focus on engagement through stylisation and contrivance, rather than on enhancing science literacy, can compromise the ability of science journalism to share scientific information."[121] If science magazines focus too much on engagement, then, it can impact the credibility or detail level of the information being shared.

In my analysis, I draw on both science magazines and online news sources to consider how de-extinction and xenotransplantation are being communicated to public audiences. In particular, I incorporate articles published in science magazines like *Scientific American*, *Discover*, *National Geographic*, and *Smithsonian Magazine*. Both *Scientific American* and *Discover* focus primarily on scientific, medical, and environmental news.[122] In contrast, *National Geographic* and *Smithsonian* bring together science, culture, and history.[123] Since they are geared towards public audiences with interests in scientific developments, articles published in these magazines often present multiple sides, including both the potential ethical risks and the benefits of these developments. Therefore, these magazines offer an important resource for analyzing the rhetorical choices used to communicate about de-extinction and xenotransplantation. Even if the goal is to present information in an unbiased way, these articles influence how public audiences perceive developments in de-extinction and

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[120] Katarzyna Molek-Kozakowska, "Making Science Trend: The Style of Popular Science Magazines," in *Insights on Science Journalism*, ed. Felicity Mellor (Routledge, 2024). 160.
[121] Molek-Kozakowska, "Making Science Trend," 171-172.
[122] "About Scientific American," *Scientific American*, accessed June 27, 2025, https://www.scientificamerican.com/page/about-scientific-american/. "About Discover Magazine," *Discover Magazine*, accessed June 27, 2025, https://www.discovermagazine.com/about.
[123] "Our Story," National Geographic Society, accessed June 27, 2025, https://www.nationalgeographic.org/society/our-story/. "About Us," *Smithsonian Magazine*, accessed June 27, 2025, https://www.smithsonianmag.com/about/.

xenotransplantation by *framing* them in specific contexts and drawing on well-known cultural references, such as to *Frankenstein* and *Jurassic Park*.

0.7.5 Podcasts and Science Communication

Along with material written by science writers and journalists, I draw on podcasts featuring interviews with proponents of de-extinction and xenotransplantation. Podcasts, like magazine articles, are often geared towards public audiences, and science podcasts are becoming an increasingly popular source of scientific information. For example, a study analyzing English-language science podcasts between 2004-2018 found that there was an exponential growth in the number of science podcasts from 2010-2018, and that the general public (rather than specialist audiences) was the target audience of most of them.[124] As an important medium through which scientific content is communicated, podcasts can provide ways for audiences to engage with new scientific discoveries or developments. Science podcasts can also be popular among specialist audiences, since, as Daniel S. Quintana and James A.J. Heathers note, they can offer "'behind the scenes' discussion," which "provides the kind of nuance that is not possible with conventional academic papers, and is analogous to the casual conversations one may have with other scholars at conferences."[125] This format can make scientific information more accessible to wider audiences, since "these insightful conversations can be made available for anyone to hear."[126] This possibility to engage in the "insightful

[124] Lewis E. MacKenzie, "Science Podcasts: Analysis of Global Production and Output from 2004 to 2018," *Royal Society Open Science* 6, no. 1 (January 9, 2019): 180932, https://doi.org/10.1098/rsos.180932.
[125] Daniel S. Quintana and James A. J. Heathers, "How Podcasts Can Benefit Scientific Communities," Trends in Cognitive Sciences 25, no. 1 (January 1, 2021): 3–5, https://doi.org/10.1016/j.tics.2020.10.003. 1.
[126] Quintana and Heathers, "Podcasts," 1.

conversations" about new scientific developments can be an important way to engage audiences in the perspectives of the guests who are interviewed to share their perspectives on a given issue.

The expertise of the guests interviewed on these podcasts contributes to the credibility of the information shared. In my analysis, I incorporate podcast episodes where interviews with scientific and medical experts working on de-extinction and xenotransplantation, such as Dr. Beth Shapiro, Dr. Robert Montgomery, and Dr. Muhammad Mohiuddin, among others, take place. These podcast episodes offer insights into the way that scientists and medical doctors working on de-extinction and xenotransplantation communicate about developments in their fields. Rather than focusing on specific science podcast series, I include content from a variety of podcasts based on the individual episode's content. For example, the *New England Journal of Medicine*'s podcast, *Intention to Treat*, covers a wide range of medical developments, and includes an episode featuring Dr. Muhammad Mohiuddin and Dr. Robert Montgomery, two transplant surgeons working on xenotransplantation. Interestingly, relevant interviews do not always take place in explicitly *science*-themed podcasts, but might be featured on podcasts that either focus on general news, or that are geared towards specific (but not necessarily scientific) interests that might intersect with developments in xenotransplantation and de-extinction. An example of this is an interview with the de-extinction scientist Dr. Beth Shapiro on *The MeatEater Podcast* hosted by Steven Rinella, which typically focuses on topics related to outdoor activities, such as hunting, fishing, and wildlife conservation.[127] While podcasts are a fairly minor addition to my analysis, they provide an important opportunity to analyze the way that experts working in de-extinction and xenotransplantation communicate about their work.

[127] MeatEater, "The MeatEater Podcast," accessed June 29, 2025, https://www.themeateater.com/listen/meateater.

0.7.6 Company Websites, Newsletters, and Press Releases

Additionally, I incorporate publicly shared material from the companies working on de-extinction and xenotransplantation. Analyzing the rhetorical choices made by biotechnology and biomedical corporations provides a distinct perspective on the communication of de-extinction and xenotransplantation. For example, science communication scholar Martin Bauer has argued that the increasing privatization and commercialization of scientific research raises new communication concerns, since "[t]his trend leads us away from science writing and journalism and into public relations."[128] The result, Bauer argues, is a risk of scientific research being communicated in a way that could exaggerate or misrepresents the developments. Dana Fennell analyzes the rhetorical choices made by companies working on producing genetically modified crops, and identified several key rhetorical strategies they use. She argues that "[t]hrough the form of their texts, companies aim to simultaneously present truths in a depersonalized way, educate consumers, and brand their company names."[129] While public audiences are not necessarily the "consumers" of the products being developed by biotechnology companies, their acceptance of the work done by these companies can be a critical factor in shaping the future of these products. At the same time, as Fennell notes, biotechnology companies are also seeking to establish their "brand." It is therefore important to consider how these companies balance promoting their work to potential investors and reassuring the public about the importance or safety of their work.

In my analysis, I investigate publicly available materials created by biotechnology companies such as Colossal Laboratories & Biosciences, Revive & Restore, eGenesis, United Therapeutics,

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[128] Martin Bauer, "Paradigm Change for Science Communication: Commercial Science Needs a Critical Public," in *Communicating Science in Social Contexts*, ed. Donghong Chen et al. (Springer Netherlands, 2008). 22.

[129] Dana Fennell, "Marketing Science: The Corporate Faces of Genetic Engineering," *Journal of Communication Inquiry* 33, no. 1 (January 1, 2009): 5–26, https://doi.org/10.1177/0196859908325144. 21.

Makana Therapeutics, and Qihan Biotech, among others. This material includes text, images, and videos on their websites, newsletters, videos shared on platforms like YouTube, and press releases. These companies typically specialize in research and development (R&D) related to biotechnology, biomedicine, and pharmaceuticals. In some cases, they have received significant media attention for their work. For example, Colossal has become well-known not just due to their research on de-extinction and genetic engineering, but also because of their collaborations with celebrities like George R.R. Martin.[130] Their website reflects their desire to engage with public audiences and inspire interest and excitement in their work: it features a variety of illustrations of their candidate species, as well as simplified descriptions and timelines for their projects (for example, see their page on "The Mammoth").[131] Other companies that I look at are less well-known, and their websites may feature more limited information about their projects. Regardless, each of these companies offers insights into the rhetoric behind how these projects are simultaneously promoted to public audiences as safe scientific research that can address critical issues, and to investors as valuable opportunities for developing new biomedical products.

0.8 Chapter Overviews: Revivifying, Repurposing, Reimagining

This dissertation is divided into five chapters across three sections: *Part I: Revivifying DNA*, *Part II: Repurposing Organs*, and *Part III: Reimagining Kinship*. In Part I and Part II, I investigate a range of narratives that either embrace or critique techno-optimistic visions of valuable, biomedical products being created through de-extinction and xenotransplantation. In Part III, I move into a close

[130] "George R.R. Martin," Colossal Laboratories & Biosciences, accessed July 3, 2025, https://colossal.com/team/george-r-r-martin/.
[131] Colossal Laboratories & Biosciences, "The Mammoth."

analysis of how two stories respond to dominant frames in de-extinction and xenotransplantation discourse by envisioning opportunities to reimagine kinship between humans and other species.

In ***Part I: Revivifying DNA***, I argue that the potential biomedical benefits of de-extinction are a significant component of de-extinction discourse. While de-extinction is typically considered an environmental and ecological project, I demonstrate in Chapter 1 that biomedicine is in fact one of the prominent discourses that appears in cultural rhetoric surrounding de-extinction. Indeed, news media, science magazines, and the companies working on de-extinction frequently invoke the potential benefits to human health offered both by research into extinct species and the development of genetic engineering tools. This techno-optimistic discourse is countered by fictional depictions of de-extinction across film and novels. As I show, the *Jurassic World* film trilogy, along with the climate fiction novel *Ghost Species* and the SF novel *The Neanderthal's Aunt*, each envision the biomedical exploitation of the beings created using de-extinction technologies. By critiquing transhumanist goals of body modification and enhancement and technosolutionistic goals of control over the environment, these fictional depictions imagine the way that human identity and agency could be altered in the biomedical future of de-extinction. Further, by considering the types of relationships that could emerge between humans and nonhuman beings, these narratives envision the posthuman possibilities that could emerge from de-extinction research.

In ***Part II: Repurposing Organs***, I trace the ethical concerns around xenotransplantation and demonstrate how ethical risks in xenotransplantation go beyond the individual body, and interact with social, political, and environmental systems. In Chapter 2, I consider how fictional and nonfictional narratives work together to shape public understanding of the bioethical risks of xenotransplantation. The YA novel *Pig-Heart Boy* and the short film *We Ate the Children Last* envision the discrimination and harassment that xenograft recipients might face due to concerns over the way that nonhuman

animal organs could alter human identity, and the potential societal impacts of xenotransplantation that could result from these changes. In contrast to the fears of monstrosity explored in fiction, the accounts of real patients and doctors that have been shared in news articles and podcasts emphasize the agency and hope that developments in xenotransplantation offer to patients. In Chapter 3, I move from the individual to the global. I trace the way that pigs have been framed by proponents of xenotransplantation as an abundant solution to the organ shortage crisis. In contrast to this technosolutionistic vision of endless organ supplies, fictional narratives like *Oryx and Crake* and *Chromosome 6* highlight how the "abundant" production of organs relies on exploitative agricultural, medical, political, and economic systems, often with global impacts. By envisioning the transcorporeal dimensions of xenotransplantation, these narratives emphasize the interconnectedness of human bodies, technologies, and environments.

In ***Part III: Reimagining Kinship***, I argue that fiction can provide important counternarratives to the dominant discourse in both xenotransplantation and de-extinction. In Chapter 4, I discuss the hype in current de-extinction discourse, and investigate the solarpunk short story "The Birdsong Fossil," which envisions an ecological and multispecies approach to de-extinction. In the short story, ecological function, along with curiosity and care for underappreciated species, are prioritized rather than being devalued, as is often the case in current genetics-based and charisma-driven approaches to de-extinction. Thus, the short story provides a critical alternative to the sensationalism and hype of current de-extinction discourse. In Chapter 5, I analyze the YA novel *Pighearted*, which depicts the interspecies care, kinship, and entanglement between a transplant patient and a chimeric pig. By depicting a relationship between a human and a pig that is based on care rather than exploitation, the novel provides a crucial counternarrative to the "spare parts" metaphor that dominates current xenotransplantation discourse. Both stories embrace the possibility

of posthuman and multispecies biotechnological futures where nonhuman animals are viewed as kin rather than as valuable (and exploitable) biomedical and biotechnological products.

Part I: Revivifying DNA

Chapter 1: Revivifying DNA: Liminality, Biovalue, and Human Health in De-Extinction Narratives

1.1 Introduction

One of the areas of biotechnological innovation that has rapidly gained media attention and public interest in recent years is de-extinction. De-extinction, or the use of cloning and genetic engineering technologies to bring back extinct species, has frequently been featured as the subject of science magazines and popular science books, and a wide variety of candidate species have been suggested, such as woolly mammoths,[132] thylacines,[133] passenger pigeons,[134] dinosaurs,[135] and gastric brooding frogs,[136] among others.[137] Most of the media attention has focused on companies like Colossal Laboratories & Biosciences and Revive & Restore, both of which propose to bring back extinct species using biotechnological tools.[138] Often, the stated goals of these projects are environmental and ecological,[139] and while the promises of de-extinction can sound enticing, significant ethical concerns are beginning to emerge. As environmental philosophy scholars Markku Oksanen and Helena Siipi note in the introduction to *The Ethics of Animal Re-Creation and*

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[132] Colossal Laboratories & Biosciences, "Mammoth," August 6, 2021, https://colossal.com/mammoth/.
[133] Colossal Laboratories & Biosciences, "Thylacine," August 16, 2022, https://colossal.com/thylacine/.
[134] Revive & Restore, "About the Passenger Pigeon," accessed September 2, 2025, https://reviverestore.org/projects/about-the-passenger-pigeon/.
[135] Montana State University, "Building a Chicken that Bites," October 15, 2013, https://www.montana.edu/news/12199/building-a-chicken-that-bites.
[136] Ed Yong, "Resurrecting the Extinct Frog With a Stomach for a Womb," *National Geographic*, March 15, 2013, https://www.nationalgeographic.com/science/article/resurrecting-the-extinct-frog-with-a-stomach-for-a-womb.
[137] Since first writing this chapter, three more candidate species have been announced by Colossal: the moa, the dodo, and the dire wolf. Colossal Laboratories & Biosciences, "Moa," July 8, 2025, https://colossal.com/moa/. Colossal Laboratories & Biosciences, "The Dodo," January 31, 2023, https://colossal.com/dodo/. Colossal Laboratories & Biosciences, "Dire Wolf," accessed September 2, 2025, https://colossal.com/direwolf/.
[138] Colossal Laboratories & Biosciences, "Colossal," August 16, 2021, https://colossal.com/.
[139] For an overview of the potential ecological applications of de-extinction, see Douglas J. McCauley et al., "A Mammoth Undertaking: Harnessing Insight from Functional Ecology to Shape De-Extinction Priority Setting," *Functional Ecology* 31, no. 5 (2017): 1003–11.

Modification, "[r]easons for de-extinction and genetic modification can be far from altruistic."[140] Instead, they argue that interest in extinct and endangered species "can stem from the valuable services and resources these animals can provide for human beings."[141] If de-extinction is *not* a solely environmental or ecological project, what other motivations are driving these projects? What types of futures are envisioned by proponents of de-extinction? And what ethical implications might arise from treating de-extinction as a source of "valuable services and resources"?

The Australian film *The Hunter* (2011)[142] provides a starting point to consider the connections between extinction, conservation, and commodification. In this film, the protagonist is commissioned by a biotech corporation, RedLeaf, to locate, collect samples from, and kill the last remaining thylacine. Thylacines (also known as Tasmanian Tigers) are an Australian marsupial species believed to have disappeared from the wild over a century ago in the 1910s, with the last, captive thylacine dying in 1936.[143] In *The Hunter*, however, RedLeaf believes that the species has *not* gone extinct, and the "hunter," Martin, begins searching for the elusive animal in a remote forest in Tasmania. As Martin hunts for the thylacine, he realizes the stakes are higher than he had anticipated. The rural Tasmanian town relies on the logging industry and is deeply hostile toward environmental activists, and since Martin is posing as an ecological researcher, he too becomes a target of the town's animosity. Beyond the hostility of the local residents, Martin realizes that there is competition to locate the thylacine, despite the secrecy around his search. While searching the forest, Martin discovers the body of Jarrah Armstrong, the man whose family he is staying with and who had

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[140] Markku Oksanen and Helena Siipi, "Introduction: Towards a Philosophy of Resurrection Science," in *The Ethics of Animal Re-Creation and Modification: Reviving, Rewilding, Restoring*, eds. Marrku Oksanen and Helena Siipi (Palgrave Macmillan, 2014), 15.
[141] Oksanen and Siipi, "Introduction," 15.
[142] Based on the novel *The Hunter* (1999) by Julia Leigh.
[143] Colossal Laboratories & Biosciences, "Thylacine," accessed January 26, 2023, https://colossal.com/thylacine/.

disappeared the previous year. Martin himself soon becomes the target of a competing hunter, and narrowly survives an attack. After the home of the Armstrong family is burned down, killing Jarrah's wife, Lucy, and daughter, Katie, Martin pursues the thylacine with even more intensity. When Martin finally locates the animal, he follows it, and—with momentary hesitation—shoots and kills the last existing thylacine.

Why is there such secrecy surrounding the search for the thylacine? Martin initially does not know why he was hired to hunt for the animal, nor does he know the company's intentions after he has obtained its genetic material. At the start of the film, a representative from RedLeaf explains that they need biological samples from the thylacine, but that no one else can be allowed to find its remains after it has been killed. Later, Martin realizes that Jarrah had, similarly, been involved with RedLeaf when he discovers old papers in the family's home with the company's logo. Lucy explains that Jarrah had been searching for the thylacine as well, but that Jarrah had wanted to stop RedLeaf from acquiring it, since "the tiger had some unique toxin, to paralyze its prey, and that RedLeaf wanted to own it—the DNA."[144] When Martin eventually locates the thylacine, he chooses to burn its body, rather than obtaining the samples that RedLeaf had wanted. After leaving the town, he calls his contact at RedLeaf, merely saying, "[w]hat you want is gone forever."[145] By destroying the thylacine, Martin sought to protect the lives of other people who would be at risk due to the intense desire to capitalize on the animal's genetic material.

The Hunter thus explores the way that extinct animals exist in complex networks of environmental and ecological concerns, potential biomedical and pharmaceutical applications, and competing financial interests. The thylacine is viewed throughout the film as a valuable source of

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[144] *The Hunter*, directed by Daniel Nettheim (Porchlight Films, 2011), 1:10:53-1:11:02.
[145] *The Hunter*, 1:34:26-1:34:28.

biological material that could lead to biomedical breakthroughs—but to capitalize on this potential, the thylacine must go extinct in the wild and subsequently be resurrected in the laboratory. This desire to capitalize on the thylacine's genetic material signals the film's engagement with Catherine Waldby's concept of "biovalue," a term that describes the value ascribed to biological material (particularly in the context of biomedicine), and calls attention to the way living matter can be commodified and repurposed for the benefit of humans.[146] As their genetic material promises new biomedical applications, extinct and endangered animals—like the thylacine—suddenly gain new value *beyond* their ecological significance.

While *The Hunter* focuses specifically on the *destruction* of the thylacine, as I will discuss in this chapter, de-extinction projects that focus on the *resurrection* of extinct species are often driven by similar interests. While de-extinction projects—both real and fictional—are frequently referred to in terms of the environmental and ecological benefits of bringing back extinct species, these projects are also often framed by their possible *human health* applications. While scholars have previously commented on this dynamic,[147] in this chapter, I build on these observations with an in-depth analysis of how de-extinction projects often diverge from the professed goal of restoring ecosystems, to instead promote the creation and commodification of biomedical and pharmaceutical products. I will focus in particular on the way that de-extinction projects are framed by science writers in publications

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[146] Catharine Waldby, *The Visible Human Project: Informatic Bodies and Posthuman Medicine* (Routledge, 2000).

[147] See, for example, jessie l. beier's comment that "[a]s Colossal makes clear, de-extinction is about not just bringing back extinct animals or enacting disruptive conservation, but also reshaping how the world thinks about approaches to advancing human health and the power of genetics to solve pressing challenges in the life sciences today." jessie l. beier, "No Going Back: Un-Fixing the Future of De-Extinction," *Animal Studies Journal* 12, no. 2 (2023), https://doi.org/10.14453/asj/v12i2.8. 167. Joshua Schuster, similarly, notes that "Perhaps the most substantial effects of de-extinction would be in the development of new existential technologies aimed at human life extension and transhumanist enhancements." Joshua Schuster, "What Is De-Extinction?," in *What Is Extinction?: A Natural and Cultural History of Last Animals* (Fordham University Press, 2023). 208.

like *National Geographic* and by scientific research companies like Colossal and Revive & Restore, alongside how fictional de-extinction projects are represented in popular culture and literature, including the representation of cloned and genetically modified dinosaurs and humans in the *Jurassic World* trilogy and Neanderthals in the speculative fiction (SF) novel *The Neanderthal's Aunt* (2014) and the climate fiction novel *Ghost Species* (2020). As I will argue, in each of these examples, de-extinction is connected not only with environmental/ecological concerns, but also with intertwined biomedical applications and financial interests, and what these new biotechnologies could mean for the future of human/nonhuman identity in the 21st century bioeconomy.

While much of the real-world coverage of de-extinction focuses on nonhuman animal species like woolly mammoths or thylacines, fictional depictions more directly engage with the way these biotechnologies could impact humans. Therefore, both real and fictional examples are critical to my analysis. As Jay Clayton argues in his discussion of literary studies and science policy, literary criticism contributes to the analysis of science communication, since "[k]nowing how language conditions ideas about science will facilitate communication for everyone involved."[148] Meanwhile, in Sherryl Vint's analysis of SF and biopolitics, she argues that she "remain[s] hopeful about the power of the speculative, utopian imaginary. Other selves, other lives, and other worlds remain both imaginable and livable."[149] In this chapter, then, I will engage both with Clayton's view that literary analysis can contribute important insights to science communication, and Vint's belief that SF can allow us to envision better futures beyond commodification. In particular, I argue that analyzing

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[148] Jay Clayton, *Literature, Science, and Public Policy: From Darwin to Genomics* (Cambridge University Press, 2023), https://doi.org/10.1017/9781009263504. 16.
[149] Sherryl Vint, *Biopolitical Futures in Twenty-First-Century Speculative Fiction* (Cambridge University Press, 2021). 24.

depictions of the beings created through de-extinction can position us to respond to the ethical issues arising from the biomedical future envisioned in de-extinction narratives.

1.2 Freeze-Drying and Revivification: Liminality and the Biovalue of the "Not-Quite-Alive"

Much of the attention on de-extinction has focused on one particular candidate species: the woolly mammoth. Numerous newspaper and science magazine articles have focused on the potential resurrection of mammoths, and several popular science books like Beth Shapiro's *How to Clone a Mammoth* (2015) and Ben Mezrich's *Woolly: The True Story of the Quest to Revive One of History's Most Iconic Creatures* (2017) have explored the science behind mammoth de-extinction and the feasibility of these projects. Woolly mammoths have also featured in numerous artistic engagements with de-extinction, and Sarah Bezan identifies mammoths as a key figure in what she calls "regenesis aesthetics."[150] So why are woolly mammoths so often at the centre of scientific and public discourse about de-extinction? Well, as Helen Pilcher puts it in *Bring Back the King*, "[m]ammoths are everything you'd want in a de-extincted animal. […] Iconic. Inspiring. Larger than life."[151] In her analysis of regenesis aesthetics, Bezan notes that "images of revived woolly mammoths help us to critique the narrative of human exceptionalism that often lies at the heart of de-extinction programs, and which also perpetuates a cult of 'cool' candidates for de-extinction according to a rubric of conservation iconology."[152] One element of the way that "the narrative of human exceptionalism" influences de-extinction is in the way that projects like woolly mammoth de-extinction are primarily

[150] Sarah Bezan, "Regenesis Aesthetics: Visualizing the Woolly Mammoth in De-Extinction Science," *Antennae*, 2019, 219.
[151] Helen Pilcher, *Bring Back the King: The New Science of De-Extinction* (Bloomsbury Sigma, 2016). 99.
[152] Bezan, "Regenesis Aesthetics," 221.

promoted for their applications in conservation and ecological restoration, but are often simultaneously driven by other potential benefits that they could hold for humans. The woolly mammoth therefore provides a useful starting point to analyze the *biomedical* applications of de-extinction science.

Two recent developments in woolly mammoth de-extinction have been shared across news media: the discovery of "freeze-dried" woolly mammoth skin,[153] and the creation of "woolly mice" by Colossal.[154] In a 2024 *Scientific American* article, Saima S. Iqbal draws on two different metaphors to explain that the mammoth skin contains well-preserved genetic material: "the pieces [of DNA] ran into a rare *molecular traffic jam*, so they hovered in place, keeping intact chromosome structures as tiny as 50 nanometers across,"[155] which is significant because in contrast to other attempts at sequencing mammoth DNA that "recovered shuffled pages from the book of life, the current one captures an *ordered stack* with dog-eared corners."[156] By providing "an ordered stack" of genetic material, the freeze-dried skin is a valuable resource that can be used in future mammoth research. Several months later, in another *Scientific American* article, Adam Popescu describes Colossal's work on woolly mammoth de-extinction, and explains how woolly mice were created as "the latest development to *emerge from that quest*."[157] As Popescu explains, these mice underwent several genetic modifications, including a mammoth gene that "was inserted into the mice to alter hair texture—specifically waviness."[158] While the freeze-dried skin provide future potential, the woolly

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[153] Saima S. Iqbal, "Meet the Mulleted, Freeze-Dried Woolly Mammoth That Yielded the First Ever Fossilized Chromosomes," *Scientific American*, October 1, 2024, https://www.scientificamerican.com/article/the-first-ever-fossilized-chromosomes-came-from-a-freeze-dried-mammoth/.
[154] Adam Popescu, "Company Seeking to Resurrect the Woolly Mammoth Creates a 'Woolly Mouse,'" *Scientific American*, March 4, 2025, https://www.scientificamerican.com/article/company-seeking-to-resurrect-the-woolly-mammoth-creates-a-woolly-mouse/.
[155] Iqbal, "Freeze-Dried Woolly Mammoth." Emphasis added.
[156] Iqbal, "Freeze-Dried Woolly Mammoth." Emphasis added.
[157] Popescu, "Woolly Mouse." Emphasis added.
[158] Popescu, "Woolly Mouse."

mice, on the other hand, are a demonstration of the *current* possibilities of de-extinction research to use the bodies of living animals as test subjects. As these examples show, de-extinction science capitalizes both on preserved biological material of dead animals (like the woolly mammoth skin) and on the working biological systems of living animals (like the woolly mice).

The extraction of genetic material from the preserved skin of a mammoth and the creation of mice with fluffy orange fur represent two ways that de-extinction research is revivifying genetic material, resulting in new, *liminal* forms of existence in the process. Susan Squier argues that biomedicine has led to the creation of "liminal lives," figures that are created (or altered) through biomedical research, or, as Squier puts it, "those beings marginal to human life who hold rich potential for our ongoing biomedical negotiations with, and interventions in, the paradigmatic life crises: birth, growth, aging, and death."[159] The freeze-dried skin and the woolly mice provide "interventions" into the extinction of mammoths, offering new ways to bring these species back—either through providing preserved genetic material *or* through the re-creation of mammoth traits in hybrid species. Liminality provides an important framework, then, for understanding the different types of biological materials involved in de-extinction science.

In Adam Searle's analysis of de-extinction candidates, he draws on the framework of liminality (in the context of geography and anthropology, in contrast to Squier's focus on biomedicine) to articulate the concept of "anabiosis."[160] As Searle explains, "the anabiotic" refers to "the liminal materiality between living and dead."[161] Along with challenging the boundaries between life and death, anabiotic material, such as the preserved genomes of extinct species, can "unsettle the

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[159] Susan Merrill Squier, *Liminal Lives: Imagining the Human at the Frontiers of Biomedicine* (Duke University Press, 2004). 9.
[160] Adam Searle, "Anabiosis and the Liminal Geographies of De/Extinction," *Environmental Humanities* 12, no. 1 (2020): 321–45, https://doi.org/10.1215/22011919-8142385. 325.
[161] Searle, "Anabiosis," 324.

previously held epistemologies of extinct and extant."[162] Searle focuses specifically on the woolly mammoth and the bucardo,[163] arguing that these two species "provide archetypal illustrations of salvaged and synthesized anabiosis, the 'not anymore' and 'not there yet.'"[164] In the case of the freeze-dried skin, the preserved genetic material represents the "not anymore" of the extinct woolly mammoth, while for the woolly mouse, the re-created traits represent the "not there yet" of future woolly mammoth resurrection. Evidently, then, de-extinction creates new "liminal lives" that bring with them unique ethical considerations.

One of ethical considerations arising from the liminal lives of de-extinction research is the potential commodification of new biotechnological products. As Melinda Cooper outlines, in the "biotech revolution," or the current proliferation of new biotechnologies, "life becomes, literally, annexed within capitalist processes of accumulation."[165] One of the consequences of this dynamic, she argues, is the rise of a "bioeconomy" in which "[r]ecent biology […] is as much interested in the limits and possible futures of life on earth as contemporary capitalism."[166] One way to think about the intersections of biology and capitalism is through the formulation of "biovalue," a term that Waldby uses to refer to "a surplus value of vitality and instrumental knowledge which can be placed at the disposal of the human subject."[167] As Waldby describes it, biovalue is produced by "a range of new biotechnologies which draw upon the bodies of the just-dead, the nearly-dead or the not-quite-

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[162] Searle, "Anabiosis," 325.
[163] Pilcher provides an overview of the bucardo (*Pyrenean ibex*) de-extinction project in the introduction to *Bring Back the King*. As Pilcher explains, samples were taken from the last existing bucardo, which was cloned after its death; however, the cloned bucardo died shortly after its birth, which gave it "the honour not just of being the first animal to be brought back from extinction, but the ignominy of being the first animal ever to go extinct twice." Pilcher, *Bring Back the King*, 15.
[164] Searle, "Anabiosis," 325.
[165] Melinda Cooper, *Life as Surplus: Biotechnology and Capitalism in the Neoliberal Era* (Seattle: University of Washington Press, 2008), 19.
[166] Cooper, *Life as Surplus*, 20.
[167] Waldby, *The Visible Human Project*), 19.

alive."[168] This is where de-extinction comes in: these projects—and the environmental and biomedical benefits they promise—rely on the use of preserved genetic material (such as the mammoth skin) that will allow the "not-quite-alive" figures of woolly mammoths, thylacines, gastric brooding frogs, or even Neanderthals to become exploitable sources of vitality.

The intersection of biomedical and environmental applications in de-extinction raises new, unique biopolitical concerns. Recently, theorists have introduced the term "cryopolitics" as a way to think through the simultaneous warming of the earth's atmosphere and the development of biotechnologies like biorepositories that rely on cold temperatures to preserve biological material. As Joanna Radin and Emma Kowal argue, cryopolitics is a "field of power where the regulation of life is extended indefinitely through technoscientific means such that death appears *perpetually deferred*."[169] Alexander Friedrich argues that our current "cryogenic culture"[170] has led to a new formulation of power, or rather, to "a cryogenic modification of biopower."[171] This "cryopower," he argues, arises from "[t]he vast biocentric network of the cryosphere has given birth to a new mode of power—with refrigeration as a main dispositif for controlling, transforming, safeguarding, and enhancing life."[172] Cryopolitics is certainly a useful framework for considering the "not-quite-alive," liminal figures central to de-extinction projects, particularly those whose biological material is extracted and stored for future use.

Several scholars have already drawn on cryopolitics in their analyses of de-extinction. For example, Joshua Schuster draws on Radin and Kowal's analysis of cryopolitics (along with the

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[168] Waldby, *The Visible Human Project*, 143.
[169] Joanna Radin, and Emma Kowal, "Introduction: The Politics of Low Temperature," in *Cryopolitics: Frozen Life in a Melting World*, eds. Joanna Radin and Emma Kowal (The MIT Press, 2017), 7. Emphasis added.
[170] Alexander Friedrich, "The Rise of Cryopower: Biopolitics in the Age of Cryogenic Life," in *Cryopolitics: Frozen Life in a Melting World*, eds. Joanna Radin and Emma Kowal (The MIT Press, 2017), 59.
[171] Friedrich, "Rise of Cryopower," 61.
[172] Friedrich, "Rise of Cryopower," 61.

concepts of biopower and biovalue) in his overview of de-extinction and the storage of biological material in "frozen zoos," noting that "[t]his liminal state raises questions concerning to whom these cells *actually belong*. Stored in patented banks and proprietary labs and zoos, the cells owe their origin as much to the work of genetic scientists as they do to the reproductive lives of animals."[173] The storage of frozen material, then, is directly connected with concerns about the future commodification and use of that material. Because of this, Schuster argues that de-extinction can have widespread biopolitical implications, since "reviving life, increasing life longevity, and enhancing life are conjoined techno-utopian aims that must be understood together as controversial new forms of power and value."[174] In order to consider the cryopolitical implications of de-extinction projects, then, it is critical to consider the liminal figures that they promise to create.

The speculative uses of the biological material of liminal species are the focus of Charlotte A. Wrigley's analysis of frozen mammoth bodies. Like Schuster, Wrigley draws on both cryopolitical theory and biocapital/biovalue in her analysis of how mammoth bodies move from the frozen space of the tundra to the artificial cooling of cryobanks, being divided into increasingly smaller components throughout the process:

> Once revered in her full form as museum exhibits and scientific specimens, the mammoth has been steadily broken down into her constituent parts until she embodies a molecular commodity, chopped up and put into freezers, squeezed into test tubes and vials, shipped off to places far from her original resting place as biocapital." [175]

While, as Wrigley notes, mammoths had once been valuable specimens for museum displays, this dynamic has changed along with new technological developments that make it easier to preserve and use genetic material. Consequently, "[t]he genetic features that 'make' a mammoth […] take on a

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[173] Schuster, "What Is De-Extinction?," 203. Emphasis added.
[174] Schuster, "What is De-Extinction?," 200.
[175] Charlotte A. Wrigley, "Ice and Ivory: The Cryopolitics of Mammoth De-extinction," *Journal of Political Ecology* 28, no. 1, (2021): 798.

greater value than the sum of their parts."[176] Wrigley's cryopolitical analysis of frozen mammoth bodies can be extended to the freeze-dried mammoth skin as well. As Iqbal explains, the skin "underwent spontaneous freeze-drying," where "[t]he low temperature of the tundra slowed the motion of its molecules, and dehydration caused by the tundra's dry atmosphere meant there was no water available for the DNA fragments to move through, leaving the leathery sample more shelf-stable than the average supermarket snack."[177] Since the skin was "freeze-dried" by a combination of cold temperatures and dry air, it represents a unique cooling process that, by protecting the structure of the mammoth's DNA, provides an even *more* valuable source of genetic material than other mammoth bodies that were not preserved under the same conditions. In this case, it is no longer the woolly mammoth body itself that is seen as valuable, but rather it is the *cooling process* it undergoes that determines the body's value.

While cryopolitics provides a useful framework for considering how the genetic material of extinct species is preserved, de-extinction projects increasingly focus not on the acquisition and use of frozen DNA, but rather on *living bodies* as test subjects for de-extinction research. These living bodies simultaneously preserve important genetic material and offer new, valuable possibilities for biomedicine. The woolly mouse is a real-world example of this dynamic: in a *Global News* article, Katie Dangerfield explains that, according to Colossal, "[i]t's the *first living animal* engineered to express cold-adapted traits from mammoth genes," and "it could serve as a *valuable model* for studying how mammals adapt to cold climates."[178] While the woolly mice themselves are not de-extinct species, by revivifying and reanimating the DNA of woolly mammoths, they act as a

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[176] Wrigley, "Ice and Ivory," 786.
[177] Iqbal, "Freeze-Dried Woolly Mammoth."
[178] Katie Dangerfield, "Jurassic Park… but Fuzzier. Scientists Say They've Made a 'Woolly Mouse,'" *Global News*, March 6, 2025, https://globalnews.ca/news/11068762/woolly-mice-genetically-modified-mammoth/.

"valuable model" that provides important insights into the extinct species. As models for studying mammoth biology, the woolly mice are an example of what Vint refers to as the "biopolitics of epivitality."[179] Vint draws on SF to consider different "biopolitical figurations" such as the "living tool."[180] As Vint explains,

> Synthetic biology is […] one of the main contexts for understanding the biopolitical figure of the living tool, an organism that is *custom designed to serve an economic end*, often through the neoliberal metric of efficiency. More bluntly put, the living processes of such organisms are reoriented away from their function for the organism—that is, to live, as an end in itself—and toward *maximizing production* of some quality that humans seek to extract—a means to an end.[181]

While Vint is discussing this process in the context of human (or human-like) characters in SF, the woolly mouse—designed with DNA extracted from frozen woolly mammoth bodies and acting as a living model for woolly mammoth research—serves as an example of how the "biopolitics of epivitality" is shaping de-extinction science. The woolly mice provide an efficient way of outsourcing woolly mammoth research, thereby "maximizing production," since, as Popescu aptly points out, "[m]ice are much easier to work with than elephants."[182]

Throughout the remainder of this chapter, I will bring together the concepts of liminality, biovalue, epivitality, and cryopolitics to investigate de-extinction narratives in the media, in corporate communication, and in fiction. Across these narratives, a range of liminal figures like woolly mammoths, thylacines, dinosaurs, Neanderthals, and human clones appear, sometimes in the form of preserved (or, to use Searle's term, "anabiotic") genetic material, and sometimes as living, embodied beings. Tracing these representations can provide an important way to consider the many ways that de-extinction science creates and commodifies liminal beings, since as Squier argues, "[o]ne of the

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[179] Vint, *Biopolitical Futures*, 4.
[180] Vint, *Biopolitical Futures*, 20.
[181] Vint, *Biopolitical Futures*, 136. Emphasis added.
[182] Popescu, "Woolly Mouse."

few places where liminality isn't normalized into invisibility, […] stories both register the impact of, and help us to navigate, the massive cultural and material transition produced by biomedicine."[183] In particular, I will focus on how de-extinction is framed by its potential biomedical benefits, produced either through the genetic insights offered by extinct species' genomes or through research into the biological systems of these species. Along with figures like the woolly mouse, this idea of the body's biological systems being exploited for valuable products has been explored in de-extinction narratives, as I will discuss in my analysis of three characters (a cloned *Homo sapiens* and two Neanderthals) in de-extinction narratives, each of whom is framed as providing insights into human health, genetics, and identity.

1.3 "Scientific and medical dividends": The Biomedical Framing of De-Extinction

Analyzing the frames used to communicate about de-extinction can provide important insights into the way that the field is being envisioned as providing new sources of biovalue. In science communication a frame is, as Brigitte Nerlich et al. explain, a way of explaining scientific developments, since "actors do not create a whole new comprehensive discursive system every time they write or talk about a new issue in the biosciences: instead an already existing one is evoked through references to story-lines."[184] According to Nerlich, a common frame in science communication is the idea that scientific research is a "race" and will lead to "breakthroughs."[185] Katarzyna Molek-Kozakowska echoes this, stating that "[a] commonly practised way to make a piece

[183] Squier, *Liminal Lives*, 9.
[184] Brigitte Nerlich et al., "Communicating Biological Sciences: An Introduction," in *Communicating Biological Sciences: Ethical and Metaphorical Dimensions*, ed. Brigitte Nerlich et al. (Ashgate Publishing Limited, 2009). 8.
[185] Brigitte Nerlich, "Breakthroughs and Disasters: The (Ethical) Use of Future-Oriented Metaphors in Science Communication," in *Communicating Biological Sciences: Ethical and Metaphorical Dimensions*, ed. Brigitte Nerlich et al. (Ashgate Publishing Limited, 2009). 203.

of science news highly attractive is to present it as *revolutionary*."[186] The "revolutionary" potential of de-extinction research has been used as a frame both by science communicators and by proponents of de-extinction who have highlighted the potential for de-extinction research to lead to the development of useful pharmaceutical or biomedical products, to provide insights into the treatment of human disease, and even to eventually lead to changes to the human body.

The biomedical framing of de-extinction can be seen in the media through references to the pharmaceutical products that could be developed using extinct or endangered species. For example, in a *National Geographic* article, Carl Zimmer notes that "scientists who favor de-extinction argue that there will be concrete benefits."[187] Among these "concrete benefits," he writes, could be human health applications: "[m]ost pharmaceutical drugs, for example, were not invented from scratch—they were derived from natural compounds found in wild plant species, which are also vulnerable to extinction."[188] In this instance, de-extinction is connected with the anticipation of *unknown* future extinctions, rather than currently extinct species, and the impact that these *potential* extinctions could have on the development of pharmaceuticals.

While Zimmer considers how extinction could impact the production of pharmaceuticals, the exploitative practices of the pharmaceutical industry are also *driving* species extinctions. For example, alongside their passenger pigeon de-extinction project, Revive & Restore also seeks to use biotechnology to *protect* species that are being exploited for their biomedical applications. One of the species highlighted on their website is the horseshoe crab, a species whose blood is used by the

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[186] Katarzyna Molek-Kozakowska, "Making Science Trend: The Style of Popular Science Magazines," in *Insights on Science Journalism*, ed. Felicity Mellor (Routledge, 2024). 165. Emphasis added.
[187] Carl Zimmer, "Bringing Them Back to Life," *National Geographic*, April 1, 2013, https://www.nationalgeographic.com/magazine/article/species-revival-bringing-back-extinct-animals.
[188] Zimmer, "Bringing Them Back to Life."

pharmaceutical industry to detect contamination in pharmaceutical products.[189] As Revive & Restore notes on their website, horseshoe crabs "have been integral to the safe production of injectable vaccines, drugs, and certain medical devices," but the "current over-exploitation of horseshoe crabs is sadly not dissimilar to other mismanaged species that were driven to extinction."[190] Revive & Restore, instead, promotes the use of a synthetic alternative[191] in the place of horseshoe crab blood. While the company's call for the protection of an endangered species that is exploited by the pharmaceutical industry is distinct from projects that seek to capitalize on possible human health benefits of de-extinction technologies, in both cases, extinct or endangered species exist as sources of exploitable biovalue within wider networks of biotechnological, biomedical, and pharmaceutical applications.

In addition to the creation of pharmaceutical products, the possibility that de-extinction could provide insights into human health has also been highlighted across media coverage. For example, the biomedical potential of de-extinction technologies has been discussed in relation to the work on the gastric brooding frog. This Australian species has been described as "the Extinct Frog With a Stomach for a Womb,"[192] and is known for its unique incubation process where it ceases the production of stomach acid and hatches its eggs in its stomach. The species quickly gained attention due to this ability to control its own production of stomach acid, and as science writer Ed Yong notes in a *National Geographic* article, "[t]he medical community took notice. If this creature could deliberately stop making acid in its stomach, it might provide new ways of treating stomach ulcers or

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[189] Horseshoe crab blood is used to create the Limulus Amebocyte Lysate (LAL) test, which is used to test pharmaceuticals. Revive & Restore, "About The Horseshoe Crab," accessed January 27, 2023, https://reviverestore.org/horseshoe-crab/.
[190] Revive & Restore, "Horseshoe Crab."
[191] This synthetic alternative is called recombinant factor C (rFC). Revive & Restore, "Horseshoe Crab."
[192] Yong, "Resurrecting the Extinct Frog."

helping people who go through stomach surgeries to heal more quickly."[193] Beyond treatments for stomach ulcers, research into gastric brooding frogs "might be able to provide [insights] about reproduction—insights that might someday lead to treatments for pregnant women who have trouble carrying babies to term."[194] Like the woolly mammoth project, the gastric brooding frog is framed not just by the *ecological* benefits of bringing back the species, but by how the revival of the frog could lead to improvements in surgical procedures and human reproductive health.

The insights into human health offered by de-extinction have also been described in relation to the "Chickenosaurus" project. In the early 2010s, the project received funding from filmmaker George Lucas.[195] This project, which paleontologist Jack Horner (one of the scientific advisors for *Jurassic Park*) outlines in *How to Build a Dinosaur* (2009), investigates the embryonic development of chickens to understand the divergence between dinosaurs and birds.[196] As science writer Riley Black explains in a *National Geographic* article, "[b]y tweaking the genes and development of chickens, […] researchers can create a bird that looks like a *Velociraptor*."[197] However, Black explains that "[i]t wouldn't be a moment of resurrection, but reinvention."[198] The Chickenosaurus project might seem to be even more speculative than other de-extinction projects, but it too has been framed in terms of the biomedical benefits that it could provide. As Jackson Landers explains in a *Washington Post* article on Horner's work, "[t]he project is considered more than an effort to make a living toy; in fact, it has the potential to *affect medical research*."[199] Landers goes on to explain that

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[193] Yong, "Resurrecting the Extinct Frog."
[194] Zimmer, "Bringing Them Back."
[195] Montana State University, "Building a Chicken that Bites."
[196] Montana State University, "Building a Chicken that Bites."
[197] Riley Black, "What Could Live in a Real Jurassic World? A Chickenosaurus," *National Geographic*, June 18, 2015, https://www.nationalgeographic.com/animals/article/150618-jurassic-world-genetic-engineering-chickenosaurus.
[198] Black, "Chickenosaurus."
[199] Jackson Landers, "Jack Horner's 'Chickenosaurus': Trying to Turn a Chicken into a Dinosaur," *Washington Post*, November 10, 2014, https://www.washingtonpost.com/national/health-science/paleontologist-jack-horner-

both Horner and Matthew Harris, another researcher working on gene expression in chickens, "agree that the research involved in designing a chickenosaurus could pay *scientific and medical dividends*,"[200] with the potential for various future biomedical applications. This could include "new treatments for spinal disorders," as well as "applications in treatment of human sarcomas."[201] Like the gastric brooding frog, then, the Chickenosaurus is framed in terms of specific human health benefits. Both species are seen as potentially providing insights into the treatment of medical conditions like ulcers and cancer, thereby making de-extinction work on these species appear to be more urgent and important.

Like the potential pharmaceutical products and biomedical treatments offered by horseshoe crabs, gastric brooding frogs, and the Chickenosaurus, research on Neanderthals is framed in the media in terms of the potential for human health applications. According to a *National Geographic* article by science writer Virginia Hughes, some of the different conditions that Neanderthal genomes could provide insight on include autoimmune disease, celiac disease, osteoporosis, and muscle wasting. [202] Indeed, work on Neanderthal genetics has even been framed in how it could lead to changes in the biology of *Homo sapiens*. Anthropologist John Hawks is quoted in this article stating that "[i]f you could find some way to tweak the human biology in a way to *make it more Neanderthal-like*, that might treat osteoporosis and muscle wasting."[203] In another *National Geographic* article, science writer Peter Miller similarly speculates on whether Neanderthal DNA could be used to improve human health and bodies, asking, "[w]hat else could humanity gain by

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is-hard-at-work-trying-to-turn-a-chicken-into-a-dinosaur/2014/11/10/cb35e46e-4e59-11e4-babe-e91da079cb8a_story.html.

[200] Landers, "Chickenosaurus." Emphasis added.

[201] Landers, "Chickenosaurus."

[202] Virginia Hughes, "Return of the Neanderthals," *National Geographic*, March 6, 2013, https://www.nationalgeographic.com/science/article/130306-neanderthal-genome-extinction-cloning-hominid-science. Emphasis added.

[203] Hughes, "Return of the Neanderthals." Emphasis added.

borrowing from the Neanderthal genome?"[204] The idea that Neanderthal genomes could "guide" human health research, or that we can "borrow" from these genetic insights to improve human health, is therefore a key rhetorical frame for potential research on Neanderthals.

In each of these examples, extinct or endangered species are framed within wider networks of their *potential* biotechnological, biomedical, and pharmaceutical applications. Across these examples, it also becomes clear that there are a range of liminal beings who are emerging from de-extinction research. To bring this back to the discussion of biovalue, these beings—the horseshoe crabs whose blood has pharmaceutical applications, the gastric brooding frogs whose reproductive processes could eventually provide insights into ulcers, the "Chickenosaurus" whose evolutionary insights could be used to treat spinal disorders, and the Neanderthals whose genomes could be used to change human biology—are each an example of how "[d]eath has become increasingly uncertain, and its borders are constantly breached and reconfigured through new forms of technogenesis, new ways of producing biovalue at the margins of living process."[205] Clearly, de-extinction is *not* a solely environmental or ecological pursuit. This rhetorical framing can have important ethical implications. For example, in a study investigating the selection of candidate species in de-extinction, Tessa Molhuizen et al. found that along with species charisma, "[a]nother motive that played a role in species selection was possible human medical implications."[206] Beyond simply functioning as a frame for understanding the potential benefits of de-extinction, then, the potential for future biomedical applications have become part of the *design* for de-extinction projects. The ethical considerations arising from capitalizing on

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[204] Peter Miller, "George Church: The Future Without Limit | Innovators," *National Geographic*, June 2, 2014, https://www.nationalgeographic.com/science/article/140602-george-church-innovation-biology-science-genetics-de-extinction. Emphasis added.
[205] Waldby, *Visible Human Project*, 160.
[206] Tessa Molhuizen et al., "Who to Revive? Explaining Charismatic Species Bias in the Selection of de-Extinction Candidate Species," *Environment and Planning E: Nature and Space*, January 19, 2025, https://doi.org/10.1177/25148486241310698. 10.

the biovalue of extinct species are, consequently, becoming increasingly urgent to address, and identifying the uses of this frame can provide an important starting point for these conversations.

1.4 "Today, the Woolly Mammoth. But tomorrow…": The Future Production of Biovalue in De-Extinction

One way to trace the ethical considerations arising from viewing de-extinction in terms of its biomedical applications is to identify the differences in the way that corporations like Colossal employ this frame. As science communication scholars have noted, there has been a shift in the communication of scientific developments, which Martin Bauer and Jane Gregory refer to as the "privatisation of scientific research."[207] Bauer elaborates on this dynamic, noting that "[m]ost funding for R&D now comes from private sources and most R&D is also performed by private actors."[208] Consequently, Bauer and Gregory argue that this has altered the science communication landscape, moving it "from a logic of journalism towards a *logic of corporate communication*."[209] Colossal certainly engages with this "logic of corporate communication": the company regularly promotes their work through videos posted on platforms like YouTube, and their website includes a "News" section with a curated selection of news articles and podcast interviews about Colossal's work.[210] While this outreach allows their work to reach a wide audience, it also means that Colossal has a higher level of control over how their work is framed. This carefully crafted image can create issues:

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[207] Martin W. Bauer and Jane Gregory, "From Journalism to Corporate Communication in Post-War Britain," in *Journalism, Science and Society: Science Communication between News and Public Relations*, ed. Martin W. Bauer and Massimiano Bucchi (Routledge, 2007). 43.
[208] Martin Bauer, "Paradigm Change for Science Communication: Commercial Science Needs a Critical Public," in *Communicating Science in Social Contexts: New Models, New Practices*, ed. Donghong Chen et al. (Springer Netherlands, 2008). 8.
[209] Bauer and Gregory, "Corporate Communication," 33. Emphasis added.
[210] Colossal Laboratories & Biosciences, "Colossal in the News," August 25, 2021, https://colossal.com/news/.

Winfried Göpfert notes that, in science communication, "[t]he provision of ready-made texts, images, radio or TV interviews produced for the sake of self-representation is problematic, since it tends to replace journalism with self-made products,"[211] which are less likely to provide a nuanced view. These "self-made" communication products shared by Colossal contribute to framing their de-extinction work in terms of *biomedical innovations*, or commodifiable products that could be created by drawing on the biovalue of species like woolly mammoths and thylacines.

At a glance, Colossal's claims for the goals of their de-extinction work are very similar to the biomedical benefits framing in the media. Colossal's "Science and Technology" page, for example, lists the many potential applications of genetic engineering, almost all of which are centered around the benefits they can have for humans: "advancing *human health*, enhancing food production, reducing environmental impact, optimizing animal health and welfare and production of cutting edge industrial applications."[212] Beyond these general applications of genetic engineering, the new biotechnologies being developed by Colossal could, the website states, "impact the efficiency and availability of everyday medicine," or even "contribute to the *eradications of disease*."[213] More specifically, Colossal proposes that "[o]ther world-bettering uses [of genetic engineering] include eradicating malaria, organ donorship, and of course, the slowing of and reversal of the extinction of species."[214] These biomedical claims have filtered through into the way that Colossal's de-extinction work is reported in the media. For example, when describing Colossal's woolly mouse in *Discover Magazine*, science writer Paul Smaglik explains that "[e]ven though the company's ultimate goal is to

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[211] Winfried Göpfert, "The Strength of PR and the Weakness of Science Journalism," in *Journalism, Science and Society: Science Communication between News and Public Relations*, ed. Martin W. Bauer and Massimiano Bucchi (Routledge, 2007). 224.
[212] Colossal Laboratories & Biosciences, "Science & Technology," August 20, 2021, https://colossal.com/technology/. Emphasis added.
[213] Colossal, "Science & Technology." Emphasis added.
[214] Colossal, "Science & Technology."

bring back the mammoth […] they say their work will help both *human health* and wildlife conservation along the way."[215] As these examples show, by connecting de-extinction with biomedicine, Colossal encourages audiences to see the way that their de-extinction technologies can be reconceptualized to improve human health.

While Colossal's rhetoric appears similar to broader media coverage of de-extinction, there are some important differences. Bauer and Gregory differentiate between science journalism and public relations (PR), noting that, in contrast to the critical approach taken by science journalists, "PR professionals […] are myth-makers."[216] Colossal certainly appears to be engaged in the process of "myth-making" as they encourage audiences to see them as capable of capitalizing on the valuable genetic material of extinct species in order to create new biotechnological tools or products that can benefit human health. For example, the "Better World" page proclaims that "[w]hile we may still be in search of the meaning of life, the boundaries of the universe, and what happens after death, humanity is no longer in search of what occurs at the *microscopic level*. We now know that there is a *biological technology* to it all."[217] The website also declares that "[t]he potential of bioscience is *almost unlimited*, and we are at the forefront, *pushing the boundaries*."[218] As Nerlich explains in her analysis of the "breakthrough" and "race" frames in science communication, the significance of scientific developments are often emphasized by referring to them as "racing along a path leading upwards, overcoming obstacles or hurdles, passing milestones or landmarks, finding a new path leading to a frontier […] etc."[219] In the case of Colossal, by "pushing the boundaries," uncovering

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[215] Paul Smaglik, "With Bushy Hair, This Engineered Woolly Mouse Could Help Revive the Woolly Mammoth," *Discover Magazine*, March 4, 2025, https://www.discovermagazine.com/the-sciences/with-bushy-hair-this-engineered-woolly-mouse-could-help-revive-the-woolly. Emphasis added.
[216] Bauer and Gregory, "Corporate Communication," 47.
[217] Colossal Laboratories & Biosciences, "A Better World," August 6, 2021, https://colossal.com/a-better-world/. Emphasis added.
[218] Colossal, "Company," August 6, 2021, https://colossal.com/company/. Emphasis added.
[219] Nerlich, "Breakthroughs and Disasters," 207.

secrets at the "microscopic level," and discovering the "biological technology to it all," they employ this framing technique as a key strategy in shaping how audiences view their de-extinction work. By combining both the biomedical benefits and the breakthrough frames as part of their "myth-making" process, Colossal encourages audiences not just to consider the biomedical applications of de-extinction, but to view Colossal as uniquely able to capitalize on these applications.

One of the ways that Colossal positions themselves as able to capitalize on the "unlimited" possibilities of using extinct species for biomedical research is in the way they refer to the *future* uses of the genetic material of the woolly mammoth. Through the extraction of valuable genetic material from the thawed bodies of woolly mammoths, Wrigley argues that the mammoth is "molecularized," and that this process "produces new configurations of value as *future capital* through the new science of de-extinction."[220] The result of this, she argues, is that the mammoth "becomes valued as something beyond her individual body and history, and instead represents something broader and *more future-oriented* through the fungibility that molecularization offers."[221] The capitalization on the "future-oriented," biomedical possibilities of de-extinction is clear in the way Colossal promotes their work. For example, their "Company" page states that "[t]oday, the Woolly Mammoth. *But tomorrow*, maybe the cure for blindness, eradication of tumors and elimination of disease."[222] Colossal therefore positions de-extinction as a process that may indeed begin by using the "molecularized" genetic material of the woolly mammoth in order to bring the species back into an embodied form, but will then *re-molecularize* the mammoth once again to access its more valuable biomedical potential. Because Colossal has uncovered the "biological technology" at the "microscopic level," they alone are able to access the biomedical insights of the woolly mammoth's molecularized body.

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[220] Wrigley, "Ice and Ivory," 790. Emphasis added.
[221] Wrigley, "Ice and Ivory," 790. Emphasis added.
[222] Colossal, "Company." Emphasis added.

In jessie l. beier's analysis of Colossal's de-extinction rhetoric, she argues that "[c]entral to Colossal's proposal for de-extinction is an economic logic, one wherein today's era of mass extinction can and will be solved via the *business of discovery*."[223] This "economic logic" that beier describes is evident in an episode of the podcast *Impact Theory*, where Tom Bilyeu interviews Colossal's co-founder Ben Lamm. Bilyeu introduces Lamm by explaining that "his team is using the same tools—machine learning, CRISPR, synthetic biology—to *build something that we've never had before*."[224] While the conversation starts by discussing Colossal's work on de-extinction, Bilyeu explains that "this conversation isn't really about animals. […] It's about *what we design next*."[225] The focus on developing "tools" and "designing" products unrelated to de-extinction is echoed by Lamm himself. While Lamm explains that Colossal has no plans to experiment on humans, he follows this by noting that there certainly *could* be future uses of Colossal's products in areas like reproductive medicine, since, "all the technologies that we develop that have an application to human health care, we will license out, we'll spin them out, so other people may use our technologies to eventually grow humans in artificial wombs or whatnot, even though Colossal will not do that."[226] Clearly, then, the company sees the potential to capitalize on the value of the human health applications of their work as they "license out" the biotechnological products developed through their de-extinction research.[227] The "economic logic" that beier identifies is therefore closely connected to Colossal's belief that de-extinction can lead to the development of biomedical products.

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[223] beier, "No Going Back," 169. Emphasis in original.
[224] Tom Bilyeu, "Designing Humans, Erasing Extinction & Ending Natural Reproduction," with guest Benn Lamm, *Impact Theory Podcast*, May 13, 2025, 1:53:49, accessed August 25, 2025, https://www.youtube.com/watch?v=01VTQpsiD2c. 0:21-0:30.
[225] Bilyeu, "Designing Humans," 0:44-0:51.
[226] Bilyeu, "Designing Humans," 36:44-36:58.
[227] As beier notes, Lamm has previously discussed the possibility of patenting new products created through de-extinction: "[a]s Lamm himself asserts, the goal with Colossal is not to monetize the mammoths themselves, but to patent and license other technology that the company develops along the way." beier, "No Going Back," 170.

In contrast to the coverage of de-extinction in the media, Colossal's website and other promotional materials are not necessarily geared towards public audiences. As Bauer and Massimiano Bucchi note, "increasingly, particularly in the context of new technologies such as IT, biotechnology, or nanotechnology, the audience is often not the general public, but other non-specialist scientists, policy makers, and investment brokers, who take media attention as cues for potential investment opportunities."[228] This dynamic can be traced in the way that Colossal's human health claims are echoed by investors. For example, among investors in the company is In-Q-Tel, an investment firm connected with the CIA that "look[s] ahead to power our partners ahead of the technology curve to ensure the national security of the U.S. and its allies."[229] This investment decision has led to a flurry of headlines proclaiming that "The CIA Wants to Bring Woolly Mammoths Back From Extinction."[230] In-Q-Tel addresses their interest in Colossal, referring to "the capability"[231] of de-extinction projects. As beier notes, "the sense of capability referenced here pertains not only to potentials for controlling technological advancements in the biosciences, but also to the project's *financial* capability, that is, the capability for this speculative venture to make a lot of money."[232] Once again, financial and biomedical possibilities are intertwined: in an echo both of Colossal's website and more general de-extinction media coverage, In-Q-Tel elaborates that Colossal's work on genome engineering could result in a wide range of benefits, including "*curing human diseases* such

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Evidently, then, biomedical innovations are just yet another possibility for Lamm's vision of a commodified future of de-extinction.

[228] Martin W. Bauer and Massimiano Bucchi, "Introduction and a Guidance for the Reader," in *Journalism, Science and Society: Science Communication between News and Public Relations*, ed. Martin W. Bauer and Massimiano Bucchi (Routledge, 2007). 7.

[229] IQT, "About," accessed January 27, 2023, https://www.iqt.org/about-iqt/.

[230] Brandon Spektor, "The CIA wants to bring woolly mammoths back from extinction," *Live Science*, October 13, 2022, https://www.livescience.com/cia-wooly-mammoth-de-extinction.

[231] Kevin O'Connell and Eugene Chiu, "How Can We Use Biology to Solve Global Issues?," In-Q-Tel, September 20, 2022. Accessed January 27, 2023, https://www.iqt.org/how-can-we-use-biology-to-solve-global-issues/. Emphasis added.

[232] beier, "No Going Back," 169-170. Emphasis in original.

as sickle-cell anemia, beta thalassemia, Duchenne muscular dystrophy, and many kinds of cancer."[233] As this shows, Colossal's framing of their de-extinction work in terms of biomedical innovations and human health applications has shaped the way that investors view de-extinction, which will thereby *also* influence the goals of future de-extinction projects.

If the biological material of animals like woolly mammoths is commodified, this has serious bioethical implications for humans as well. As Waldby argues the alteration and commodification of biological materials in biomedicine can easily be extended to humans, since "[h]uman tissue and biomass demonstrate the same degree of responsiveness, pluripotency and waywardness to technics as do other kinds of tissue."[234] This can result in the need to reaffirm human identity. For example, Justin Omar Johnston identifies "a central contradiction"[235] that arises from the discourse around biotechnology, where,

> on the one hand, only by selling visions of a biotech future can scientists and pharmaceutical companies attract the attention of much-needed investors, but, on the other hand, this attention always risks enflaming cultural and political disputes about the definition of human life, the status of patented life, the growth of medical inequality, and the overall desirability of these biotechnological futures.[236]

Colossal is an example of the "contradiction" that Johnston describes. For example, while the company's "De-Extinction" page states that one of their goals is "[t]o make humanity more human,"[237] Lamm insists that Colossal will not work directly on human health or genetics, explaining that "we as a company aren't going to work on humans, because we already get so many crazy conspiracy theories about the company, given that In-Q-Tel and others are investors, they're like

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[233] O'Connell and Chiu, "How Can We Use Biology." Emphasis added.
[234] Waldby, *Visible Human Project*, 161.
[235] Justin Omar Johnston, *Posthuman Capital and Biotechnology in Contemporary Novels* (Palgrave Macmillan, 2019). 8.
[236] Johnston, *Posthuman Capital*, 8.
[237] Colossal, "De-Extinction," https://colossal.com/de-extinction/. For a more extended analysis of Colossal's desire to "[m]ake humanity more human," see beier, "No Going Back."

'What are they doing? What is this secret program they don't tell us about?'"[238] Evidently, the "contradiction" that Johnston describes is at play: Colossal is simultaneously "selling visions of a biotech future" that can enhance human health *and* identity, while also dismissing "crazy conspiracy theories" arising from public anxiety about the ease with which Colossal's genetic engineering work could be extended to human bodies.

These tensions around Colossal's human health claims extend even further, as the idea of enhancing the human body through biotechnology gestures at the potential transhumanist aims of de-extinction. The connection between de-extinction, body modification, and transhumanism has previously been identified: for example, Schuster critiques the way that proponents of de-extinction have drawn on transhumanist rhetoric,[239] which beier draws on her in analysis of Colossal.[240] The influence of transhumanism on de-extinction—and the ethical issues arising from this influence—is apparent in Lamm's interview on *Impact Theory*. Lamm and Bilyeu spend a significant portion of the interview considering how biotechnology can change the future of human health, discussing the genetic screening and editing of embryos along with various medical therapies and treatments that could extend human lives.[241] And while Lamm reiterates several times that Colossal will not work on humans, he adds that,

> But I do think though that other people, thank God it's not us, but *other people* will have to think about what is the line between making selections for the betterment of a society from a genetics perspective before you go all out Gattaca or it looks like eugenics. Those are really hard things, like I'm glad I don't have to make those decisions.[242]

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[238] Bilyeu, "Designing Humans," 35:25-35:35.
[239] Schuster, "What Is De-Extinction?," 208-209.
[240] beier, "No Going Back," 175-176.
[241] For example, their discussion of genetic screening, embryo selection, and genetic editing starts at approximately 37:29, while their discussion of human health, medical therapies, and immortality begins at approximately 1:23:40.
[242] Bilyeu, "Designing Humans," 36:43-37:26. Emphasis added.

Even though Lamm notes that there is a risk that biotechnological tools could be used in a way that "looks like eugenics," he dismisses the need for Colossal to consider this risk, since "other people will have to think about it." And other people are: in Nikila Lakshmanan's feminist analysis of transhumanist philosophy, she argues that transhumanism's approach to technological modification risks creating a "new eugenics," which "is not identical, but still worryingly similar to the old."[243] As Lakshmanan explains, transhumanism can lead to a "disturbingly ableist"[244] vision of the body, since "[t]he new eugenic approach to disability stems directly from this desire to transcend the body."[245] Because of this concerning possibility for developments in biotechnology to lead to serious ethical problems, it is critical that proponents of de-extinction consider the future applications of their work. Lamm's dismissal of the need for Colossal to think through the applications of de-extinction technologies—including the very tools that Colossal intends to eventually "license out" to other users—is a troubling example of the way that corporations rely on the biomedical innovations frame *without* engaging in a meaningful way with the ethical ramifications of this approach to de-extinction.

Even if the companies and researchers working on de-extinction do not directly experiment on human bodies, it is clear that by framing de-extinction in terms of commodifiable biomedical products, the work of companies like Colossal raises concerns about how this research will impact humans. To return to Squier's discussion of liminality, she argues that the "liminal lives" created in biomedicine "demand our attention, because they are powerful and dangerous representatives of a transformation we are all undergoing as we become initiates in a *new biomedical personhood* mingling existence and nonexistence, organic and inorganic matter, life and death."[246] From this

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[243] Nikila Lakshmanan, "The New Eugenics of Transhumanism: A Feminist Assessment," *Gender Forum*, no. 68 (June 2018): 41–56, 43.
[244] Lakshmanan, "The New Eugenics," 53.
[245] Lakshmanan, "The New Eugenics," 46.
[246] Squier, *Liminal Lives*, 5. Emphasis added.

perspective, then, the commodification of the genetic material of woolly mammoths—and other species like dinosaurs and Neanderthals—can lead to a new form of "biomedical personhood" that shapes human existence as well, even if humans are not directly involved in biomedical experimentation. With this "biomedical personhood" in mind, beyond Colossal's visions of commodifying biological material and developing biomedical products, what other implications does de-extinction have for human identity? To better answer this question, I will now turn to three de-extinction narratives that each center around the question of how the boundaries between "human" and "nonhuman" identity are blurred by de-extinction technologies. These narratives focus primarily on how de-extinction projects—and the potential to commodify genetic material and its biomedical applications—both reinforce and challenge assumptions about what makes humanity "human."

1.5 "A whole new frontier": Commercialized Biotechnology in the *Jurassic World* Trilogy

The most notorious fictional exploration of de-extinction takes place in the *Jurassic Park* film franchise. The franchise started with the iconic *Jurassic Park* film,[247] which was released in 1993 and shortly followed by several sequels that centred around a dinosaur theme park built on the fictional Isla Nublar. In 2015, the franchise was rebooted with a trilogy of *Jurassic World* films.[248] *Jurassic World* (2015) begins by depicting the operations of a successful theme park which is now open to the public. The film follows the park's operations manager, Claire Dearing, and a velociraptor trainer, Owen Grady. Following the creation of a transgenic, hybrid dinosaur species, the *Indominus rex*, the dinosaur escapes and rampages through the park. While the park is abandoned after these events, in

[247] Based on the novel *Jurassic Park* (1990) by Michael Crichton.
[248] While the three films had initially appeared as a trilogy, in July 2025, another new film was released: *Jurassic World Rebirth*, directed by Gareth Edwards (Universal Pictures, 2025).

Jurassic World: Fallen Kingdom (2018), a volcanic eruption is about to destroy the island and cause the (re)extinction of the dinosaurs. When several of the dinosaurs are rescued from the island, it quickly becomes apparent that the goal is *not* to protect the endangered species, but rather to capitalize on them. Even more insidiously, Claire and Owen discover that a weaponized transgenic dinosaur has been created, using both *Velociraptor* and *Indominus rex* DNA. When a fire threatens to kill the remaining dinosaur species, Benjamin Lockwood's granddaughter Maisie (who, it turns out, is a clone of Charlotte, Lockwood's daughter) chooses to release the dinosaurs from captivity. The impacts of Maisie's decision are explored in *Jurassic World: Dominion* (2022), as the dinosaurs have begun integrating into the wild and infringing on human spaces. After acquiring the rights to the dinosaurs, the company Biosyn Genetics kidnaps Maisie in order to study her genome and use it (along with dinosaur DNA) to develop biomedical products. Claire and Owen eventually team up with the trio from the original *Jurassic Park* film—Ellie Sattler, Alan Grant, and Ian Malcolm—and together they rescue Maisie while also exposing Biosyn's nefarious activities. The trilogy concludes with an optimistic vision of a world in which humans and dinosaurs learn to coexist *beyond* the exploitative relationship that had characterized the films.[249]

While de-extinction is often primarily seen as an environmental initiative, in the *Jurassic World* films, bringing back the dinosaurs is a purely commercial pursuit. Rather than proposing that dinosaurs could somehow reverse human-caused environmental destruction, the scientists and business executives behind dinosaur de-extinction see it as a way to bring in revenue via the theme park. Consequently, the cloned or genetically modified beings depicted in the films—dinosaurs as

[249] For a discussion of the interspecies kinship and potential "post-anthropocentric" future envisioned in *Jurassic World: Fallen Kingdom*, see Jerika Sanderson, "Listening to Nonhuman Animals in Science Fiction Film: Establishing Empathy through Dinosaur Voices in *Jurassic World: Fallen Kingdom*," in *Animals and Science Fiction*, ed. Nora Castle and Giulia Champion, (Palgrave Macmillan, 2024).

well as other extinct species like Cretaceous insects—are frequently discussed in terms of their economic value. While initially, this value is intended to come from the draw of seeing dinosaurs in person by visiting Jurassic Park, the *Jurassic World* trilogy takes the commodification of biological material even further. In *Jurassic World*, the company uses genetic engineering to design transgenic species with entirely new morphological and behavioural characteristics. As Claire explains,

> Our shareholders have been patient, but let's be honest, no one is impressed with a dinosaur anymore. Twenty years ago, de-extinction was right up there with magic. These days, kids look at a stegosaurus like an elephant from the city zoo […] Consumers want them bigger, louder, more teeth. The good news? Our advances in gene splicing have opened up *a whole new frontier*.[250]

This "whole new frontier" that Claire describes—which mirrors Colossal's claims about being "at the forefront, pushing the boundaries"[251]—is the ability of genetic engineering to create new, custom-designed species like the *Indominus rex*. The *Indominus rex* fuels hype by fulfilling consumers' desire for "more teeth," since, as Claire explains, "[e]very time we've unveiled a new asset, attendance has spiked. Global news coverage. Celebrity visitors. Eyes of the world."[252]

Despite the destruction caused by the *Indominus rex* in *Jurassic World*, the alteration of dinosaur genomes to maximize their value does not end there. In both *Fallen Kingdom* and *Dominion*, rather than simply attempting to create more "exciting" dinosaurs to draw in consumers, the animals are increasingly viewed in terms of their potential use *beyond* their entertainment value. For example, *Dominion* introduces yet another new way that corporations can capitalize on de-extinction projects: through their *agricultural* applications. *Dominion* begins with scenes showing massive swarms of

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[250] *Jurassic World*, directed by Colin Trevorrow (Universal Pictures, 2015), 07:10-07:42. Emphasis added.
[251] Colossal, "Company," https://colossal.com/company/.
[252] *Jurassic World*, 08:21-08:31. Interestingly, Claire's description of the public response to genetically modified "assets" has recently been mirrored in the reception of Colossal's genetically modified "dire wolves." These genetically modified wolves—like *Jurassic World*'s genetically modified dinosaurs—have drawn the "eyes of the world" due to extensive news coverage and celebrity involvement. See Chapter 4 for a discussion of how "hype" has driven the interest in Colossal's genetically modified wolves.

locusts destroying entire fields of crops while terrified children run for their lives. Ellie Sattler, a paleobotanist and one of the three scientists who had visited the original iteration of Jurassic Park, is called in to investigate the locusts. After her examination, Ellie concludes that the locusts have DNA from Cretaceous-era insects, and that "[n]one of the crops they're eating are Biosyn seed."[253] The Biosyn communications officer, Ramsay Cole, later explains that the initial goal of creating the locusts—an initiative referred to as the Hexapod Allies project—had been "to spread genetic modifications to crops. Protection against droughts, frost, disease. A breakthrough."[254] Despite this seemingly altruistic intention, the actual result of the project has been to decimate non-Biosyn crops and ensure that the genetically modified Biosyn crop would dominate agricultural markets, eventually leading to a complete monopoly. In contrast to the claim that de-extinction can restore ecosystems and contribute to biodiversity, in *Dominion*, it has instead resulted in even more widespread ecological and economic damage. Interestingly, though, *Dominion* calls attention to the way that this type of ecological control has always been implicit in corporate biotechnological experimentation: as Ellie notes, "[f]irst the big companies try to *kill off* all the insects, now this."[255] However, instead of "kill[ing] off all the insects," Biosyn has realized that the creation of genetically modified locusts can provide an even *more valuable* application of biotechnology.[256]

Even though Hexapod Allies has resulted in an agricultural and ecological crisis, Dodgson insists that geneticist Dr. Henry Wu continue his work, explaining, "[y]ou understand the value of these creatures. I do too. And we don't stop because a, what, a little side project went south?"[257]

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[253] *Jurassic World: Dominion*, directed by Colin Trevorrow (Universal Pictures, 2022), 33:05-33:09.
[254] *Dominion*, 1:49:24-1:49:30.
[255] *Dominion*, 27:28-27:33. Emphasis added.
[256] For a discussion of how insects can feature in de-extinction narratives not as monstrous or commodified products, but rather as multispecies kin, see Chapter 4.
[257] *Dominion*, 54:00-54:07.

Despite his involvement in the creation of the locusts (and indeed, earlier in the creation of the *Indominus rex*), Henry has had a change of heart and tries to convince Dodgson to let him try to find a way to stop the spread of the transgenic locusts. Dodgson refuses, insisting that they abandon the locust project rather than trying to rectify it, telling Henry that "if they trace the locusts back to us, they come for the dinosaurs. All your work gone. Billions of dollars in assets, gone. Diamonds with no one to mine them."[258] This comparison of the creation of dinosaurs with the mining of diamonds frames the de-extinction project within the context of the commodification of natural resources. Part of the biotech revolution, Melinda Cooper argues, is that there will be a shift in the resources that are considered valuable. She notes that

> Henceforth, profits will depend on the accumulation of biological futures rather than on the extraction of nonrenewable resources and the mass production of tangible commodities. Nor does the move into bioproduction signify the dissolution of ecological limits. The new life science conglomerates have not overcome waste, depletion, or any other of the catastrophic limits to life on earth, but they *have simply divested themselves of the costs*.[259]

Biosyn's capitalization on ancient insect DNA in *Dominion* engages with this future of "life science conglomerates" that Cooper envisions, since the company's focus has shifted to the "accumulation of biological futures" in the form of the transgenic locusts that can shape global food production. At the same time, Biosyn has "divested themselves of the costs," as Dodgson expresses little concern for the "catastrophic" impacts that his company has on the environment.

While the trilogy depicts the entertainment and agricultural applications of de-extinction projects, the films simultaneously echo the media's focus on the *biomedical* benefits of de-extinction by exploring the idea that dinosaurs could hold the key to biomedical and pharmaceutical breakthroughs. It is, perhaps, unsurprising that this frame for de-extinction is prevalent both in fiction

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[258] *Dominion*, 54:10-54:24.
[259] Cooper, *Life as Surplus*, 24. Emphasis added.

and nonfiction: as Nerlich et al. explain in their discussion of frames in science communication, "[f]rames do not exist in isolation. They evoke and are linked to shared storylines and storytelling."[260] The potential biomedical and pharmaceutical applications of the dinosaurs are envisioned by one of Lockwood's employees, Eli Mills, in *Fallen Kingdom*. While Mills' primary interest had been in creating weaponized dinosaurs, he simultaneously speculates on other uses for the dinosaurs, noting their "unique biopharmaceutical properties,"[261] and estimating their value at "four million per species."[262] The potential to capitalize on the "biopharmaceutical properties" of the dinosaurs appears again in *Dominion*. When Ellie and Alan visit Biosyn, Dodgson insists that "No, it's not about money. No, we've already identified dozens of applications for paleo-DNA. We're talking about cancer, Alzheimer's, autoimmune. We will be saving lives."[263] Dodgson's claim about the "dozens of applications" for the genetic material of extinct species in biomedicine echoes the way that various science writers and corporations have referred to the "scientific and medical dividends"[264] offered by de-extinction. Indeed, Dodgson's reference to the various diseases and conditions that could be treated or cured through Biosyn's work is extraordinarily similar to the claims that de-extinction research could lead to treatments for—to name a few—ulcers, sarcomas, spinal disorders, blindness, cancer, sickle-cell anemia, osteoporosis, and muscle wasting. Evidently, then, the shift in the films from the entertainment or military value of the dinosaurs to their *biomedical* value provides an example of how this frame serves as one of the "shared storylines" in de-extinction, not just in the media, but also in fiction.

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[260] Nerlich et al., "Communicating Biological Sciences," 8.
[261] *Fallen Kingdom*, 52:52-52:54.
[262] *Fallen Kingdom*, 52:55-52:57.
[263] *Dominion*, 46:54-47:02.
[264] Landers, "Chickenosaurus."

Despite Dodgson's altruistic claim that he will use the company's ownership over dinosaur DNA to "save lives" rather than to profit off of the pharmaceutical applications of their genetic material, the company quietly turns its attention to Maisie: the child who was cloned using the same technologies that created the dinosaurs. In *Fallen Kingdom*, Maisie is originally said to have been created by Lockwood as a way of coping with his grief after his daughter died. After Lockwood's murder, Mills plans to keep Maisie at the estate. However, beyond stating that he "understand[s] her value,"[265] Mills does not elaborate on his plans to capitalize on that value.[266] It is not until *Dominion* that these plans are further expanded upon when Maisie's backstory story changes: it is revealed that Maisie's mother Charlotte Lockwood, a former Jurassic Park scientist, chose to clone *herself* and give birth to the cloned child before her death from a genetic disease. Charlotte developed a gene-altering treatment that she used to change Maisie's genome, curing Maisie of the disease that would later kill Charlotte. Because of this, Biosyn seeks to capitalize on Maisie as a source of *medically beneficial* biovalue: her genome, they argue, could hold the secrets to human health and disease. Dodgson views Maisie as yet another valuable contribution to his aims of developing new pharmaceutical products, telling Henry that Maisie is "the most valuable intellectual property on the planet."[267] As Nikolas Rose notes in his analysis of biopolitics and biomedicine, research in the biological sciences "has become bound up with the generation of intellectual property, and illness and health have become major fields for corporate activity and the generation of shareholder value."[268] As a result, he argues, "human vitality has been opened up, at the molecular level, for technical innovation, economic

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[265] *Fallen Kingdom*, 1:16:32-1:16:33.
[266] For a more in-depth analysis of biovalue in *Fallen Kingdom*, see Jerika Sanderson, "Posthuman Mothers and Reproductive Biovalue in *Blade Runner: 2049* and *Jurassic World: Fallen Kingdom*," in *Feminist Posthumanism in Contemporary Science Fiction Film and Media: From* Annihilation *to* High Life *and Beyond*, eds. Julia Empey and Russell Kilbourne (Bloomsbury Press, 2023).
[267] *Dominion*, 54:42-45.
[268] Nikolas Rose, *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century* (Princeton University Press, 2007), 11.

exploitation, and for highly competitive forms of bioeconomics."[269] Dodgson's desire to capitalize on Maisie as a valuable form of intellectual property is part of the way that human vitality has become integrated into the bioeconomy, demonstrating the way that—like gastric brooding frogs, thylacines, and woolly mammoths—humans themselves can become the focus of future de-extinction projects.

An important element of the incorporation of human vitality into the bioeconomy, Vint argues, is the way that it results in "[t]he biopolitics of epivitality."[270] This new biopolitical dimension, she argues, arises when "what one brings to market is increasingly a biological capacity of one's body—gestation, the production of blood or bone marrow, an organ, cellular responses to pharmaceuticals—rather than labor-power understood as an expression of the capacities of a full human subject."[271] Maisie's "value" as a cloned human is what I refer to as the "reproductive biovalue"[272] of her bioengineered genome, and the potential applications of her DNA in future, unspecified projects. To return to Wrigley's discussion of the commodification of woolly mammoth bodies and genes, she argues that by "becoming molecular, [the mammoth] is imbued with lively future possibility."[273] In *Fallen Kingdom* and *Dominion*, Maisie, like the woolly mammoth that Wrigley describes, "becom[es] molecular," with the "lively" potential of her DNA becoming the focus of characters like Mills and Dodgson.

This focus on Maisie's biovalue also extends beyond Mills' and Dodgson's fairly simplistic portrayals as corporate villains who seek to capitalize on the cloned girl as a form of intellectual property. Indeed, the way that Maisie is treated by other, more sympathetic characters is equally troubling. Even Henry, despite his increasing sense of guilt over Biosyn's activities and his desire to

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[269] Rose, *Politics of Life Itself*, 11.
[270] Vint, *Biopolitical Futures*, 4.
[271] Vint, *Biopolitical Futures*, 4.
[272] Sanderson, "Posthuman Mothers and Reproductive Biovalue," 93-94.
[273] Wrigley, "Ice and Ivory," 798.

rectify the damage that had been inflicted through the Hexapod Allies project, still views Maisie in terms of her potential to radically advance biomedical and genetic research. When Maisie arrives, Henry is the one to explain how Charlotte had edited Maisie's genome, telling Maisie, "Charlotte's discovery is a part of you now. Your DNA could *change the world*, and I have to know how she did it […] if I could just study you…"[274] To return to Vint's concept of epivitality, what Maisie "brings to market" is her ability to "change the world" by allowing her genetics to be used in future biomedical research projects. This results in the dynamic that Vint describes, where "subjects and objects, organic and manufactured beings, persons and things blur into one another as biology becomes caught up in projects of bioeconomic innovation."[275] As a result of the desire to capitalize on the biomedical and biotechnological applications of de-extinction, Maisie's identity both as a person and as a "piece of intellectual property" blur, reducing her status to that of a commodifiable object of scientific research.

The *Jurassic World* trilogy explores several ways that the biovalue of extinct species can be capitalized on and provides a critique of the exploitation of the "de-extinct" dinosaurs. The *Jurassic World* films, then, appear to align with the message of the original *Jurassic Park* film: as Daniel Dinello argues in his analysis of "technophobia" in SF like *Jurassic Park*, the film "comes off as anti-biotechnology, anti-science, and of course pro-nature,"[276] especially given that "*Jurassic Park* implies that corporate interests control the power of science to serve their own selfish ends."[277] And yet, while the *Jurassic World* films appear to condemn the commodification of living beings for entertainment, military, and even agricultural purposes, the films' stance on the biomedical possibilities arising from

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[274] *Dominion*, 1:19:35-1:19:50. Emphasis added.
[275] Vint, *Biopolitical Futures*, 5.
[276] Daniel Dinello, *Technophobia! Science Fiction Visions of Posthuman Technology* (University of Texas Press, 2005). 214.
[277] Dinello, *Technophobia*, 214.

de-extinction research is less clear. Charlotte's application of cloning and genetic engineering is portrayed as distinctly different than Mills' and Dodgson's use of the same biotechnological tools. When Maisie asks Ellie about Charlotte, Ellie describes Charlotte's application of genetic engineering as being more noble and altruistic than that of the other scientists at Jurassic Park, since "she had a conscience. While they were out building theme parks, well, she was determined to prove that genetic power could *save lives*."[278] While Maisie initially interprets this as meaning that Charlotte created her as an "experiment,"[279] Ellie reassures her that Charlotte "wanted you to have what she couldn't. A full life."[280] Learning this about Charlotte later inspires Maisie to allow Henry to use her genetic material as well. As Catherine Pugh notes in her analysis of the *Jurassic* films, they "make a distinction between genetic engineering efforts for the sake of conservation and those done for capitalist gain," since, "[i]ntent matters in the *Jurassic Park* universe […] scientific intervention is not punished by avenging Nature as long as it is done with altruistic conservation in mind."[281] This distinction evidently applies beyond conservation to medical scenarios as well: while *Dominion* still appears to be critiquing the corporations that capitalize on the applications of genetic material, the *biomedical* use of human genetic material as a source of biovalue that can "save lives" is framed in a significantly more positive light. Ultimately, then, the films simultaneously critique and reinforce the biomedical benefits frame in de-extinction discourse by condemning the commodification of biomedical products, while still envisioning a future where the genetic material of both extinct species *and* humans can lead to important medical breakthroughs. [282]

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[278] *Dominion*, 1:39:38-1:39:48. Emphasis added.
[279] *Dominion*, 1:39:49-1:39:50.
[280] *Dominion*, 1:39:57-1:40:02.
[281] Catherine Pugh, "Swallow You Whole: The Jurassic Park Franchise, Eco-Horror and the Devouring Gothic," *Cinergie – Il Cinema e Le Altre Arti*, no. 24 (December 2023): 24, https://doi.org/10.6092/issn.2280-9481/16748. 97.
[282] Interestingly, a similar dynamic can be seen in *Jurassic World Rebirth*, where the CEO of a pharmaceutical company that seeks to create new medications using dinosaur DNA is depicted—like Mills and Dodgson—as a

1.6 "The Latest Accessories for Ladies Who Lunch": Genetic Engineering and Designer Babies in *The Neanderthal's Aunt*

Like the *Jurassic World* films, other narratives have similarly explored the potential biomedical benefits of de-extinction. Like the *Jurassic* films, Gina DeMarco's novel *The Neanderthal's Aunt* (2014) also explores de-extinction in the context of human health. Unlike the *Jurassic World* films, however, the novel focuses more on the societal problems that arise from using de-extinction science to create test subjects. *The Neanderthal's Aunt* was published by ScienceThrillers Media, a company that "specializes in page-turning stories, both fiction and popular nonfiction, that have real science, technology, engineering, mathematics, or medicine in the plot."[283] The story depicts the creation of a Neanderthal baby by a biotech start-up in New York City, and the events of the story follow Sara Nicoletta, a biologist who observes—in amusement, disbelief, and later horror—her widowed sister's decision to fund the Neanderthal project. Sara had initially dismissed her sister Liz's interest in the project as merely being a distraction from her grief over losing her husband to a degenerative genetic disease. However, the project gains momentum and media attention, with Neanderthal babies becoming the latest fad for wealthy families. Eventually, a man attempts to kidnap Linda, the chimpanzee surrogate mother, in order to ransom the unborn Neanderthal baby back to Liz. While they prevent Linda from being kidnapped, during this brief outing outside of the laboratory, Linda (and the Neanderthal baby) are exposed to Panola virus, a virus which has caused the sudden deaths of large flocks of birds resulting in an ecological crisis. Shortly after this, Linda gives birth to Svea, who initially appears healthy. However, it quickly

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two-dimensional villain. This provides a stark contrast to other characters in the film who seek to use dinosaur DNA in more altruistic ways by making the genomes open access. Again, then, the *biomedical* use of genetic material is itself not depicted as dangerous or unethical.

[283] Gina DeMarco, *The Neanderthal's Aunt* (Sacramento: ScienceThrillers Media, 2014), 221.

becomes apparent that Svea will not survive: while humans are unaffected by Panola, Svea—whose Neanderthal genome does not contain immunity to the virus—dies from the infection days after her birth. Svea's death signals the end of the Neanderthal project.

Like in the *Jurassic* films, the goals of de-extinction in *The Neanderthal's Aunt* are unconnected with any environmental or ecological goals. Instead, Neanderthal children are viewed as commodities that can be purchased by the wealthy elite. Sara quickly becomes suspicious of the project, concluding that the project leader Theo Barlas' motivations must be based on defrauding wealthy women like Liz.[284] Sara's suspicions are raised further when she realizes that Theo himself is not a scientist. While she had visited Barlas Labs expecting to speak with the researchers behind the project, Theo "was slick [...] Smooth. Scientists were never like this—only the sales reps."[285] As more individuals emerge professing interest in adopting a Neanderthal baby, the target audience for the Neanderthal project begins to become clear: wealthy and health-conscious women like Liz who are willing to invest in the possibility of creating a bioengineered child. In the words of a news source following the Neanderthal project, Neanderthal babies were "The Latest Accessories for Ladies Who Lunch."[286] The article reflects on how "[i]t seems Neanderthals are the latest breeder craze in designer babies. And why not? Designer clothes, designer pets. Why not genetically modified designer babies?"[287] While Sara grows increasingly uncomfortable with the way the Neanderthal baby is being treated as a "designer" product, Liz insists that the child will "have a lovely life"[288] since Barlas Laboratories is "making friends for her."[289] For Sara, however, the plan to create additional

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[284] DeMarco, *Neanderthal's Aunt*, 8.
[285] DeMarco, *Neanderthal's Aunt*, 12.
[286] DeMarco, *Neanderthal's Aunt*, 90.
[287] DeMarco, *Neanderthal's Aunt*, 90.
[288] DeMarco, *Neanderthal's Aunt*, 189.
[289] DeMarco, *Neanderthal's Aunt*, 189.

Neanderthal children will not lead to the creation of a community, but rather amounts to merely "[r]olling them off the assembly line"[290] to meet the demands of wealthy consumers.

While the Neanderthal baby is framed as a fad for wealthy women, the even more insidious truth behind Liz's decision to invest in the project is eventually revealed. After an ultrasound shows the Neanderthal fetus is alive and well, Sara begins to reflect on the words of one of her colleagues, who had told her that "[i]f you can make a Neanderthal, you can make anything."[291] Sara eventually confronts Liz, asking, "[i]t's not done when the Neanderthal is born, is it? There's going to be another child, isn't there?"[292] Liz reluctantly admits that part of the goal of the Neanderthal research is to develop the necessary biotechnological tools to re-engineer *human* genomes as well. Liz explains that her husband, John, had "always wanted children. He just didn't want to pass on his disease […] Now we can make our children but with no disease."[293] The Neanderthal baby, then, is just the first step in "[t]he vivification of information," which Waldby argues "has changed the terms of the relationship between the living and the dead."[294] What this means, Waldby argues, is that "[d]eath has become increasingly uncertain, and its borders are constantly breached and reconfigured through new forms of technogenesis, new ways of producing biovalue at the margins of living process."[295] The project promises to "reconfigure" death not only by resurrecting the extinct Neanderthal, but also through reviving John's DNA and resurrecting *him* through the creation of a genetically modified *Homo sapiens* child. Once again, then, de-extinction is depicted as being more about *human health* than about any environmental or ecological considerations.

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[290] DeMarco, *Neanderthal's Aunt*, 189.
[291] DeMarco, *Neanderthal's Aunt*, 188.
[292] DeMarco, *Neanderthal's Aunt*, 188.
[293] DeMarco, *Neanderthal's Aunt*, 190.
[294] Waldby, *Visible Human Project*, 160.
[295] Waldby, *Visible Human Project*, 160.

Liz's admission that the goal of the project was to allow her to create genetically modified children using her deceased husband's DNA also demonstrates the bioethical concerns that can arise regarding the "liminal lives" that are created through de-extinction projects. Theo does not appear to have any concerns about the legal status of the Neanderthal baby, instead telling Sara "almost with a sense of pride"[296] that "[t]he technology is ahead of the law."[297] While Theo sees the liminality of the Neanderthal baby as reflective of his company's cutting-edge research, for Sara, this inability to classify the baby is a troubling ethical problem. After discovering Liz's goal to use the Neanderthal project as a starting point for the creation of more children using John's DNA, she accuses Liz of using the Neanderthal baby only as a step in creating "real" children: "She's a prototype! You couldn't start with a real child, so you started with one who's *not quite real*?"[298] The not-quite-realness of the Neanderthal baby allows for her biomedical exploitation, with the grey areas surrounding Neanderthals' legal status making it possible to experiment with Neanderthal embryos in a way that would not be permitted with *Homo sapiens*. As Waldby argues, part of what makes the ascription of biovalue so dangerous is that it often capitalizes on the bodies of individuals who are marginalized by society,[299] since "[t]his surplus value is produced through setting up certain kinds of hierarchies in which marginal forms of vitality – the foetal, the cadaverous and extracted tissue, as well as the bodies and body parts of the *socially* marginal – are transformed into technologies to aid in the intensification of vitality for other living beings."[300] Given their precarious legal and social status, Neanderthals are an example of the marginalized beings that Waldby describes. Therefore, as a

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[296] DeMarco, *Neanderthal's Aunt*, 73.
[297] DeMarco, *Neanderthal's Aunt*, 73.
[298] DeMarco, *Neanderthal's Aunt*, 188. Emphasis added.
[299] Waldby describes how one of the bodies donated to the Visible Human Project was the body of a man who was serving a prison sentence for murder. As she explains, relying on the bodies of prisoners for medical experimentation is an example of "a long history in which medical knowledge was intimately bound up with penal and sovereign power." Waldby, *Visible Human Project*, 52.
[300] Waldby, *The Visible Human Project*, 19.

"marginal form of vitality," the Neanderthal baby is exploited to "aid in the intensification of vitality" of other people through her ability to contribute to genetic research that cannot be ethically performed using human subjects.

This desire to use the Neanderthal child as a step in curing human disease frames de-extinction in the context of the transhuman desire to transform the human body, since, as Pramod K. Nayar explains, "[t]ranshumanists believe in the perfectibility of the human, seeing the limitations of the human body (biology) as something that might be transcended through technology so that faster, more intelligent, less disease-prone, long-living human bodies might one day exist on Earth."[301] Indeed, this perspective is outlined in detail by transhumanist philosopher Max More. In a series of "amendments to the human constitution"[302] that propose improvements to the human body, More proclaims that "[w]e will no longer tolerate the tyranny of aging and death. Through genetic alterations, cellular manipulations, synthetic organs, and *any necessary means*, we will endow ourselves with enduring vitality and remove our expiration date."[303] In *The Neanderthal's Aunt*, exploiting Neanderthals as test subjects for genetic engineering is an example of how the transhumanist pursuit of freedom from death and disease through "any means necessary" can result in unethical medical experimentation, where the liminal beings created through de-extinction are expected to enhance the vitality of humans.

The Neanderthal's Aunt, then, raises questions about the way that biotechnological interventions into the human body can result in discriminatory biomedical practices. To return to

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[301] Pramod K. Nayar, *Posthumanism* (Polity, 2014). 6.
[302] Max More, "A Letter to Mother Nature," in *The Transhumanist Reader: Classical and Contemporary Essays on the Science, Technology, and Philosophy of the Human Future*, ed. Max More and Natasha Vita-More (Wiley-Blackwell, 2013). 450.
[303] More, "A Letter to Mother Nature," 450. Emphasis added.

Lakshmanan's discussion of the "new eugenics" of transhumanism, she argues that a key ethical issue arising from attempts to create idealized versions of bodies through modification is that

> The new eugenicists attempt to distinguish themselves from their predecessors by claiming that the use of enhancement technologies should be a matter of individual discretion. Governments and other entities cannot force people to use them. The new eugenicists present their case for individual choice as though it promotes the values of freedom, genetic diversity, and experimentation.[304]

This approach, then, raises the concern that not everyone will have the same "freedom" to undergo modification. As *The Neanderthal's Aunt* shows, beings like Svea who are seen as "not quite real" will not be granted the same ability to decide how they engage with new biomedical developments; instead, Svea becomes a test subject whose body is used as a step in creating healthier *human* bodies. Ultimately, then, in contrast to the *Jurassic* film's depiction of Maisie's participation in biomedical research, Neanderthals in *The Neanderthal's Aunt* experience a very different form of "biomedical personhood," where they do not have the ability to decide on how their bodies or genetic material will be used. Instead, the Neanderthals become tools for biomedical research. Therefore, the way that Neanderthal children are viewed in terms of their biomedical value reinforces the hierarchy of those who are considered worthy of dignity and autonomy, and those—like Svea—who are not.

1.7 "It's up to us to re-engineer the world": Anthropocentric Dreams in *Ghost Species*

As the *Jurassic World* trilogy and *The Neanderthal's Aunt* show, biotechnological developments that allow greater interventions into the genome will inevitably have implications for humans as well. In James Bradley's novel *Ghost Species* (2020), the impacts of de-extinction technologies on "human" identity are explored through the character of a cloned Neanderthal, who

[304] Lakshmanan, "The New Eugenics," 43.

unlike Svea in *The Neanderthal's Aunt*, survives her birth and eventually learns her identity as a Neanderthal. *Ghost Species* begins with the premise that humans need to atone for the damage that has been inflicted on the environment. The novel follows the perspective of the biologist Kate Larkin, who is invited alongside her husband, Jay Gunesekera, to work for a research centre called the Foundation. Based in Tasmania, the Foundation is led by billionaire CEO Davis Hucken, and the Foundation's goal is to bring back various extinct species in order to reverse environmental destruction and climate change. Rather than simply bringing back species that had recently gone extinct due to human activity, the Foundation chooses to focus part of their efforts on cloning a Neanderthal. While Kate is initially skeptical of the Neanderthal de-extinction project, she agrees to work for the Foundation, and the project culminates in the birth of Eve, a Neanderthal girl. Kate grows increasingly uncomfortable with the project, and eventually leaves the Foundation, taking Eve with her. Eventually, their location is discovered, and Kate and Eve return to the Foundation. Initially, Eve's development is closely monitored, but as time passes Davis loses interest in Neanderthal de-extinction. The remainder of the story follows Eve's life as a teenager as the world faces increasingly severe environmental problems.

In *Ghost Species*, Eve is never referred to, as Maisie and Svea were, as a biomedical product, but she is rather just one of many attempts that were made by the Foundation to reverse human-caused environmental destruction. The motivation for Eve's creation is, Davis explains, that humans "need to be tested by other minds, other perspectives. […] Imagine speaking to another species!"[305] After Jay and Kate visit the Foundation, Jay is immediately enamored with the facilities, and when Kate expresses doubts about the project, he simply echoes Davis' earlier words: "imagine the possibility of encountering another species. One that sees the world differently from us. Imagine what

[305] James Bradley, *Ghost Species* (London: Hodder Studio, 2020), 20.

that might mean, how it might change the way we see the planet. Imagine connecting us to our deep past like that."[306] For Jay, the primary benefit in the Neanderthal project is that it will teach the human characters more about *themselves*, which he is even more intrigued by than the project's potential environmental and ecological applications. This idea is common across de-extinction narratives: for example, in *Dominion*, the Biosyn slogan is repeated several times throughout the film, reassuringly telling the public that "[a]t Biosyn, we're dedicated to the idea that dinosaurs can teach us more about ourselves."[307] Similarly, we can recall Colossal's goal "[t]o make humanity more human."[308] Even though Davis and Jay do not explicitly speculate on the biomedical applications of the Neanderthal project, this rhetoric similarly engages with of the idea of using the genetic material of extinct species to "improve" the human body and enhance human identity and vitality.

Kate is concerned from the start about how the Neanderthal child will be treated. While Jay and Davis are carried away with excitement for the project's potential to benefit humans, Kate continues to feel doubts. She considers the legal implications of Neanderthal de-extinction, asking, "[w]ill they have rights? We need some kind of guarantee they will be protected by the law, that they'll have the same rights of self-determination as a normal child."[309] Neither Davis nor Jay take her concerns seriously. When Davis first introduces the project, he tells Kate and Jay that "[i]t's only the beginning,"[310] a sentiment which Jay, once again, echoes, by telling Kate that "[i]f we can make one child *we can make more*."[311] Like Eli Mills' claims in *Fallen Kingdom* that the development of transgenic dinosaurs is "an overture to something much more ambitious,"[312] Sara's fear in *The*

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[306] Bradley, *Ghost Species*, 23.
[307] *Dominion*, 06:39-06:45.
[308] Colossal Laboratories & Biosciences, "De-Extinction," https://colossal.com/de-extinction/.
[309] Bradley, *Ghost Species*, 35.
[310] Bradley, *Ghost Species*, 32.
[311] Bradley, *Ghost Species*, 62. Emphasis added.
[312] *Fallen Kingdom*, 53:27-53:30.

Neanderthal's Aunt that "[i]f you can make a Neanderthal, you can make anything,"[313] and even Colossal's claim that their genetic research "will create new opportunities that reach *far beyond* our de-extinction endeavors,"[314] Eve's role in the Foundation's Neanderthal project is seen as only the start to a significantly larger project. These unspecified, potential future directions of de-extinction once again engage with the speculative biovalue of genetic material. Indeed, across these narratives, de-extinction becomes part of the "accumulation of biological futures"[315] that Cooper identifies as a component of the biotech revolution.

Rather than providing genetic material, like Maisie, or acting as a test subject, like Svea, Eve's biomedical potential is instead in the way that she reaffirms expectations about the "human" body. As a child, Eve is initially treated as a valuable source of information, providing insights into the differences between humans and Neanderthals. For example, after Jay finds Kate and brings her and Eve back to the Foundation, a new home is set up for them with cameras to provide constant surveillance on Eve's development. Eve undergoes "a battery of tests," including "scans of her skull and brain, measurements of reaction times and muscle and hormonal levels" along with cognitive tests to measure "differences between her Neanderthal mind and their sapient minds."[316] While Eve does not directly provide genetic material for future projects, her body is still viewed in terms of the insights that it can provide, as her anatomy, hormones, and cognitive capacities become important datapoints for measuring the distance between *Homo sapiens* and Neanderthals. As Waldby argues in her analysis of biovalue, "medicine engages in a constant, paradoxical quest to shore up the status of the human through its material reconfiguration."[317] By offering insights into human identity, Eve

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[313] DeMarco, *Neanderthal's Aunt*, 188.
[314] Colossal, "Science & Technology," https://colossal.com/technology/. Emphasis added.
[315] Cooper, *Life as Surplus*, 24.
[316] Bradley, *Ghost Species*, 121.
[317] Waldby, *Visible Human Project*, 49.

"shore[s] up the status of the human." Consequently, as a Neanderthal, Eve's body, like Svea's in *The Neanderthal's Aunt*, is used as a biomedical tool to enhance other—more "human"—lives.

Despite Davis' initial claims that Neanderthal de-extinction will counteract human-caused climate change and allow humans to interact with the world in a completely new way, he and the rest of the Foundation team show very little interest in interacting with Eve. Kate eventually snaps, telling Jay, "[t]his is why I left in the first place. You want to observe her, study her, but nobody's interested in her."[318] Davis had insisted that Neanderthal de-extinction "gives us the chance to undo the wrong that was done when they were wiped out," and that "we need them; the world needs them. Look at the Earth, at what our carelessness has done to it. We can't let that happen again."[319] And yet, despite these claims, once Eve has gone from being a potential way to reconnect with nature to being an actual, living person, Davis' condemnation of human carelessness disappears. As Radin and Kowal note in their discussion of cryopolitics, "the most striking temporal dimension of cryopolitics" is that "the *abdication of responsibility* for action in the present [is] made possible by recourse to the promise of an ever-receding, and technoscientifically enabled, horizon of future salvation."[320] Wrigley identifies this precise dynamic at play in mammoth de-extinction, noting that "[t]he process of molecularization and subsequent de-molecularization of the mammoth through various vested interests is indicative of a grasping for greater control as we hurtle towards a future that portends a lack of it."[321] In *Ghost Species*, the Foundation's work on Neanderthal de-extinction is an attempt at using biotechnology as a means of "grasping for greater control" in the face of environmental

[318] Bradley, *Ghost Species*, 111.
[319] Bradley, *Ghost Species*, 20.
[320] Radin and Kowal, "Introduction," 9. Emphasis added.
[321] Wrigley, "Ice and Ivory," 796.

catastrophes, which provides a way for them to justify their project, despite their complete lack of interest in the individual that their project creates.

Indeed, despite Davis' professed desire to learn from nonhuman perspectives, his plans for how to achieve this goal ironically seem to rely on the anthropocentric assumption that humans can continue to control the natural world using technology. Before beginning the Neanderthal project, Davis explains to Kate that "[t]he question now isn't how to save what we had, it's how we make something new."[322] Making "something new," for Davis, is all about technology: "[w]e have to accept that the old binaries, nature and technology, the human and the environmental, no longer makes sense, that it's up to us to re-engineer the world."[323] Davis' belief in his ability to draw on both nature and technology to "re-engineer the world" is reminiscent of Colossal's claims that they have discovered the "biological technology to it all," which uniquely positions them to address environmental crises. Like Wrigley's argument that woolly mammoth de-extinction "crystallizes around the point at which the planet is no longer providing the optimal conditions for human survival and the potential for human technologies to bend those conditions to suit us once more,"[324] *Ghost Species* explores de-extinction as a way to use technology to force nature "to suit us once more"—*not* by altering the conditions that led to the environmental crisis, but rather by "re-engineer[ing] the world." Kate eventually realizes that Davis' plan "fails to see their solution is part of the problem, a misplaced belief that this is another problem they can manage, engineer, control."[325] Rather than learning from the nonhuman world, Davis' plan engages much more with *transhumanist* dreams about being able to use technology to control and enhance the world for the benefit of humans.

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[322] Bradley, *Ghost Species*, 14.
[323] Bradley, *Ghost Species*, 14.
[324] Wrigley, "Ice and Ivory," 798.
[325] Bradley, *Ghost Species*, 63-64.

This belief in humanity's ability to control the natural world appears across de-extinction narratives. When Kate eventually asks Jay his opinion on Davis' plan to "re-engineer" the natural environment, Jay simply responds, "[w]hen you have his kind of money almost anything is possible."[326] This echoes Dodgson's words in *Dominion*, when, after Biosyn's facilities are destroyed by a fire, he insists that they can continue their work since "I can get money. Money's cheap these days."[327] For both Davis and Dodgson, the limiting factor is not natural resources, or scientific capacity, or ethical considerations, but simply the funding to make it happen: they both believe that with enough financial resources, they *can* engineer the world to suit their visions. While Rose is referring to biomedical innovations when he argues that "biology has become imbued with dreams of technological reformation,"[328] in de-extinction projects, biomedical *and* environmental concerns converge in visions of using biotechnology to re-engineer the world to suit human desires. This can be seen as another instantiation of transhuman beliefs: as Vint notes, rather than disrupting the binaries that have shaped the world, transhumanism "fuel[s] twenty-first-century fantasies of a privileged elite, invested in visions of immortality through technology, *escaping a dying Earth* in virtual bodies or by colonizing Mars, sometimes imagined as achieved in part by optimizing human bodies for extraplanetary life."[329] Rather than "escaping a dying Earth in virtual bodies," though, in *Ghost Species* the transhumanist dream of immortality is manifested in the characters' desire to use biotechnology to reinvigorate the earth so that it can better support humanity's continued existence, *without* making meaningful changes to the way that humans interact with the surrounding world.[330]

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[326] Bradley, *Ghost Species*, 22.
[327] *Dominion*, 2:07:50-2:07:55.
[328] Rose, *Politics of Life Itself*, 51.
[329] Sherryl Vint, "Speculative Fiction" in *After the Human*, ed. Sherryl Vint (Cambridge: Cambridge University Press, 2020), 225-226. Emphasis added.
[330] Schuster similarly calls attention to this dynamic in transhumanist de-extinction discourse, where he notes that "[t]he desire to live an enhanced transhuman life that persists into deep-time futures is not the same as the concern for sustaining the deep-time of Earthly ecologies," since "the motive to maximize life continues to

As Eve grows from a child into a teenager, there is even less interest in her from a scientific perspective, and none at all from the perspective of learning from another living being how to better coexist with the rest of the world. Despite this, Eve recognizes the problems that humans had been inflicting on the world are due to an innate part of human nature. Eve thinks about how

> She has read enough to know this violence is part of what makes her mother's species what they are, that it is part of what happened to her own. The desire to dominate, to kill, to give in to their most primal urges infects human society, disfiguring it at every level. Even the fires she can smell, the disruption of the forest can be seen as an expression of that same violence, enacted on a planetary scale.[331]

By connecting both extinctions and the impacts of climate change like forest fires with human domination and violence towards other species, Eve calls attention to the problems inherent in a de-extinction project that merely relies on other species, rather than on humans themselves to change their behaviour. Indeed, this perspective is reinforced when it is eventually revealed that the de-extinction efforts have actually started having the opposite effect: "Davis's efforts seem to be making things worse rather than better […] If anything, rates of mortality have risen."[332] The continuing lack of care for the environment, combined with the abandonment of the Neanderthal de-extinction project, shows that human society in *Ghost Species* was never going to be able to move beyond the anthropocentric biases that shaped their technological and scientific projects.

The Foundation eventually abandons the Neanderthal project completely without any discussion of the impact this will have on Eve. Rather than seeing Eve as a person with thoughts, feelings, and agency, Davis does not seem to think about her at all: Eve is nothing more than another derailed project to him. Davis' final mention in the novel is when he has abandoned the Foundation

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draw from the technologies and discourses of de-extinction, yet shifts the purposes for such work further away from the concerns of how to find a way to share the planet ecologically with diverse life forms." Schuster, "What is De-Extinction?," 209.

[331] Bradley, *Ghost Species*, 196.

[332] Bradley, *Ghost Species*, 169.

entirely and "relocated to a safehouse in New Zealand," leaving the rest of the Foundation "overwhelmed" as environmental conditions rapidly intensify and "disasters proliferate."[333] Eventually, Jay and the rest of the Foundation staff give up on the project as environmental conditions spiral out of control. Eve feels a sense that "everything is gathering momentum, slipping downhill,"[334] and after Kate's death, this downhill spiral culminates in the complete breakdown of human systems. Within a few weeks, Eve wakes suddenly during the night to realize that something has changed: "[t]hrough the window the lights by the road have gone out. There is an audible click, and the house falls silent, the fridge spinning down. And just like that the world is over."[335] Davis' de-extinction project failed to stop the impending crisis, and human society has been pitched into chaos on a global scale. Davis' Neanderthal de-extinction project shows the arrogance and lack of foresight in humanity's attempts to use technology to reassert control over the natural world. While in *Dominion*, biotechnology does end up being the solution to the problem posed by the transgenic locusts, *Ghost Species* implies that biotechnologies that are developed to address anthropogenic environmental crises will always reinforce the same anthropocentric biases.

1.8 "Not even a real person anyway": Defining the "Human" Across De-Extinction Narratives

As this analysis shows, the *Jurassic World* trilogy, *The Neanderthal's Aunt*, and *Ghost Species* each explore the separation between the humans who benefit from biomedical research, and the liminal, "nonhuman" characters who are treated as sources of biovalue. Maisie, Svea, and Eve are all created in scientific research laboratories, and each of the characters are framed as nonhuman due

[333] Bradley, *Ghost Species*, 212.
[334] Bradley, *Ghost Species*, 224.
[335] Bradley, *Ghost Species*, 228-229.

to both their biotechnological origins (which frame them as "unnatural" or "artificial" beings) and their perceived closeness to nonhuman animals and the environment (which in contrast frames them as being "natural" or "animalistic"). How can these fictional depictions of liminal beings allow us to reflect on real-world de-extinction projects? And can these characters provide an opportunity to reflect on the possible results of commodifying de-extinction technologies? To return to Vint's discussion of epivitality, she argues that "[t]he integration of governance and biotechnology under conditions of biocapital is central to how 'the human' is put under pressure in the context of epivitality," with the result that this pressure being exerted on "the human" is "prompting us to rethink personhood anew."[336] Vint's argument that we must "rethink personhood anew" in the context of new biotechnologies, like Squier's argument that biomedical developments are resulting in a new "biomedical personhood," provides an important starting point for considering the depictions of how de-extinction technologies like cloning and genetic engineering can impact human identity. Another useful means for thinking through these depictions of de-extinction is Barbara Creed's concept of the "the anthropogenic stray."[337] As Creed argues, the Anthropocene has resulted in significant changes for both humans and nonhuman animals, and consequently, "the concept of the stray as an outsider, a homeless creature, has shifted in its meaning as the traditional notion of what constitutes 'home' is radically undermined."[338] As a variation of Creed's "anthropogenic stray," Maisie, Svea, and Eve are "biotechnological strays"[339] created through de-extinction, who, due to their liminal identity as clones or genetically engineered beings, are displaced and treated as "outsiders." By exploring the depiction of these liminal characters, we can better understand how de-extinction narratives engage with

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[336] Vint, *Biopolitical Futures*, 14.
[337] Barbara Creed, *Stray: Human-Animal Ethics in the Anthropocene* (Power Publications, 2017). 167.
[338] Creed, *Stray*, 167.
[339] See the Introduction of this dissertation for a discussion of the term "biotechnological stray" in the context of de-extinction science.

concerns about how personhood will be defined in a future where biotechnological interventions are increasingly common.

In *The Neanderthal's Aunt*, Svea is depicted as liminal in multiple ways: she exists in between life/death, nature/technology, and human/animal. These binaries become a significant focus throughout the novel as characters grapple with how Svea should be treated. Indeed, the question of whether a Neanderthal baby would be considered a human or an animal—and what this means for Svea's future—is continually raised. While Liz plans to adopt Svea and raise her as a member of her family, Svea is still frequently aligned more with animals than with humans. For example, unlike Eve in *Ghost Species*, Svea is carried by a chimpanzee surrogate rather than a human. And as the characters navigate the uncertainty about Neanderthal identity, many of them ascribe Neanderthals with a "naturalness" that humans lack. Early in the project, Sara reflects on how "I've seen an abstract idea floating around that the Neanderthals were somehow more in-tune with their environment and the animal kingdom,"[340] a sentiment which is later expressed at the Neanderthal baby shower when one of the "Ladies Who Lunch" declares that Neanderthal children might be more sensitive to chemicals, since "Neanderthals are just *so much more natural*, you know."[341] This ironic commentary shows that, for the *Homo sapiens* characters, Svea's liminality creates a sense of discomfort, and as de-extinction blurs "technology" and "nature," they choose to think of Svea as a more *natural* being to avoid reflecting on the interventions into the body made possible by de-extinction technologies.

The separation of "animal" and "human" is particularly significant in *The Neanderthal's Aunt*. As Nayar argues, this separation "has been naturalized through centuries of representations which in turn have naturalized particular kinds of exploitative material interactions of human and

[340] DeMarco, *Neanderthal's Aunt*, 54.
[341] DeMarco, *Neanderthal's Aunt*, 65. Emphasis added.

animal."[342] These "exploitative material interactions" can be seen in *The Neanderthal's Aunt*, as Svea's uncertain status as human or animal is used to justify her treatment as a designer product. When someone breaks into Barlas Labs and kidnaps Linda with the hopes of ransoming the pregnant chimpanzee back for four million dollars (which, oddly, is the same value that Mills estimates per dinosaur in *Fallen Kingdom*), he justifies his actions by insisting to Theo and Sara that "[i]t's not kidnapping! […] I'm stealing an animal."[343] While Theo warns the kidnapper that if anything happens to Svea he would be convicted of murder, the kidnapper simply responds that "[m]urder of an animal ain't murder."[344] Choosing to view Svea as a nonhuman animal, then, makes it possible for the kidnapper to think about her as a product rather than a person: the kidnapper's crimes are "theft" rather than kidnapping, and—while he does not explicitly articulate this—it would appear that from this perspective, any harm to Svea is property damage rather than murder. Like Kate had worried in *Ghost Species*, then, Neanderthals are not granted the same rights as *Homo sapiens.* Instead, viewing Svea as an animal makes it possible to circumvent any legal protections for her.

While Liz engages with the rhetorical positioning of Neanderthals as "natural" and insists that Linda—the chimpanzee surrogate mother—undergo a "natural" pregnancy, the Neanderthal baby is simultaneously seen as "unnatural" because of her creation in a lab. When Sara learns the plan for Linda to undergo a "natural" birth, she is amused by the absurdity of the situation, as "[t]he oddness of it rushed over me. A natural pregnancy: that boat had sailed long ago. Thirty-thousand years ago."[345] For Sara, the birth in a laboratory of a cloned and genetically modified Neanderthal child from a chimpanzee surrogate mother is inherently *unnatural*. As Nayar describes, "unnatural births"

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[342] Nayar, *Posthumanism*, 97.
[343] DeMarco, *Neanderthal's Aunt*, 150.
[344] DeMarco, *Neanderthal's Aunt*, 150.
[345] DeMarco, *Neanderthal's Aunt*, 179.

have long been used as a way to distinguish between "human" and "nonhuman," since "'[u]nnatural births' signify the monstrous, and creatures such as Victor Frankenstein's invention, born inside a laboratory, would readily classify as monstrous due to the process of his birth."[346] There is a tension throughout *The Neanderthal's Aunt* between the Neanderthal child as a "natural" being who is more in tune with nature and represents an earlier state of life, and as a monstrous and "unnatural" being who is created using modern biotechnologies and destabilizes the future of both human and nonhuman existence.

In *Fallen Kingdom* and *Dominion*, similar questions arise about Maisie's biotechnological origins, and how her "unnatural" birth and identity as a clone impact her status as "human." Like Eve, Maisie is isolated from other people in order to protect her identity. After rescuing Maisie from Eli Mills in *Fallen Kingdom*, in *Dominion*, Claire and Owen take Maisie to a remote cabin to try to protect her from people who seek to capitalize on her genome. However, this isolation leads Maisie to feel dehumanized. When Claire, attempting to reassure Maisie, tells her that "it's ok for us to depend on each other. That's what people do,"[347] Maisie responds, "[h]ow would I know what people do? The only people I've spoken to in the last four years are you both. Besides, I'm *not even a real person anyway*."[348] Maisie's internal conflict stems not only from her lack of interaction with other people, but from her belief that her identity as a clone makes her less "human." While Maisie tries to navigate the complexities of being a clone, her distress is clear, and she tells Claire, "I was made from someone else. I'm not me."[349] Maisie's belief that she is "not a real person" comes down to her genetic identity. Vint describes how "[g]enetics threatens to be the most sinister example of the power

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[346] Nayar, *Posthumanism*, 86.
[347] *Dominion*, 20:10-20:14.
[348] *Dominion*, 20:15-20:25. Emphasis added.
[349] *Dominion*, 20:26-20:30.

of a discourse to produce its normalized subjects – both through its representations of what it is to have 'normal' genes and through its power to control the materialization of genetic combinations through selective abortion or IVF screening."[350] In the depiction of Maisie in the *Jurassic World* trilogy, we can certainly see this "sinister" side of genetic discourse, since even though Maisie *appears* human and does not share Svea's and Eve's Neanderthal DNA and physical, species-based differences, she still feels dehumanized because of her genetic identity.

Similar questions arise in *Ghost Species*. Throughout Eve's childhood, Kate finds herself constantly questioning Eve's development. Like Sara in *The Neanderthal's Aunt*, Kate fixates on the difference between Neanderthals and *Homo sapiens*; however, Kate is unable ever to come to a definitive conclusion about whether the developmental, social, and cognitive differences between Eve and other children are due to genetics, or simply Eve's lack of childhood socialization. Kate insists to the other Foundation staff that

> Eve is *not an experiment*, she is a conscious being, she deserves the right to find her own path, to be her own person. She deserves love, not just people hired to care for her. But more than that, she deserves to grow up on her own terms, unburdened by other people's expectations to discover what she is for herself.[351]

For Kate, Eve's status as human is directly connected with whether or not she is viewed as "an experiment."[352] Evidently, concerns over the binaries between natural and artificial are once again central to human identity. Similarly to how these anxieties had resulted in characters in *The Neanderthal's Aunt* treating Svea as a more "natural" or "animalistic" being than themselves, in

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[350] Sherryl Vint, *Bodies of Tomorrow*: *Technology, Subjectivity, Science Fiction,* University of Toronto Press, 2007, 63.
[351] Bradley, *Ghost Species*, 64. Emphasis added.
[352] In Katrin Althans' analysis of *Ghost Species*, she notes the gendered dynamic in the way that characters like Kate, Jay, and Davis relate to Eve, arguing that "Science is […] from the beginning characterized as diametrically opposed to nurturing, at least according to Hucken, who functions as the mad scientist-father prototype in the novel." Katrin Althans, "The NewClear Family in Times of the Anthropocene: The Nea-Human and Her Family in James Bradley's *Ghost Species*," *Gender Forum*, no. 81 (August 2021): 80–92. 82.

Ghost Species, Kate insists on separating Eve from her experimental origins, distancing the Neanderthal girl from biotechnology. Unlike in *The Neanderthal's Aunt*, though, where the animality of Svea is a justification for her exploitation, in *Ghost Species*, separating Eve from biotechnology is Kate's way of granting her personhood.

While Kate had hoped for Eve to discover "what she is for herself," it proves to be impossible for Eve's identity to not be influenced by other people, and Eve's understanding of herself is filtered through cultural expectations of what constitutes a "normal" human. When Eve eventually learns her identity as a Neanderthal, she too begins to question whether her behaviour and appearance are "human." Eve's understanding of herself is shaken: she "cannot make sense of it. What can it mean? Who is she? Is this why she feels so different? So alone?"[353] Eve watches films like *Frankenstein*, *Splice*, and *Blade Runner* in an attempt to find similarities between herself and other bioengineered beings. Rather than feeling a connection with any of these characters, however, Eve's feelings of isolation from human society are simply amplified. Eve notes that "[e]very time the story is the same: the thing created is monstrous but also tragic, its desire for life *a violation of the natural order*."[354] As this shows, even though Kate had sought to separate Eve from her experimental creation, Eve still considers herself as "a violation of the natural order." Like the way that Maisie had questioned her ability to relate to other people because of her identity as a clone, Eve's identity as a biotechnological creation shapes her ability to envision relationships with other people. Eve questions, "[i]s this why her mother and Jay keep her away from people, why they are so careful to control her movements, even at the facility? Would she be *shunned, tormented, driven out*?"[355] Because of these questions and Eve's uncertainty about where she falls between "natural" and "artificial," she is never able to be

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[353] Bradley, *Ghost Species*, 177.
[354] Bradley, *Ghost Species*, 178-179. Emphasis added.
[355] Bradley, *Ghost Species*, 178-179. Emphasis added.

fully comfortable in the presence of people aside from her small family circle. Like Maisie, then, Eve's sense of self is primarily influenced by her perception that she is less "human" because of her creation using biotechnology.

For each of these liminal figures—Maisie, Svea, and Eve—their identity is always constructed in relation to what it means to be "human." In Johnston's analysis of "human capital" in SF, he notes that "many of the characters in the novels I analyse are uncomfortably torqued: while their bodies are posthuman, they still find themselves competing for recognition of their human belonging."[356] This dynamic is certainly clear in these three de-extinction narratives: Maisie and Eve both struggle to view themselves both as "human" and a "person," and Sara navigates questions about humanity versus animality leading up to Svea's birth. Each of these characters, then, exist in this state of tension that Johnston describes, constantly striving for a sense of "human belonging" despite their biotechnological origins. To return to the idea of the stray, Creed argues that "[b]y exploring what it means to be a stray, we can see more clearly the essentially fragile nature of the borders we have constructed between the civilised and settled, and the jettisoned, abandoned creatures—both human and animal."[357] Identifying the constructed boundaries that create strays, Creed argues, can therefore elicit "questions about the ethical response to these 'others,' who all lack one thing: a place to belong, a sense of belonging and a sense of feeling cared for/or loved."[358] By depicting how liminal beings created through de-extinction projects might be perceived as being less "human" because of the constructed boundaries between human/nonhuman and natural/technological, the *Jurassic World* films, *The Neanderthal's Aunt*, and *Ghost Species* each respond to this need to consider the ethical implications of the creation of new beings through biotechnological experimentation.

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[356] Johnston, *Posthuman Capital*, 26.
[357] Creed, *Stray*, 10.
[358] Creed, *Stray*, 10.

1.9 Posthuman Perspectives and "decommodified futures" in De-Extinction Narratives

As this analysis of liminal figures in de-extinction narratives demonstrates, these narratives are often preoccupied with questions about the impact of biotechnological intervention on identity. The framing of Eve, Svea, and Maisie as "nonhuman" is used by various human characters as a justification for both their exploitation and commodification in the pursuit of benefits to human health, society, and the environment. This is an unsurprising dynamic, since, according to Waldby, "[a]natomy and other biomedical disciplines frequently rely on the bodies of the less valuable and those deemed less human to act as model technologies or experimental objects, useful for the preservation of the health of the more fully human."[359] As a response to our current biopolitical moment as one in which value is increasingly being ascribed to biological processes, Vint argues that "we need to reimagine personhood in posthuman terms as a way to form alliances and lifeways that offer *decommodified* futures."[360] Do any of these three narratives achieve a "decommodified future" beyond the exploitation of the liminal figures at the edges of de-extinction narratives?

In *The Neanderthal's Aunt*, despite the framing of Svea—and Neanderthals in general—as animalistic and inhuman, Sara eventually begins to see Svea as just as human as *Homo sapiens*. When Liz describes Svea as "a Neanderthal human," Sara responds that "[s]he's a human, Liz. There aren't different types of human. There aren't regular humans and Neanderthal humans. There are just humans."[361] While Sara herself oscillates on whether the Neanderthal baby would be a human, an

[359] Waldby, *The Visible Human Project*, 52.
[360] Vint, *Biopolitical Futures*, 7. Emphasis added.
[361] DeMarco, *Neanderthal's Aunt*, 189

animal, or something else entirely, part of what clarifies this categorical problem for Sara is when she considers what Svea's Neanderthal mother would have been like. Sara thinks, "I had no doubt the baby's mother would have loved her. She would have picked her up in her arms and fed her. She would have carried her around and protected her."[362] The love for a child is ultimately what outweighs Sara's concerns about comparisons between *Homo sapiens* and Neanderthals. After Svea's birth, Sara has an epiphany where she realizes that kinship can outweigh their differences:

> I didn't look for the differences. I didn't care. I was overwhelmed with feelings of love for this tiny child, to hold her, to protect her. I didn't notice the differences. I observed them. I remembered them: her high forehead, her broad nose, her thick hair, the peach fuzz on her face that was soft and light but still a little different from what most babies have. I can analyze them if I recall her picture in my mind's eye, but at the moment I didn't see them. I didn't think. I just experienced being in the presence of this infant. I was incapable of anything else.[363]

For Sara, the bond she immediately forms with Svea overrides questions about Svea's identity. Rather than being concerned with the physical differences she observes, Sara only feels love. Sara can finally definitively say that Svea "was not an experiment, or a hominid, or a prototype […] She was our baby."[364] Finally, then, Svea has becomes something more than a product, and the novel suggests that through kinship, there is a chance at a "decommodified future" for Neanderthals.

This moment of kinship, however, is brief. Despite showing the potential for moving beyond traditional categories of human identity (and the way that these exclusionary categories had allowed Neanderthal babies to ever be conceived of as "designer" products or biomedical test subjects), the novel ends with Svea's death. The brief reformulation of human/nonhuman boundaries has had no lasting impact or permanence since "the Neanderthal was once again extinct."[365] Indeed, since the

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[362] DeMarco, *Neanderthal's Aunt*, 186.
[363] DeMarco, *Neanderthal's Aunt*, 201.
[364] DeMarco, *Neanderthal's Aunt*, 218.
[365] DeMarco, *Neanderthal's Aunt*, 218.

family chooses to bury Svea in secret, there is no evidence of Svea's existence, and the public is ultimately "convinced that it had all been a hoax."[366] Interestingly, Svea's brief existence mirrors the de-extinction (and subsequent re-extinction) of the bucardo: while a cloned bucardo was born, the animal died within minutes of its birth, and as Searle explains,

> It was not only the first de-extinct animal but also the first to go extinct twice, subject to what we could call a *re-extinction*. It is the only example of a mammal whose cells have outlived its population, who is anabiotically entangled in the liminal geographies of de/extinction, distorted between the spaces of science and evolution.[367]

In *The Neanderthal's Aunt*, the Neanderthal, like the bucardo, becomes trapped in the space between de-extinction and re-extinction, and Svea remains in the "anabiotically entangled" state that Searle describes. Not only is there no trace of the Neanderthal baby, but the novel ends by affirming "human" futurity with another birth: in the epilogue, Theo has served his jail sentence for committing fraud just in time for the birth of his and Sara's (*Homo sapiens*) child. In *The Neanderthal's Aunt*, then, there is neither a "decommodified future" where *Homo sapiens* and Neanderthals coexist, nor a "commodified" future where Neanderthals are continually exploited as a source of biovalue. Rather, the novel relegates Neanderthals to existing only in an "anabiotic" state.

While *The Neanderthal's Aunt* ends with both Neanderthal re-extinction and a *Homo sapiens* birth that restores the balance between "human" and "nonhuman," in *Ghost Species*, the novel more promisingly ends by indicating that perhaps there is a world beyond the "human." As Katrin Althans argues, *Ghost Species* blends SF, climate fiction, and coming-of-age genre conventions to explore how the combination of biotechnological experimentation and climate issues impact Eve as she grows from a child to a teenager.[368] While Eve is never able to view herself as fully human, what it means to

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[366] DeMarco, *Neanderthal's Aunt*, 219.
[367] Searle, "Anabiosis," 333. Emphasis in original.
[368] Althans, "The NewClear Family," 81.

be "human" changes as society descends into an apocalyptic state caused by anthropogenic environmental destruction. And yet, life does not end; instead, Eve notes that the world is continuing to transform into a new way of being. She thinks, "[i]t is as if the entire planet is convulsing, slipping free of [humanity's] models, their fantasies of control."[369] Through this, Althans argues that the novel "ask[s] us to reconsider our understandings of the world as we know it."[370] Davis and his team had envisioned a world where human engineering and technology could be used to re-engineer the environment, and beings like Neanderthals would be designed and created specifically to reconnect humans with the natural world. Instead, the answer had been in throwing off human control entirely.

Indeed, while the original team working on Neanderthal de-extinction had fragmented—Kate had died, Jay had left Australia, and Davis had fled into a bunker—Eve's storyline does not end there. Instead, the novel explores how the world could continue in spite of the escalating anthropogenic environmental crises. The result, according to Althans, is that "[j]ust like Earth's development mirrors the different stages of the decline of homo sapiens, it also mirrors the coming of-age of the Nea-Human: rather than being fatally connected to our species, Earth is entering a new phase of its life, the post-Anthropocene."[371] After leaving Australia, Eve eventually finds other Neanderthals who had been created in another lab in France. When Eve finally meets the other Neanderthals, she is immediately and unquestioningly accepted by the Neanderthal woman, who, in the novel's final line, "steps forward and, grasping Eve's hand, pulls her close."[372] The Neanderthal woman's quiet acceptance of Eve signals the possibility of a new world, and a new form of "human"—or to use Althans' term, "Nea-Human"—existence beyond *Homo sapiens*.

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[369] Bradley, *Ghost Species*, 265.
[370] Althans, "The NewClear Family," 87.
[371] Althans, "The NewClear Family," 90.
[372] Bradley, *Ghost Species*, 269.

To return to Creed's anthropogenic stray ethics, she argues that "[i]t questions the humanist notion of the full subject and points to the possibility of new subjectivities that include the marginalised, the inhuman and the animal."[373] In *Ghost Species*, the depiction of Eve as a liminal figure who does not conform to anthropocentric expectations highlights that there can be "new subjectivities" beyond the human. Through the uncertain ending, *Ghost Species* shows that while de-extinction narratives do not need to end with an affirmation of humanity (as in *The Neanderthal's Aunt*), nor do they need to end with clear answers about what the future of species like Neanderthals might be. In contrast to the inescapability of Svea's anabiotic existence, the depiction of Eve as a liminal figure highlights her potential future agency: as Creed argues, "stray ethics reminds us that many (but not all) strays are both vulnerable and strong. Fragility does not mean a loss of resilience."[374] While to be liminal is a vulnerable state, it is, as Eve shows, also possible for liminality to be generative. In *Ghost Species*, then, a "decommodified future" for de-extinction is one that envisions ongoing liminality and resilience.

While *The Neanderthal's Aunt* ends with a return to an uncomplicated "human" identity, and *Ghost Species* ends with a potential future beyond the "human," the depiction of Maisie in the *Jurassic World* trilogy lies somewhere between the two. Despite Maisie's initial struggle to view herself as a "real person," her perspective shifts after she meets Henry. While in *Fallen Kingdom* Maisie had been told that she was cloned by her grandfather after her mother's death, in *Dominion*, Henry instead explains that it was Charlotte who chose to clone herself: "Charlotte was able to have a child all by herself. She created you with her own DNA."[375] This realization—that Maisie was created by someone who *chose* to clone themselves, rather than through the exploitation of a deceased

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[373] Creed, *Stray*, 100.
[374] Creed, *Stray*, 100.
[375] *Dominion*, 1:18:46-1:18:53.

woman's genetic material—completely reframes her perspective, and she realizes that "I do have a mother."[376] After Henry helps Maisie to escape from Biosyn, Maisie reunites with Claire and Owen, and the film ends with Maisie, Claire, and Owen back at their cabin, laughing and sharing marshmallows over a bonfire.

And yet, despite Maisie's integration into human society, Maisie still demonstrates the potential for kinship between the human and nonhuman world. In a significant moment in *Fallen Kingdom*, Maisie chooses to release the dinosaurs into the wild, rather than allowing them to die.[377] This action demonstrates Maisie's ability to *empathize* with the dinosaurs, rather than merely sympathizing with them as characters like Owen and Claire do, and this empathy is what allows for the potential of a post-anthropocentric future.[378] Like Eve, Maisie can therefore be viewed in terms of Creed's stray ethics, since "[s]traying is […] not always an act of separation, but it can potentially unite human and animal, particularly woman and animal, living at the fringes of society."[379] While Maisie does not ultimately leave human society, like Eve does, her liminal status allows her to connect with the dinosaurs in a way that other human characters do not. This connection between Maisie and the dinosaurs carries over into *Dominion*: as Pugh notes in her analysis of the film, the baby velociraptor, Beta, is intentionally aligned with Maisie.[380] As Pugh argues, by depicting kinship across the boundaries of human/dinosaur and nature/technology, the film "creat[es] an interwoven pseudo-family based on biology, technology and found families."[381]

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[376] *Dominion*, 1:18:55-1:18:57. The connection between family and "human" identity has been explored across SF novels and films. For a discussion of how this dynamic is explored in a young adult novel about xenotransplantation, see Chapter 5.
[377] *Fallen Kingdom*, 1:52:47-1:52:52.
[378] Sanderson, "Listening to Nonhuman Animals," 105.
[379] Creed, *Stray,* 9.
[380] Pugh, "Swallow You Whole," 92.
[381] Pugh, "Swallow You Whole," 92.

Maisie's earlier decision to free the dinosaurs has lasting consequences for the world, and *Dominion* concludes with a stark reminder in the form of a videoclip of Charlotte before her death, saying, "[w]e're part of a fragile system made up of all living things. If we're going to survive, we'll have to trust each other, depend on each other. Coexist."[382] Pugh argues that this ending suggests "that humankind and Nature exist in balance and, therefore, unexpected disruptions (such as the rewilding of dinosaurs) can be accepted and even adapted into a harmonious dynamic."[383] While Maisie, unlike Eve, is finally able to view herself as fully "human" and returns home with her family (no longer either liminal or a stray), the film still concludes with the possibility of ongoing human/dinosaur kinship, as well as a reminder that humans must learn to "coexist" with other life forms in order to avoid further environmental and ecological destruction.[384] In the *Jurassic* franchise, then, a "decommodified future" of de-extinction is not like that in *Ghost Species*, where human society collapses, making way for liminal figures to exist beyond human/nonhuman distinctions, but rather one where species boundaries remain intact while humans and animals coexist.[385]

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[382] *Dominion*, 2:29:00-2:29:16.
[383] Pugh, "Swallow You Whole," 98.
[384] Interestingly, *Jurassic World Rebirth* undermines this ending by showing a world where dinosaurs have largely gone re-extinct, aside from a limited number of dinosaurs that are still surviving in captivity or living in remote environments. In *Rebirth*, co-existence and interspecies kinship no longer appear to be a priority.
[385] For another recent analysis of the *Jurassic* franchise in the context of Colossal's de-extinction work, see jessie l. beier, "De-Extinction," in *The Routledge Companion to Gender and Animals* (Routledge, 2024). In beier's chapter, she analyzes Colossal's discourse and the idea of genetics as data. Additionally, beier draws on queer theory to analyze the *Jurassic* films' depiction of "reproductive futurism," arguing that "*Jurassic Park*'s cloning narrative foretells a future that is increasingly characterized by a range of queer progeny who may not even be human, much less our biological offspring." 721. While I focus primarily on the biomedical rhetoric of de-extinction (in contrast to beier's focus on data and information), beier's analysis and my own align in several key ways. For example, like beier, I note that *Dominion* concludes with a reinstatement of human identity while also still gesturing at a potential post-anthropocentric future beyond commodification. As beier similarly argues, "the question is not how to 'fix' the future but how to practice modes of collaborative survival that involve living with, and not in spite of, the ecological ruination and queer progeny that increasingly characterize life in an era of mass extinction." 722. Notably, *The Neanderthal's Aunt* goes even further than *Dominion* to reinforce human identity and futurity in the face of de-extinction science, and beier's discussion thus provides an insightful angle to consider the depiction not just of *Jurassic*'s Maisie, but also of *The Neanderthal's Aunt*'s Svea.

While the depictions of each of these liminal figures engage with posthumanist concerns about recognizing that identity, agency, and kinship extend beyond traditional "human" categories, *Ghost Species* takes this exploration further than either of the other two depictions. Unlike Maisie, who ultimately sees herself as human and reunites with her adoptive parents, and Svea, whose death marks the re-extinction of Neanderthals, the depiction of Eve allows for the possibility of a future beyond humanity. Eve, like Maisie, initially measures herself against "human" identity, and both characters feel inadequate due to their genetic makeup. However, Maisie is much closer to "human" than Eve: as a human clone, Maisie is easily able to integrate into human society and is able to choose to see herself as "human," while Eve is both physically and behaviourally distinct from *Homo sapiens* and is never at ease among other people. Beyond their ability to integrate into "human" society, the impact of the three characters on society also differs. Svea, both through her death and through the lack of evidence that she had ever existed, does not have a lasting impact on the society depicted in *The Neanderthal's Aunt*. Maisie, on the other hand, is able to show agency by choosing to allow her DNA to be used to address the transgenic locust invasion, leading to an end to Biosyn's Hexapod Allies project. While the story ends with humans having to learn to co-exist with their biotechnological creations, there is still to some extent the ability to control these creatures by using biotechnology. Eve, meanwhile, never fulfils her intended purpose of reversing anthropogenic climate change. Instead, Eve's story ends with her abandoning the few remaining people she knows, and what happens next—whether Eve forms a new community with the other Neanderthals, whether they can survive in an increasingly unstable climate, whether they will eventually repeat the mistakes of *Homo sapiens*—is left unanswered, but what is not disputable is that *Ghost Species* ends with a radical shift in the hierarchy of humans over other forms of life.

1.10 Conclusion

Across these narratives, we can see three very different visions of what de-extinction could mean. Significantly, while the potential for ecological restoration is the justification at the heart of most real-world de-extinction projects, that goal is not achieved in any of these three narratives. Instead, the stories focus much more closely on the bioethical (and cryopolitical) implications of de-extinction projects. Rather than exploring de-extinction as an environmental initiative, these narratives focus on the biomedical applications of these projects, and ask how these projects are emerging as another instantiation of the 21st century bioeconomy. By exploring the commodification of the bodies of liminal figures created using de-extinction technologies, these narratives also ask us to reconsider "human" and "nonhuman" identity, and how what it means to be human is changing in response to new biotechnologies.

While the goal of this investigation into de-extinction has been to trace its representations both in terms of the biomedical discourse surrounding real-world projects *and* in terms of the fictional portrayal, ending with an analysis of these three narratives allows us to take the bioethical concerns arising from de-extinction further. As Vint argues, narratives are a powerful way to consider the far-reaching implications of new technologies, since they "often enable us to see how otherwise neutral or even beneficial technologies may have undesirable consequences if issues of equity are not addressed in how they are implemented."[386] While the ecological impacts of de-extinction are yet to be seen, these projects continue to gain traction as a new form of conservation biology. Because of this, we must consider the potential consequences of these projects, and in particular, how they will alter our relationships with the environment, with nonhuman animals, and with ourselves.

[386] Vint, *Biopolitical Futures*, 8.

While de-extinction continues to develop, these fictional depictions can allow us to think through the consequences that could arise from these projects while also considering *other* futures beyond environmental destruction and commodification. It remains to be seen whether de-extinction will ever be able to address the ongoing damage that has been inflicted on the environment or if it will lead to the worlds envisioned by the *Jurassic World* trilogy, *The Neanderthal's Aunt*, and *Ghost Species*, where de-extinction projects become either a means of capitalizing on new biomedical and pharmaceutical products, a fad that momentarily captures public attention, or simply a distraction from anthropogenic environmental destruction. Perhaps, then, by bringing a posthuman perspective to de-extinction, we will be better prepared to respond to this rapidly developing area of biotechnology.

Part II: Repurposing Organs

Chapter 2: Repurposing Organs I: Investigating the Ethics of Experimental Medicine through Xenotransplantation Narratives

2.1 Introduction

Xenotransplantation is an experimental medical procedure that is rapidly becoming a critical area for bioethical inquiry. Because of recent advancements in biotechnologies like CRISPR-Cas9 gene editing, proponents of xenotransplantation believe that organs from genetically modified pigs will be able to be used for human patients, with the goal being to reduce (or eliminate) the increasingly long waitlists for human organs.[387] Medical doctors and researchers are optimistic about the future of xenotransplantation: in an April 2023 TEDx Talk by Dr. Andrew Cameron, the Surgeon-in-Chief at the Johns Hopkins School of Medicine, Cameron notes that FDA approval for clinical trials could be only two years away, and that "[t]he future is getting close."[388] As it turns out, Cameron was not wrong: as of 2025, trials for genetically modified pig kidney transplants have been approved for both eGenesis and United Therapeutics.[389] In a recent *National Geographic* cover story titled "This Pig Could Save Your Life," science journalist Matthew Schaer discusses eGenesis' work, and writes that these new developments in xenotransplantation represent "the forefront of a *major revolution* in the science of organ transplantation—a revolution that will have implications for the

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[387] *Xenotransplantation: Past, Present, Future | Andrew Cameron | TEDxJHU*, 2023, https://www.youtube.com/watch?v=bHG5OlTnH38.
[388] *Xenotransplantation: Past, Present, Future*, 15:35-15:37.
[389] Matthew Schaer, "This Pig Could Save Your Life," *National Geographic*, May 1, 2025, https://www.nationalgeographic.com/science/article/pig-organ-transplant-xenotransplantation. United Therapeutics, "United Therapeutics Corporation Announces FDA Clearance of Its Investigational New Drug Application for the UKidney Xenotransplantation Clinical Trial," Press Release, accessed June 25, 2025, https://ir.unither.com/press-releases/2025/02-03-2025-120011819.

global human donor shortage and the thousands of sick patients who wait every year for a new kidney."[390]

If xenotransplantation is "a major revolution" and "the future" of transplant medicine, it is essential that we consider its potential bioethical implications, and how the procedure will impact patients. Cameron ends his TEDx Talk by raising this very concern, asking, "[j]ust because we can do it, should we do it? […] What are the ethics of putting a pig organ in someone? If it were my sister or my daughter, would I want her to be the first to have a pig organ?"[391] These questions—not just whether we should proceed with xenotransplantation, but also whether we would want our own loved ones to be among the first to undergo a new experimental medical procedure—are critical. Cameron concludes that science and ethics must be considered in tandem to ensure that the implications of the procedure will be fully understood. And while bioethicists and medical experts have discussed a range of bioethical dimensions, the cultural narratives forming around xenotransplantation are also an essential component of how these procedures are understood, since these narratives can call attention to bioethical issues and shape public perceptions of the experimental medical procedure.

In this chapter, I investigate narratives about xenotransplantation to better understand the "biomedical imaginary" around the procedure. As Catharine Waldby argues, "[t]he biomedical imaginary refers to the speculative, propositional fabric of medical thought, the generally disavowed dream work performed by biomedical theory and innovation."[392] The companies promoting xenotransplantation, medical practitioners supporting their patients through the surgeries, media coverage of these early procedures, the way that patients themselves describe their participation in the

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[390] Schaer, "This Pig Could Save Your Life." Emphasis added.
[391] *Xenotransplantation: Past, Present, Future*, 16:25-16:45.
[392] Catherine Waldby, *The Visible Human Project: Informatic Bodies and Posthuman Medicine* (Routledge, 2000). 136

experimental medical procedure, and fictional depictions of xenotransplantation across genres are all part of the "propositional fabric of medical thought" that Waldby describes.

Interestingly, some of the most prominent figures in xenotransplantation have acknowledged how the biomedical imaginary—and specifically *fiction*—shapes public understanding and acceptance of new biomedical procedures. For example, in Cameron's TEDx Talk, he describes surgical developments in the field of xenotransplantation, telling the audience that "if this seems again too far-fetched, too much like *science fiction* […] I can tell you, it's real. It's all real."[393] Similarly, in a 2022 article published in *The Guardian*, author Malorie Blackman reflects on her novel *Pig-Heart Boy* (1997), which depicts a boy undergoing a pig heart transplant, and considers it in the context of the recent developments in xenotransplantation. Blackman notes that "[w]hat some call science fiction, I prefer to call *science possible* or sometimes science probable."[394] Despite their different perspectives on xenotransplantation, as both Blackman's and Cameron's references to the overlap between *science fiction* and *scientific reality* demonstrate, the biotechnological developments that have driven progress in xenotransplantation are occurring at such a pace that science fiction might be the public's primary framework for understanding and navigating the experimental medical procedure.

In this chapter, I respond to the need for interdisciplinary perspectives on the future of xenotransplantation by analyzing how the procedure—and its potential bioethical implications—has been envisioned in fiction and communicated in the media. In my analysis, I investigate fictional depictions of pig organ transplantation in Blackman's British speculative young adult (YA) novel

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[393] *Xenotransplantation: Past, Present, Future*, 11:35-11:58. Emphasis added.
[394] Malorie Blackman, "Malorie Blackman on Seeing Her Sci-Fi Novel about a Pig Heart Transplant Come True," *The Guardian*, January 25, 2022, sec. Books, https://www.theguardian.com/books/2022/jan/25/malorie-blackman-on-seeing-her-sci-fi-novel-about-a-pig-heart-transplant-come-true. Emphasis added.

Pig-Heart Boy (1997) and in the Canadian satirical short film *We Ate the Children Last* (2011), alongside the media coverage of recent surgeries as well as the biotechnological and pharmaceutical industry rhetoric around xenotransplantation. Across these depictions, concerns about the bioethical dimensions of xenotransplantation are raised, particularly issues related to the treatment and experience of *patients*, such as vulnerability, exploitation, and discrimination, and issues related to the risks posed to the *public*, such as disease transmission. As my analysis demonstrates, while companies and researchers currently working on xenotransplantation frame it in techno-optimistic terms, fiction can raise important concerns about the impacts that xenotransplantation will have on the patients themselves, as well as the potential for more widespread societal implications. And while these fictional depictions of xenotransplantation explore the potential for patients to experience exploitation and discrimination, resulting in complex feelings about their bodily identity, balancing these narratives with the experiences of real patients, their families, and their medical teams shows that xenotransplantation is also seen as a way for patients to regain autonomy and agency by making decisions about their health and contributing to medical science. Ultimately, this analysis demonstrates that the cultural responses to xenotransplantation can help us to navigate the complex bioethical concerns around this developing experimental medical procedure, and better prepare for the future of medicine that proponents of xenotransplantation envision.

2.2 Xenotransplantation: Fact and Fiction

To begin my analysis, it is important to establish a brief history of xenotransplantation. While xenotransplantation might primarily be associated with 21st-century biomedical advancements, attempts to repurpose organs and biological material from nonhuman animals have been made for hundreds of years. As Paul Craddock outlines in *Spare Parts: The Story of Medicine Through the History of Transplant Surgery*, nonhuman animals such as dogs, sheep, goats, and cows have long

been involved in transplant medicine, starting with blood transfusions in the early seventeenth century.[395] David C.K. Cooper et al. outline subsequent attempts at transplanting biological materials from nonhuman animals, including skin and corneas in the nineteenth century, as well as islet cells, kidneys, and livers in the latter half of the twentieth century.[396] While pig and cow heart valves are now used in heart surgery,[397] transplanting hearts from nonhuman animals into human patients is significantly more challenging. Several attempts were made during the 20th century to transplant primate hearts into human patients, but the patients either did not survive the surgery, or later died due to organ rejection.[398]

Despite these unsuccessful early attempts at using nonhuman animal hearts, there has recently been renewed interest in xenotransplantation, particularly the use of pig kidneys and pig hearts. Multiple companies worldwide are currently working to develop pig organs and islet cells that can be safely used in medicine, including eGenesis, Makana Therapeutics, Revivicor Inc. (subsidiary of United Therapeutics), Qihan Biotech, Diatranz Otsuka Ltd., and NZeno. Each of these companies is taking a unique approach to developing products that can be used in xenotransplantation: for example, Qihan Biotech has worked on developing "Pig 3.0," a pig which has been genetically modified to eliminate porcine endogenous retroviruses,[399] while Revivicor Inc.'s GalSafe pigs are genetically modified so that they do not contain the alpha-gal sugar that can cause immune reactions in

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[395] Paul Craddock, *Spare Parts: The Story of Medicine Through the History of Transplant Surgery* (St. Martin's Press, 2021).
[396] David K. C. Cooper, Burcin Ekser, and A. Joseph Tector, "A Brief History of Clinical Xenotransplantation," *International Journal of Surgery*, Special Issue: Xenotransplantation, 23 (November 1, 2015): 205–10, https://doi.org/10.1016/j.ijsu.2015.06.060.
[397] Mayo Clinic, "Heart Valve Surgery," n.d., https://www.mayoclinic.org/tests-procedures/heart-valve-surgery/about/pac-20384901.
[398] Chesney Siems et al., "A Brief History of Xenotransplantation," *The Annals of Thoracic Surgery* 113, no. 3 (March 1, 2022): 706–10, https://doi.org/10.1016/j.athoracsur.2022.01.005. Cooper et al., "A Brief History of Clinical Xenotransplantation."
[399] Qihan Biotech, "Qihan Biotech Publishes First Clinical Xenotransplantation Prototype, 'Pig 3.0', in Nature Biomedical Engineering," Press Release, September 2020, https://www.qihanbio.com/press/8.

humans.[400] In a major development in 2020, the FDA granted approval for the therapeutic use of GalSafe pigs.[401] Since then, several experimental surgeries have taken place in the United States, including two pig heart transplants in 2022 and 2023 (David Bennett Sr.[402] and Lawrence Faucette[403]) and three pig kidney transplants in 2024 (Richard Slayman,[404] Lisa Pisano,[405] and Towana Looney[406]). While xenotransplantation had not yet been approved for human trials when these patients were offered pig organs, these surgeries were approved by the FDA on a "compassionate" basis.[407] Most of these patients only survived for several weeks to several months following their surgeries. Towana Looney is an exception to this: while her pig kidney was removed in early 2025 and she is now on dialysis, her experience "set a new record for a pig organ in a human."[408]

These early procedures have resulted in renewed interest in the possibilities of xenotransplantation. In *National Geographic*, Schaer notes that after these early procedures,

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[400] FDA, "FDA Approves First-of-Its-Kind Intentional Genomic Alteration in Line of Domestic Pigs for Both Human Food, Potential Therapeutic Uses," FDA, December 14, 2020, https://www.fda.gov/news-events/press-announcements/fda-approves-first-its-kind-intentional-genomic-alteration-line-domestic-pigs-both-human-food.
[401] FDA, "FDA Approves First-of-Its-Kind Intentional Genomic."
[402] Deborah Kotz, "IN MEMORIAM: David Bennett, Sr.," University of Maryland School of Medicine, March 9, 2022, https://www.medschool.umaryland.edu/news/2022/in-memoriam-david-bennett-sr.html.
[403] Deborah Kotz, "In Memoriam: Lawrence Faucette," University of Maryland School of Medicine, October 31, 2023, https://www.medschool.umaryland.edu/news/2023/in-memoriam-lawrence-faucette.html.
[404] Massachusetts General Hospital, "World's First Genetically-Edited Pig Kidney Transplant into Living Recipient Performed at Massachusetts General Hospital," March 21, 2024, https://www.massgeneral.org/news/press-release/worlds-first-genetically-edited-pig-kidney-transplant-into-living-recipient.
[405] *NYU Langone News*, "First-Ever Combined Heart Pump & Gene-Edited Pig Kidney Transplant Gives New Hope to Patient with Terminal Illness," April 24, 2024, https://nyulangone.org/news/first-ever-combined-heart-pump-gene-edited-pig-kidney-transplant-gives-new-hope-patient-terminal-illness.
[406] Jon Cohen, "Longest Human Transplant of Pig Kidney Fails," *Science*, April 11, 2025, https://www.science.org/content/article/longest-human-transplant-pig-kidney-fails.
[407] Tanya Lewis, "Milestone Pig-to-Human Heart Transplant May Pave the Way for Broader Trial," *Scientific American*, October 18, 2023, https://www.scientificamerican.com/article/milestone-pig-to-human-heart-transplant-may-pave-the-way-for-broader-trial/. Will Sullivan, "Second Patient Receives Gene-Edited Pig Kidney Transplant in Breakthrough Surgery," *Smithsonian Magazine*, April 26, 2024, https://www.smithsonianmag.com/smart-news/second-patient-receives-gene-edited-pig-kidney-transplant-in-breakthrough-surgery-180984230/. Cohen, "Longest Human Transplant of Pig Kidney Fails."
[408] Cohen, "Longest Human Transplant of Pig Kidney Fails."

> eGenesis and United Therapeutics, along with hospitals around the country, fielded a torrent of inquiries from patients who had spent years on a list for a human donor kidney. It didn't matter that FDA regulators were still only authorizing expanded access trials. News of the transplants had *opened the floodgates*.[409]

In 2025, clinical trials of pig organ transplants began to take place. The most recently announced patient, Tim Andrews, received a pig kidney in January 2025 as part of a trial with eGenesis.[410] United Therapeutics is also working on clinical trials of their genetically modified "UKidney," and up to 50 patients could undergo pig kidney transplants.[411] As science writer Tanya Lewis explains in a *Scientific American* article about United Therapeutics, these trials represent an important step, since they "would allow a broader and healthier range of individuals to be enrolled to better assess xenotransplant feasibility in a wider population."[412] As Lewis notes, this is an important difference, since "most of the people who have received a xenotransplant on a compassionate use basis have been severely ill, making it harder to assess the success of the transplant itself."[413] With these recent developments "open[ing] the floodgates" and resulting in renewed medical and public interest in xenotransplantation, it is increasingly important to consider how xenotransplantation is being represented to public audiences.

Alongside these real-world developments, xenotransplantation has been depicted across a variety of literary genres, including medical thrillers, speculative fiction (SF), and YA literature. Particularly relevant to my analysis is Blackman's novel *Pig-Heart Boy*. The novel explores xenotransplantation from the perspective of a thirteen-year-old boy with heart disease who undergoes

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[409] Schaer, "This Pig Could Save Your Life." Emphasis added.
[410] Schaer, "This Pig Could Save Your Life."
[411] United Therapeutics, "United Therapeutics Corporation Announces FDA Clearance of Its Investigational New Drug Application for the UKidney Xenotransplantation Clinical Trial," Press Release, accessed June 25, 2025, https://ir.unither.com/press-releases/2025/02-03-2025-120011819.
[412] Tanya Lewis, "Animal-to-Human Organ Transplants Hit Long-Awaited Testing Milestone," *Scientific American*, February 13, 2025, https://www.scientificamerican.com/article/pig-to-human-organ-transplants-will-finally-begin-clinical-trials-this-year/.
[413] Lewis, "Long-Awaited Testing Milestone."

a controversial new medical procedure: a pig heart transplant. The novel opens with Cameron Kelsey learning that his father had made an appointment with a xenotransplantation researcher and surgeon, Dr. Bryce, who offers to perform the first ever pig-heart transplant on Cameron. While Cameron's mother is initially horrified at the prospect of her son receiving a nonhuman heart, his parents allow him to decide for himself whether to undergo the procedure. For Cameron, the initial decision is easy: he chooses to seize his only remaining chance to survive. And yet, after undergoing the procedure, Cameron quickly realizes it was not nearly as simple as he'd first imagined. Cameron is bombarded by public attention, both positive and negative. While some of Cameron's classmates are in awe of his bravery and newfound fame, others are disgusted and afraid of him. And while newspapers offer Cameron's family huge sums of money for exclusive interviews with him, animal rights activists harass him and his family. When, just a few months after the surgery, Cameron's body begins to reject his new heart, he refuses to undergo a second pig-heart transplant due to the discrimination and social isolation he had faced. However, Cameron eventually changes his mind after his grandmother's death, and the novel ends with Cameron recording a video for his soon-to-be-born younger sibling, Alex, declaring that he does not regret his decision, especially if it means he will live long enough to meet Alex. Because of the novel's in-depth exploration of the experience of a xenograft recipient, including the impact of the procedure on Cameron's relationships with his friends and family members, it provides a platform for considering literature's ability to engage with the bioethical concerns about how xenograft recipients might be treated following their surgeries.

Like *Pig-Heart Boy*, *We Ate the Children Last* depicts the transplantation of pig organs into human patients. The short film, directed by Andrew Cividino and adapted from a short story by the same name written by Yann Martel, explores the societal impacts of the transplantation of pig

digestive tracts into human patients, starting with Patient D.[414] After his diagnosis with terminal stomach cancer, Patient D is the first to undergo the experimental medical procedure, and quickly recovers and returns to a (seemingly) normal life. And yet, despite Patient D's remarkable recovery, something *does* change: he discovers that he has developed a voracious appetite for rotten food and garbage. Even with this disturbing side effect, Patient D's surgery is viewed as a success, and more and more patients undergo the procedure. "Porsicure" is soon marketed not just as a cure for stomach cancer, but as an elective procedure for the public to optimize their health and increase their vitality. However, even as the procedure is framed as a "revolutionary" overhaul of human health, it soon becomes apparent that the uncontrollable appetites caused by the procedure are leading to thefts, riots, missing pets, and even cannibalism. Society quickly turns against individuals who had undergone the procedure—even those who eat garbage quietly within their homes—and Porsicure patients begin to face discrimination, harassment, and assault. The film ends with Patient D's doctor helping him to flee the city as Porsicure patients are executed in the streets. In Tom Ue's analysis of both the short story and the film, he identifies key themes including the "commentary on consumerism culture, our unquestioning faith in scientific and medical breakthroughs, and/or what we sacrifice in exchange for social conformity,"[415] and notes that the film, unlike the short story, explores "communities that are prejudiced against the operated; and divisive election campaigns predicated on their fears."[416] The film's disturbing—and even monstrous—depiction of xenograft recipients and society's response to

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[414] While the main character is not named in the film, in the short story he is referred to as "Patient D." Yann Martel, "We Ate the Children Last," *The Guardian*, July 17, 2004, https://www.theguardian.com/books/2004/jul/17/originalwriting.fiction4.
[415] Tom Ue, "Digesting the Indigestible: Narrative, Guilt, and Responsibility in Yann Martel's and Andrew Cividino's "We Ate the Children Last"," *Film Matters* 10, no. 3 (2019): 171–75. 173.
[416] Ue, "Digesting the Indigestible," 173.

them provides insights into some of the cultural fears about how pig organs might change recipients, as well as bioethical issues related to the potential public health risks posed by the use of pig organs.

While there are other fictional depictions of xenotransplantation, such as Robin Cook's medical thriller novel *Chromosome 6* (1997), Margaret Atwood's SF novel *Oryx and Crake* (2003), and Alex Perry's YA novel *Pighearted* (2021), *Pig-Heart Boy* and *We Ate the Children Last* are unique in their focus on the experiences of the first patients to undergo experimental xenotransplantation procedures, particularly their experiences following their surgeries.[417] Both of these texts can therefore provide a useful starting point for discussions about the bioethical implications of new biotechnologies and experimental medical procedures, and SF's ability to call attention to important bioethical questions. As Sherryl Vint argues, the genre of SF can play an important role in calling attention to the unforeseen impacts of new technologies, since "[n]arratives foreground such cultural forces and often enable us to see how otherwise neutral or even beneficial technologies may have undesirable consequences if issues of equity are not addressed in how they are implemented."[418] As she argues, "[a]t its best, speculative fiction can help us envision and materialize alternative futures that seek to transform rather than intensify contemporary injustices."[419] Jay Clayton, similarly, argues for the role of fiction in shaping science policy in its ability to call attention to ethical concerns, since "great works of literature bring ethical issues alive."[420] Because xenotransplantation is a rapidly developing area of biomedicine that will carry new and unique

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[417] For a discussion of the global impacts of xenotransplantation envisioned in *Chromosome 6* and *Oryx and Crake*, see Chapter 3; for an analysis of the depiction of animals used as a source of organs in xenotransplantation in *Pighearted*, see Chapter 5.
[418] Sherryl Vint, *Biopolitical Futures in Twenty-First-Century Speculative Fiction* (Cambridge University Press, 2021). 8.
[419] Vint, *Biopolitical Futures*, 8.
[420] Jay Clayton, *Literature, Science, and Public Policy: From Darwin to Genomics* (Cambridge University Press, 2023), https://doi.org/10.1017/9781009263504. 14.

bioethical considerations, fictional depictions like *Pig-Heart Boy* and *We Ate the Children Last* can help us to navigate the impacts that this procedure might have on patients as well as the public.

2.3 Xenotransplantation as "a last-ditch gamble": Risk, Vulnerability, and Exploitation in Experimental Medicine

One of the potential bioethical considerations for experimental medical procedures is the risk that vulnerable patients will be exploited or coerced into undergoing poorly understood procedures so that their bodies will contribute to furthering medical knowledge. In Adam Negri and Lauren Wilson's analysis of the bioethical concerns arising from xenotransplantation, they note that "the *vulnerability* of xenotransplant recipients" like David Bennett Sr. needs to be considered further, since it is currently "an underdiscussed aspect of current xenotransplantation practice."[421] One way to approach this vulnerability is by considering the way that patients are used as a source of what Waldby describes as biovalue, or the "surplus value of vitality and instrumental knowledge"[422] produced through biomedical experimentation. Indeed, as Waldby notes, vulnerable individuals have historically been exploited by biomedical projects, since "[m]edicine has a long history in which certain persons are *used as test technologies* or instrumentalised to produce a surplus value of knowledge, in order to enhance the well-being and functioning of the more fully human."[423] This concern about the exploitative production of biovalue and the use of vulnerable individuals as "test

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[421] Adam Negri and Lauren Wilson, "Future Systems of Xenotransplantation: Melding Historical and Bioethical Methodology," *Cell Transplantation* 32 (January 2023), https://doi.org/10.1177/09636897231170510. 5. Emphasis added.
[422] Waldby, *The Visible Human Project*, 19.
[423] Waldby, *The Visible Human Project*, 20. Emphasis added. While this chapter focuses on the exploitation of vulnerable patients in xenotransplantation, for an analysis of the exploitation of beings created through de-extinction research, see Chapter 1.

technologies" in biomedical projects is particularly relevant when it comes to experimental medical procedures, where patients may be the first to undergo new surgeries and treatments.

Across media coverage of developments in xenotransplantation, news and magazine articles often emphasize the risks posed by the procedure and the precarious position of patients who opt to receive an animal organ. In *The Scientist Magazine*, science writer Ed Yong describes the history of xenotransplantation, and how "[s]ince the 1900s, a few surgeons have tried transplanting kidneys, livers, and hearts from pigs, baboons, and chimps into *desperate patients with no other options*," although as Yong adds, "[n]one of these operations were successful."[424] In the more recent 21st-century attempts at transplanting pig organs into humans, patients are similarly driven by the lack of access to more conventional medical treatments. For example, in the media coverage of David Bennett Sr.'s surgery in *Discover Magazine*, Kenneth R. Miller describes how "[d]esperately ill and seeking a miracle, David Bennett Sr. took a *last-ditch gamble* on Jan. 7, when he became the first human to be successfully transplanted with the heart of a pig."[425] In a *Scientific American* article, David Bennett Sr. himself used similar language to emphasize the precarity of his position: "[i]t was either die or do this transplant. I want to live. I know it's a *shot in the dark* but it's my *last choice*."[426] Similar emphases characterize the coverage of Lawrence Faucette's surgery. For example, another *Scientific American* article describes how the pig organ used in Faucette's surgery was approved by the FDA for "compassionate use," a unique circumstance "in which the U.S. Food and Drug Administration permits an unapproved therapy when a person is seriously ill or dying and has *no*

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[424] Ed Yong, "Replacement Parts," *The Scientist Magazine*, August 1, 2012, https://www.the-scientist.com/features/replacement-parts-40673. Emphasis added.
[425] Kenneth R. Miller, "Pig Heart Transplant Offers Uncertain Hope," *Discover Magazine*, December 11, 2022, https://www.discovermagazine.com/health/pig-heart-transplant-offers-uncertain-hope. Emphasis added.
[426] Tom Metcalfe, "Surgeons Transplant Pig's Heart into Dying Human Patient in a First," *Scientific American*, January 11, 2022, https://www.scientificamerican.com/article/surgeons-transplant-pigs-heart-into-dying-human-patient-in-a-first/. Emphasis added.

other options available."[427] A *Washington Post* news article similarly frames Faucette's death by stating that "[d]ying from heart failure and ineligible for a human heart transplant, Lawrence Faucette knew that *the last chance* he had at extending his life was to receive a heart transplanted from a pig"[428] More recently, Schaer describes in *National Geographic* how another recent xenotransplantation surgery "demanded untested faith, *a hefty dose of desperation*, and an unmeasurable amount of luck,"[429] highlighting the risks taken by early xenograft recipients. As these examples show, patients' decisions to undergo xenotransplantation are framed across news and science magazine articles as a desperate attempt to save their lives by engaging in the risky (and historically unsuccessful) procedure.

While the frequent use of phrases like "last chance" and "no other options" in the media coverage of xenotransplantation might encourage the public to view xenotransplantation primarily as a potentially life-saving procedure, the desperation and precarity of these patients can also create a troubling dynamic. As Negri and Wilson note in their analysis of the vulnerability of David Bennett Sr., his surgery raises some important bioethical questions, including concerns about patient well-being following their procedures, since

> during the time that Bennett was kept alive through the use of a xenoheart, he was described as bedridden and on life support. Some of the promotional material coming out of the University of Maryland School of Medicine's animal-to-human transplant program, where Bennett was receiving care, certainly suggested a *less-than-pleasant quality of life*.[430]

As they note, part of what made Bennett eligible to undergo the experimental procedure was the likelihood of his death if he did not undergo treatment and his ineligibility for a human-to-human

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[427] Lewis, "Milestone Pig-to-Human Heart Transplant." Emphasis added.
[428] Timothy Bella, "Second Pig Heart Transplant Patient Dies Six Weeks after Rare Surgery," *Washington Post*, November 1, 2023, https://www.washingtonpost.com/health/2023/11/01/pig-heart-transplant-lawrence-faucette-dead/. Emphasis added.
[429] Schaer, "This Pig Could Save Your Life." Emphasis added.
[430] Negri and Wilson, "Future Systems of Xenotransplantation," 6. Emphasis added.

transplant. However, Negri and Wilson argue that "[d]eath […] is a worrisome criterion to base the progress of an entirely new branch of biomedical practice, given that the finality of death can quickly lead to *justifying more human suffering* than might otherwise have been permitted."[431] As this shows, then, desperation can potentially lead to the exploitation of patients who may not be prepared for (or informed about) the potential outcomes of their procedures.

This concern about patient vulnerability is a central focus of both *Pig-Heart Boy* and *We Ate the Children Last*. Both narratives highlight the concern that, in order to promote xenotransplantation, the medical institutions and pharmaceutical corporations involved in developing the procedure will capitalize on the desperation of vulnerable patients—or at the very least, that these patients will not be adequately informed about the potential risks of their procedures. For example, at the start of *We Ate the Children Last*, Patient D explains that because of his terminal stomach cancer, he underwent "a full-organ xenograft replacing the entire digestive tract of a human being with that of a pig,"[432] and that "[t]he procedure was the first of its kind."[433] Even before the audience is aware of the physiological and behavioural side effects of the procedure, Patient D pre-emptively defends his decision, explaining, "I was dying of stomach cancer. You would have done the same thing."[434] Despite Patient D's insistence that anyone would have chosen to undergo the risky surgery even without knowing the potential outcome, it is also unclear whether Patient D had even fully agreed to undergo the experimental procedure. The opening scene of the film shows him sitting in apparent anguish in a room surrounded by medical practitioners in lab coats and scrubs, one of whom reaches

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[431] Negri and Wilson, "Future Systems of Xenotransplantation," 6. Emphasis added.
[432] *We Ate the Children Last*, directed by Andrew Cividino (Film Forge, 2011), 12:04, https://vimeo.com/27633865. 0:55-1:02.
[433] *We Ate the Children Last*, 0:52-0:54.
[434] *We Ate the Children Last*, 0:34-0:49.

over and manipulates Patient D's hand to sign the consent form.[435] In Ue's analysis of the film, he notes that this scene is an important departure from the short story, since "[w]here Martel's patient 'waived all rights to legal redress should the procedure go wrong,' Cividino leaves it unclear whether he gives consent."[436] The film therefore highlights the precarity of Patient D's position: he is shown to be extremely vulnerable without other available medical options, and is potentially either unwilling or unable to fully consent to the surgery.

The state of Cameron's health at the start of *Pig-Heart Boy* puts him in a similarly desperate condition. Cameron, whose heart was damaged by a viral infection, is unlikely to receive a human heart transplant in time to save his life, leaving him with only two options: accept the pig organ, or succumb to heart disease. As Emma Trott describes in her posthumanist analysis of *Pig-Heart Boy*, Cameron's "experiences as a Black British boy growing up in London inform his recognition that inherent to xenotransplantation are issues of power and oppression."[437] While Trott argues that *Pig-Heart Boy* "reimagines the medical life of a Black body where it is not exploited subject but agential participant,"[438] it is important to consider the factors that influenced Cameron's decision to undergo the procedure. Like Patient D, Cameron is the first person to undergo the procedure, and like Patient D, Cameron is shown agreeing only because his quality of life had significantly deteriorated. For example, at the start of the novel, Cameron is too weak to play sports or swim with his friends. While Cameron's friends continue to invite him along, he feels isolated, thinking, "[i]t was as if there was a glass wall separating me from the rest of the world. All I could do was watch and envy my friends as

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[435] *We Ate the Children Last*, 0:33-0:37.
[436] Ue, "Digesting the Indigestible," 173.
[437] Emma Trott, "A Change of Heart: Animality, Power, and Black Posthuman Enhancement in Malorie Blackman's *Pig-Heart Boy*," in *Animals and Science Fiction*, ed. Nora Castle and Giulia Champion (Palgrave Macmillan Cham, 2024), https://doi.org/10.1007/978-3-031-41695-8_13. 227.
[438] Trott, "A Change of Heart," 231.

they swam and dived and did whatever they wanted without a care in the world."[439] Cameron grows increasingly apathetic, since "I was always a spectator, never a participant. I didn't call that living. I was alive—but that was all."[440] In addition to his social isolation, Cameron feels intense guilt over his parents' deteriorating relationship, attributing it to his health problems, and he blames himself for "[t]earing them apart."[441] Indeed, Cameron first learns about Dr. Bryce and the option for him to undergo a pig heart transplant when he overhears his parents arguing about it. While his mother is adamantly against her son receiving a pig heart, his father argues that "[o]ur son has a year to live—at most. There aren't enough human organ donors to go around. So we have a simple choice. We can allow our son to have a pig's heart or we can watch our son die."[442] Cameron, like his father, sees it as a "simple choice" between life and death, and agrees to undergo the procedure, believing it to be his only opportunity for a life that isn't defined by isolation and unhappiness.

The debilitating health conditions and deteriorating quality of life experienced by Patient D and Cameron lead them both to agree to be the first to undergo experimental medical procedures, and neither patient is clearly informed about the potential ramifications of their surgeries. At first, there is little acknowledgment on the part of medical practitioners or the company behind Porsicure that patients in *We Ate the Children Last* are at risk of any problematic side effects. After Patient D's surgery is deemed a medical success, "regulatory approval came swiftly,"[443] and Porsicure is soon widely marketed to the public. In an ad that plays during the film, the public is encouraged to consult with their physicians about their eligibility for the procedure, since "Porsicure is a simple procedure that prevents or removes cancer in over 95% of patients."[444] While this is a promising statistic that

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[439] Malorie Blackman, *Pig-Heart Boy* (Corgi Books, 1997). 16.
[440] Blackman, *Pig-Heart Boy*, 17-18.
[441] Blackman, *Pig-Heart Boy*, 25.
[442] Blackman, *Pig-Heart Boy*, 22.
[443] *We Ate the Children Last*, 1:21-1:23.
[444] *We Ate the Children Last*, 1:28-1:34.

offers hope to people with cancer, the ad also rapidly lists potential side effects, including "increased appetite, insomnia, increased salivary production, internal hemorrhaging, and dry mouth."[445] Despite the warning of multiple side effects, including an "increased appetite," this Porsicure ad does not provide any indication of the voracious hunger for garbage, rotten food, and uncooked meat that many Porsicure patients begin to experience. Even as the public starts to recognize the extreme hunger resulting from the procedure, the company behind Porsicure downplays the side effects and insists that they are not to blame. In a news report, a reporter notes that "a spokesperson from TFL labs cautions that it's important not to let fear get in the way of saving lives."[446] This statement from TFL Labs attempts to assuage public fears about the side effects of xenotransplantation—and exonerate the company—by emphasizing the potential that their fears are disproportionate to the situation, and will "get in the way of saving lives."

In *Pig-Heart Boy*, Cameron's mother criticizes her son's medical team for not discussing the potential risks of the procedure, including the potential risk of zoonotic infection. Citing prominent examples of infectious diseases that had originated in nonhuman animals such as HIV, mad cow disease, and the flu, Cameron's mother asks,

> How d'you know that some defect in these pigs won't appear maybe five or ten or fifty years later on? And what about the possible diseases that pigs may carry? There may be diseases that a pig can take in its stride which would be lethal to us humans. […] So how d'you know you won't be importing a retro-virus into my son when you put a pig's heart in his body?[447]

While a member of the team, Dr. Ehrlich, attempts to reassure Cameron's mother that "we're doing our best to make sure that we tackle or are at least aware of every potential problem,"[448] Cameron's mother does not consider this an adequate response. When she points out that "as you said – you can't

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[445] *We Ate the Children Last*, 1:36-1:42.
[446] *We Ate the Children Last*, 2:45-2:52.
[447] Blackman, *Pig-Heart Boy*, 56.
[448] Blackman, *Pig-Heart Boy*, 56.

guarantee it," Dr. Ehrlich simply responds "[n]o, we can't,"[449] and Cameron notices that "[f]or the first time since we'd met her, Dr Ehrlich wasn't smiling."[450] When Cameron's mother pushes the medical team to acknowledge that the procedure could carry serious risks, they admit that they are unable to guarantee that Cameron will not experience adverse health impacts—something which Cameron does not clearly understand and cannot fully consent to due to his age.

In both *We Ate the Children Last* and *Pig-Heart Boy*, then, the desperation of vulnerable individuals and their families puts them at risk for exploitation and complicates their ability to consent to experimental procedures. Additionally, the medical teams, corporations, and institutions involved in the controversial new procedures are shown in both narratives as downplaying the risks and side effects of xenotransplantation. As with any experimental medical procedure, xenotransplantation will likely, at least initially, only be available to patients who are experiencing extreme health problems without other viable medical options. As Negri and Wilson point out, however, "bioethics has been accounting for a host of other considerations in biomedical practice, including patient autonomy and measures of consent, for decades. To fail to include such discourse in the xenotransplant space is concerning."[451] The depictions of vulnerable patients in *We Ate the Children Last* and *Pig-Heart Boy* contribute to the need to discuss concerns about patient autonomy and vulnerability by highlighting the problematic power dynamics at play in experimental medical procedures. By showing the way that the risks of xenotransplantation are downplayed so that the surgeries can proceed without the patients objecting, these fictional depictions demonstrate the way that medical institutions and pharmaceutical corporations capitalize on the biovalue of Cameron and Patient D as experimental test subjects.

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[449] Blackman, *Pig-Heart Boy*, 56.
[450] Blackman, *Pig-Heart Boy*, 56.
[451] Negri and Wilson, "Future Systems of Xenotransplantation," 7.

2.4 "Engineering Hope": Techno-Optimism and Transhumanism in Xenotransplantation

While some media coverage of xenotransplantation has focused on the risks inherent to the procedure and the difficulty of the situation for patients who do not have other medical options, supporters of xenotransplantation have embraced a techno-optimistic approach. Indeed, Negri and Wilson have called attention to the way that "the rhetoric around xenotransplantation research today paints *an alarmingly optimistic, solution-oriented picture*," particularly considering that "xenotransplantation has not yet engaged with a number of critical ethical issues, such as how human subjects will be used as the proving ground for this therapy."[452] This "alarmingly optimistic" approach can be seen across the websites of various biomedical research companies, where proponents have optimistically expressed their hopes that the procedure will become widely available to patients, and biotechnology will thereby "solve" the organ shortage crisis. For example, on the website for the Massachusetts-based biotechnology company eGenesis, they describe how "[w]e envision a world in which the supply of transplantable organs and cells does not determine the length or quality of one's life,"[453] which they aim to achieve by "*[p]ushing the bounds of what's possible* in transplantation."[454] This techno-optimistic rhetoric is echoed by Florida-based Makana Therapeutics. In an animated video on the company's website, xenotransplantation is described as being "*the most promising solution* for those who will otherwise never receive a life-saving kidney transplant."[455] As the video's narrator explains, "Makana's ability to produce xeno-kidneys […] will ensure that

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[452] Negri and Wilson, "Future Systems of Xenotransplantation," 2. Emphasis added. Similarly, Nik Brown has called attention to the way that proponents of xenotransplantation often turn to the hopeful, life-saving possibilities of xenotransplantation as a way of counteracting public anxieties, which he refers to as "[t]he compulsion to hope." Nik Brown, "Xenotransplantation: Normalizing Disgust," *Science as Culture* 8, no. 3 (1999): 327–55, https://doi.org/10.1080/09505439909526550. 346.
[453] eGenesis, "Engineering Hope," accessed February 1, 2023, https://egenesisbio.com/.
[454] eGenesis, "Engineering Hope," emphasis added.
[455] Makana Therapeutics, "Makana Therapeutics," accessed June 23, 2023, https://makanatherapeutics.com/xenotransplantation/. 1:34-1:42. Emphasis added.

everyone who wants a transplant, can receive a transplant, eliminating the organ shortage crisis and *delivering hope* for a normal, healthy, and happy life."[456] Both eGenesis and Makana frame their work in terms of its ability to produce hope for transplant patients: eGenesis declares that they are "[e]ngineering hope"[457] through their xenotransplantation research, while Makana claims to be "delivering hope"[458] through their work on developing "xeno-kidneys." In both instances, "hope" is framed as a product that these companies will be able to design and distribute to "solve" a public health crisis.

Pig-Heart Boy and *We Ate the Children Last* both engage with similar rhetoric about the ability of biotechnology to "solve" human health issues. This techno-optimism is most apparent in *We Ate the Children Last*, as Porsicure quickly becomes a health fad. Porsicure is surprisingly effective, and Patient D is not only cured of stomach cancer following his procedure, but is in even better physical health than ever before: in a scene where Patient D is shown running on a treadmill, he describes how "every test came back the same. I was more fit and strong than ever in my life."[459] This improved vitality experienced by Porsicure patients leads to a public fervor, and Porsicure rapidly gains popularity as an elective procedure. As the procedure is marketed in television ads and billboards, members of the public flock to surgical centres. Patient D describes how Porsicure "was the beginning of *a revolution*. A revolution of the gut. And it devoured the nation. People had never felt better in their lives. And the more we ate, the better we felt."[460] Like the way that Schaer describes xenotransplantation as "the forefront of a *major revolution*,"[461] *We Ate the Children Last*

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[456]Makana Therapeutics, "Makana Therapeutics," 2:30-2:50. Emphasis added.
[457] eGenesis, "Engineering Hope."
[458] Makana Therapeutics, "Makana Therapeutics," 2:30-2:50.
[459] *We Ate the Children Last*, 2:32-2:38.
[460] *We Ate the Children Last*, 4:12-4:27. Emphasis added.
[461] Schaer, "This Pig Could Save Your Life." Emphasis added.

also highlights the "revolutionary" potential offered by pig organs. This ability of pigs' biological material to enhance health is capitalized on by the company TFL Labs, and it quickly becomes clear that a large portion of the public has electively chosen to undergo the procedure. This depiction of Porsicure engages with transhumanist techno-optimism about how medical and technological advancements could revolutionize human health. As philosophy scholar Francesco Paolo Adorno argues, transhumanist goals of human enhancement have permeated 21st century culture: "we have reached a point where enhancement—improvement, optimisation, upgrading, perfection—has become the watchword, the motto of the contemporary world, if not its imperative."[462] While Porsicure had started as an experimental procedure to save the lives of terminally ill patients, it had been rebranded by TFL Labs as a way for people to "improve" or "optimise" their bodies.

The depiction of the initial fervor for Porsicure in *We Ate the Children Last* draws on transhumanist rhetoric in several ways. For example, TFL Labs capitalizes on the "liberating" nature of the procedure, encouraging potential patients to view xenotransplantation as a means of enhancing their bodies. Soon after Patient D's procedure, the company releases ads that encourage the public to "talk to your doctor about Porsicure,"[463] ending with the tagline: "Porsicure: you're not just saving your life, *you're making it better*."[464] The goal is that the procedure will improve patients' wellness and increase their vitality in a way that supposedly gives them greater freedom. This belief becomes widespread after a celebrity, Ricki Rogers, opts to undergo the procedure "for nonmedical reasons."[465] Rogers—proudly displaying his surgical scar for a clamouring audience—explains his rationale for undergoing such an invasive procedure, claiming, "[i]t's liberty. It's freedom from all the

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[462] Adorno, Francesco Paolo. *The Transhumanist Movement*. Palgrave Macmillan, 2021. 68.
[463] *We Ate the Children Last*, 1:26-1:28.
[464] *We Ate the Children Last*, 1:43-1:47. Emphasis added.
[465] *We Ate the Children Last*, 3:34-3:35.

materialism in the hierarchy inherent in our society, you know. And it's sexy."[466] This association between medical procedures and the desire for freedom from both physical and societal constraints is an even more direct reference to the transhumanist movement. As Adorno explains, "[t]ranshumanists are globally and fundamentally technophiles and consider that technology is the main instrument of emancipation and liberation of human beings. […] Technology is not specifically a political tool but is at the service of the advancement of individual freedom."[467] As transhumanism is primarily occupied with "freeing" humans from the constraints of the body, Porsicure's depiction as an elective procedure that can improve patient's lives, rather than a last chance at life for desperate patients, engages with this view.

The desire for elective medical procedures that can restore vitality raises another key concept connected with transhumanism. The freedom to alter the body using technological enhancements is described as "morphological freedom," which Anders Sandberg connects with both technological developments and "augmentative medicine."[468] As Sandberg notes, morphological freedom "fits in well with the new view of patients not as clients but rather as *customers*."[469] Certainly, this view of the role of morphological freedom in altering how patients access medical treatments and relate to medical practitioners aligns with *We Ate the Children Last*'s depiction of Porsicure patients, particularly in scenes showing people lining up at clinics and counters ticking upwards with each new "customer." The depiction of patients as customers and xenotransplantation as a product in *We Ate the Children Last* connects experimental medicine, transhumanism, and commodification. In Justin

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[466] *We Ate the Children Last*, 3:49-3:57.
[467] Adorno, *The Transhumanist Movement*, 37.
[468] Anders Sandberg, "Morphological Freedom--Why We Not Just Want It, but Need It," in *The Transhumanist Reader: Classical and Contemporary Essays on the Science, Technology, and Philosophy of the Human Future*, ed. Max More and Natasha Vita-More (Wiley-Blackwell, 2013). 58.
[469] Sandberg, "Morphological Freedom," 63. Emphasis added.

Omar Johnston's discussion of "human capital," he argues that "the *never healthy enough* body is also never 'human enough,' particularly since health is a classic metric for human capital. In this context, the transhumanist promise of regenerating one's bodily capacities with the aid of biotechnology is deeply seductive, especially for the ultra-rich and consumer classes."[470] Beyond functioning as a cure for cancer, Porsicure offers a means to enhance the "never healthy enough body," thereby increasing the human capital of patients.

The connection between augmentative medicine, morphological freedom, and human identity is also highlighted by Patient D's doctor. In a television interview, he defends Porsicure, saying, "let's talk about unnatural. Breast augmentation, artificial hips, hearing aids. Humans are a flawed being. This procedure is *a cure*."[471] By conflating elective and non-elective medical procedures and framing them as evidence of the "unnaturalness" of humans, while also promoting xenotransplantation as a "cure" for humanity's flaws, Patient D's doctor appears to see medicine through a transhumanist lens. Interestingly, similar rhetoric is at play in the real-world media coverage of xenotransplantation. For example, in Schaer's coverage of eGenesis' xenotransplantation clinical trials, he writes that "[t]his—an *escape* from dialysis, a whole-body *reinvigoration*—is the future."[472] While I do not mean to suggest that Schaer is promoting a transhumanist approach where patients are viewed as customers, the combination of the desire for "an escape" from the limitations of the body, the potential for "whole-body reinvigoration," and the techno-optimistic hope for the "future" of biomedicine highlights the desire for a future where corporations like eGenesis can offer patients increased control over their bodies and the possibility of renewed vitality through xenotransplantation.

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[470] Justin Omar Johnston, *Posthuman Capital and Biotechnology in Contemporary Novels*, Palgrave Studies in Literature, Science and Medicine (Palgrave Macmillan, 2019). 21. Emphasis added.
[471] *We Ate the Children Last*, 2:48-3:00. Emphasis added.
[472] Schaer, "This Pig Could Save Your Life." Emphasis added.

In *Pig-Heart Boy*, meanwhile, xenotransplantation is not depicted as becoming an elective surgery, and the only patients who are approached to undergo the procedure are those like Cameron who are without other medical options. However, like *We Ate the Children Last*'s depiction of Porsicure, xenotransplantation is initially glamourized after Cameron's procedure, and his new identity as the "pig-heart boy" comes with financial opportunities and increased social status. The connection between xenotransplantation and human capital becomes apparent as Cameron quickly realizes that the media is particularly interested in reporting on his surgery and is willing to pay for access to information. Early in the novel, Cameron's mother had questioned the security protocols surrounding Dr. Bryce's lab, asking, "Does Dr Bryce think we're going to sell his address to the newspapers or something?"[473] Later, it becomes apparent that this indeed is a major concern. When Cameron confides in his best friend, Marlon, Marlon's parents immediately sell information about Cameron to a newspaper, and soon Cameron's controversial procedure becomes public knowledge. Despite feeling betrayed by Marlon, Cameron initially enjoys the extra attention he gets from his classmates, and he reflects on how the procedure has increased his social status:

> From the moment I walked into school I was surrounded by my friends and others who'd never had one word to say to me before. Although it was embarrassing, in a strange way it was also quite nice! I was the centre of attention. *I was special*. A couple of kids even asked me for my autograph. It was bizarre![474]

Cameron's sense of being "special" grows when he realizes how much money newspapers are offering his family in exchange for his story. Cameron discovers multiple letters offering "thousands of pounds" for the family's "exclusive story," provided they get "unlimited access to Cameron for the next year."[475] Cameron is thrilled by the prospect of the money, chanting "We're rich! We're rich!"

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[473] Blackman, *Pig-Heart Boy*, 50.
[474] Blackman, *Pig-Heart Boy*, 140. Emphasis added.
[475] Blackman, *Pig-Heart Boy*, 131

and daydreaming about how "I can get a mountain bike with twenty-four gears! I could get a car if I wanted to!"[476] While *Pig-Heart Boy* does not depict pig organs as a transhumanist product like *We Ate the Children Last*, xenotransplantation is still framed in terms of the valuable insights offered by the patients who undergo the experimental procedure, with Cameron himself becoming a commodity.

Like the Porsicure patients in *We Ate the Children Last*, though, Cameron begins to feel dehumanized by the way he is viewed and treated by others. While Cameron is excited by the potential to capitalize on his new—and unexpectedly valuable—identity as the first pig heart recipient, he also realizes this value will only last until the media hype moves on to other patients. When Cameron tries to convince his parents to accept the money, he explains, "[i]f we don't take the money, they'll just give it to *the next transplant patient* Dr Bryce talked about. That's our money."[477] For Cameron, xenotransplantation has given him new, unforeseen value, but value that will be lost if his family does not immediately capitalize on it. As Johnston notes, "because our human capital is tied to our embodied life, it is not really a form of capital we can *own* per se."[478] This dynamic starts to become apparent for Cameron as he navigates the impermanence of the value that the media has ascribed to him. Because the media's willingness to pay for Cameron's story about his pig heart transplant will likely decrease (or disappear completely) as soon as another patient receives a xenograft, Cameron's ability to capitalize on his perceived "value" is also temporary.

Being treated as a commodity starts to impact Cameron's sense of self. As Cameron grapples with the media and his newfound fame, his mother warns him not to get caught up in the attention:

> Cameron, you're a very special boy. Your dad and I love you very much—we always have and we always will. But now lots of people are going to say you're only special because of your operation. They'll want to throw money at you and goodness only knows what else. But

[476] Blackman, *Pig-Heart Boy*, 132.
[477] Blackman, *Pig-Heart Boy*, 133. Emphasis added.
[478] Johnston, *Posthuman Capital*, 21.

> don't let them, or you'll start to believe that the only thing about you that's worth anything is your new heart. And then the true you will get lost.[479]

While Cameron initially reacts angrily to his parents' refusal to sell his story, he later realizes that his mother had been right about the impact that media attention would have on him. When Cameron listens to Dr. Bryce explaining the procedure during a press conference, he starts to feel discomfort about how the doctor refers to him: "an icy feeling squeezed at my stomach and started to fan out through the rest of my body. He made the whole thing sound so cold, so clinical. He could've been talking about a new make of car that would make everyone's life better or a new brand of microwavable chip."[480] Later, Cameron attempts to articulate his discomfort in a video he records, saying, "*Dr Bryce talked about me as if I was just a piece of machinery on an assembly line*. / *The first of many. Bring them on. Next*!"[481] While Dr. Bryce's message for the public—like the Porsicure ad—appears to be full of the same techno-optimism that pig organ transplants could have significant, beneficial health impacts on patients, Cameron instead feels uncomfortable with how the procedure is being represented as a potential product. This feeling of dehumanization later influences Cameron's decision to hide his physical symptoms when his body begins to reject his new heart. After losing consciousness when swimming alone, Cameron realizes that "I began to think that my new heart was all I was. That's why I wanted to touch the bottom of the swimming pool, to prove to myself that I was *something more*."[482] For Cameron, then, the dehumanizing belief that he was "only special because of [his] operation" is what leads him to risk his life in order to prove that there is more to his identity than his new heart.

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[479] Blackman, *Pig-Heart Boy*, 135.
[480] Blackman, *Pig-Heart Boy*, 125.
[481] Blackman, *Pig-Heart Boy*, 136. Emphasis in original.
[482] Blackman, *Pig-Heart Boy*, 194-195. Emphasis added.

While *We Ate the Children Last* more directly engages with transhumanist techno-optimism about the ability of medical technologies to revolutionize human health than *Pig-Heart Boy*, both texts show the commodification of biological material and patients' bodies, and the impacts that this has on xenograft recipients. In these narratives, patients undergoing experimental procedures are seen as a source of medical biovalue that can provide insight into the development of new medical procedures in order to create future profits, and their value is capitalized on by biomedical companies, medical researchers, and the media. Rather than the transhumanist dream of freeing humans from their biological bodies being realized, these texts instead show patients being dehumanized by the treatment they experience at the hands of their medical practitioners, and ultimately experiencing adverse physical and mental health impacts. While Porsicure patients are initially seen as being part of a "revolution of the gut," and Cameron had enjoyed his new "special" status in the eyes of his classmates, in both texts, xenograft recipients experience complex changes to their sense of identity. Indeed, as Adorno argues, "the narrative proposed by transhumanism is too smooth, too flat, to be accepted without detailed analysis."[483] While *We Ate the Children Last* depicts a much more directly transhumanist approach to xenotransplantation where biotechnology is viewed as a simple tool to capitalize on the desire to improve human vitality and increase personal liberty, the techno-optimistic rhetoric that often drives biomedical innovation is worth interrogating, particularly in the case of experimental medical procedures.

[483] Adorno, *The Transhumanist Movement*, 5.

2.5 "This isn't *Jurassic Park*!": Monstrous Imaginaries of Xenotransplantation

In contrast to the techno-optimism and technosolutionism expressed by proponents of xenotransplantation, *Pig-Heart Boy* and *We Ate the Children Last* imagine the use of pig organs in transplant medicine by drawing on cultural anxieties about contagion and identity. One of the core concerns raised by bioethicists is that xenotransplantation could have widespread societal—or even global—impacts. For example, in a review written by cardiothoracic surgeons in *Artificial Organs*, John W. Entwistle et al. argue that "[x]enotransplantation is unique because no other medical treatment puts *so many others at risk*."[484] The risk that they identify is the potential transmission of viruses that are encoded in pig DNA, which are called porcine endogenous retroviruses[485] (the very concern that Cameron's mother raises when speaking with his doctors in *Pig-Heart Boy*). Currently, these viruses are not well understood, and it remains unclear whether they will infect human xenograft recipients, whether they will have any adverse health impacts, and whether this will pose any public health risks. In the same issue of *Artificial Organs*, Kathleen N. Fenton notes that because of the uncertainties about the risks of zoonotic infection in xenotransplantation, "[s]ociety as a whole […] needs to come to some understanding of the risk/benefit calculus and reach a decision regarding whether or not to proceed. How to protect everyone involved while preserving individual rights, particularly in pluralistic societies, is problematic."[486] In both *We Ate the Children Last* and *Pig-Heart Boy*, public fears about the potential risks posed by xenograft recipients are a central concern.

In *We Ate the Children Last*, one of the implications of xenotransplantation is that Porsicure patients will face public and medical scrutiny. When, soon after undergoing his procedure, Patient D

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[484] John W. Entwistle et al., "Clinical Xenotransplantation Seems Close: Ethical Issues Persist," *Artificial Organs* 46, no. 6 (2022): 987–94, https://doi.org/10.1111/aor.14255. 989. Emphasis added.
[485] Entwistle et al., "Clinical Xenotransplantation Seems Close," 987.
[486] Kathleen N. Fenton, "Xenotransplantation: A Microcosm of Bioethics," *Artificial Organs* 46, no. 6 (2022): 995–96, https://doi.org/10.1111/aor.14260. 996.

sneaks out at night to satisfy his newfound appetite, someone photographs him as he eats out of a garbage bin. In a later scene, his medical team is shown examining the photographs while Patient D undergoes a series of physical tests. While it is not clear who had photographed Patient D, it *is* clear that his post-surgery health and behaviour are being closely monitored and analyzed by medical experts. In Fenton's discussion of bioethical concerns around xenotransplantation, Fenton notes that because of the uncertainties about whether xenograft recipients will be able to transmit porcine endogenous retroviruses, these patients "will therefore require *lifelong surveillance* both to detect and treat an unexpected disease, as well as to protect those around them (and the public as a whole)."[487] Entwistle et al. similarly consider the extent of the surveillance that will be necessary to ensure xenograft recipients do not pose public health risks, asking, "[i]f a recipient acquires a contagious zoonotic infection, how long would quarantine be necessary: for life?"[488] Therefore, while *We Ate the Children Last*'s depiction of the treatment of Porsicure patients may appear dystopian, the film's exploration of the societal response to xenotransplantation raises important bioethical questions about how xenograft recipients will be treated, and whether it is possible to manage the public health risks of xenotransplantation while still respecting patients' privacy and autonomy.

Because the risks of porcine endogenous retrovirus transmission are often cited in relation to xenotransplantation, there is additionally the risk that this concern will predispose the public to fear xenograft recipients. For example, science magazine articles about xenotransplantation frequently raise the potential public health risks posed by porcine endogenous retroviruses. In an article in *Discover Magazine*, Carl Engelking opens by describing how "[p]igs and humans share a number of physiological and anatomical similarities, but pigs also carry *harmful viruses* in their genome making

[487] Fenton, "Microcosm of Bioethics," 995. Emphasis added.
[488] Entwistle et al., "Clinical Xenotransplantation Seems Close," 989.

pig-to-human transplants dangerous."[489] By encountering the uncertainties surrounding porcine endogenous retrovirus transmission in the opening paragraph of a science magazine article, readers are likely to associate xenotransplantation with carrying potential public health risks. *We Ate the Children Last* draws on similar anxieties: while Porsicure had initially been promoted as a safe and effective treatment for cancer in the film, Porsicure patients are depicted as undergoing behavioural and physiological changes due to their surgeries. For example, in contrast to his lack of appetite before his surgery, Patient D explains that after receiving a pig's digestive tract, he is suddenly incredibly hungry: "I'd forgotten the joy of being hungry. In fact, eating was all I could think about after a while."[490] While Patient D explains that he initially hid his appetite from his medical team because he was "embarrassed to tell them I couldn't stand the taste of normal food anymore,"[491] this doesn't stop him from seeking out foods that *did* appeal to him: "garbage tasted like, well, egg shells, putrid sausage, moldy brie—my mouth is watering."[492] While Porsicure's impact on patient behaviour is initially shown in a comedic light through patients' cravings for garbage, the procedure's unintended side effects quickly become sinister.

In its depiction of Porsicure patients developing unintended side effects, the film incorporates elements of the horror genre. As Emily Russell notes in her analysis of organ transplantation in fiction, "[h]orror is […] powerful as a genre in cadaver donation because it draws forth the often-denied reality that death and life are inexorably tied in this exchange."[493] While Russell explores this dynamic in narratives featuring human-to-human organ transplants, the potential risks of

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[489] Carl Engelking, "Gene Editing Could Make Pig-to-Human Organ Transplants Feasible," *Discover Magazine*, October 12, 2015, https://www.discovermagazine.com/health/gene-editing-could-make-pig-to-human-organ-transplants-feasible. Emphasis added.
[490] *We Ate the Children Last*, 1:10-1:18.
[491] *We Ate the Children Last*, 2:17-2:21.
[492] *We Ate the Children Last*, 2:23-2:30.
[493] Emily Russell, *Transplant Fictions: A Cultural Study of Organ Exchange* (Palgrave Macmillan, 2019). 23.

xenotransplantation are also framed in terms of horror and monstrosity in *We Ate the Children Last*. For example, the unexpected side effects caused by Porsicure can no longer be ignored or minimized when first pets, and later, humans, start to go missing. After a murder investigation, it's revealed that some Porsicure patients have started to cannibalize other people: a detective reveals that "[t]he teeth marks and bite patterns on the bones are consistent with those found at other sites. They are human."[494] Ricki Rogers, the celebrity who had publicly promoted Porsicure on a television talk show after undergoing the procedure, is eventually arrested for murdering and cannibalizing a technician in his band. Rather than the public health concerns over viral transmission, the film instead focuses on the potential for *social* contagion, where the Porsicure procedure (and its unintended side effects) "spreads" among the public, creating new public health risks.

The film's depiction of Porsicure as a social contagion raises concerns about the potential discrimination that xenograft recipients might face. In a *Scientific American* article, Karen Weintraub notes that "[w]hether or not pig retroviruses would truly pose a risk of causing disease in humans remains controversial," and that "[t]hat concern, particularly amid the HIV epidemic, has helped stall such research for the past couple decades."[495] Weintraub's reference to the HIV epidemic draws attention to the way that public fears about porcine endogenous retrovirus transmission could lead to discrimination against xenograft recipients. Indeed, Entwistle et al. note that "[r]ecipients of an animal organ might suffer *social isolation or hostility*, on grounds of being a health risk to others,"[496] citing both the HIV epidemic and the COVID-19 pandemic as instances where public fears about viral transmission were linked to rises in discrimination and harassment. *We Ate the Children Last*

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[494] *We Ate the Children Last*, 5:06-5:12.
[495] Karen Weintraub, "Gene-Editing Success Brings Pig-to-Human Transplants Closer to Reality," *Scientific American,* August 10, 2017, https://www.scientificamerican.com/article/gene-editing-success-brings-pig-to-human-transplants-closer-to-reality/.
[496] Entwistle et al., "Clinical Xenotransplantation Seems Close," 990. Emphasis added.

similarly explores the discrimination that xenograft recipients might face if they are identified as a potential public health or safety risk. And while the majority of Porsicure patients are not depicted as showing cannibalistic tendencies, because of these incidents, Porsicure patients come to no longer be seen as "revolutionary," trendy, health-conscious individuals, but instead as dangerous, unpredictable, and violent.

As a result, Porsicure patients are targeted by harassment, discriminatory practices, and acts of physical violence: a woman with the tell-tale Porsicure scar approaches a restaurant only to stop when she sees a sign in the window declaring "No Pigs!",[497] a man leaves his house to find his car has been vandalized with the word "OINK,"[498] and a child is bullied in a schoolyard. Eventually, Anti-Porsicure demonstrators fill the streets. As the behavioural and physiological changes experienced by Porsicure patients become more widely known, anti-Porsicure protestors begin to conflate their fears of contagion with fears about human identity as they attempt to justify violence against Porsicure patients. As Elaine L. Graham argues,

> Monstrosity has long been a trope for invasion, contamination, assimilation and loss of identity, the ascription of monstrous and subhuman traits serving to rationalize xenophobia and prejudice. That which is different becomes pathologized as 'monstrous' and thus inhuman, disposable and dangerous; the monster is personified as a threat to purity and homogeneity.[499]

Meanwhile, as Ray Carr notes in his biopolitical analysis of contagion in xenotransplantation discourse, "the *perceived infectiousness* of non-human animals can be exacerbated by their categorical transgression; conversely, reaffirmation of categories can serve to appease concerns over contagion, treating medical contagion as a *problem of boundary control*."[500] The way that Porsicure

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[497] *We Ate the Children Last*, 6:22.
[498] *We Ate the Children Last*, 6:14.
[499] Elaine L. Graham, *Representations of the Post/Human: Monsters, Aliens and Others in Popular Culture* (Manchester University Press, 2002). 53.
[500] Ray Carr, *Species of Contagion: Animal-to-Human Transplantation in the Age of Emerging Infectious Disease* (Palgrave Macmillan, 2022). 52. Emphasis added.

patients are—to use Graham's words—"pathologized as monstrous" is a strategy for the public in *We Ate the Children Last* to enforce the "boundary control" that Carr describes. For example, in one scene, a religious extremist condemns Porsicure, declaring that "It's wrong! It's dead wrong when we *befoul the sanctity of the human body with that of an animal*. And I hope more people die and more people perish until His message is received."[501] In another scene, a politician publicly encourages violence against Porsicure patients, telling his supporters that "You can't reason with a wild animal. We tried and *we've been bitten*. There's us, and there's them, and we can't change that."[502] Evidently, much of the conflict between Porsicure patients and the public is centred on Porsicure patients being perceived as inhuman and animalistic: their bodies have been "befouled" and the public is at risk of being "bitten." By rhetorically aligning Porsicure patients with nonhuman animals and arguing that they are less "human" due to the procedure, anti-Porsicure activists seek to justify both systemic discrimination and extreme violence.[503]

In response, Porsicure patients initially attempt to reaffirm their humanity. One Porsicure patient beseeches the public to stop viewing him as an animal, telling a reporter that "I'm a law-abiding citizen, I pay my taxes, and I'm afforded certain rights and representation. *I'm not an animal*, I'm a human being."[504] Before the man can finish speaking, however, he is assassinated. Because of the violence being incited against Porsicure patients, Patient D explains, "[w]e got tired of being *treated like animals*. So we took to the streets to stand up for ourselves."[505] Despite these attempts at reaffirming their humanity, *We Ate the Children Last* ends with the legally sanctioned execution of the remaining Porsicure patients, with Patient D only narrowing escaping with the help of his

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[501] *We Ate the Children Last*, 6:14-6:21. Emphasis added.
[502] *We Ate the Children Last*, 7:01-7:10. Emphasis added.
[503] For an analysis of animality in *Pig-Heart Boy*, see Trott, "Change of Heart."
[504] *We Ate the Children Last*, 7:29-7:36. Emphasis added.
[505] *We Ate the Children Last*, 6:41-6:47. Emphasis added.

physician. As the two men drive away from the violent scenes unfolding in the city, Patient D sees police storming the homes of other Porsicure patients and even makes eye contact with a woman kneeling in the street in the moments before she is killed. While Patient D manages to escape, the film ends with him reflecting on how "[e]veryone knew what happened, and how and where, and to this day everyone knows. But no one talks about it. And no one's guilty. I must live with that."[506] For Porsicure patients, then, their perceived animality and monstrosity enables the public to justify discrimination and violence against them; and, as Patient D explains, "no one's guilty"—the pharmaceutical company that had promoted Porsicure and encouraged its adoption as a health fad in the first place never has to atone for what happens to their patients.

While *We Ate the Children Last* focuses more on the societal fears about contagion and the resulting discrimination and violence against Porsicure patients, *Pig-Heart Boy* focuses on the experience of the first pig heart recipient, Cameron, as he navigates the perceived changes to his body by others and the impact that this has on his interpersonal relationships. As Peta S. Cook argues in an analysis of the bioethical issues arising from xenotransplantation,

> The medical imperative to treat ill-health creates a new kind of body, one which shapes individual understanding. The 'new' body which appears through medical intervention, while potentially more physically functional, may be *difficult to recognise and reconcile* for the xenotransplant recipient whom must embody and 'live' it.[507]

For Cameron, his inability to "recognize and reconcile" with his body after surgery is not because of *physical* changes like what Porsicure patients experience, but rather because of how other people view his body and identity after his surgery. Indeed, the potential stigmatization that xenograft recipients might face as a result of their surgery, and the impacts that this could have on the patients, is a significant bioethical concern. In a report on public opinions about xenotransplantation, Johannes

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[506] *We Ate the Children Last*, 10:08-10:24.
[507] Peta S. Cook, "The Social Aspects of Xenotransplantation," *Sociology Compass* 7, no. 3 (2013): 237–54, https://doi.org/10.1111/soc4.12022. 246. Emphasis added.

Kögel and Georg Marckmann describe the guidelines for xenotransplantation that were established at a citizens' conference they organized, where members of the public discussed their concerns about the procedure with experts. One of these guidelines, they report, is that for the acceptable development of xenotransplantation, we must "[e]nsure a social climate *free of stigmatization*."[508] Entwistle et al. similarly note that "[a] person whose survival depends on an animal heart might suffer emotional distress, or at least carry the burden of *being abnormal in some way*," noting that "[s]uch problems have emerged in recipients of transplanted hands and faces, and patients living with a left ventricular assist device (LVAD) or artificial heart. It seems likely that some porcine xenotransplant recipients will manifest similar problems."[509] Part of why bioethicists are concerned about the potential for xenograft recipients to "manifest similar problems" is because of the risk of these patients being seen (or indeed, seeing themselves) as having fundamentally changed due to receiving a pig organ, and consequently being perceived as less "human."

In *Pig-Heart Boy*, these concerns about the impact a pig organ might have on identity are explored in the way that Cameron's family members, friends, and strangers all view him as having changed (and even become "abnormal") at different stages of the process. Before Cameron's surgery, when Cameron's father admits he has been discussing xenotransplantation with one of Cameron's doctors, Cameron's mother is immediately concerned about the potential for the pig heart to alter Cameron's identity. When she raises concerns that the procedure could "deform" her son, Cameron's father insists that "[y]ou wouldn't say that if this was a human heart—," to which she points out that "that's the whole point. It's not, is it? You want to make our son a pig-heart boy."[510] When Cameron's father presses her on why she has such an adverse reaction to Cameron receiving a pig's

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[508] Johannes Kögel and Georg Marckmann, "'Xenotransplantation Challenges Us as a Society,'" *EMBO Reports* 21, no. 9 (September 3, 2020): e50274, https://doi.org/10.15252/embr.202050274. 2. Emphasis added.
[509] Entwistle et al., "Clinical Xenotransplantation Seems Close," 990. Emphasis added.
[510] Blackman, *Pig-Heart Boy*, 21.

heart, since pig skin and insulin are already established medical products, she insists "[i]t's not the same," and that "if you don't know [why] then I can't tell you."[511] While she is unable to articulate exactly why she feels such intense discomfort at the prospect of her son receiving a pig heart, she believes there is a fundamental difference between human organs and pig organs, and that that difference will negatively impact Cameron's bodily identity (turning him into a "pig-heart boy") if he undergoes the surgery.

Cameron's mother is not the only character shown experiencing uncertainty or discomfort around how the xenograft might change Cameron. When Cameron finally returns to school after his operation, he has to navigate the changes in how his friends and classmates treat him. Some of his classmates have a newfound respect for Cameron; for example, Travis, the school bully, immediately greets Cameron, telling him, "you're braver than me […] I don't know if I could have done what you did."[512] Cameron is shocked, and interprets Travis' words as an attempt at friendship, thinking, "[i]f Travis thought we could be friends now, he had another thought coming. Not after all the grief he'd given me over the last year!"[513] While Cameron sees Travis' words as complimentary, the interaction—and Travis' comment on Cameron's bravery—also reinforces the idea that there is something abnormal or aberrant about the pig heart. Other classmates express similar perspectives, although in significantly less complimentary ways. For example, Cameron is initially excited to see Julie, a classmate he had a crush on but had not pursued a relationship with before his procedure. When Cameron tries to talk to Julie, he immediately realizes she is behaving differently around him: "it slowly dawned on me what was going on. She was *scared* of me."[514] In an analysis of this scene, Trott argues that through Julie's reaction, "[t]he specific concern about zoonosis broadens into a less

[511] Blackman, *Pig-Heart Boy*, 22.
[512] Blackman, *Pig-Heart Boy*, 140.
[513] Blackman, *Pig-Heart Boy*, 140.
[514] Blackman, *Pig-Heart Boy*, 146.

easily defined perception of foreignness and alienation in Cameron's body, a loss of control over the material self and over the ability to categorize what makes us human."[515] As Trott notes, while this scene draws on contemporary fears about porcine endogenous retroviruses and other zoonotic diseases, it soon becomes apparent that Julie isn't merely afraid of potential infections—instead, she sees Cameron as having *fundamentally* changed—and become less definitively "human"—due to his procedure. Evidently, even without exploring fears about contagion in the same depth, *Pig-Heart Boy* engages with some of the same anxieties about identity and boundary control as *We Ate the Children Last*.

Along with depicting the discomfort of Cameron's friends and family members as they try to make sense of xenotransplantation, *Pig-Heart Boy* engages with fears of monstrosity through the invocation of well-known SF stories that envision the consequences of unethical scientific experimentation. Throughout the novel, several characters draw on references to well-known SF stories to find ways to articulate anxieties about the confusion of human/nonhuman boundaries. Before Cameron's procedure, he attempts to alleviate his mother's concerns by laughingly reassuring her that "Mum, it's all right. *This isn't Jurassic Park*!"[516] While Cameron attempts to make light of his mother's fears, similar cultural references to scientists altering bodies in "monstrous" ways become more troubling for Cameron once he has undergone the pig heart transplant. At a press conference after his operation, Cameron is deeply offended when a journalist asks Dr. Bryce "[d]on't you think you're behaving like Dr Frankenstein and *creating monsters*?," and before Dr. Bryce can respond, Cameron angrily asks, "[a]re you calling me a monster?"[517] While Cameron had previously drawn on *Jurassic Park* in a joking manner, the reference to *Frankenstein*—and the implication that

[515] Trott, "A Change of Heart," 222.
[516] Blackman, *Pig-Heart Boy*, 55. Emphasis added.
[517] Blackman, *Pig-Heart Boy*, 126. Emphasis added.

Cameron is now the story's "monster"—makes the stigma toward xenograft recipients more apparent. The journalists are not deterred by Cameron's outburst, however, and continue to ask dehumanizing questions about Cameron's identity, including when they ask Cameron's parents, "[d]o you consider him to be a normal boy now?"[518] Once again, the implication is that by accepting the pig heart, Cameron has ceased to be "normal," which other characters attempt to navigate by drawing on speculative visions of science altering bodies and identity in monstrous ways.

While *Pig-Heart Boy* provides a fictional depiction of characters using SF as a point of reference for understanding the impacts that xenotransplantation might have on human identity, similar references to SF have also occurred across media coverage of xenotransplantation and biotechnologically altered animals. In Nik Brown's article about xenotransplantation and disgust, for instance, he argues that "[g]enres of science fiction (SF) are amongst the most sedimented constellation of stock images, narratives and themes which mediate popular cultural anxieties regarding science and technology."[519] Brown includes several examples of headlines about xenotransplantation that reference *Frankenstein* and *Jurassic Park*, noting that "[c]learly, through science fiction, [xenotransplantation] is embedded within some of 'our' most notorious stories of modern hubris."[520] And while Brown's article was examining headlines in the 1990s, similar references still appear—albeit less frequently—in coverage of more recent xenotransplantation developments. For example, the inflammatory headline of a 2018 *Daily Mail* tabloid article about research developments at Meiji University and Kyoto Prefectural University declares that "Japanese scientists develop genetically modified 'Frankenstein' pigs with organs that can be transplanted into

[518] Blackman, *Pig-Heart Boy*, 128.
[519] Brown, "Xenotransplantation: Normalizing Disgust," 339.
[520] Brown, "Xenotransplantation: Normalizing Disgust," 341.

HUMANS,"[521] while a 2021 headline for an article published on the animal rights group PETA's website insists that "Pigs Aren't Spare Parts! We Don't Need 'Frankenscience' to Solve the Organ Shortage."[522]

Even science magazines will occasionally reinforce the connections between the genetic modification of animal bodies and *Frankenstein*. For example, in a *Discover Magazine* article on chimeric species, science writer Nathaniel Scharping writes that while "the process [of creating chimeras] doesn't imbue them with special characteristics," "[c]himeras inevitably spawn comparisons to Frankenstein, mutants and a range of other science fiction creations."[523] While Scharping's reference to *Frankenstein* is less intentionally inflammatory than the tabloid headlines, it still reinforces the story as one of the primary frameworks through which to understand new scientific developments related to genetic modifications. For public audiences learning about xenotransplantation, these references to science fiction provide one potential framework for understanding the impacts that the procedure will have on bodily identity. This can lead to problematic outcomes like those depicted in *Pig-Heart Boy*, as texts like *Frankenstein* and *Jurassic Park* that depict the disturbing, disastrous, and even monstrous consequences of scientific experimentation contribute to public feelings of discomfort and fear about the prospect of xenotransplantation complicating species boundaries. And as *Pig-Heart Boy* shows, drawing on these cultural references to articulate discomfort with xenotransplantation can be harmful for xenograft

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[521] Annie Palmer, "Japanese Scientists Develop Genetically Modified 'Frankenstein' Pigs with Organs That Can Be Transplanted into HUMANS," *Daily Mail*, March 8, 2018, http://www.dailymail.co.uk/sciencetech/article-5478995/Scientists-create-half-human-half-animal-organs-human-transplant.html.
[522] Danny Prater, "Pigs Aren't Spare Parts! We Don't Need 'Frankenscience' to Solve the Organ Shortage," PETA, October 21, 2021, https://www.peta.org/blog/pig-kidney-attached-human-problems-frankenscience/.
[523] Nathaniel Scharping, "Why Scientists Have Been Creating Chimeras in the Lab for Decades," *Discover Magazine*, May 19, 2021, https://www.discovermagazine.com/health/why-scientists-have-been-creating-chimeras-in-the-lab-for-decades.

recipients who, like Cameron, might experience feelings of alienation and dehumanization, and face discrimination from people who see them as less "human" following their procedures.

In both *We Ate the Children Last* and *Pig-Heart Boy*, the stigma associated with xenotransplantation has lasting impacts on xenograft recipients. The confrontations that Cameron has with his family, classmates, and the media force him to recognize that, even if he does not believe his bodily identity to have been altered by the transplant, the way that other people perceive him *has* changed. Cameron regretfully reflects on how "[a]fter my operation, I thought I'd be just like everyone else. That was my whole reason for doing it. Only I hadn't realized that some people […] might think otherwise."[524] For Cameron, then, it is not the xenograft itself, but rather the stigma associated with the transplant, and other people's fears about the impact the pig heart has on his identity, that keep him from being "just like everyone else." Ultimately, the potential risks that patients might face discrimination on the basis of having nonhuman animal organs are emphasized in both texts, whether that is in the blatant discrimination and violence in *We Ate the Children Last*, or in the subtler impact on a patient's relationships with their families and friends in *Pig-Heart Boy*. In both cases, xenograft recipients are shown struggling with the real or perceived changes to their bodily identity, and consequently experiencing isolation, alienation, and dehumanization.

2.6 Working Toward a Posthumanist Bioethics of Xenotransplantation

By drawing on monstrosity and horror as they engage with concerns about contagion and identity, these xenotransplantation narratives can provide a way to engage with the significant bioethical concerns arising both from xenotransplantation, and from experimental medicine more

[524] Blackman, *Pig-Heart Boy*, 153.

generally. For example, as Russell argues in her analysis of organ transplantation in horror, "[r]ather than criticizing these negative portrayals as a roadblock to greater public acceptance, […] I argue that an outlet for public fears is a necessary part of coming to grips with radically experimental medical practices."[525] One way that *Pig-Heart Boy* and *We Ate the Children Last* can help audiences to "com[e] to grips" with xenotransplantation is by encouraging audiences to consider bodies and medicine through a different lens. In Tana Jean Welch's discussion of medical posthumanism, she argues that this approach "can help *mitigate violence, oppression, and prejudice* that comes from commonplace binary thinking. It can promote equity and equality in health care through a rethinking of who and what matters."[526] A critical posthumanist approach to medicine can complement bioethical analyses in important ways, and provide insights into depictions of xenotransplantation.

Through its satirical depiction of xenotransplantation, *We Ate the Children Last* challenges the problematic "binary thinking" that Welch describes. Because Porsicure is initially framed by a transhumanist approach to medicine and the body—where enhancement is seen as a way to gain greater freedom and control over the body—the unanticipated, uncontrollable side effects of Porsicure are viewed as even more threatening, not just in terms of the potential for "contagion" and public health risks, but also in the loss of control over the body and potential disruptions to human identity. In contrast, the idea that bodies are constantly undergoing change is a core aspect of posthumanism: for example, Waldby considers biomedicine from a posthumanist perspective, arguing that "[t]he possibility of the posthuman is not to do with the transcendence of the human, its replacement, but rather with the recognition and exposure of the networks of production which *constitute human*

[525] Russell, *Transplant Fictions*, 193.
[526] Tana Jean Welch, *Advancing Medical Posthumanism Through Twenty-First Century American Poetry* (Palgrave Macmillan Cham, 2024), https://doi.org/10.1007/978-3-031-49888-6. 12. Emphasis added.

techno-genesis."[527] From this perspective, the body is *constantly* being shaped by biomedicine. Indeed, Trott draws on a similar approach to the body in her posthumanist analysis of *Pig-Heart Boy*, noting that "[n]onhuman (organic and machine) enhancements demand a new understanding of identity as our bodily encounters with actors, including medical, pharmaceutical, and technological, replace the notion of the 'natural' human body with myriad posthuman bodies."[528] *We Ate the Children Last*'s depiction of the intense fear about the changes that could result from xenotransplantation therefore provides an important starting point for conversations about the way that human identity is *always* undergoing change and *always* entangled with other factors, which can impact behaviour and identity in complex, unanticipated ways. Perhaps counterintuitively, by envisioning how xenotransplantation could change the body through the lens of horror and monstrosity, the film demonstrates the risks that arise from viewing bodies as either static and unchanging, or as controllable through transhumanist enhancement. Instead, recognizing the ongoing changes experienced by the body can provide a starting point from which to alleviate fears about the way that xenotransplantation might alter xenograft recipients.

A critical posthumanist bioethics, similarly, encourages audiences to reframe their perception of life and death to allow for a wider range of possible futures for transplant patients. Indeed, Welch argues that "[p]osthumanist thinking can […] help us become more accepting of death and the limitations of medicine while fostering affinity and kinship through our *shared vulnerability*."[529] In *Pig-Heart Boy*, Cameron experiences this "shared vulnerability" through his relationship with his grandmother. In an analysis of intergenerational relationships in *Pig-Heart Boy*, Emma-Louise Silva discusses Cameron's relationships both with his grandmother, Nan, and with his unborn sibling, Alex.

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[527] Waldby, *Visible Human Project*, 49.
[528] Trott, "Change of Heart," 220.
[529] Welch, *Advancing Medical Posthumanism*, 12-13. Emphasis added.

Silva argues that through the intergenerational relationships depicted in the novel, "it becomes possible to see how forms of thinking across generations can impact the will to confront uncertain futures."[530] In particular, Silva argues that Cameron's relationship with Nan is a significant aspect of the novel, since—in contrast to his parents and friends—Nan "becomes his ally in openly talking about suffering and death."[531] While Silva does not directly connect these relationships with critical posthumanism, the vulnerability that Cameron and Nan share shows a posthumanist acknowledgement of the "limitations of medicine" that runs counter to the transhumanist enthusiasm for body modifications, enhancement, and even immortality.

Along with Cameron's relationship with his grandmother and their openness about discussing death, the novel's structure itself also encourages a critical posthumanist approach to life, death, and medicine. The novel does not end by reassuring readers that Cameron will survive: he undergoes a second pig heart transplant, but, as he explains to Alex in the final recording in the novel, "I'm not doing so well this time around. It's taking me a long time to get my strength back."[532] While Cameron tells Alex that "I'm hoping to be around when you're born,"[533] he recognizes that whether this will happen is "much more uncertain"[534] than his previous goal of reaching the bottom of the swimming pool. Through the ambiguous ending, the novel embraces a distinctly posthumanist perspective on the ability of xenotransplantation to mediate life/death and health/illness. As Welch argues,

> To understand our posthuman condition is to recognize our *corporeal embeddedness* in a material landscape—one that is constantly *shifting, transitory, and dying*. This understanding would necessarily coincide with a diminishment in the belief of medicine's power to both

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[530] Emma-Louise Silva, "'A Chance of Life Against No Chance At All': Intergenerational Minds in Malorie Blackman's *Pig-Heart Boy*," *Cahier voor Literatuurwetenschap* 15 (November 2024), https://doi.org/10.62956/etqj0y84. 14.
[531] Silva, "Intergenerational Minds," 11.
[532] Blackman, *Pig-Heart Boy*, 207.
[533] Blackman, *Pig-Heart Boy*, 207.
[534] Blackman, *Pig-Heart Boy*, 208.

> "fix" the ill body and to infinitely prolong death. However, neither accepting the fragmented nature of our existence nor accepting the inevitability of death means disregarding life.[535]

By leaving Cameron's future open-ended and depicting the challenges of Cameron's recovery, *Pig-Heart Boy* encourages readers to view him in terms of a "corporeal embeddedness" that is always "transitory." Despite the lack of certainty about Cameron's future, the novel's ending does not encourage readers to see Cameron's condition as "disregarding life." Indeed, Cameron still hopes to meet his sibling, and thinks about how his goal of surviving long enough to meet Alex "wouldn't be much of a challenge if it was easy, would it?"[536] By resisting the transhumanist desire to "solve" the organ shortage and "fix" the body, and instead exploring a much less certain—and much more embodied—future, *Pig-Heart Boy* suggests a posthumanist approach to the futures offered by experimental medicine.

2.7 "A life worth living": Narratives of Hope and the Future of Xenotransplantation

While this analysis has primarily focused on the bioethical concerns arising from xenotransplantation—particularly in relation to fears about its potential public health risks and the stigma and discrimination that might be experienced by patients—it is also important to note that, for many people, xenotransplantation is viewed in a significantly more hopeful and empowering light that differs from the techno-optimism seen in transhumanist rhetoric. And while the fictional depictions in *We Ate the Children Last* and *Pig-Heart Boy* can provide a useful way to examine the potential bioethical issues involved in xenotransplantation arising from the exploitation of desperate patients, it is important to balance this by considering how participating in experimental medical procedures can also be seen by patients as a way to reclaim autonomy over their health. Indeed, while

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[535] Welch, *Advancing Medical Posthumanism*, 16. Emphasis added.
[536] Blackman, *Pig-Heart Boy*, 208. Emphasis added

in *We Ate the Children Last* it is clear that Patient D will experience lifelong guilt and trauma, in *Pig-Heart Boy*, Cameron does not ultimately regret his procedure. For Cameron, receiving a pig heart was worthwhile despite the challenges he faced and even though his first transplant failed. When Cameron considers the prospect of undergoing a second pig heart transplant, he reflects on the factors motivating his decision:

> A crowd of images burned through my mind—images of me jumping and running and playing football. They were all worth holding onto—weren't they? Yes, there was a downside—pills and medicines and doctors and hospitals and Julie and animal rights extremists. But the upside was life. A life worth something. *A life worth living*. And surely a life worth living was a life worth fighting for.[537]

For Cameron, the potential benefits of xenotransplantation, and the possibility of regaining enough health and strength to participate in the activities he loved and spend more time with his family and friends outweigh all of the negatives he has experienced. Instead, xenotransplantation is a way for Cameron to reclaim a "life worth living."

We can see the same sentiment reflected in the perspectives of the patients who have chosen to undergo xenotransplantation procedures, as well as in the perspectives of their families and surgeons as they support them through the process. Before their surgeries, both David Bennett Sr. and Lawrence Faucette expressed hope for the possibility that the transplant might extend or improve their quality of their lives. For example, in a video shared by the University of Maryland School of Medicine, Lawrence Faucette and his wife, Ann Faucette, discuss his upcoming surgery. Faucette pragmatically acknowledges that "realistically, this is still an early-stage learning process and I have to be ready to accept whatever outcome we end up at."[538] Despite the uncertainties around the

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[537] Blackman, *Pig-Heart Boy*, 202-203. Emphasis added.
[538] University of Maryland School of Medicine, *Pig Heart Transplant Recipient Lawrence Faucette Expresses Optimism Prior to His Historic Surgery*, 2023, 2:33, https://www.youtube.com/watch?v=Jxe12v6RsoI. 1:08-1:30.

procedure, he explains that "at least now *I have hope* and I have a chance."[539] And while Lawrence Faucette only survived for a few additional weeks after his surgery, his loved ones have also expressed gratitude that the opportunity was available to him. For example, Ann Faucette describes her husband's decision to undergo the pig heart transplant in a *Washington Post* article, where she explains how

> He knew his time with us was short, and this was his last chance to do [something] for others […] He never imagined he would survive as long as he did, or provide as much data to the xenotransplant program. He was a man who was *always thinking of others*, especially myself and his two sons."[540]

For Ann Faucette, her husband's decision to undergo the surgery was a selfless choice that he made to benefit others and contribute to medical science.

The families of other xenograft recipients have also publicly spoken about their loved ones' decisions to undergo xenotransplantation, similarly highlighting both the extra time that the surgeries provided and the fulfillment that their loved ones experienced through having the ability to undergo the experimental procedures. David Bennett Sr.'s son, David Bennett Jr., has discussed his perspective in several media interviews. In a *Scientific American* article, he explains that his father "lived for two months, and we got to spend more time with him. So I was grateful for that […] I'm thankful for every dream and hope and every person that is involved in this and the ability that it has to move forward."[541] In an episode of the *New England Journal of Medicine*'s podcast *Intention to Treat*, he describes the experience in more detail, saying,

> My dad made probably the most courageous decision he's ever made in his entire life. He was either going to die or he was going to get a pig heart. And a pig heart had never been tried before in a human. But the surgeon was optimistic that this would give my dad more time with us, if nothing else. It was a time that I was able to get closer to my dad and find a greater love for what he was willing to do—not just for himself, but so many others.[542]

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[539] University of Maryland School of Medicine, *Historic Surgery*, 0:55-1:01. Emphasis added.
[540] Bella, "Second Pig Heart Transplant." Emphasis added.
[541] Lewis, "Milestone Pig-to-Human Heart Transplant."
[542] "Is Xenotransplantation Ready for Prime Time?," 3:36-4:14.

David Bennett Jr. views his father's decision to undergo xenotransplantation as worthwhile despite his father's death, not only because it gave them more time together, but also because it gave his father an opportunity regain agency and to help others. In a statement released by the Massachusetts General Hospital following Richard Slayman's death, Slayman's family shared similar sentiments:

> Millions of people worldwide have come to know Rick's story. We felt – and still feel – comforted by the optimism he provided patients desperately waiting for a transplant. […] After his transplant, Rick said that one of the reasons he underwent this procedure was to provide hope for the thousands of people who need a transplant to survive. Rick accomplished that goal and his hope and optimism will endure forever. His legacy will be one that *inspires patients, researchers, and health care professionals everywhere*.[543]

Across the statements made by the family members of xenograft recipients, it is clear that the procedure is seen as an opportunity for their loved ones to courageously help others and contribute to the future of transplant medicine, even if it does not significantly extend their own lives. Having an opportunity to inspire other transplant patients and to leave a "legacy" through which they would be remembered therefore gives xenotransplant patients and their families a sense of purpose and restores their sense of bodily and medical autonomy.

The surgeons involved in xenotransplantation research have also spoken about the importance of allowing patients to participate in these types of experimental procedures. In the *New England Journal of Medicine*'s podcast, Dr. Muhammad Mohiuddin, a transplant surgeon who was involved in both David Bennett Sr.'s and Lawrence Faucette's surgeries, explains that

> you can tell what those 60 days meant for Mr. Bennett. And you can talk to the family of Mr. Fawcett, and you will find out what those 40 days meant for them. So even though it looks like a short period of time, it meant a lot for that family and for the patient. And we can make that small progress.[544]

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[543] Massachusetts General Hospital, "An Update on Mr. Rick Slayman, World's First Recipient of a Genetically-Modified Pig Kidney," May 11, 2024, https://www.massgeneral.org/news/rick-slayman-family-and-mgh-statements. Emphasis added.
[544] "Is Xenotransplantation Ready for Prime Time?," 19:33-19:52.

In the same podcast episode, Dr. Robert Montgomery emphasizes the needs of patients who are waiting for organs. Montgomery explains how his own experience as a transplant patient has shaped his involvement in xenotransplantation, explaining that

> as a result of my own experience of developing heart failure, being very sick, having seven cardiac arrests, which I survived just by luck, basically, it became very clear to me that you have to get so sick in order to even get on the transplant list. […] And so it became very clear that we had to turn to an alternative source of organs. And xenotransplantation is the most promising, at this point.[545]

Following Lisa Pisano's death, Dr. Montgomery shared an update on the NYU Langone website, where he echoed this hope for the future of xenotransplantation, saying that "Lisa's contributions to medicine, surgery, and xenotransplantation cannot be overstated. Her legacy as a pioneer will live on […] Lisa helped bring us closer to realizing a future where someone does not have to die for another person to live."[546] From the perspective of the surgeons involved in xenotransplantation research, then, the procedure has the potential to make a real difference for transplant patients.

These patient-centred perspectives therefore provide a stark contrast to some of the other narratives that make up the biomedical imaginary around xenotransplantation. From the perspectives of xenograft recipients, their families, and their medical teams, it is clear that xenotransplantation is *not* the exploitative practice depicted in *We Ate the Children Last* but is much more aligned with Cameron's experience in *Pig-Heart Boy*, where it still poses serious challenges, but is also an opportunity to regain agency and spend more time with the patient's loved ones. Notably, these patients' willingness to participate as "pioneers" in experimental medical procedures and their hope that their experiences will benefit other transplant patients aligns with the way that organ donation is

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[545] "Is Xenotransplantation Ready for Prime Time?," 7:22-8:37.
[546] *NYU Langone News*, "First-Ever Combined Heart Pump & Gene-Edited Pig Kidney." Interestingly, this statement does not acknowledge that death is still involved in xenotransplantation, as pigs are killed so that their organs can be harvested. For further discussion of anthropocentrism and speciesism in xenotransplantation, see Chapter 5.

often framed as an altruistic "gift" from one person to another. As Russell discusses in her analysis of transplant fictions, this can be a meaningful way to make sense of organ transplantation, since "[t]he 'gift of life' metaphor […] offer[s] families and prospective donors an ideological anchor for their choices."[547] Altruism as an "ideological anchor" certainly seems to be present in xenotransplantation discourse, where patients who participate in early attempts at transplanting pig organs frame their experience in the context of a gift for future transplant patients.

It is equally important to recognize that for many potential xenograft recipients, opting to participate in an experimental medical procedure is an incredibly difficult decision with uncertain outcomes—both medically and socially. Analyzing depictions of xenograft recipients in fictional texts like *Pig-Heart Boy* and *We Ate the Children Last* can help to highlight the vulnerability and desperation of patients in need of transplants. On the other hand, the perspectives of real patients and their families can also help to temper the techno-optimistic rhetoric of biotechnology companies' claims that they can "engineer" or "deliver" hope to a patient like it is a product to be manufactured and sold, and the even more dehumanizing depiction of xenotransplantation as a transhumanist commodity in *We Ate the Children Last*. From the testimonies of xenotransplantation patients, as well as those of their families and surgeons, the procedure provides an intangible and uncommodifiable value by giving patients more time with their loved ones. And as Cameron concludes in *Pig-Heart Boy*, "surely a life worth living was a life worth fighting for."[548]

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[547] Russell, *Transplant Fictions*, 14.
[548] Blackman, *Pig-Heart Boy*, 202-203.

2.8 Conclusion

As a rapidly emerging area of biomedicine, xenotransplantation brings with it uncertain outcomes for both patients and for society. While this chapter has devoted the majority of its analysis to speculative depictions of xenotransplantation that explore the way the procedure could lead to the exploitation of and discrimination against xenograft recipients, these depictions must be balanced with the experiences of real patients. In a *BBC News* article, David Bennett Jr describes how "he hoped his father's transplant would 'be the beginning of hope and not the end.'"[549] To enable this goal to be realized, we must anticipate and respond to the bioethical issues that can arise from new biomedical developments like xenotransplantation. While the techno-optimistic rhetoric embraced by biotechnology and pharmaceutical corporations frames the procedure as an opportunity for biotechnology to "solve" a major medical problem, in *We Ate the Children Last*, the problematic nature of transhumanist approaches to "enhancing" the human body results in dehumanization and discrimination against those who undergo xenotransplantation. Meanwhile, in *Pig-Heart Boy*, despite the isolation that Cameron experiences due to the stigma of receiving a pig heart, he still ultimately sees the procedure as worthwhile, which more closely aligns with the way that real xenotransplantation patients and their families have described it as an opportunity for those patients to reclaim agency. As this analysis of xenotransplantation in the biomedical imaginary shows, the procedure is often referenced in relation to cultural narratives about unethical scientific experimentation on the body and the potential for xenotransplantation to fundamentally alter the identity of xenograft recipients. And yet, xenotransplantation can also provide patients with real hope—not hopes of achieving an "enhanced" and "liberated" body, like in *We Ate the Children Last*,

[549] *BBC News*, "Man given Genetically Modified Pig Heart Dies," March 9, 2022, sec. Health, https://www.bbc.com/news/health-60681493.

but rather the hope of regaining agency to engage in the activities that a patient no longer can and to spend more time with their loved ones.

So is xenotransplantation an opportunity for patients to reclaim agency, or is it possible that it will lead to discrimination and dehumanization? Will vulnerable patients be exploited and alienated, or will xenotransplantation become a health fad that promises to circumvent disease to enhance human health and optimize the human body? While it is too early to know what the future of xenotransplantation might be, raising questions about the bioethical implications that the experimental medical procedure might have for patients and for society can help us to better navigate the changing landscape of biomedicine. As companies continue to work to develop genetically modified pigs whose organs can be used in xenotransplantation, as medical researchers and surgeons attempt to identify ways to use xenotransplantation to address the current organ shortage crisis, and as patients on increasingly long waitlists seek alternative options, it is essential to proactively articulate and respond to the bioethical issues arising from this type of procedure. To return to Clayton's discussion of the role of literary analysis in shaping policies around new scientific developments, he argues that "[s]cience policy is now formulated in ways that allow a wide range of new actors to participate, giving the humanities a renewed opportunity to make their voices heard in the public sphere."[550] As I hope to have demonstrated through my analysis of xenotransplantation in the biomedical imaginary, literary analysis of narratives like *Pig-Heart Boy* and *We Ate the Children Last* can give us a valuable means to navigate the bioethical questions that arise from experimental medical procedures and gain a more nuanced understanding of both the risks and the hopes encompassed by new biomedical developments.

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[550] Clayton, *Literature, Science, and Public Policy*, ix.

Chapter 3: Repurposing Organs II: Investigating the Transcorporeal Dimensions of Xenotransplantation Narratives in the 21st Century Bioeconomy

3.1 Introduction

Even though organ transplantation has become increasingly successful as surgical techniques have evolved, a key problem facing transplant medicine in the 21st century is the widening gap between patients in need of organs and the number of organs available. This problem has been referred to as a "transplant shortage crisis,"[551] which the biotechnology company eGenesis describes as "a global crisis that continues to worsen" because "[t]he supply simply cannot keep pace with the demand."[552] As the company's webpage explains, factors like increasing life expectancy and rising rates of obesity have led to more patients being in need of organ transplants.[553] Several possible approaches have been proposed to address this significant medical problem, including the rapidly developing field of xenotransplantation, where organs or biological materials from nonhuman animals (primarily pigs) are transplanted into human patients. Following the 2020 FDA approval for therapeutic use of Revivicor Inc.'s genetically modified GalSafe pigs, xenotransplantation has gained momentum, and genetically modified pigs are increasingly favoured as a source of organs for transplantation. While xenotransplantation is a controversial approach that raises significant bioethical concerns,[554] it has been touted as a potential "solution" to the shortage of human organs,

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[551] eGenesis, "Transplant Shortage Crisis," accessed May 11, 2024, https://egenesisbio.com/transplant-shortage/.
[552] eGenesis, "Transplant Shortage Crisis."
[553] eGenesis, "Transplant Shortage Crisis."
[554] For an overview of the bioethical considerations in xenotransplantation, see John W. Entwistle, Robert M. Sade, and Daniel H. Drake, "Clinical Xenotransplantation Seems Close: Ethical Issues Persist," *Artificial*

and companies like eGenesis, Qihan Biotech, United Therapeutics, and Makana Therapeutics have started to develop pigs with a range of genetic modifications meant to make them better candidates for use in transplant medicine. Given the rapidly growing support for xenotransplantation, it is important to consider the rhetorical and narrative strategies used to frame xenotransplantation. While proponents draw on technosolutionism as they describe pig organs as the key to the organ shortage crisis, fictional depictions of the procedure instead explore the potential ecological, environmental, and political dimensions of xenotransplantation.

One such rhetorical strategy is demonstrated in a 2018 TEDx talk, where Dr. Luhan Yang, a geneticist and co-founder of biotechnology companies eGenesis and Qihan Biotech, advocates for the future use of pig organs in transplant medicine. eGenesis's proposed solution is Laika, a genetically modified pig that can be used as a "platform […] to solve the immunology problem"[555] that is currently delaying developments in xenotransplantation. Laika the pig serves as a reference to the rapid developments in space science and exploration in the mid-twentieth century, and as Yang argues, the pig is "the first critical step" in xenotransplantation.[556] Ray Carr discusses eGenesis' use of Laika as a strategy to promote xenotransplantation, noting that the pig "contributes to the credibility of eGenesis' vision of a *future organ surplus*, engendering faith in the science of genetic engineering."[557] Further, Carr notes that Laika is represented as "[a] regenerable resource"[558] providing ongoing opportunities to capitalize on the pig as a biomedical product. Importantly, Laika

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Organs 46, no. 6 (2022): 987–94, https://doi.org/10.1111/aor.14255. For a discussion of the bioethical issues related to the experience of xenograft recipients, see Chapter 2.

[555] *How to Create a World Where No One Dies Waiting for a Transplant*, TED, 2018, https://www.ted.com/talks/luhan_yang_how_to_create_a_world_where_no_one_dies_waiting_for_a_transplant. 9:10-9:17.

[556] *How to Create a World Where No One Dies Waiting for a Transplant*, 9:03-9:45. Emphasis added.

[557] Ray Carr, *Species of Contagion: Animal-to-Human Transplantation in the Age of Emerging Infectious Disease* (Palgrave Macmillan, 2022). 144. Emphasis added.

[558] Carr, *Species of Contagion*, 142.

is not just *regenerable*: the pig is also *expendable.* In a *Smithsonian Magazine* article about the dog Laika's trip into space to test the impact of space travel on animals, Alice George notes that the decision to use dogs may have been because "stray dogs were *plentiful* in the streets of the Soviet Union—easy to find and unlikely to be missed."[559] Dogs like Laika were viewed as an expendable or disposable resource that could be freely used for scientific experimentation. It is notable, then, that eGenesis chose to name their genetically modified pig after Laika: in addition to explicitly drawing a parallel between revolutionary space travel and developments in biomedicine, there are also unspoken parallels in the ways that pigs and dogs have both been viewed as "plentiful" (and therefore disposable) resources that can be exploited and sacrificed in the name of scientific advancement.

In this chapter, I contrast how organs have been described as an "abundant" and "sustainable" resource in the media coverage of xenotransplantation with the way that speculative literary depictions of xenotransplantation have instead explored the potential for the procedure to have adverse global impacts. As I will demonstrate, the "abundance" of pig organs has been used as a rhetorical frame to promote the procedure as an easy and "renewable" solution to the organ shortage crisis. While the abundance frame makes pigs appear as an appealing source of transplantable organs that can "solve" the organ shortage crisis, fictional depictions of xenotransplantation have instead explored the procedure within the context of overconsumption. Two literary depictions are especially relevant: *Oryx and Crake* (2003), a speculative fiction (SF) novel by Canadian writer Margaret Atwood, and *Chromosome 6* (1997), a medical thriller by American writer Robin Cook. Both novels depict societies where corporations capitalize on animals as an abundant supply of organs against a backdrop of environmental, agricultural, political, and economic exploitation. The speculative futures

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[559] Alice George, "The Sad, Sad Story of Laika, the Space Dog, and Her One-Way Trip Into Orbit," *Smithsonian Magazine*, April 11, 2018, https://www.smithsonianmag.com/smithsonian-institution/sad-story-laika-space-dog-and-her-one-way-trip-orbit-1-180968728/. Emphasis added.

depicted in these novels raise ethical concerns about the use of animals as "abundant" resources and encourage audiences to recognize the way that xenotransplantation is not solely a medical topic, but is also interconnected with numerous human systems. While xenotransplantation is a promising medical field that could have significant benefits for transplant patients, analyzing these literary depictions can help to identify potential ethical considerations about how xenotransplantation will develop within and be shaped by existing systems of exploitation. Therefore, this chapter will focus on an investigation of the ethical concerns arising from the environmental, political, and economic dimensions of xenotransplantation.[560] By tracing the transcorporeal dimensions involved in biomedical research, we can better prepare for and respond to the multifaceted ethical issues that arise from new biotechnologies like xenotransplantation.

3.2 A Transcorporeal Analysis of Overconsumption in Xenotransplantation Narratives

As new biotechnologies continue to develop, it is essential to consider how they become embedded in and shaped by 21st-century bioeconomies.[561] In an analysis of the way the term "bioeconomy" has emerged across academic literature, Markus M. Bugge et al. identify three specific visions of the 21st-century bioeconomy. One of these, they note, is the "bio-technology vision," which focuses on the "application and commercialisation of bio-technology in different sectors."[562] The

[560] Along with its bioethical, political, economic, and environmental considerations, xenotransplantation also raises animal rights concerns. While a discussion of animal ethics is beyond the scope of this chapter, Chapter 5 engages more directly with the depiction of xenotransplantation animals themselves to consider the role of literature in inspiring more compassionate and ethical treatment of nonhuman beings.
[561] In this chapter, I use "bioeconomy" to refer to the global economic implications of biotechnological developments, while "biovalue" refers to the way that bodies are commodified in biomedical research to create new sources of vitality.
[562] Markus M. Bugge, Teis Hansen, and Antje Klitkou, "What Is the Bioeconomy? A Review of the Literature," *Sustainability* 8 (2016), https://doi.org/doi:10.3390/su8070691. 9.

"bio-resource vision," on the other hand, describes an economy where "the potentials in upgrading and conversion of the biological raw materials"[563] are a key component. In both ways of conceptualizing the bioeconomy, biological materials and biotechnologies are seen in terms of how they can be used to generate capital. As Bugge et al. note, while these visions are proposed as a means of addressing the "grand challenges" like climate change, the primary focus is on economic growth and the production of "a very wide spectrum of marketable products"[564] rather than any specific environmental or ecological concerns. Importantly, in the bio-technology vision, "risks and ethical concerns are subordinate priorities to economic growth."[565] Bugge et al. therefore call for scholars working in the humanities and social sciences to analyze the ethical and societal dimensions of the bioeconomy. In response to this need, I consider xenotransplantation in relation to the commercialization of biotechnologies and the commodification of organs as raw materials and marketable products.

New biotechnologies and biomedical procedures are also developing in the context of the massive overconsumption that defines the 21st century. For example, environmental studies researchers Diana Stuart et al. argue that an "ideology of overconsumption" has emerged because "[c]apitalist production requires and therefore creates increasing rates of excess consumption."[566] As an economic system that not only relies on, but actively *creates* conditions for "excess consumption," capitalism has led consumers to view consumption differently, and to "accept and normalize the prioritization of economic growth"[567] over other factors. Because of this prioritization of economic

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[563] Bugge et al., "What Is the Bioeconomy?" 9.
[564] Bugge et al., "What Is the Bioeconomy?" 10.
[565] Bugge et al., "What Is the Bioeconomy?" 10.
[566] Diana Stuart, Ryan Gunderson, and Brian Petersen, "Overconsumption as Ideology Implications for Addressing Global Climate Change," *Nature and Culture* 15, no. 2 (June 22, 2020): 199–224, https://doi.org/10.3167/nc.2020.150205. 206.
[567] Stuart et al., "Overconsumption as Ideology Implications," 211.

growth, the ideology of overconsumption is also linked to anthropogenic environmental crises. As Stuart et al. explain, "[o]verconsumption in the US has direct and indirect impacts on climate change,"[568] and part of this is that "there exists a powerful ruling class resisting anything that might reduce increasing levels of production and profit."[569] As a medical procedure, xenotransplantation may seem to exist outside of this economic system of overconsumption and its environmental impacts. Indeed, *over*consumption implies that there is in fact an acceptable or correct rate of consumption. This presupposition can make the connection of xenotransplantation with capitalist overconsumption problematic, since it can be difficult, or even impossible, to define the "correct" rate of consumption when it comes to life-saving medical products. However, as I argue in this chapter, the production and commodification of organs for xenotransplantation is depicted in SF as being interconnected with global systems of (over)consumption that can exacerbate inequalities and contribute to environmental concerns, including medical tourism, resource extraction, and animal agriculture. Thus, it is not the procedure itself that is contributing to overconsumption, but rather the capitalistic and Anthropocentric conditions in which the procedure is developed and carried out.

It is important to consider how the use of pig organs in xenotransplantation is emerging within a harmful anthropocentric economic system that prioritizes the commodification of raw materials and the exploitation of natural resources, often to the detriment of people, animals, and the environment. The term "Necrocene" has been proposed to highlight the way that capitalist economies result in widespread death and extinction.[570] Justin McBrien differentiates the term "Necrocene" from

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[568] Stuart et al., "Overconsumption as Ideology Implications," 209.
[569] Stuart et al., "Overconsumption as Ideology Implications," 211.
[570] Oriol Batalla, "Green Capitalism? Politics from the Necrocene to the Eleutherocene," *E-Cadernos CES* 34, no. 34 (2021), https://doi.org/10.4000/eces.5553; Justin McBrien, "Accumulating Extinction: Planetary Catastrophism in the Necrocene," in *Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism*, ed. Jason W. Moore (PM Press/Kairos, 2016).

the term "Anthropocene," which is commonly used to describe the way that humanity has shaped natural environments on a global scale; McBrien argues that this term "reinforces what capital wants to believe of itself: that human 'nature,' not capital, has precipitated today's planetary instability."[571] The term Necrocene, instead, emphasizes how capitalism—and capitalism's exploitative practices—shapes the world through *ending lives*. Similarly, while Catherine Waldby's term "biovalue" traces the exploitation of vitality in biomedicine,[572] the term Necrocene calls more pointed attention to the way that certain lives are *ended* to enhance the lives of others on a global scale. By relying on the production, harvesting, and distribution of animal organs to extend human lives, xenotransplantation is an example of the way that biovalue is created and ascribed within the context of the Necrocene. As I will explore, proponents of xenotransplantation position animals as abundant resources that can provide unlimited organs for human patients. In some literary depictions, however, xenotransplantation is linked directly with exploitative systems, highlighting that while the procedure can benefit the lives of patients in need, it is also emerging within the context of the Necrocene, where the deaths of some beings are reframed as a source of vitality for others.

A transcorporeal, posthumanist analysis can allow us to trace the ways that an ideology of overconsumption is woven into xenotransplantation narratives. Stacy Alaimo introduces the concept of transcorporeality as a way of tracing the interconnections between bodies, materials, environments, and human systems. This posthumanist approach has important ethical implications: Alaimo argues that "[p]otent ethical and political possibilities emerge from the literal contact zone between human corporeality and more-than-human nature," since "[i]magining human corporeality as trans-corporeality, in which the human is always intermeshed with the more-than-human world, underlines

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[571] McBrien, "Accumulating Extinction," 119.
[572] Catherine Waldby, *The Visible Human Project: Informatic Bodies and Posthuman Medicine* (Routledge, 2000).

the extent to which the substance of the human is ultimately inseparable from 'the environment.'"[573] One of the outcomes of tracing transcorporeality is that identifying these networks of exchange and interconnection demonstrates that the "human" is always interacting with the environment. While Alaimo focuses primarily on toxic chemicals, her approach can be extended to an analysis of xenotransplantation since the procedure moves biological material between bodies and across species, bringing these bodies into contact with political, economic, environmental, ecological, and medical systems. Analyzing the transcorporeal dimensions of xenotransplantation across global systems including medical tourism, resource extraction, and animal agriculture reveals that the ethical concerns raised by xenotransplantation extend beyond the immediate impacts that the procedure will have on the patient; indeed, understanding these ethical concerns involves interrogating anthropocentric attitudes towards exploitation and overconsumption.

3.3 The "wind and solar" of Organ Transplantation: Framing Xenotransplantation in Terms of Abundance, Sustainability, and Scientific Advancement

The idea that animals are an *abundant* resource that can be used to address the organ shortage crisis has become a dominant frame for xenotransplantation. As Brigitte Nerlich et al. describe, frames refer to the "interpretive packages and storylines"[574] that are frequently employed when discussing scientific developments. Analyzing the frames that are used to communicate about scientific developments is important because "frames simplify complex issues by lending greater

[573] Stacy Alaimo, *Bodily Natures: Science, Environment, and the Material Self* (Bloomington: Indiana University Press, 2010). 2.
[574] Brigitte Nerlich, Richard Elliott, and Brendon Larson, eds., *Communicating Biological Sciences: Ethical and Metaphorical Dimensions* (Routledge, 2016). 7.

weight to certain considerations and arguments over others."[575] In xenotransplantation discourse, the frame of abundance has permeated all dimensions of conversations about the procedure: biotechnology and pharmaceutical companies, medical practitioners, researchers, and science writers have all referenced the "abundant" supplies of pig organs as a viable solution to the lack of human organs. For example, Makana Therapeutics hopes to "solve the transplantable organ shortage crisis by using genetically modified pigs to provide *an abundant supply* of donor organs for individuals in desperate need,"[576] while Revivicor Inc. proclaims that "[p]igs can provide *a plentiful and accessible supply* of transplantable organs,"[577] and eGenesis similarly refers to pigs as a strong candidate for xenotransplantation because of the "*abundance* of the species."[578] Each of these companies contributes to what the CEO of United Therapeutics, Martine Rothblatt, describes as a vision of "mov[ing] us from today's transplant *paradigm of scarcity* to a new transplant *paradigm of abundance*."[579]

In some cases, pigs are not simply referred to as an abundant source of organs, but as an *unlimited* source. For example, Dr. Muhammad Mohiuddin, the director of the Cardiac Xenotransplant Program at the University of Maryland School of Medicine, sees pigs as providing "*an endless supply* of these organs,"[580] while Dr. Andrew Cameron, the surgeon-in-chief at the Johns Hopkins Hospital, argues that "[i]f we pull this off, there will be *an essentially unlimited supply* of

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[575] Nerlich et al., eds., *Communicating Biological Sciences,* 7.
[576] Makana Therapeutics, "Makana Therapeutics," accessed June 23, 2023, https://makanatherapeutics.com/xenotransplantation/. Emphasis added.
[577] Revivicor, "Revivicor," accessed June 23, 2023, https://www.revivicor.com/. Emphasis added.
[578] eGenesis, "Xenotransplantation," accessed May 11, 2024, https://egenesisbio.com/xenotransplant/. Emphasis added.
[579] Martine Rothblatt, "A Personal Perspective on the Science, Ethics, and Commercialization of Xenotransplantation," *Xenotransplantation* 25, no. 3 (2018): e12414, https://doi.org/10.1111/xen.12414. 2. Emphasis added.
[580] Tom Metcalfe, "Surgeons Transplant Pig's Heart into Dying Human Patient in a First," *Scientific American*, January 11, 2022, https://www.scientificamerican.com/article/surgeons-transplant-pigs-heart-into-dying-human-patient-in-a-first/. Emphasis added.

organs for our sick patients *to fill that unmet need forever*."[581] eGenesis similarly declares that "[o]ur goal is to create *an unlimited supply* of safe and effective HuCo™ organs and cells for xenotransplantation."[582] This language appears in science magazines as well: in one *Discover* article, Elizabeth Svoboda writes that "these organs could feed *an inexhaustible cross-species transplant pipeline*."[583] As these widespread examples demonstrate, the abundance frame positions pigs as an exploitable and unlimited resource that can provide a seemingly unproblematic solution to the challenges of the human organ transplant system.

Given how widespread the use of the abundance frame is in the public discussion of xenotransplantation, it is important to understand the implications of this rhetorical choice. As Nerlich et al. note, "[l]anguage, whether of the breakthrough-and-hype or humility-and-honesty variety, is the essential tool scientists and journalists use when they engage in scientific discovery and scientific storytelling," since "[i]t can attract attention, increase funding, excite people, encourage them to accept a new technology and so on."[584] Consequently, they argue, "this process has political and ethical implications that need to be understood and discussed."[585] One of the implications at play in the use of the abundance frame is that the goal is to make xenotransplantation appear as not simply a long-term solution to the organ shortage crisis, but also an *ethically acceptable* approach for public audiences. In a *Scientific American* article about Luhan Yang's work on xenotransplantation, Sharon Begley notes that "[w]here other people see bacon, biologist Luhan Yang sees lifesaving organs — *hundreds and thousands* of them, pig livers and pig kidneys and diabetes-curing pancreases, and

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[581] *Xenotransplantation: Past, Present, Future*, 2023, https://www.youtube.com/watch?v=bHG5OlTnH38. 6:32-6:42. Emphasis added.
[582] eGenesis, "Our EGEN™ Platform," accessed May 11, 2024, https://egenesisbio.com/our-approach/.
[583] Elizabeth Svoboda, "Doctors Break the Interspecies Barrier to Save Lives," *Discover Magazine*, December 3, 2023, https://www.discovermagazine.com/the-sciences/doctors-break-the-interspecies-barrier-to-save-lives. Emphasis added.
[584] Nerlich et al., eds., *Communicating Biological Sciences.* 5.
[585] Nerlich et al., eds., *Communicating Biological Sciences.* 5.

possibly hearts and lungs, all growing inside *droves of pampered swine*."[586] In addition to framing pig organs as an abundant resource that appears in "droves," this imagery of "pampered swine" is employed to imply that these pigs will lead comfortable—even luxurious—lives before their organs are harvested for human use. This idea extends beyond science journalism: in an analysis of the moral permissibility of eating chimeric pigs, Christopher Bobier also promotes the idea that the pigs created for xenotransplantation will be "pampered":

> There is good reason to think that chimeras will be treated well independently of the legal regulations. In order to maximize the health of the transplantable organs, chimeras will not be housed in cramped, miserable cages, nor will they live in their own waste. They will be housed in sanitary labs and fed nutritious food. To reduce psychological stress, which can be transmitted to the organs, chimeras will have some stimulation, including toys and possibly conspecifics. They will not be slaughtered in massive slaughtering factories that increase stress and pain; rather, in order to ensure the safe harvesting of organs as well as to reduce stress transmission to organs, the sedation will be as painless as possible.[587]

Whether Bobier's highly optimistic vision of chimeric pigs living comfortably, eating "nutritious food," and playing with toys will come to pass remains to be seen, but because pigs are not usually a "pampered" species, this rhetorical choice might lead audiences to believe that these animals will lead better lives than agricultural pigs, making the sacrifice of the animals for medical use appear to be more ethically acceptable.

As noted above, another ethical consideration in science communication is that "frames simplify complex issues,"[588] which can lead to the nuanced dimensions of a scientific development being lost. In the context of the abundance frame, one of the ways that this is achieved is by metaphorically comparing xenotransplantation to renewable energy by referring to pig organs as

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[586] Sharon Begley, "Seeking Pig Organs for Human Transplants," *Scientific American*, April 16, 2017, https://www.scientificamerican.com/article/seeking-pig-organs-for-human-transplants/. Emphasis added.
[587] Christopher Bobier, "Should We Eat the Human-Pig Chimera?," *Food Ethics* 5, no. 1 (2020): 15, https://doi.org/10.1007/s41055-020-00073-6. 4.
[588] Nerlich et al., eds., *Communicating Biological Sciences.* 7.

"sustainable" and "renewable" resources. Dr. Robert Montgomery, the Director of the NYU Langone Transplant Institute and a vocal advocate for xenotransplantation, has invoked these types of metaphors when referring to the use of pig organs. For example, in *Scientific American*, science writer Tanya Lewis notes the parallel Montgomery draws between the North American human-to-human organ transplant system and fossil fuels. Montgomery, who is quoted in the article, argues that "[y]ou can have it burn cleaner, you can make all these various changes […] but it's still never going to be what you really need, which is something that's renewable, that is sustainable."[589] In an episode of the podcast *The Pursuit of Precision: The Science of Advancing Individualized Medicine*, Montgomery draws even more heavily on the imagery of renewable energy as he argues that "I kind of look at artificial organs and xenotransplantation as sort of the *wind and solar* of the future of organ availability. It's a *sustainable way* to create a new source of organs, and […] that's our number one unmet need in transplantation right now."[590] By framing pig organs as a *sustainable* resource and drawing connections between xenotransplantation and renewable wind and solar energy, Montgomery invokes environmental imagery associated with abundance to argue that using pig organs will solve the problems of the (currently "unsustainable") human-to-human organ transplant system.

The metaphorical connection between pig organs and renewable resources can have important implications for public understanding and support of xenotransplantation. As Nerlich argues, "[c]reating critical awareness of the metaphorical enactment of certain 'scripts' or 'frames' in the process of science communication, whether it is intended to create positive expectations or

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[589] Tanya Lewis, "How New Advances in Organ Transplants Are Saving Lives," *Scientific American*, November 1, 2023, https://www.scientificamerican.com/article/no-one-should-die-waiting-for-an-organ-transplant-these-doctors-want-to-ensure-that-doesnt-happen/.
[590] Mayo Clinic Center for Individualized Medicine, "Xenotransplantation and Regenerative Medicine," *The Pursuit of Precision: The Science of Advancing Individualized Medicine*, 2023, accessed August 29, 2023. 8:45-10:18. Emphasis added.

negative ones, to create hope or fear or to make promises or issue warnings, should […] be an important task for sociologists, linguists and other scholars,"[591] because "[o]nly then can 'the public' engage critically with science in society."[592] In the case of xenotransplantation, the abundance frame can mislead audiences by implying that using pig organs in xenotransplantation will be medically beneficial (it will "solve" the organ shortage crisis), while also being ethical (the pigs will be "pampered") and environmentally friendly (as the "wind and solar" of transplant medicine). By creating these associations, this frame of abundance can obscure other important ethical considerations. For example, if pig organs are a truly abundant resource, will everyone who needs an organ be able to receive one, or will financial barriers make the procedure inaccessible to some patients? In other words, will some patients be prioritized above others? Similarly, if pig organs are considered an abundant resource, what global and political considerations might arise as corporations seek to capitalize on organs as raw materials? Additionally, while this frame aligns xenotransplantation with being environmentally friendly, considering that animal agriculture has been a major contributor to climate change and environmental destruction, how can we trace the material environmental and ecological impacts of raising pigs for xenotransplantation?

Literary depictions of xenotransplantation can reflect on and respond to these unanswered questions that are obscured by the frame of abundance, including the global impacts that xenotransplantation can have, and the material impacts of capitalizing on animal organs as a commodity. Fictional narratives about xenotransplantation, such as Atwood's *Oryx and Crake* and Cook's *Chromosome 6*, counter this rhetorical frame of abundance that implies that animal organs are a resource that can be easily and unproblematically repurposed for human benefit. Instead, these

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[591] Brigitte Nerlich, "Breakthroughs and Disasters," in *Communicating Biological Sciences: Ethical and Metaphorical Dimensions*, ed. Brigitte Nerlich, Richard Elliott, and Brendon Larson (Routledge, 2016). 215.
[592] Nerlich, "Breakthroughs and Disasters," 215.

narratives depict corporations capitalizing on the perceived "abundance" of animal organs in ways that come at a cost—whether social, political, or environmental—and are not universally beneficial. As Alaimo argues, "[a] trans-corporeal ethics calls us to somehow find ways of navigating through the simultaneously material, economic, and cultural systems that are so harmful to the living world and yet so difficult to contest or transform."[593] By exploring how xenotransplantation is emerging in relation to these harmful but difficult to identify systems, these narratives show that "abundant" resources are rarely truly accessible for the majority of people, nor are they truly "sustainable" and without environmental and ecological costs. By considering xenotransplantation narratives alongside xenotransplantation discourse (particularly the rhetorical frame of "abundance"), I aim to call attention to some of the material considerations of the future of xenotransplantation.

3.4 Growing Organs in Living Bioreactors: Corporate Greed and Life as a Commodity in *Oryx and Crake*

Margaret Atwood's highly acclaimed speculative novel *Oryx and Crake* provides a counternarrative to the claims that using pigs in xenotransplantation will be a "sustainable" practice. *Oryx and Crake* depicts xenotransplantation in the context of capitalism and overconsumption, exploitative animal agriculture, widespread infectious disease transmission, and corrupt biotechnology corporations. As the first novel in the *MaddAddam* trilogy, *Oryx and Crake* follows two storylines that take place before and after a worldwide pandemic. One storyline features Jimmy as he grows from a child into an adult, and the other follows "Snowman," the identity that Jimmy adopts following the pandemic. Jimmy's storyline depicts his childhood growing up in a wealthy

[593] Alaimo, *Bodily Natures*, 18.

compound while his parents work for HelthWyzer, a bioengineering company that creates products like the pigoons, which are modified pigs that can grow human organs for transplantation. When Jimmy's childhood friend Crake later begins working for the biotechnology corporation RejoovenEsense, Crake pulls strings to get Jimmy hired. Jimmy discovers that Crake had been working on the creation of genetically modified humans called "Crakers." This storyline ends with the release of a deadly virus in a worldwide attack that was orchestrated by Crake himself, who had envisioned a world where the greedy and environmentally destructive human population would be replaced by Crakers. Meanwhile, in the Snowman storyline, most humans have died from the virus that Crake released. Following Crake's wishes, Snowman leads the Crakers out of the compound and into the wild, where they become self-sufficient. Other genetically modified beings, including pigoons, have also escaped and populated the wilderness around the compounds. The pigoons—modified so they could be used not only for organ transplantation, but also for the transplantation of skin and neocortical tissue—are highly intelligent, and begin to hunt Snowman, who only narrowly escapes. Snowman eventually realizes that several other humans had survived the virus, and sets out to meet them.[594]

Throughout *Oryx and Crake*, it is apparent that biological material is widely considered to be a commodity. With society becoming highly segmented based on economic stratification, biomedical and pharmaceutical corporations like HelthWyzer and RejoovenEsense capitalize on the desires of wealthy individuals to maintain their health and youth. The genetically modified pigoons created by HelthWyzer are one example of this commodification of life. The pigoons are designed as vessels that can grow multiple human organs, which can then be used for xenotransplantation. Early in the novel, it is explained that Jimmy's father was involved in the development of the pigoons and that "[t]he

[594] *Oryx and Crake* is followed by two sequels: *The Year of the Flood* (2009) and *MaddAddam* (2013).

goal of the pigoon project was to grow an assortment of foolproof human-tissue organs in a transgenic knockout pig host."[595] These pigs are optimized to grow as quickly as possible and create as many organs as possible:

> A rapid-maturity gene was spliced in so the pigoon kidneys and livers and hearts would be ready sooner, and now they were perfecting a pigoon that could grow five or six kidneys at a time. Such a host animal could be reaped of its extra kidneys; then, rather than being destroyed, it could *keep on living and grow more organs*, much as a lobster could grow another claw to replace a missing one.[596]

Through the depiction of the rapidly growing, oversized, genetically modified pigs producing "five or six kidneys at a time," and able to *continue* producing new organs throughout their lifespans, *Oryx and Crake* foresees the way that xenotransplantation is now framed in terms of infinite abundance. Traci Warkentin argues that Atwood's depiction of pigoons is an example of "mechanomorphosis," where "the bodies of animals are modified to grow in ways that result in commercially valuable and consumable 'parts' and processes for medicinal or agricultural purposes."[597] Similarly, in an analysis of the pigoons, Silvia Camporesi argues that "the use of animals as biofactories, as would be the case for using pigs to grow humanized organs, could and often does reveal and reflect the worst tendencies of our species," including "the seemingly inevitable tendency towards factory farming, where economic efficiencies are prioritized over environmental and safety concerns."[598] Part of what makes the depiction of the pigoons especially troubling (and reflective of "the worst tendencies" of humans) is the transgressive genetic modification that allows pigoons to seemingly *over*produce organs to meet the demand of wealthy consumers. *Oryx and Crake* therefore provides an example of a society that

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[595] Margaret Atwood, *Oryx and Crake* (Vintage Canada, 2003). 22.
[596] Atwood, *Oryx and Crake*, 22-23. Emphasis added.
[597] Traci Warkentin, "Dis/Integrating Animals: Ethical Dimensions of the Genetic Engineering of Animals for Human Consumption," *AI & SOCIETY* 20, no. 1 (January 2006): 82–102, https://doi.org/10.1007/s00146-005-0009-2. 84.
[598] Silvia Camporesi, "Crispr Pigs, Pigoons and the Future of Organ Transplantation: An Ethical Investigation of the Creation of Crispr-Engineered Humanised Organs in Pigs," *Etica & Politica/Ethics & Politics* 3 (2018), https://doi.org/10.13137/1825-5167/22584. 44.

has embraced genetically modified pigs as an ultimate source of abundant transplantable material—albeit abundant only in the context of the wealthy biotech and pharmaceutical compounds.

While *Oryx and Crake* satirizes the use of animals as vessels for producing organs, the company Qihan Biotech has recently (and unironically) embraced a similar vision of endless supplies of pig organs for xenotransplantation. On their website, Qihan Biotech states that they "pioneer in engineering extensively genome-modified pigs as *bioreactors* to 'grow' xenogeneic cells, tissues and organs for safe and effective clinical applications."[599] A bioreactor is a container that creates the conditions required for the formulation of products from various biological materials[600]—or, to put it more simply, it is "a machine for growing organisms."[601] As a vessel (or "machine") used to manufacture useable products, bioreactors are typically inanimate objects like stainless steel tanks. Conceptualizing pigs as bioreactors that can create products for humans frames the process as one that is sterile, scientific, and efficient, turning pigs into operable machines that produce organs according to human needs. This can obscure the ethical considerations of using pigs for organs by encouraging audiences to see pigs in terms of inorganic machinery. And while the similarities between Qihan Biotech's vision of pigs as bioreactors and Atwood's depiction of pigoons are (almost) certainly unintentional, the rhetorical move towards turning pigs into scientific machinery[602] moves toward a similar outcome: a society that views animal bodies as exploitable products without regard for the animals themselves.

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[599] Qihan Biotech, "Science," accessed May 6, 2024, https://www.qihanbio.com/science. Emphasis added.
[600] "What Is a Bioreactor," Bioreactors.Net (blog), accessed July 21, 2024, https://bioreactors.net/about/what-is-a-bioreactor/.
[601] "Definition of 'Bioreactor,'" Collins English Dictionary, July 16, 2024, https://www.collinsdictionary.com/dictionary/english/bioreactor.
[602] For a more in-depth discussion of how the pigoons in *Oryx and Crake* lose their animal qualities through "mechanomorphosis," see Warkentin, "Dis/Integrating Animals."

While *Oryx and Crake* engages with the idea that biotechnology can "solve" the organ shortage by providing an abundant source of organs, this approach is not depicted by Atwood as an ethical or sustainable solution. Instead, the depiction of pigoons as bioreactors in the novel oversimplifies the production of organs. Camporesi considers the way that proponents of xenotransplantation like Dr. George Church, a geneticist who co-founded the xenotransplantation companies eGenesis and Qihan Biotech, see xenotransplantation as creating "a rosy utopia," and contrasts this with how "bioconservatives" like Margaret Atwood instead see it instead as "a grim dystopia."[603] The dystopian future that Atwood describes, according to Camporesi, is one "where humanity is exploiting animals for the mass manufacture of organs for the benefit of only a small portion of society, the technologically advanced, while the social inequalities have grown exponentially leading to violence, riots and widespread living in gated community."[604]

Indeed, throughout *Oryx and Crake*, not only are animals exploited by companies like HelthWyzer, but so too are humans when these companies promise that their products will provide health, wellness, and youth. For example, when Jimmy's father excitedly reveals the plans to develop neocortical tissues using pigoons, Jimmy's mother is immediately skeptical. While Jimmy's father insists that "[w]e can give people hope. Hope isn't ripping them off!,"[605] Jimmy's mother responds that "[a]t NooSkins' prices it is. You hype your wares and take all their money and then they run out of cash, and it's no more treatments for them. They can rot as far as you and your pals are concerned."[606] It is evident from this exchange that, like other HelthWyzer products, neocortical tissue for xenotransplantation would only be accessible by the select few who can pay for the product.

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[603] Camporesi, "Crispr Pigs," 41.
[604] Camporesi, "Crispr Pigs," 41.
[605] Atwood, *Oryx and Crake*, 56.
[606] Atwood, *Oryx and Crake*, 56-57.

Rather than the abundance of pig organs benefitting patients, this fictional depiction of xenotransplantation instead speculates that corporations are more likely to prioritize capitalizing on the biovalue of these organs,[607] making them financially inaccessible for most prospective patients.[608]

Beyond merely capitalizing on consumers' desire for health and vitality, HelthWyzer is also shown actively creating dependence on their products to ensure continuous consumption. Crake reveals to Jimmy that HelthWyzer had purposefully created "hostile bioforms"[609] to infect the public. As Crake explains, the company used "a really elegant delivery system"[610] where they concealed viruses in products like vitamins, so that when consumers took the pills, they would become infected. Then, Crake explains, "they develop the antidotes at the same time as they're customizing the bugs, but they hold those in reserve, they practise the economics of scarcity, so they're guaranteed high profits."[611] As this indicates, the company not only actively infects the public with a virus so that they will have to purchase HelthWyzer's antidotes to counteract the infection, but also that HelthWyzer artificially limits the amount of antidotes on the market so that the public will be forced to pay high rates. A second strategy that these corporations employ is hoarding and stealing intellectual property, resulting in the perpetual threat that their products will be stolen or sabotaged. Even as a child, Jimmy

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[607] For another analysis of *Oryx and Crake* (and the rest of the *MaddAddam* trilogy) that draws on Waldby's concept of "biovalue," see Amelia DeFalco, "MaddAddam, Biocapitalism, and Affective Things," *Contemporary Women's Writing* 11, no. 3 (2017): 432–51, https://doi.org/10.1093/cww/vpx008. DeFalco focuses on the commodification of both information and material, arguing that "[b]iotechnology's convergence of bioscience and computer science, which depends on the molecular compartmentalization of life, introduces new market opportunities." DeFalco, "MaddAddam," 14. Consequently, she argues that throughout the novels, "'biovalue' is powerful to the point of domination, producing a biocapitalist economy in which biotech corporations like OrganInc Farms, NooSkins, and RejoovenEssense trade in genetic material and modifications, in viruses, vaccines, tissues and organs." DeFalco, "MaddAddam," 15.
[608] For a discussion of xenotransplantation and transhumanism, including the shift of xenograft recipients from patients to "customers," see Chapter 2.
[609] Atwood, *Oryx and Crake*, 28.
[610] Atwood, *Oryx and Crake*, 211.
[611] Atwood, *Oryx and Crake*, 211.

is aware that "[a] great deal of investment money had gone into OrganInc Farms"[612] where the pigoons are produced. To protect this investment, the pigoons "were kept in special buildings, heavily secured,"[613] because "the kidnapping of a pigoon and its finely honed genetic material by a rival outfit would have been a disaster."[614] Despite the security measures taken to protect the pigoons, Jimmy considers how:

> the CorpSeCorps men—the ones Jimmy's father called our people—these men had to be on constant alert. When there was so much at stake, there was no telling what the other side might resort to. The other side, or the other sides: it wasn't just one other side you had to watch out for. Other companies, other countries, various factions and plotters.[615]

Because the pigoons can produce large quantities of organs and neocortical tissue for transplant patients, as well as skin for cosmetic procedures, safeguarding the genetic material of the pigoons and preventing microbiological sabotage is essential in ensuring that HelthWyzer can continue to produce marketable products for paying customers. These two tactics—creating artificial scarcity and stealing intellectual property from other companies—allow the corporations in *Oryx and Crake* to ensure that they maintain biopolitical and economic control of their consumer base. As this demonstrates, while pig organs are initially depicted as being an "abundant" resource that can be mass produced by pigoon bioreactors, within the exploitative bioeconomy depicted in the novel, resources are only accessible under specific conditions and to specific people, and companies are only interested in being part of this bioeconomy as long as it remains profitable.

This depiction of competition between corporate entities parallels recent developments in xenotransplantation science. For example, as Lesley A. Sharp notes, there has been a distinct shift in how xenotransplantation science is being conducted between the 1990s and the 2020s, where data-

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[612] Atwood, *Oryx and Crake*, 22-23.
[613] Atwood, *Oryx and Crake*, 25.
[614] Atwood, *Oryx and Crake*, 25-26.
[615] Atwood, *Oryx and Crake*, 27-28.

sharing and collaborative efforts have given way to a new system in which "xeno's prized genetically altered, experimental pigs are developed and supplied by privately owned biotech firms that carefully guard their lab techniques and methods as proprietary knowledge."[616] Johannes Kögel et al. similarly note that biotechnology companies like Revivicor and eGenesis have developed unique genetic modifications for their pigs, each targeting different concerns, and argue that their "competing approaches have the potential to develop into national market strategies as companies work to develop different models of genetically modified pigs as new biocommodities."[617] The desire to safeguard genetic data and create unique "biocommodities" that capitalize on the growing interest in pig organs creates a disturbing connection between *Oryx and Crake*'s corporations and the real-world xenotransplantation industry.

In *Oryx and Crake*'s depiction of xenotransplantation, medical care in an advanced capitalistic society devolves into a system where only those who can pay high prices can access the medical products or services they need, while the companies producing biomedical products capitalize on exploitative practices to maintain substantial profit margins. Given that xenotransplantation research taking place within biotechnology corporations mirrors the intense competition between corporations in *Oryx and Crake*, the bioethical implications of these practices must be considered. For example, John W. Entwistle et al. note that "[t]he animals used for xenotransplantation are largely created by private companies, so substantial intellectual property issues are involved, requiring other companies to create their own set of genetic modifications."[618]

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[616] Lesley A. Sharp, "Disrupting the 'Near Human' in Contemporary Xenotransplantation," *BioSocieties*, 2025, https://doi.org/10.1057/s41292-025-00354-5. 3.
[617] Johannes Kögel et al., "Engineering Organs, Hopes and Hybridity: Considerations on the Social Potentialities of Xenotransplantation," *Medical Humanities*, December 18, 2024, https://doi.org/10.1136/medhum-2024-013061. 4.
[618] John W. Entwistle, Robert M. Sade, and Daniel H. Drake, "Clinical Xenotransplantation Seems Close: Ethical Issues Persist," *Artificial Organs* 46, no. 6 (2022): 987–94, https://doi.org/10.1111/aor.14255. 992.

This insular research approach, Entwistle et al. argue, could lead to "sacrificing even more animals"[619] throughout the research process: since "[e]ach companies' approaches to gene editing contain proprietary information," the result is that "details may not be readily available for an independent analysis of risk."[620] As this shows, while pig organs are often framed as an abundant resource, the competition between corporations will instead likely result in additional waste through the sacrifice of pigs. *Oryx and Crake* anticipates the way that current xenotransplantation research is being conducted by multiple competing biotechnology companies, and explores the potential issues around intellectual property and economic competition that could arise from this approach to biomedical research. By depicting xenotransplantation in the context of a bioeconomy that is fueled by corporate greed, *Oryx and Crake* highlights the problems arising from the frame of abundance in xenotransplantation discourse.

3.5 "Pigoon pie again": Xenografts, Meat, and the Necrocene

Along with the depiction of how biotechnology corporations compete to create valuable biocommodities, *Oryx and Crake* envisions a future where capitalism, consumer culture, and biotechnology have intertwined to create a bioeconomy that relies on the overconsumption of biomedical products. This society serves as an example of the "Necrocene," which refers to the way that capitalism as an economic system has caused widespread death and extinction. As Batalla argues, "acknowledging the deathly and extinctive nature of capitalism in all its forms" is an important ethical move, because it can consequently "illuminate how thinking through the Necrocene and emphasizing death and extinction as a consequence of capitalist accumulation might be fruitful to

[619] Entwistle et al., "Clinical Xenotransplantation Seems Close," 992.
[620] Entwistle et al., "Clinical Xenotransplantation Seems Close," 993.

challenge capitalism by bringing its inconsistencies and its lethal nature more convincingly to the fore."[621] In *Oryx and Crake*, the "lethal nature" of capitalism is apparent, particularly through the ever-increasing number of products that promise to enhance human vitality by exploiting the biological material of animals. Batalla argues that the consumption that defines the Necrocene "creat[es] the world of the living dead: entities that are nothing more than fodder to be consumed or exploited."[622] In *Oryx and Crake* this "consumption" is literal: animals are consumed as both food and medical products. The use of pigoons as food is particularly worth investigating since, as Alaimo notes, "[p]erhaps the most palpable trans-corporeal substance is food, since eating transforms plants and animals into human flesh."[623] Given that "peculiar material agencies may reveal themselves during the route from dirt to mouth,"[624] it is important to consider the material agencies being explored in *Oryx and Crake*.

The creation of "the living dead" as consumable products is highlighted in the way that the high-tech society in *Oryx and Crake* attempts to employ biotechnology to work around the dwindling access to resources by creating nutrient-dense sources of protein. For example, ChickieNobs— "an animal-protein tuber"[625] created using chicken DNA—were developed to provide a fast-paced, efficient source of protein, creating edible meat within only two weeks.[626] Pigoons, on the other hand, were developed primarily as a source of organs, before being repurposed as a source of food. Jimmy uncomfortably recalls situations where he suspected that pork-based food items had used pigoon meat, such as when he visited his father's workplace and his father's coworkers joke about eating

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[621] Batalla, "Green Capitalism?," 65.
[622] Batalla, "Green Capitalism?," 71.
[623] Alaimo, *Bodily Natures*, 12.
[624] Alaimo, *Bodily Natures*, 12.
[625] Atwood, *Oryx and Crake*, 202.
[626] Atwood, *Oryx and Crake*, 203.

"Pigoon pie again […] Pigoon pancakes, pigoon popcorn."[627] The pigoons, which serve as dual-purpose products that can enhance human vitality through both organs and meat products, exemplify the way that medical and agricultural applications of animals intersect. In Camporesi's analysis of xenotransplantation in *Oryx and Crake*, she connects the ChickieNobs with the novel's depiction of xenotransplantation and research animals, noting that the widespread production of animals as both a food product and a research object converge "in ways that possibly bring to the fore the worst elements of our species."[628] As Camporesi argues, the exploitation of the vitality of animals in the novel is twofold: both in medical research and agriculture, the genetic modification of animals is used to enhance their benefit to humans, and it represents humanity's disregard for the natural environment and nonhuman beings. Building on these ethical concerns about the exploitation of animals in medicine and agriculture, it is important to consider how Atwood's depiction of pigoons aligns with current discourse around pigs as a source of both organs and food.

Despite being a work of SF, *Oryx and Crake*'s depiction of companies like HelthWyzer and RejoovenEsense and products like the dual-purpose pigoons are not far off from current developments in xenotransplantation. In a press release following the FDA approval of Revivicor Inc.'s GalSafe pigs,[629] FDA Commissioner Stephen M. Hahn is quoted referring to the decision as "a tremendous milestone for scientific innovation."[630] This techno-optimistic vision of the GalSafe pigs frames them in terms of their many possible applications in biomedicine and agriculture. As a "first ever approval of an animal biotechnology product for both food and as a potential source for

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[627] Atwood, *Oryx and Crake*, 24.
[628] Camporesi, "Crispr Pigs," 41.
[629] FDA, "FDA Approves First-of-Its-Kind Intentional Genomic Alteration in Line of Domestic Pigs for Both Human Food, Potential Therapeutic Uses," (FDA, December 14, 2020), https://www.fda.gov/news-events/press-announcements/fda-approves-first-its-kind-intentional-genomic-alteration-line-domestic-pigs-both-human-food. These pigs have been genetically modified to eliminate the Alpha-gal sugar, which can trigger reactions in people with red meat allergies.
[630] FDA, "FDA Approves First-of-Its-Kind."

biomedical use,"[631] Hahn argues that this development "underscores the success of the FDA in modernizing our scientific processes to optimize a risk-based approach that advances cutting-edge innovations in which consumers can have confidence."[632] In this jargon-saturated quotation, the techno-optimistic belief that research in xenotransplantation can lead to other profitable outcomes is apparent: as a "cutting-edge" product, the GalSafe pigs are framed as a particularly valuable scientific achievement because they promise to "optimize" the way that pigs' biological material can be used across medical and agricultural industries, leading to new ways for "consumers" to make use of the animals. And this techno-optimistic vision has recently materialized: members of the public can now purchase GalSafe meat from sellers such as Amaroo Farms, a family-run farm based in Tennessee and North Carolina that offers a wide selection of "GalSafe® Pork Products," ranging from sausages, ribs, and steaks to livers and hearts.[633] Through the vision of GalSafe pigs as innovative, dual-purpose medical and agricultural products that can inspire confidence among consumers, current directions in xenotransplantation research mirror Atwood's depiction of pigoons as commodities that can be purchased as a source of both meat and organs.

Even before the FDA approval of GalSafe pigs, science writers have drawn explicit connections between xenotransplantation and meat consumption. For example, in a *Scientific American* article about breakthroughs in genomic research in pigs that could lead to new disease models and organs for xenotransplantation, science writer Alison Abbott writes that "[s]cientists are *salivating*. For the past couple of decades they have been slowly teasing information from the pig genome, applying it to *breed healthier and meatier pigs*, and to try to create more faithful models of

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[631] FDA, "FDA Approves First-of-Its-Kind."
[632] FDA, "FDA Approves First-of-Its-Kind."
[633] Amaroo Hills, "GALSAFE® PORK," accessed August 6, 2025, https://amaroohills.com/collections/gasafe-pork.

human disease."[634] Framing the pigs used in medical research in terms of their status as "meaty" agricultural animals implicitly draws connections between how the flesh and organs of the animals are products created for (different forms of) consumption by humans. Now, rather than simply creating "meatier" pigs that have higher quantities of consumable flesh, these pigs have become cornucopias that contain other useful parts that can be integrated into the human body in new ways. The "salivating" scientists in Abbott's article also links these pigs to the ideology of overconsumption: through the imagery of humanity's ravenous desire for more ways to consume the animals' biological material, biotechnology is depicted as the method through which new forms of consumption can be unlocked. While this example is an uncanny reflection of the exploitation of pigoons in *Oryx and Crake*, it also provides an important contrast to Jimmy, who recognizes the dual-purpose pigoons as indicative of capitalist society's exploitative practices.

While, in the context of *Oryx and Crake*, capitalizing on the biovalue of animal bodies as simultaneously medical and agricultural products is an emblem of the exploitative practices that shape the Anthropocene (or Necrocene), for proponents of xenotransplantation, animal agriculture has been used to *reaffirm* the ethical acceptability of using the same animals as a source of organs. Indeed, references to the consumption of meat have been used as an argumentative strategy to gain public support for the use of pigs in xenotransplantation. This rhetorical strategy can be seen in the TEDx Talk by Luhan Yang, the geneticist and co-founder of eGenesis and Qihan Biotech who introduced Laika the pig. During the TEDx talk, the host questions how Yang would respond to animal rights concerns about using "cute" pigs as a source of organs. When Yang affirms her stance that it is ethically acceptable that the pigs be used for medical and scientific advancements, the host jokingly

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[634] Alison Abbot, "'Draft Sequence' of Pig Genome Could Benefit Agriculture and Medicine," *Scientific American*, November 14, 2012, https://www.scientificamerican.com/article/draft-sequence-of-pig-genome-could-benefit-agriculture-and-medicine/. Emphasis added.

adds, "[p]lus, no one can say that to you if they eat bacon, right?"[635] This offhand comment (which assumes that the audience is not ethically opposed to the consumption of pigs as meat), implies that the ethical dimensions of using pigs in both scenarios are the same—i.e. that the logic of anyone who is opposed to using pigs in xenotransplantation (but *is* comfortable eating bacon) is inherently flawed.

Some advocates of xenotransplantation have emphasized the vastly higher number of pigs that are consumed as meat compared to the number of pigs that would be necessary to provide organs for patients on waitlists. For example, Martine Rothblatt, the founder of United Therapeutics, argues that "[s]o long as society countenances the use of animals to feed billions of people, I think it is only right that it countenance the use of animals to heal millions of people."[636] In this stance, the "millions" of animals that might be sacrificed for xenotransplantation are inconsequential in comparison to the "billions" used in agriculture, without any further discussion of whether the use of animals in either scenario raises ethical concerns. This aligns with Kögel et al.'s recent discussion of the social aspects of xenotransplantation, where they note that "[i]n terms of the non-human animals involved, the ethical focus is often restricted to comparing the relatively small number of pigs used for research with the much larger numbers of animals farmed for meat production."[637]

But beyond simply limiting the discussion of ethics, comparisons between xenotransplantation and animal agriculture have been used to *suppress* ethical concerns about the use of pigs in xenotransplantation. In a *Scientific American* article, Tanya Lewis notes that while "[a]nimal welfare groups have asked whether it is ethical to kill an animal to save a human life," that "[x]enotransplant advocates counter that animals raised to feed people vastly outnumber any that

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[635] *How to Create a World Where No One Dies Waiting for a Transplant*, TED, 2018, https://www.ted.com/talks/luhan_yang_how_to_create_a_world_where_no_one_dies_waiting_for_a_transplant. 13:28.
[636] Rothblatt, "A Personal Perspective," 4.
[637] Kögel et al., "Engineering Organs," 2.

would be used for transplants."[638] Rather than engaging in a meaningful discussion about the unique ethical considerations in both the medical and agricultural use of pigs, in this example, the status of pigs as agricultural animals is used as a way of masking any ethical concerns about the use of pigs in xenotransplantation. While *Oryx and Crake*'s critical perspective on the exploitation of animal bodies as medical and agricultural products condemns both practices, proponents of xenotransplantation have instead used public acceptance of animal agriculture as a way to gain support for biomedical experimentation as well.

Since the consumption of meat and the use of organs in xenotransplantation are clearly intertwined in the biomedical imaginary, it is important to consider the transcorporeal connections created by the movement of both organs and flesh across bodies. Despite proponents' claims that willingness to consume meat should automatically translate to support for xenotransplantation, the reality is more complex. Indeed, while in *Scientific American*, science writer Karen Weintraub argues that "people are less squeamish about harvesting body parts from an animal raised for meat than they would be about a primate's,"[639] in an interview with Stanford Medicine researcher Dr. Hiromitsu Nakauchi that was published in *Discover Magazine*, Nakauchi acknowledges that the idea of farms dedicated to harvesting animal organs can create "an unpleasant feeling — an icky feeling."[640] Additionally, there is some evidence that members of the public will not be comfortable with receiving an organ transplant from an animal that they view as a source of food. In a study that surveyed public opinions about xenotransplantation, sociologist Gill Haddow found that while some

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[638] Lewis, "Saving Lives."
[639] Karen Weintraub, "Gene-Editing Success Brings Pig-to-Human Transplants Closer to Reality," *Scientific American*, August 10, 2017, https://www.scientificamerican.com/article/gene-editing-success-brings-pig-to-human-transplants-closer-to-reality/.
[640] Jeremy Rehm, "Organs Grown to Order," *Discover Magazine*, May 21, 2019, https://www.discovermagazine.com/health/organs-grown-to-order.

focus group participants were vocal about believing that the use of pig organs is ethically equivalent to consuming meat, the survey results "paint a different story."[641] Instead, participants who consume meat showed a similar rate of being opposed to xenotransplantation as participants who identified as vegetarians (48% and 46%, respectively).[642] As Haddow reports, some participants commented on the pig's status as a farm animal as a negative factor when considering the potential of receiving a pig organ. In light of these responses, Haddow concludes that "[i]t may be that practice of transplanting pigs' organs is not the equivalent of choosing to consume pork or ham."[643] If the transfer of biological material between animals and humans via organ transplantation is not seen as equivalent to the transfer of biological material via meat consumption, then the belief that people who eat meat will embrace xenotransplantation—and that it will not raise new ethical concerns—is evidently flawed.

Oryx and Crake also explores this discomfort with dual-purpose medical and agricultural animals. However, in contrast to Haddow's study which found that participants who are comfortable with meat consumption might not be comfortable with receiving an organ from a species they view as an *agricultural animal*, in *Oryx and Crake* the focus is instead on characters' discomfort with consuming animals they view as *medical products*. Jimmy is troubled by the transfer of biological material through consumption, particularly when it comes to bioengineered animals. This anxiety about how meat destabilizes bodily and ethical boundaries is apparent in the way that Jimmy first reacts to the ChickieNobs. While the scientist who describes the ChickieNobs to Jimmy explains that "the animal welfare freaks won't be able to say a word, because this thing feels no pain,"[644] Jimmy still feels disturbed by the creatures, wondering, "[w]hy is it he feels some line has been crossed,

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[641] Gill Haddow, "'Dirty Pigs' and the Xenotransplantation Paradox," *Medical Humanities* 47, no. 4 (December 1, 2021): 417–24, https://doi.org/10.1136/medhum-2021-012187. 422.
[642] Haddow, "'Dirty Pigs' and the Xenotransplantation Paradox," 422.
[643] Haddow, "'Dirty Pigs' and the Xenotransplantation Paradox," 422.
[644] Atwood, *Oryx and Crake*, 203.

some boundary transgressed? How much is too much, how far is too far?"[645] The anxiety that Jimmy feels about the ChickieNobs mirrors his childhood anxieties about the use of pigoons as both a source of organs and a source of food. Jimmy reflects on how HelthWyzer had insisted pigoons would be used for medical purposes only, since "no one would want to eat an animal whose cells might be identical with at least some of their own."[646] Instead, Jimmy suspects that pigoon meat has become a regular menu item. Despite not being vegetarian or vegan, Jimmy finds the idea of consuming pigoon meat to be particularly transgressive, verging on cannibalistic.

The concerns that Atwood anticipated might become more prevalent as meat products from genetically modified pigs like the GalSafe pigs become more widely available. Companies selling the meat of animals produced for xenotransplantation will need to navigate public anxieties that could arise from the recognition that the same species is being used to provide both meat and organs. This can already be seen in the sale of GalSafe meat: Amaroo Farms prefaces their selection of GalSafe Pork products with a note that "Amaroo Hills GalSafe® pigs do not have any other genetic additions or alterations and are raised *strictly for food use*."[647] This note reassures customers that the GalSafe pigs used to supply cuts of meat—including livers and hearts for consumption—are not simultaneously providing materials for other purposes. While their website does not explicitly mention the use of GalSafe pig organs in xenotransplantation, the biomedical applications of the pigs are hinted at through the intimation that, outside of the farm, some GalSafe pigs might be raised for purposes other than agriculture. Amaroo Farms therefore anticipates (and attempts to address) the potential for customers to experience the same discomfort as Jimmy does when he realizes that pigoons are being simultaneously used for both organs and meat. These real and fictional examples

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[645] Atwood, *Oryx and Crake*, 206.
[646] Atwood, *Oryx and Crake*, 23-24.
[647] Amaroo Hills, "GALSAFE® PORK." Emphasis added.

show the potential that for some people, eating an animal intended for medical use may violate perceived boundaries around which types of biological materials are consumed, and how.

As this analysis demonstrates, the use of pigs as sources of both food and organs is often linked in xenotransplantation discourse. The literary representation of this interconnection in *Oryx and Crake*, when read alongside the results of studies that indicate that acceptance of meat consumption does not directly translate to support for xenotransplantation, demonstrates the nuanced ways that individuals may perceive the transcorporeality between bodies, with the transfer of biological material between species only being considered acceptable under certain circumstances. While proponents of xenotransplantation have used the fact that most people are willing to eat meat as a straightforward way to suppress concerns about the use of pigs as a source of organs, this does not mean that there are not unique ethical considerations in xenotransplantation, nor does it mean that the ethical considerations in animal agriculture are not worth discussion. Instead, framing the ethics of xenotransplantation in terms of public acceptance of meat consumption oversimplifies important ethical considerations related to the (over)consumption of animal products. By analyzing the rhetorical framing of xenotransplantation alongside literary depictions of xenotransplantation, anxieties about the interconnections between medical and agricultural uses of pigs—and the ethical problems that arise—can be better understood.

3.6 "They ate them even when they weren't hungry": Xenotransplantation, Overconsumption, and the Climate Crisis

In *Oryx and Crake*, the exploitation of animal bodies as "limitless" resources is not without consequences: the novel depicts a world in which overconsumption under capitalism has led to climate change, widespread disease, and societal collapse. As Anne Franciska Pusch notes in an

analysis of the *MaddAddam* trilogy, it "depict[s] a bioengineered future where humanity has reached a dead end."[648] This "dead end" is caused by overconsumption through the exploitation of natural resources and the commodification of living matter. While Jimmy and Crake grow up in a gated compound populated by the employees of HelthWyzer and do not experience the dwindling natural resources as acutely, the world outside of the company compounds is described as a growing wasteland. As Crake explains to Jimmy, biotechnological innovations are humanity's last hope, since "[a]s a species we're in deep trouble, worse than anyone's saying […] we're running out of space-time."[649] Living in the compound establishes a barrier between the privileged HelthWyzer employees and the outside world, creating an artificial sense of security in the power of technology to facilitate their ability to overconsume resources without consequences. While this belief in the ability to manufacture ways to circumvent the limitations of natural resources aligns with current xenotransplantation discourse, in *Oryx and Crake*, this techno-optimism is not able to prevent environmental collapse.

The environmental destruction depicted in *Oryx and Crake* provides a stark contrast to the frame of abundance and renewable energy that has been used to encourage support for xenotransplantation. While this frame can downplay the environmental impact of using pigs as a source of raw materials, references to sustainability and renewable energy are not new among biotechnology corporations. In an investigation of the rhetoric of companies that create genetically engineered (GE) crops, Dana Fennell notes that these companies often draw on environmental rhetoric as they "work to emphasize a connection between their products and nature by tying them to

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[648] Anne Franciska Pusch, "Splices: When Science Catches Up with Science Fiction," *NanoEthics* 9, no. 1 (April 1, 2015): 55–73, https://doi.org/10.1007/s11569-014-0216-8. 57.
[649] Atwood, *Oryx and Crake*, 295.

sustainability and stewardship."[650] Fennell explains that this appears to be a response to public concerns about GE crops, since "[c]ritics have claimed that GE crops are unsustainable and dangerous for the environment. Biotechnology companies therefore employ the terms and ideals of environmental stewards."[651] If framing biotechnological products in the context of environmentalism and sustainability is a strategy to pre-emptively address potential criticism, the risk, then, is that this environmental rhetoric could encourage audiences to believe that xenotransplantation *is* environmentally friendly, without providing evidence for this view.

Along with references to sustainability and renewable energy, proponents of xenotransplantation often downplay the environmental impact of raising pigs for organs by comparing medical and agricultural systems. For example, the environmental assessment for Revivicor Inc.'s GalSafe pigs declares that the genetically modified pigs will not pose any significant environmental or ecological concerns beyond those of agricultural pigs. The FDA press release insists that the environmental risk posed by the pigs "is no greater than from conventional pigs,"[652] and that "no animal safety concerns were noted for GalSafe pigs beyond those that would be expected in well-managed, commercial swine operations."[653] This attempt to minimize concerns about the environmental impact of pigs raised for xenotransplantation (in comparison to the environmental impact of agricultural pigs) mirrors the way that proponents have also minimized the ethical concerns of using pig organs in medicine.

Although the environmental impact of medical pigs is justified as not being worse than that of agricultural pigs, many people *have* called attention to the environmental impact of animal agriculture

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[650] Dana Fennell, "Marketing Science: The Corporate Faces of Genetic Engineering," *Journal of Communication Inquiry* 33, no. 1 (2009): 5–26, https://doi.org/10.1177/0196859908325144. 20.
[651] Fennell, "Marketing Science," 20.
[652] FDA, "FDA Approves First-of-Its-Kind."
[653] FDA, "FDA Approves First-of-Its-Kind."

and factory farming. Animal agriculture is often cited as one of the key drivers of both environmental and public health problems, with studies finding that current agriculture systems are environmentally unsustainable[654] and linking pig farming to public health issues such as antibiotic resistance.[655] Because of widespread evidence that animal agriculture is contributing to climate change, environmental destruction, zoonotic disease, and antimicrobial resistance, medical researchers Nelson Iván Agudelo Higuita et al. argue that the "[c]onsumption of a high-resource diet based on animal products without a reciprocal nutritional value while degrading the environment and animal and human health is unethical and no longer sustainable."[656] To counter the overconsumption of animal products, they argue that "a radical transformation of the global food system is long overdue and will depend on genuine and transparent political will, adaptation of both producers and consumers, and countering the financial interests and power of industrial animal farming."[657] Because of the many environmental and health issues raised by animal agriculture, adopting a plant-based diet is often recommended by environmental authorities.[658] Therefore, while some proponents of xenotransplantation might dismiss concerns about the environmental impacts of pigs raised for organs as being justifiable because the impact does not add significantly to that of commercial agricultural pigs, this argument fails to acknowledge that animal agriculture is already a significant contributor to climate change and public health concerns.

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[654] Marco Springmann et al., "Options for Keeping the Food System within Environmental Limits," *Nature* 562, no. 7728 (October 2018): 519–25, https://doi.org/10.1038/s41586-018-0594-0.
[655] "Antibiotic-Resistant Staph May Be Spreading Between Pigs, Humans," *Laboratory Equipment*, March 2021.
[656] Nelson Iván Agudelo Higuita et al., "Climate Change, Industrial Animal Agriculture, and the Role of Physicians – Time to Act," The Journal of Climate Change and Health 13 (September 2023): 100260, https://doi.org/10.1016/j.joclim.2023.100260. 4.
[657] Agudelo Higuita et al., "Time to Act," 4.
[658] United Nations, "Your Guide to Climate Action: Food," United Nations (United Nations), accessed May 11, 2024, https://www.un.org/en/actnow/food.

While the satirical society depicted in *Oryx and Crake* seems to embody a similar disregard for the environmental impacts of the use of animals in both agriculture and medicine, the belief that animals and natural resources are abundant commodities for humans to use at will is at the heart of the overconsumption that eventually causes society's downfall. As Crake explains to Jimmy, overconsumption has led to global environmental issues that will have consequences even within the artificially maintained space of the biotech and pharmaceutical corporations' compounds: the "[d]emand for resources has exceeded supply for decades in marginal geopolitical areas, hence the famines and droughts; but very soon, demand is going to exceed supply for everyone."[659] One of the ways that these consequences become apparent is in the repurposing of pigoons as a source of meat. Jimmy recollects visiting his father's workplace as a child and observing the frequency with which pork-based foods were offered on the lunch menu. These memories are intertwined with commentary on the rapidly deteriorating environmental conditions and the impending climate crisis:

> as time went on and the coastal aquifers turned salty and the northern permafrost melted and the vast tundra bubbled with methane, and the drought in the midcontinental plains regions went on and on, and the Asian steppes turned to sand dunes, and meat became harder to come by, some people had their own doubts. Within OrganInc Farms itself it was noticeable how often back bacon and ham sandwiches and pork pies turned up on the staff cafe menu.[660]

While pigoons were not created with the explicit intention of being used as a source of meat, this delineation between medical and agricultural animals changes as the climate does, since environmental destruction makes more socially palatable sources of meat increasingly difficult to acquire. In an analysis of meat in *Oryx and Crake*, Jovian Parry argues that "real meat" becomes increasingly valuable in the novel as "a symbol of prestige and social status, a commodity imbued

[659] Atwood, *Oryx and Crake*, 295.
[660] Atwood, *Oryx and Crake*, 24.

with a profound nostalgia for a simpler, better time that has since passed."[661] The "time that has since passed" in this context is a time when a seemingly more "natural" version of commercial animal agriculture was still possible; because of the environmental conditions in *Oryx and Crake*, people must increasingly turn to consuming animals that were created using biotechnology and intended for use as medical products. As a distinctly *unnatural* source of food, the pigoons are troubling for human characters like Jimmy not only because of the blurring of species boundaries and bodily identity, but also because they make the connections between meat consumption and anthropogenic environmental harm increasingly visible.

After the virus that Crake releases results in the deaths of almost all humans, meat consumption as a form of anthropogenic environmental harm becomes a framework for how Jimmy (now renamed "Snowman") understands humanity's relationship with the surrounding world. Snowman, who lives alongside the Crakers, is regularly asked to tell them their origin story. Rather than describing Crake's use of a virus to kill humans, Snowman opts to focus on human society's disregard for the natural world, telling them that "[t]he people in the chaos were full of chaos themselves, and the chaos made them do bad things."[662] The "bad things" that humans did, Snowman explains, included "eating up all the Children of Oryx, against the wishes of Oryx and Crake."[663] But in this origin story, it isn't simply eating animals that results in humanity's downfall. Instead, Snowman emphasizes the *overconsumption* of animals, explaining that "[e]very day they were eating them up. They were killing them and killing them, and eating them and eating them. They ate them *even when they weren't hungry*."[664] As beings who are "full of chaos," humans have overexploited

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[661] Jovian Parry, "Oryx and Crake and the New Nostalgia for Meat," *Society & Animals* 17, no. 3 (January 1, 2009): 241–56, https://doi.org/10.1163/156853009X445406. 254.
[662] Atwood, *Oryx and Crake*, 103.
[663] Atwood, *Oryx and Crake*, 103. Oryx had worked with Crake to develop and raise the Crakers; the "Children of Oryx" refers here to nonhuman animals.
[664] Atwood, *Oryx and Crake*, 103. Emphasis added.

resources to the point of their own destruction. By describing the insatiable greed of humans, Snowman's tale serves as a warning to the Crakers, emphasizing the need to maintain ecological and environmental harmony—albeit a potentially unnecessary warning, given that the Crakers are depicted as eating only plants.[665] In *Oryx and Crake*, then, xenotransplantation is framed in the context of a society that, because it views animals as endlessly exploitable (and endlessly "abundant") resources, has irreversibly damaged the natural environment.

While cultural attitudes about the acceptability of consuming the meat of animals that are also used as a source of life-saving organs will likely continue to evolve, reading *Oryx and Crake* alongside media coverage of xenotransplantation demonstrates that both proponents and opponents of xenotransplantation conceptualize the procedure as a continuation of the way that humans have used animals in agriculture. While proponents of xenotransplantation see this as a *positive*—if people will eat pig meat, they must therefore be ethically aligned with the use of pig organs in medicine—opponents of xenotransplantation instead see it as another example of the ideology of overconsumption that has shaped 21st-century society. Similarly, while the environmental impact of medical pigs is seen by some proponents as being inconsequential compared to the environmental impact of agricultural pigs, another perspective that we can take is that the use of animals in medicine, just like the use of animals in agriculture, is a demonstration of the anthropocentric disregard for the environment and nonhuman animals that has led to the climate crisis. The fictional society that *Oryx and Crake* envisions—where the pigoons are remembered by Snowman in the context of rampant commodification and exploitation rather than as necessary biomedical products—therefore provides an important means of reconsidering the exploitation of animals as an "abundant"

[665] For a discussion of the Crakers and veganism, see Emelia Quinn, *Reading Veganism: The Monstrous Vegan, 1818 to Present* (Oxford University Press, 2021).

resource by calling attention to the environmental and ecological destruction that these anthropocentric beliefs have already caused.

3.7 Xenotransplantation and "wealthy, health-conscious, cash-paying patients": Xenotourism in *Chromosome 6*

While Atwood's *Oryx and Crake* highlights the connection between xenotransplantation and the existing overconsumption of animals in agriculture, Robin Cook's novel *Chromosome 6* explores how the desire for abundant supplies of organs could result in other exploitative systems, such as transplant tourism networks. In Sharp's analysis of current issues in xenotransplantation, she introduces the concept of "*organ hunger*," which she defines as "the desire for an unlimited supply of reusable parts [that] drives and legitimates xeno research."[666] Sharp describes the way that researchers have capitalized on the bodies of pigs, nonhuman primates, and humans in early xenotransplantation research, leading to "a dizzying array of entangled categories of bodies and beings."[667] This "organ hunger" and the need for an abundance of experimental bodies—both patients *and* donors—could lead to the development of international xenotransplantation industries. In this section, I will consider how transplant tourism (and more specifically, xenotourism) and illicit international biomedical research networks are depicted as a response to "organ hunger" in *Chromosome 6*. In particular, I will consider how the novel draws attention to global, transcorporeal networks that shape developments in xenotransplantation. As Alaimo argues, "the material self cannot be disentangled from networks that are simultaneously economic, political, cultural, scientific, and substantial," with the result being that "what was once the ostensibly bounded human subject finds herself in a swirling landscape of

[666] Sharp, "Disrupting the 'Near Human,'" 4.
[667] Sharp, "Disrupting the 'Near Human,'" 8.

uncertainty where practices and actions that were once not even remotely ethical or political matters suddenly become the very stuff of the crises at hand."[668] *Chromosome 6* explores the way that xenotourism entangles human subjects in the "swirling landscape of uncertainty" that Alaimo describes, encouraging readers to consider how xenotransplantation is not solely a medical topic, but rather is interconnected with economic and political systems. The novel brings to the forefront concerns that, as corporations strive to capitalize on xenotransplantation and fulfil both doctors' desires for high-paying patients and patients' demands for abundant supplies of organs, exploitative practices will emerge that capitalize on regulatory differences across countries while also reinforcing neocolonial power structures. This analysis of *Chromosome 6* calls attention to the need to consider the intertwined global impacts of biomedical research.

In contrast to *Oryx and Crake*'s futuristic depiction of a society that has been taken over by biotech and pharmaceutical corporations, *Chromosome 6* offers a modern-day (but still speculative) depiction of xenotransplantation. Two simultaneous storylines are explored throughout *Chromosome 6*. One is set in New York City and follows the perspectives of two medical examiners, Jack and Laurie, during investigations into the cause of death of an unidentified homicide victim, who they discover had received a transplanted organ from a primate. The second storyline depicts a simultaneous investigation into unusual bonobo behaviour at a research facility in the city of Cogo in Equatorial Guinea, which follows the perspective of three of the facility's employees: Kevin (a geneticist), Melanie (a reproductive scientist), and Candace (a transplant nurse). As these two storylines converge, it becomes apparent that the American biotechnology corporation GenSys has been conducting highly lucrative primate research and performing xenotransplant surgeries in Equatorial Guinea. Wealthy and well-connected Americans can sign up for the expensive program,

[668] Alaimo, *Bodily Natures*, 20.

and subsequently have a medical "double" created: a genetically modified bonobo that provides a ready source of organs should the patron ever need to undergo a transplant. Kevin, who experimented with genetic modifications to allow human patients to receive bonobo organs without experiencing adverse immune reactions, soon suspects that these modifications have also altered the cognition and behaviour of the bonobos. Against the explicit orders of the site manager, Siegfried Spallek, Kevin, Candace, and Melanie travel to the island where the bonobos are housed. During this trip, they discover that the genetically modified bonobos are not only more aggressive than typical bonobos, but that the animals have also designed tools, discovered fire, and developed limited speech. Kevin, Candace, and Melanie are imprisoned by GenSys for visiting the island, but they are eventually able to escape with the help of Jack and Laurie, whose investigation had led them to Cogo. After deciding to release the genetically modified bonobos, the group escapes, and the story ends with the implication that they will go public about GenSys' unethical research practices, resulting in the research facility in Equatorial Guinea being shut down.

Chromosome 6 calls attention to the potential for xenotransplantation to have global socio-economic impacts through the establishment of xenotourism networks, which, rather than creating an abundant source of organs for patients in need, could reinforce existing health inequalities. Xenotourism is a form of medical tourism in which countries with less stringent regulations around animal experimentation, genetic research, and experimental medical procedures become a hub for xenotransplantation research and surgeries.[669] As xenotransplantation continues to develop, it is essential to consider how the procedure might develop around currently existing transplant tourism networks, particularly because transplant tourism can have serious detrimental impacts on both local and global scales. In their discussion of bioethical concerns about xenotransplantation, John W.

[669] Entwistle et al., "Clinical Xenotransplantation Seems Close," 992.

Entwistle et al. call attention to the risk that patients might rely on xenotourism for access to new, experimental procedures. Entwistle et al. note that "[t]ransplant tourism has been a reality for many years and takes advantage of local populations for financial gain by those at high levels, to the detriment of the less well-off who make the sacrifices necessary to provide the services to foreigners, such as organ donors."[670] Like transplant tourism, xenotourism could pose numerous ethical issues, including concerns about who is able to access the procedures, where and how patients will undergo the procedures, and what the impact will be on local communities.

While the formation of sophisticated xenotourism networks might appear to be a distant concern, cases of xenotourism have already occurred. As Peta S. Cook et al. describe in their discussion of the biopolitics of xenotransplantation, patients have already traveled across borders to access treatments using animal products. Specifically, Cook et al. discuss how Laboratorio de Xenotransplantes in Mexico gained attention in the early 2000s from the International Xenotransplant Association (IXA), after Canadian patients traveled to Mexico to undergo treatment for diabetes using insulin-producing cells from pigs.[671] While this example occurred two decades ago, it highlights the intricacies of how access to xenotransplantation might differ across regulatory boundaries, which can result in the movement of patients across international borders to access procedures or products that are otherwise inaccessible to them. While patients traveling to receive xenografts is one of the more obvious examples of the global scale of xenotransplantation, research networks can also develop across international borders. Cook et al. note that companies based in the Global North might take advantage of international differences in regulations and outsource their own xenotransplantation research to the Global South. For example, they discuss how Living Cells Technologies (LCT)

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[670] Entwistle et al., "Clinical Xenotransplantation Seems Close," 992.
[671] Peta S. Cook et al., "The Textures of Globalization: Biopolitics and the Closure of Xenotourism," *New Genetics and Society* 30, no. 1 (March 1, 2011): 101–14, https://doi.org/10.1080/14636778.2011.552303. 104.

conducted trials of their product DIABECELL (which is made using pig islet cells) in Russia, which "allowed LCT to bypass the now expired XTP moratorium in Australia and tight XTP regulations in New Zealand."[672] Varying regulations around animal experimentation and genetic research between countries can result in corporations circumventing ethics protocols. And while Cook et al. discuss examples from the 2000s, given the recent resurgence in xenotransplantation research in the 2020s, it is possible that new international research and xenotourism networks will emerge. Consequently, it is essential to consider the ethical implications of these global networks.

Chromosome 6 can provide a starting point for conversations about the ethics of xenotourism. For proponents of xenotransplantation, animal organs could "solve" the organ shortage crisis, and Amber N. Carrier et al. note that despite the ethical issues raised by xenotransplantation, "[t]here are many social benefits that xenotransplantation can help realize," including the "elimination of coercion and financial compensation for organs."[673] In contrast to this optimistic vision of xenotransplantation, the xenotourism industry in *Chromosome 6* is based on a private, two-tiered medical system. As Raymond Lyons, a medical doctor and GenSys employee explains, "[f]or a price we create an immunological double for a client […] it is a significant price but not unreasonable for the peace of mind it affords."[674] Beyond simply paying to sign up for the program, clients are also required to pay for ongoing investment in the scheme: according to Raymond, "how we really make money is that the client must pay a yearly tuition to maintain his double."[675] In this depiction, xenotransplantation is *not* an experimental medical procedure that is made available to desperate patients in need,[676] but rather is

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[672] Cook et al., "The Textures of Globalization," 107.
[673] Amber N. Carrier et al., "Xenotransplantation: A New Era," *Frontiers in Immunology* 13 (2022), https://www.frontiersin.org/articles/10.3389/fimmu.2022.900594. 7.
[674] Robin Cook, *Chromosome 6* (Penguin Random House, 1997). 99.
[675] Cook, *Chromosome 6*, 99.
[676] For a discussion of the vulnerability of xenograft recipients, see Chapter 2.

an expensive and ongoing insurance policy that wealthy consumers can invest in to protect themselves against future, hypothetical scenarios of organ failure. By depicting xenotransplantation as an insurance policy for wealthy patients, *Chromosome 6* engages with the idea that animals can provide "abundant" sources of transplantable organs—but only for those who are able to pay for it.

In addition to depicting the consumers investing in GenSys as wealthy, upper-class Americans, the novel also depicts the xenotransplantation program as a way for people who are already in positions of socioeconomic power to increase their wealth and status. When recruiting a new physician to join the group of American physicians providing access to GenSys's xenotransplantation resources, Raymond notes that the benefit of joining the company's physician network is the "opportunity to significantly augment your income as well as provide a state-of-the-art service to *select patients*."[677] Raymond explains that GenSys's physician network is "like a merchandising pyramid," and that "[f]or every client you recruit, you get a percentage, not only of the initial price but each year from the tuition."[678] The "significant" increase in income that GenSys promises also arises from recruiting new physicians who are looking for a second income stream. These physicians are primarily recruited based on their existing roster of wealthy patients and their ability to network with other physicians in similar positions. As Raymond explains, "we will encourage you to recruit other physicians like yourself with collapsing patient bases but who still have a number of *wealthy, health-conscious, cash-paying patients*."[679] The high costs of xenotransplantation are therefore inflated to allow for financial kickbacks for the physicians involved in recruiting "wealthy, health-conscious, cash-paying" individuals. And because GenSys operates

[677] Cook, *Chromosome 6*, 97-98. Emphasis added.
[678] Cook, *Chromosome 6*, 99.
[679] Cook, *Chromosome 6*, 99. Emphasis added.

within a clandestine network of internal recruits, those who are able to capitalize on the valuable new "product" are those who are already professionally and socially connected.

In the two-tiered medical system depicted in *Chromosome 6*, xenotransplantation is not universally beneficial or even universally accessible. Instead, by depicting xenotransplantation in the context of a global xenotourism network, the novel explores the concern that has been raised by bioethicists that this type of system "has the potential to exacerbate inequities in care."[680] And while currently, xenotransplantation is an experimental medical procedure with uncertain health outcomes, it is possible that it will eventually become an established procedure that can be tailored to individual patients like in *Chromosome 6*. Entwistle et al. note that "[i]f the results of xenotransplantation rival those of allotransplantation, then there is likely to be the disparity in organ access, favoring those with better financial resources," which "could result in a two-tiered system, in which wealthier individuals have greater access to life-saving therapies and can avoid a prolonged time on the waitlist."[681] By depicting a xenotourism industry that limits access to a select group of patients, *Chromosome 6* raises important concerns about how xenotransplantation might become entangled in (and exacerbate) existing inequalities in medical care.

3.8 "much-needed foreign currency": Xenotransplantation, Resource Extraction, and Neocolonialism

In addition to its depiction of how commercializing xenotransplantation can result in unequal access to medical care, *Chromosome 6* explores the possibility that xenotourism networks will exploit

[680] Entwistle et al., "Clinical Xenotransplantation Seems Close," 993.
[681] Entwistle et al., "Clinical Xenotransplantation Seems Close," 991.

regulatory differences in the Global South and develop through existing neocolonial power structures. This perspective is most clearly seen in the storyline that takes place in the city of Cogo in Equatorial Guinea. Like the secure research facilities in the compounds in *Oryx and Crake*, xenotransplantation research in *Chromosome 6* takes place away from the general public: Cogo is selected by the American biotech corporation GenSys as a base for their research and is considered to be "the perfect spot for GenSys's intended primate facility"[682] due to its isolated location. However, unlike the desire of corporations like HelthWyzer in *Oryx and Crake* to protect against the theft or sabotage of their work by other corporations, the need for isolation in *Chromosome 6* is because it gives GenSys privacy as they exploit lax regulations around primate research. Kevin reflects on how these less-stringent laws make Equatorial Guinea an attractive site for xenotransplantation research:

> Recognizing the difficulties attached to primate biomedical research, GenSys had sited their facility in Equatorial Africa where the animals were indigenous. This move cleverly sidestepped the industrialized West's inconvenient web of import/export restrictions associated with primates, as well as the disruptive influence of animal-rights zealots.[683]

By establishing its operations in Equatorial Guinea, GenSys was able to circumvent regulations around primate research *and* reduce negative public attention that might have arisen due to their use of bonobos. This decision to use Cogo as a base for operations has additional benefits, since "[t]he operation proved to be extraordinarily successful so quickly that GenSys expanded it to serve as a convenient spot for other biotechnology companies, especially pharmaceutical giants, to out-source their primate testing."[684] As a result, the company's value skyrockets so quickly that "[t]he growth shocked the GenSys economic forecasters."[685] GenSys, evidently, has used Equatorial Guinea as a base for capitalizing on bonobo biovalue.

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[682] Cook, *Chromosome 6*, 24.
[683] Cook, *Chromosome 6*, 50-51.
[684] Cook, *Chromosome 6*, 51.
[685] Cook, *Chromosome 6*, 51.

This depiction of an American biotechnology company "outsourcing" primate research to the Global South to exploit gaps in international regulations contextualizes xenotourism within concerns about neocolonialism and resource extraction. GenSys is framed throughout the novel as having significant impacts, not only on the local community in Cogo, but also on the broader Equatorial Guinean economic and political landscape. Despite the company's headquarters being based in the United States and its Cogo location being staffed primarily by American researchers and medical practitioners, GenSys is deeply enmeshed in the Equatorial Guinean government. After discovering a paper trail connecting GenSys to Equatorial Guinea, Laurie—one of the American medical investigators who discovered the xenotourism network—notes that "GenSys chose Equatorial Guinea because of the favorable reception they received from the government, which even passed laws to aid their operation."[686] The reason for this "favorable reception," Laurie explains, was because "GenSys has become the government's major source of much-needed foreign currency."[687] GenSys is therefore depicted as exploiting Equatorial Guinea's economic instability to establish their Cogo operations and improve the company's profits by capitalizing on unethical primate research, thereby creating a new bioeconomy.

While *Chromosome 6* focuses on xenotourism, the novel's depiction of GenSys' influence in Equatorial Guinea is similar to the economic, political, and cultural impact that resource extraction by foreign corporations has on countries in the Global South. The xenotourism network that GenSys builds in Equatorial Guinea relies on the company's ability to influence corrupt government officials, capitalize on lax regulations, and circumvent laws in order to increase the corporation's profits, without regard for how the activities will impact the country's citizens. In Hannah Appel's

[686] Cook, *Chromosome 6*, 289.
[687] Cook, *Chromosome 6*, 289.

ethnographic analysis of the oil and gas industry in Equatorial Guinea, she argues that we need to "shift our critical understanding of capitalism from one in which 'markets' merely deepen or respond to post-colonial inequality, to one in which markets are made by that inequality."[688] At the time that Cook was writing *Chromosome 6*, the oil industry was beginning to take advantage of the precarity in Equatorial Guinea. As Appel notes, "[i]n the mid-1990s, Equatorial Guinea was governed by an authoritarian regime on its last legs, ready to acquiesce to nearly any industry condition in exchange for complicity and support."[689] Appel explains that the oil industry has become incredibly powerful within the country, exerting powerful control over local laws: "In exchange for a funded regime, the Equatoguinean government must negotiate with oil companies to change local environmental, labor, or taxation laws that might affect those companies' profit margins."[690] Cook's depiction of Equatorial Guinea in *Chromosome 6* engages with the rise of oil and gas in the 1990s, but speculatively reimagines the biomedical research and xenotourism industry as being at the centre of the exploitation of the country's precarious economy.

In addition to the oil and gas industry, mining is another form of resource extraction that has emerged alongside (and through) neocolonial power structures. In an analysis of mining companies and resource extraction in African countries, Iva Peša notes that local communities often find it difficult to call attention to the negative environmental impacts of the corporations that work in their areas: "[b]ecause of the economic and political power of mining companies and their close alliance with colonial and postcolonial governments, it proved difficult to voice grievances about

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[688] Hannah Appel, *The Licit Life of Capitalism: US Oil in Equatorial Guinea* (Duke University Press, 2019), https://doi.org/10.1215/9781478004578. 2.
[689] Appel, *The Licit Life of Capitalism*, 6.
[690] Appel, *The Licit Life of Capitalism*, 17.

pollution."[691] Since these corporations often wield significant political and economic power, local communities might feel pressured to ignore the detrimental impacts of their activities. Throughout *Chromosome 6*, it becomes clear that while GenSys might offer enticing economic incentives, these benefits are superficial, only applying to select upper-level GenSys employees and Equatorial Guinean government officials, while the local Cogo community does not experience the same material benefit. At one point, Esteban, who had emigrated from Equatorial Guinea to the United States, describes the divide among local residents over GenSys's presence to Jack and Laurie, noting that "[a] lot of people like GenSys because they pay well, but others don't like GenSys because they have too much power with the government."[692] This depiction mirrors the dynamics that often emerge around resource extraction, where communities may have conflicting opinions about the beneficial or detrimental impact caused by the presence of foreign corporations. While *Chromosome 6* does not explore the perspectives of Cogo residents in any depth, the novel does depict GenSys as utilizing neocolonial power structures to engage in a form of resource extraction through their primate research facility.

Furthermore, GenSys's operations perpetuate socioeconomic disparities caused by Cogo's colonial history. Resource extraction in general is often connected to colonial histories: for example, as Peša notes, "[s]tudies of resource extraction have emphasized how mines, oil wells, and their attendant environmental destruction both *built on and intensified colonial inequalities*."[693] And while *Chromosome 6* focuses on outsourcing primate research rather than mining, the dynamic that Peša describes is apparent throughout the novel. Most of the researchers and medical staff at the GenSys

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[691] Iva Peša, "Anthropocene Narratives of Living with Resource Extraction in Africa," *Radical History Review* 2023, no. 145 (January 1, 2023): 125–38, https://doi.org/10.1215/01636545-10063818. 128.
[692] Cook, *Chromosome 6*, 309.
[693] Peša, "Anthropocene Narratives," 131. Emphasis added.

facility are *not* Equatorial Guinean citizens, and the characters who stand to profit from GenSys through the company's investment scheme (including Kevin, Bertram, and Raymond) are primarily white American men. The patients receiving xenografts at the GenSys facility, like the staff working there, are *also* not Equatorial Guineans; instead, they are primarily wealthy and well-connected American citizens. Meanwhile, among the few Cogo residents in the novel, the majority are depicted as being employed as low-paid domestic workers and labourers and are not shown benefiting from GenSys—either as patients or as employees. Instead, for some of these characters, the presence of GenSys is controlling and oppressive. For example, one Equatorial Guinean character, Esmeralda, is employed by GenSys as a housekeeper in Kevin's home. She explains to Kevin that GenSys requires her to stay overnight during the week rather than going home to her family, and even when Kevin encourages her to go home on weeknights, she refuses, simply telling him that "she'd been ordered to remain in Cogo."[694] While the novel stops short of fully exploring the impacts that GenSys has on Cogo residents, it does highlight the way that xenotourism networks could become entangled with—or even develop because of—existing neocolonial power structures that exploit regulatory differences in the Global South and siphon profit to North America, without benefits for local communities.

This fictional depiction of xenotransplantation calls attention to an important dynamic in medical tourism: that residents of the local community will rarely benefit. Problematically, this disparity is partially why governments and medical institutions might find medical tourism (and consequently, xenotourism) appealing. As tourism scholar John Connell notes, the "[e]arnings from incoming patients are potentially greater than from domestic patients, especially where the public sector dominates health care, and the expenditure of medical tourists can be greater than that of

[694] Cook, *Chromosome 6*, 25.

'standard' tourists, because of the duration of stay and accompanying carers."[695] In other words, a country's profit from medical tourists who travel to access specific medical procedures can be significantly higher than what local residents in these countries are able to pay. To return to Sharp's discussion of "organ hunger," she argues that it leads to "the desire to control porcine bodies, alongside a need for experimental human subjects."[696] In *Chromosome 6*, this hunger to capitalize on "experimental human subjects" is reframed as hunger for the *highest paying patients*, whose desire for access to cutting-edge medical procedures—even those not permitted in their countries of residence—spans international borders, prompting GenSys' production of organs. The prioritization of wealthy patients over local residents is depicted through the way that the Equatorial Guinean government overlooks—and even supports—GenSys' unethical and illegal activities because the company brings in wealthy American patients who can contribute to the country's economy. And while this may superficially appear to provide economic benefits, the novel instead shows how GenSys fuels the socioeconomic divides between the local Cogo community, the Equatorial Guinean government, and GenSys patients and employees. Through this depiction, *Chromosome 6* raises concerns about the future of xenotransplantation, and how the medical procedure could perpetuate neocolonialism through resource extraction and medical tourism.

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[695] John Connell, "Medical Mobility and Tourism," in *Handbook of Globalisation and Tourism*, ed. Dallen J. Timothy (Edward Elgar Publishing, 2019). 307.
[696] Sharp, "Disrupting the 'Near Human,'" 4.

3.9 The "goose that lays the golden egg": The Biopolitical Dimensions of Xenotourism

Beyond the broader societal and economic implications of medical tourism, *Chromosome 6* depicts the biopolitical impacts of GenSys' influence over the Equatorial Guinean government. In Priscilla Wald's analysis of biological material, patent law, and *Chromosome 6*, she focuses on the concept of "bioslavery," but concludes that "biocolonialism" might be a more useful concept for thinking through the implications of biomedical experimentation, since

> The danger of biotechnology is not, as popular culture typically depicts it, that scientists will produce something that will enslave us. Rather, biotechnological developments disclose issues (such as the definition of "human being" or the unequal distribution of resources) that have never been resolved. With this resurfacing comes the opportunity to look anew at structural inequities: local, national, and global.[697]

In *Chromosome 6*, one way that "structural inequities" are apparent is in the way that GenSys uses their political and economic power to exploit both humans and animals and maintain control of their biomedical research network. As Batalla argues, "the Necrocene theory might help us move beyond the non-human towards the human and back. That is, it entails in its nomenclature the inequalities, inconsistencies and exploitation of non-human animals, cultures, peoples and societies."[698] The depiction of xenotransplantation in *Chromosome 6* can provide an important opportunity to consider how biomedical research functions within the context of the Necrocene, where both human and nonhuman lives become exploitable.

Throughout the novel, it is clear that GenSys exploits their influence over the Equatorial Guinean government to circumvent laws in order to maintain profits, often resorting to violence to do so. For example, when Kevin, Melanie, and Candace begin investigating the genetically altered

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[697] Priscilla Wald, "What's in a Cell?: John Moore's Spleen and the Language of Bioslavery," *New Literary History* 36, no. 2 (2005): 205–25. 222.
[698] Batalla, "Green Capitalism?," 68.

bonobos, the GenSys site manager, Siegfried, is quick to draw on corrupt government officials to maintain control and prevent disruptions at the research facility. When discussing how to quickly and quietly stop the three staff members from disrupting operations, Siegfried malevolently notes, "[t]he government is eager to ensure that nothing threatens the goose that lays the golden egg. All we need to say is that they are seriously interfering with GenSys operations."[699] As the "goose that lays the golden egg," GenSys is invaluable to the Equatorial Guinean government. While Kevin, Melanie, and Candace initially downplay Siegfried's threats and assume that their identity as American citizens will shield them (as Wald argues, they "invoke their talismanic status as Americans,"[700] which is an example of how "Cook offers *American* values as an antidote to the corporate greed of the global conglomerate and to irresponsible science"[701]), this offers little protection against the power GenSys holds in Equatorial Guinea. Part of this power is the ability to make individuals who threaten GenSys disappear: as Siegfried describes to Bertram, when he gives the word, the trio will "be lined up out in the soccer field in front of a firing squad before they knew what hit them."[702] As another example of xenotransplantation in the Necrocene, this depiction therefore shows the biotech corporation as capable of exerting its power to eliminate individuals who threaten to destabilize the company.

Like the overconsumption of animals and resulting environmental destruction that is depicted in *Oryx and Crake*, *Chromosome 6* envisions the exploitation of animals by GenSys as extending far beyond the use of animals in biomedicine. For example, along with the bonobos that are sacrificed to provide organs, the novel also depicts the deaths of other animals that are not involved in xenotransplantation, as high-ranking GenSys employees exploit the local environment, ecosystems,

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[699] Cook, *Chromosome 6*, 385.
[700] Wald, "What's in a Cell?," 215.
[701] Wald, "What's in a Cell?," 215.
[702] Cook, *Chromosome 6*, 375.

and animals. To ensure the smooth running of GenSys operations, Siegfried, a former game hunter, was hired to oversee Cogo operations. When the site's veterinarian, Bertram, visits Siegfried's office to discuss Kevin's concerns about the bonobos' behavioural changes, he is disturbed to see the way that Siegfried has decorated his office:

> As a veterinarian and moderate environmentalist, he did not appreciate the decor. Covering the walls and every available horizontal surface were glassy-eyed, stuffed heads of animals, many of which were endangered species. There were cats such as lions, leopards, and cheetahs. There was a bewildering variety of antelope, more than Bertram knew existed. Several enormous rhino heads peered blankly down from positions of prominence on the wall behind Spallek. On top of the bookcase there were snakes, including a rearing cobra. On the floor was an enormous crocodile with its mouth partially ajar to reveal its fearsome teeth. The table next to Bertram's chair was an elephant foot topped with a slab of mahogany. In the corners stood crossed elephant tusks.[703]

The collection and display of the preserved bodies of animals—including endangered species—shows the complete lack of regard that Siegfried has for nonhuman animals, seeing them as commodities and trophies. Like GenSys's use of primates in xenotransplantation research, Siegfried's trophy hunting is another way that *Chromosome 6* explores xenotransplantation within the context of colonialism. Trophy hunting has long been identified as a way that colonial and neocolonial power is exerted; for example, in an analysis of social media comments on news stories about trophy hunting by African media outlets, tourism and conservation researcher Mucha Mkono found that the primary "lens" that posters used to engage with the stories about trophy hunting was through "the colonial histories of Africa and the associated neo-colonial distribution of power, money and access to resources in the present day."[704] Meghan Bird similarly argues that "[t]oday's hunters who travel to Africa continue to express this symbolic lust for power, manifested in neo-colonial actions."[705] By

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[703] Cook, *Chromosome 6*, 77.
[704] Mucha Mkono, "Neo-Colonialism and Greed: Africans' Views on Trophy Hunting in Social Media," *Journal of Sustainable Tourism* 27, no. 5 (2019). 700.
[705] Meghan Bird, "Stolen Trophies: Hunting in Africa Perpetuates Neo-Colonial Attitudes and Is an Ineffective Conservation Tool," *Journal of Integrative Research & Reflection* 1 (2020). 39.

participating in this neocolonial expression of a "symbolic lust for power," Siegfried's desire to kill and display endangered species demonstrates his perspective that Equatorial Guinea is a place that he can exploit for entertainment and sport without consequences, while simultaneously profiting from GenSys' unethical primate research.

Colonialist attitudes toward the exploitation of natural resources and animals frequently manifest as violence towards and dehumanization of people. In Bird's discussion of trophy hunting and conservation, she notes that "[i]n the history of dramatic conflicts between white men and nature in Africa, it can be argued that the groups of individuals who have suffered the most are not endangered animal species, but human native populations."[706] One of the ways this is explored in *Chromosome 6* is in the perception of trophy hunting as a legally "acceptable" practice, while poaching is condemned and punished as an illegal activity. Mkono notes that "[i]n postcolonial times, what constitutes hunting versus poaching is also a racially drawn demarcation, as the 'pastime' of trophy hunting can only be afforded almost exclusively by rich white foreigners."[707] This dynamic is clearly at play in *Chromosome 6*: as Bertram examines Siegfried's office, he notices that alongside the bodies of hunted animals, there are *human* skulls displayed on Siegfried's desk. These skulls were taken from Equatorial Guineans who had been executed for "the capital offense of interfering with GenSys operations" after "they had been caught poaching wild chimps on the Zone's designated hundred-square-mile land."[708] As Bertram regards the skulls of the executed Equatorial Guineans, he reflects on how hunting was not typically considered a crime in itself, but that it was treated as one in this case because "Siegfried considered the area his own private hunting reserve."[709] While the

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[706] Bird, "Stolen Trophies," 41.
[707] Mkono, "Neo-Colonialism and Greed," 700-701.
[708] Cook, *Chromosome 6*, 78.
[709] Cook, *Chromosome 6*, 77-78.

Equatorial Guineans who are executed for hunting chimpanzees were illegally "poaching," the site manager's killing of animals is consider legally acceptable "hunting." Through the depiction of the violence that Siegfried inflicts on both animals and humans, as well as the way that GenSys exerts biopolitical control over the Equatorial Guinean government to maintain dominance over their employees, local communities, and animals, *Chromosome 6* highlights the way that new biotechnologies and biomedical developments can be embedded in—and perpetuate the violence of—colonial histories and neocolonial power structures.

Like *Oryx and Crake*, *Chromosome 6* explores the way that the "abundance" of animal organs for xenotransplantation comes at hidden costs. In *Oryx and Crake*, these costs were primarily environmental and ecological, whereas in *Chromosome 6* they are geopolitical and economic. The biopolitics of xenotransplantation are especially important to consider in relation to the global systems that might shape how access to the procedure develops. Will xenotransplantation be widely accessible to patients in need, or will only patients with significant financial means be able to afford the procedure? If consistent regulations are not agreed upon around the world, will xenotourism networks develop? And if so, what will the local impacts of these global networks be? In *Chromosome 6*, xenotransplantation is depicted as a form of resource extraction, and the unethical and exploitative systems that develop around sourcing animal organs are rooted in violent colonial histories. In this depiction, then, animal organs are not an "abundant" resource that will solve the organ shortage crisis; instead, access to xenografts follows already existing patterns of exploitation and commodification. While the real-world future of xenotransplantation might not resemble the speculative future that *Chromosome 6* envisions, the novel raises important concerns about the systems that will shape biomedical developments.

3.10 Speculative Futures of Xenotransplantation

While both novels highlight the ways that xenotransplantation could become entangled in 21st-century political, social, and economic systems, contributing to issues such as transplant tourism, resource extraction, and climate change, the futures that the novels envision differ drastically. In *Oryx and Crake*, the pigoons' escape from their secure facilities has implications both for ecosystems and for the human survivors of the pandemic. Part of their ability to survive is attributed to their "human" characteristics: as we see in *Oryx and Crake*, the pigoons' genetic modifications have resulted in their developing a dangerous combination of intelligence and aggression. When Snowman attempts to sneak onto a compound to scavenge leftover food and supplies, the pigoons try to ambush him, and Snowman reflects on how "[t]hey'd bowl him over, trample him, then rip him open, munch up the organs first. He knows their tastes. A brainy and omnivorous animal, the pigoon. Some of them may even have human neocortex tissue growing in their crafty, wicked heads."[710] As Pusch notes in her analysis of the *MaddAddam* trilogy,

> The turn of events allowing the spliced animals in the trilogy to go feral is a literary device mirroring society. It can be seen as indirectly criticizing the methods and goals of bioengineering and technoscientific developments which have the potential to lead to such dystopian scenarios as shown in the MaddAddam trilogy.[711]

In *Oryx and Crake*, then, the way that the pigoons take on the "crafty, wicked" traits of the humans who had bred them as an "abundant" source of both organs and food, can be seen as a critique of the overconsumption of resources depicted in the novel.

Like *Oryx and Crake*'s depiction of pigoons developing extreme aggression due to their genetic modifications, *Chromosome 6* indicates that because the bonobos have been altered to be more similar to humans, they have become significantly more aggressive than is typical for their

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[710] Atwood, *Oryx and Crake*, 235.
[711] Pusch, "Splices," 58.

species. For example, earlier in the novel, a bonobo kills a GenSys employee who had come to get one of the bonobos for an upcoming transplant surgery by throwing a rock. Kevin describes the situation to Melanie and Candace, observing that "[t]hat kind of aggression is more associated with human behavior than with bonobos."[712] Likewise, when the GenSys employees investigate the island, Kevin realizes that they could also be in danger of being attacked by the bonobos, but attributes this to the genetic modifications that had made the bonobos more human-like: "Maybe it was true that the creatures' hospitality could not be counted upon, not because of the bonobo part of their heritage but because of the human part."[713] In both novels, then, the animals created for xenotransplantation eventually threaten humans—not because of their animality, but because of their *human* characteristics.

While the novels both explore conflict between human characters and genetically modified animals, they both also consider possibilities for kinship. Despite the initial antagonism between Snowman and the pigoons, the subsequent novels in Atwood's *MaddAddam* trilogy depict the pigoons through a more empathetic, posthumanist lens. As Pramod K. Nayar explains, as a theoretical approach, "critical posthumanism does not see the human as the centre of all things: it sees the human as an instantiation of a network of connections, exchanges, linkages and crossings with all forms of life."[714] After the pandemic in *Oryx and Crake*, humans are no longer "the centre of all things." Instead, as scholars have argued, the new relationship that develops between the pigoons and humans can be viewed in terms of posthuman kinship. For example, Monica Sousa brings a posthumanist care perspective to the *MaddAddam* trilogy. Sousa describes how the trilogy ends with "the pigoons […]

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[712] Cook, *Chromosome 6*, 112.
[713] Cook, *Chromosome 6*, 364.
[714] Pramod K. Nayar, *Posthumanism*, Themes in Twentieth- and Twenty-First-Century Literature and Culture (Cambridge, UK: Polity, 2014). 5.

living happily in forests, untroubled by the human survivors,"[715] which she argues is enabled by the Crakers, since their care for the pigoons is what leads the human characters to also recognize the creatures as beings worthy of care.[716] This coexistence, she explains, "suggests a vision for a future of posthumanity" in which "[c]aring-about other species, even ones that were originally created for human consumption agendas, is a frame of mind that can be cultivated and practiced."[717] While pigoons had initially been viewed by the human characters in *Oryx and Crake* as an abundant source of both organs and meat, the development of this posthuman kinship has required a radical shift in the way that the human characters view meat consumption. For example, Esther Muñoz-González discusses the way that changing concepts of "personhood" across the trilogy result in the pigoons being "incorporated into the moral community"[718] of humans: "[t]he implication of this for the MaddAddamite humans is that the Pigoons are kin to them, and eating their kin would be a kind of cannibalism."[719] Ultimately, she notes that "each group has to adapt their food consumption behaviors in order to create a peaceful society."[720]

These analyses draw attention to the way that more ethical relationships between humans and nonhuman beings can be achieved by rejecting the exploitation of animals as abundant sources of useable (and commodifiable) material. As Pusch concludes in her analysis, reading works like the *MaddAddam* trilogy alongside current developments in biomedicine can contribute to bioethics, since it "can open up new questions and debates that are of high importance regarding human and other animal life, and especially regarding future scenarios of how all beings can live together in greater

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[715] Monica Sousa, "Human and Animal Futurity: Survival, Flourishing, and Care in Margaret Atwood's *MaddAddam* Trilogy and Bong Joon-Ho's *Okja*," *SFRA Review* 51, no. 4 (October 18, 2021). 183.
[716] Sousa, "Human and Animal Futurity," 183.
[717] Sousa, "Human and Animal Futurity," 183.
[718] Esther Muñoz-González, "Maddaddam: Eternal Return?," in *Posthumanity in the Anthropocene: Margaret Atwood's Dystopias* (Routledge, 2023). 28.
[719] Muñoz-González, "Maddaddam: Eternal Return?," 28.
[720] Muñoz-González, "Maddaddam: Eternal Return?," 28.

harmony without destroying other species, or the environment."[721] To bring this analysis back to Alaimo's concept of transcorporeality, the *MaddAddam* trilogy highlights the interconnections between human behaviour, genetically modified animals, and biomedical procedures. As Alaimo argues, transcorporeality can elicit an understanding of the "entanglement" between bodies and systems, and "[t]his profound sense of entanglement, intra-activity, and perpetual emergence fosters an ethical stance that insists that the activities and knowledge practices of the human are always part of, and accountable to, the wider world."[722] For the *MaddAddam* trilogy, this is certainly the case, as the novels highlight the accountability of the human characters to "the wider world" that they are entangled with. The shift in the relationship between humans and pigoons reflects a larger shift in how the human characters view their relationship with the world, resulting in a rejection of the overconsumption that had previously defined this relationship.

In contrast to the *MaddAddam* trilogy's depiction of how the relationship between humans and pigoons develops after the pigoons' escape, the future of the genetically modified bonobos in *Chromosome 6* is left uncertain. Like the pigoons, the genetically modified bonobos display behavioural changes due to their genetic alterations. Throughout the novel, Kevin worries about the implications of the bonobos' genetic modifications, telling his colleagues that "I have no idea what I've created"[723] and "I'm terrified I've overstepped the bounds."[724] When pressed to explain his concerns, Kevin admits that he believes the modified bonobos have become "a kind of protohuman."[725] When Kevin, Candace, and Melanie visit the island, they quickly realize that Kevin's fears about the modified bonobos are accurate. Kevin explains:

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[721] Pusch, "Splices," 72.
[722] Alaimo, *Bodily Natures*, 158.
[723] Cook, *Chromosome 6*, 75.
[724] Cook, *Chromosome 6*, 75.
[725] Cook, *Chromosome 6*, 110.

> I'm afraid the jury is in, and the verdict is bad. We've only been on the island for an hour, but the question that brought us here has already been answered. Besides collective hunting, we've seen totally upright posture, opposable thumbs, toolmaking, and even rudimentary speech. I sense they can vocalize just like you and I.[726]

After realizing the extent of the bonobo's cognitive and behavioural changes, Kevin, Melanie, and Candace agree that the xenotransplantation research needs to cease. Despite Kevin's horror at the behavioural and cognitive changes in the bonobos, *Chromosome 6* ends on a seemingly optimistic note, as he chooses to release the bonobos from captivity.

Like *Oryx and Crake*, *Chromosome 6* gestures at the possibility of posthuman kinship between humans and the modified animals that were designed as a source of organs. Kevin, in particular, is driven to release the modified bonobos by the connection he feels with his own genetic double. Kevin realizes that the genetic modifications had crossed both species boundaries *and* temporal boundaries: "if he had inadvertently created a race of protohumans, then he was in some metaphoric way meeting himself six million years earlier."[727] The relationship that Kevin believes exists between himself and the anachronistic, hybrid being he created leads him to momentarily experience a greater appreciation of multispecies evolution and kinship. However, while Kevin feels a palpable connection with his genetic double, the modified bonobo does not express the same feeling of kinship. Before the modified bonobos cross the bridge to freedom at the end of novel, the pair have a final interaction: "Kevin stared into the animal's face to try to see any emotion, but he couldn't. All he got was a repeat of the uncanny sensation that he was looking into an evolutionary mirror."[728] Additionally, despite Kevin's fascination with his genetic double, he does not experience a meaningful shift in perspective on his own identity. As Wald notes, the human characters "elide their definitional uncertainty and submit to the reassuring narrative of national history and identity as they

[726] Cook, *Chromosome 6*, 334.
[727] Cook, *Chromosome 6*, 325.
[728] Cook, *Chromosome 6*, 446.

escape from their literal captivity to American soil."[729] By leaving Equatorial Guinea, then, Wald argues that the characters "retreat into a familiar narrative of human liberty and human potential."[730] By depicting the lack of a reciprocal bond between Kevin and his double, along with the human characters' reinforcement of their *human* identity, *Chromosome 6* does not offer a vision for ongoing posthuman kinship to form between the human characters the genetically modified animals that they created. Unlike *Oryx and Crake*, which emphasizes the way that biomedical experimentation can result in changes both to animals *and* to humans, *Chromosome 6* does not ultimately depict xenotransplantation as altering human identity.

While *Chromosome 6* does not envision lasting changes to human identity, it does still imply that the bonobos' release will have ongoing impacts. While Kevin had released the bonobos to atone for the treatment they had suffered, it instead appears likely that the release of the bonobos will lead to further conflict. Along with the fact that "[n]othing was done to them to affect their fertility"[731]—meaning that the bonobo population could continue to grow—the novel also hints at the possibility that the genetically modified animals will continue to undergo cognitive and behavioral changes that will make them increasingly human. Part of Kevin's rationale for releasing the modified bonobos had been that, if they stayed in captivity, they would continue to be reduced to medical commodities and "[t]heir human potential was not to be realized, and their striking accomplishments thus far would be lost."[732] However, if the reason for releasing the modified bonobos was so that they could realize their "human potential" and continue their "striking accomplishments," presumably the modified bonobos that were developing humanlike cognition and aggression would eventually clash with local human

[729] Wald, "What's in a Cell?," 216.
[730] Wald, "What's in a Cell?," 216.
[731] Cook, *Chromosome 6*, 363.
[732] Cook, *Chromosome 6*, 410.

communities. Therefore, while *Oryx and Crake* envisions a post-anthropocentric future where humans and pigoons can live alongside one another, *Chromosome 6* indicates that the modified animals could become increasingly similar to the humans that created them, which could result in an anthropocentric struggle for dominance between the modified bonobos and humans.

With this uncertainty about the ability of humans and modified bonobos to live alongside each other, the release of the bonobos has serious, long-term implications for the town of Cogo. When Kevin, Melanie, and Candace flee Equatorial Guinea and return home to the United States, the residents of Cogo are unknowingly left to face the consequences of the bonobos' release. While Kevin may have seen his decision to release the modified bonobos as an act of compassion for them, he does not consider the possible conflicts that could arise between the bonobos and local residents, since he himself will be geographically removed from the situation. The creation and release of the bonobos by the American researcher therefore functions as a possible source of "slow violence": as Rob Nixon explains, slow violence is "a violence that occurs gradually and out of sight, a violence of delayed destruction that is dispersed across time and space, an attritional violence that is typically not viewed as violence at all."[733] As Nixon describes, slow violence often occurs when the source of environmental and ecological destruction is geographically and temporally removed from the outcome. In this case, the ecological and political impacts of the bonobos' release will likely not be immediately apparent, and while Kevin plans to expose GenSys for their exploitative behaviour, he does not recognize how his own decisions might lead to a continuation of GenSys' detrimental ecological and political impacts in Equatorial Guinea.

[733] Rob Nixon, *Slow Violence and Environmentalism of the Poor* (Harvard University Press, 2011). 2.

3.11 Conclusion

Given that proponents of xenotransplantation draw on the "abundance" of pigs as a justification for their use as bioreactors to create organs for humans, it is critical to consider how xenotransplantation will interact with other systems like animal agriculture, resource extraction, and transplant tourism. In both *Oryx and Crake* and *Chromosome 6*, the use of nonhuman animals is shown to be unsustainable. And in both cases, the novels question whether an "abundant" resource will truly be accessible for all patients, instead depicting the possibility that xenotransplantation will be limited to select, high-paying customers. Is it possible to envision a future for xenotransplantation outside of this exploitative framework? It is particularly interesting that both *Oryx and Crake* and *Chromosome 6* depict the bioengineered animals taking on the "human" trait of violence due to their genetic modifications and using this trait to strike back against the species that had created them as commodifiable biomedical objects. And while this analysis does not intend to suggest that this is a realistic outcome of the genetic modification of the pigs used in real-world xenotransplantation, these narratives can provide a means through which to reconsider anthropocentric assumptions about the use of animals as seemingly "abundant" resources for human use. When considered through a transcorporeal, posthuman lens, these novels demonstrate the potential interconnections between the creation of bioengineered animals for xenotransplantation and exploitative economic, medical, agricultural, and environmental practices. By investigating fictional depictions of xenotransplantation and recognizing how biomedical experimentation brings bodies into contact with different social, political, and economic systems, we can better identify and address potential issues as xenotransplantation continues to develop.

Part III: Reimagining Kinship

Chapter 4: Reimagining Kinship in De-Extinction: Countering Charisma and Hype through Curiosity, Immersion, and Technological Entanglements in "The Birdsong Fossil" (2021)

4.1 Introduction

In current de-extinction discourse, sensational claims abound of genetic engineering being used to re-create extinct charismatic megafauna. Evidently, this sensationalism sells: through funding from a wide range of investors,[734] Colossal Laboratories & Biosciences has genetically modified grey wolves to create what they refer to as "dire wolves," and they have ongoing plans to create genetically engineered "proxies" for woolly mammoths, thylacines, and dodos.[735] In response to the sensationalized claims of a dire wolf or mammoth being resurrected through genetic engineering, important questions need to be answered. For science communicators, there are concerns about whether claims that species can be "brought back" via genetic engineering could contribute to spreading misinformation by misleading the public, both about the realities of the scientific limitations of de-extinction, and about the ability of genetic engineering alone to re-create a species. For ecologists and conservationists, questions are arising regarding the futures of these "de-extinct" animals, including how they will be integrated into ecosystems, and how they will interact with other species. And for ethicists, concerns are growing over the focus on "charismatic" candidate species, and which species are being left out of conservation efforts.

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[734] Colossal Laboratories & Biosciences, "A Colossal $60 Million Series A," September 15, 2021, https://colossal.com/a-colossal-60-million-series-a/.
[735] Colossal Laboratories & Biosciences, "Species," January 31, 2023, https://colossal.com/species/.

Fiction plays a critical role in envisioning the future of scientific developments like de-extinction. In this chapter, I will address questions arising from recent developments in de-extinction science by analyzing D.K. Mok's short story, "The Birdsong Fossil" (2021). As an example of solarpunk fiction—a speculative genre that focuses on addressing climate change through sustainable technologies and societies[736]—the short story depicts a behavioural and ecological approach to de-extinction. In contrast to the media hype around Colossal's "dire wolf" project, "Birdsong Fossil" envisions a more ecologically conscientious future of de-extinction, where the behaviour and "culture" of a species is prioritized above genetics or morphology, and instead of sensationalizing charismatic megafauna, the importance of including underappreciated species in de-extinction efforts is explored. By drawing on environmental and de-extinction ethics, multispecies studies, and solarpunk literary theory, I argue that fiction like "Birdsong Fossil" can provide an important counternarrative to current de-extinction discourse by encouraging readers both to take a broader perspective on the way that species are shaped by their ecological entanglements, and to consider underappreciated species as important candidates for de-extinction and conservation efforts. Through envisioning futures where humans, technology, and nature form new entanglements, solarpunk short stories like "Birdsong Fossil" can inspire greater interest in the ethical application of de-extinction science and technology.

[736] For an overview of the solarpunk movement and literary genre, see Juan David Reina-Rozo, "Art, Energy and Technology: The Solarpunk Movement," *International Journal of Engineering, Social Justice, and Peace* 8, no. 1 (2021): 55–68, https://doi.org/10.24908/ijesjp.v8i1.14292.

4.2 Hype in De-Extinction Discourse: "Semantics" and Sensationalism

In April 2025, Colossal made headlines around the world for "resurrecting" the dire wolf. One of the first articles to cover the news appeared in *TIME*, dramatically titled: "The Return of the Dire Wolf."[737] Other articles followed, albeit with more tempered headlines, such as "U.S. scientists genetically engineer wolves to resemble the extinct dire wolf"[738] and "A biotech company has, sort of, revived the long-extinct dire wolf."[739] Colossal has fueled the frenzied media attention: for example, they released a video featuring the fluffy wolf puppies, where audiences can hear "The First Dire Wolf Howl in Over 10,000 Years."[740] Meanwhile, images of *Game of Thrones* author George R.R. Martin—who invested in the project—have circulated showing him standing side-by-side with Colossal's CEO Ben Lamm while holding one of the wolf puppies,[741] along with reports that *Game of Thrones* actors Sophie Turner and Kit Harrington have acted as "cultural advisors" for the project.[742] As reactions to Colossal's genetically engineered wolves ranging from excitement to skepticism arise, it is critical to question the goals and motivations for this type of research. Rather than being caught up in the awe of Colossal's claims, I argue that the conversation about de-extinction needs to be reframed in terms of the ecological and ethical concerns that arise from attempts to re-create extinct species. Have dire wolves *actually* been revived? Why do different headlines use different language

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[737] Jeffrey Kluger, "The Return of the Dire Wolf," *TIME*, April 7, 2025, https://time.com/7274542/colossal-dire-wolf/.
[738] Christina Larson, "U.S. Scientists Genetically Engineer Wolves to Resemble the Extinct Dire Wolf," *The Globe and Mail*, April 8, 2025, https://www.theglobeandmail.com/world/article-us-scientists-genetically-engineer-wolves-to-resemble-the-extinct-dire/.
[739] Kevin Maimann, "A Biotech Company Has, Sort of, Revived the Long-Extinct Dire Wolf," *CBC News*, April 9, 2025, https://www.cbc.ca/news/dire-wolf-deextinction-1.7505369.
[740] Colossal Biosciences, *The First Dire Wolf Howl in Over 10,000 Years*, 2025, https://www.youtube.com/watch?v=vPX4tm-J2bU.
[741] David Bloom, "Long Extinct, Dire Wolves Are Back, And Not Just In 'Game Of Thrones,'" *Forbes*, April 8, 2025, sec. Media, https://www.forbes.com/sites/dbloom/2025/04/08/long-extinct-dire-wolves-are-back-and-not-just-in-game-of-thrones/.
[742] Colossal Laboratories & Biosciences, "Culture," accessed April 13, 2025, https://colossal.com/direwolf/culture/.

to refer to this development? Beyond that, what are the next steps for rewilding these animals, and what ecological impact could they have? And finally, are dire wolves a species that conservation and de-extinction efforts *should* be prioritizing? While dire wolves are not the focus of my analysis, they provide an important example of a larger issue within de-extinction discourse.

The "dire wolf" development draws attention to an important factor driving de-extinction discourse: sensationalism. The sensationalization of scientific discoveries and developments is often referred to as *hype*. In an analysis of hype in science communication, Kristen Intemann discusses how hype is a form of "exaggeration," which, she argues, "may not strictly be *false* but ha[s] the potential to be misleading or deceptive."[743] As Intemann notes, hype can result in scientific developments being aggrandized in ways that can confuse and mislead audiences. Perhaps unsurprisingly, sensationalism occurs widely across de-extinction discourse. Media headlines often focus on dramatic claims about how genetic engineering can be used to resurrect lost species and they feature awe-inspiring images of charismatic megafauna like woolly mammoths (and now, Colossal's genetically engineered wolves). In a special issue of the *Hastings Center Report*, Claudio Campagna et al. argue that the term "de-extinction" can be misleading, since it "gives the impression that extinction is reversible," with the consequence that "[d]e-extinction […] has more to do with wordplay than reality. Human-induced extinction is real and permanent; the rest is distraction and wishful thinking."[744]

Even before the announcement about Colossal's wolves, examples of hype in de-extinction discourse have been noticed. For example, David E. Blockstein analyzes the discourse around

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[743] Kristen Intemann, "Understanding the Problem of 'Hype': Exaggeration, Values, and Trust in Science," *Canadian Journal of Philosophy* 52, no. 3 (April 2022): 279–94, https://doi.org/10.1017/can.2020.45. 284.
[744] Claudio Campagna, Daniel Guevara, and Bernard Le Boeuf, "De-Scenting Extinction: The Promise of De-Extinction May Hasten Continuing Extinctions," *Hastings Center Report* 47, no. S2 (2017): S48–53, https://doi.org/10.1002/hast.752. 48.

passenger pigeon de-extinction, raising concerns about what de-extinction promises. As he puts it, "one of the ethical violations of the proponents of 'de-extinction' is to lure and seduce the public with false promises and fantastical visions of bringing extinct species back from the grave."[745] These "false promises" include the claim that genetics alone can be used to restore a species. Instead, Blockstein argues that "[a] species is more than an accumulation of its genes,"[746] and that "synthetic biology […] is a tool to create new organisms, not to restore extinct organisms," meaning that the passenger pigeon cannot be resurrected through this approach.[747] As Blockstein points out, part of what makes current de-extinction discourse misleading is that it focuses disproportionately on the role of genetics in shaping species identity. Instead, it is important to acknowledge that scholars are still grappling with what "authentic" de-extinction would look like.[748]

Interestingly, even scientists who have openly discussed the limitations of de-extinction science seem hesitant to acknowledge that hype can result in misleading public audiences about de-extinction science. For example, ancient DNA researcher Beth Shapiro has been vocal about the fact that de-extinction will never re-create extinct species; instead, it will create new "proxy" species that may resemble extinct species and share some ecological functions.[749] In an interview on *The MeatEater Podcast*, Shapiro explains that "once a species is extinct it is gone. This is not a solution to the extinction crisis. De-extinction […] it's an idea that is shaped more by imagination than by reality."[750] And while across her media appearances, Shapiro is clear about the limitations of what de-

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[745] David E. Blockstein, "We Can't Bring Back the Passenger Pigeon: The Ethics of Deception Around De-Extinction," *Ethics, Policy & Environment* 20, no. 1 (2017): 33–37, https://doi.org/10.1080/21550085.2017.1291826. 34.
[746] Blockstein, "The Ethics of Deception," 35.
[747] Blockstein, "The Ethics of Deception," 34.
[748] Helena Siipi, "The Authenticity of Animals," in *The Ethics of Animal Re-Creation and Modification: Reviving, Rewilding, Restoring*, ed. Markku Oksanen and Helena Siipi, 2014. 77-78.
[749] Steven Rinella, "Cloning Mammoths," *The MeatEater Podcast*, 2017. 1:07:39-1:07:53; 1:30:20-1:30:33.
[750] Rinella, "Cloning Mammoths," 15:35-16:05.

extinction can offer, Colossal—where she now holds the position of Chief Science Advisor—has been somewhat less clear. During an interview for the *What's Your Problem?* podcast, host Jacob Goldstein pointed out that Shapiro's stance does not appear to align with what Colossal promotes on their website:

> It seems somewhat at odds with the sort of public messaging of Colossal. […] But it is the case that like the homepage of Colossal right now says 'We endeavor to jumpstart nature's ancestral heartbeat, to see the woolly mammoth thunder upon the tundra once again.' Right, like which is not 'To see the Asian elephant with some phenotypical traits of the woolly mammoth.' […] Like how do you reconcile those? Is it just like there's sort of a public story that needs to be simplified because that's the nature of public stories, and then a more complex technical story?[751]

As Goldstein points out, Shapiro's more tempered description of creating *new* species that share some similarities with extinct species runs counter to Colossal's more dramatic, sensational claims about resurrecting extinct species like woolly mammoths.

Evidently, there is a disconnect in the way that de-extinction is described across different platforms. For example, when Shapiro responds that Colossal does explain elsewhere on their website that they are creating something distinct from a mammoth, Goldstein backtracks, noting, "I don't want to get too caught up in the semantics, right I understand that it can mean different things to different people."[752] And while Shapiro reiterates that she does not view de-extinction as a solution to extinction or a way to bring back an exact copy of an extinct species, she echoes Goldstein by stating, "[b]ut am I willing to say that we shouldn't try this, that we shouldn't develop these tools that may have application to helping species not become extinct, because we're worried that somebody is going to get tied up in the *semantics* of something and accuse us of something we're not? No."[753] Rather than using this moment of confusion as an opportunity to discuss the importance of accurate

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[751] Jacob Goldstein, "Bringing Back Mammoths and Dodos*," *What's Your Problem?*, 2024. 9:36-10:17.
[752] Goldstein, "Mammoths and Dodos," 11:27-11:37.
[753] Goldstein, "Mammoths and Dodos," 11:42-13:08. Emphasis added.

science communication in shaping public understandings of science and the way that hype can mislead audiences about the capabilities of scientific developments, Shapiro reduces issues of ethical and accurate science communication to "semantics." This exchange is particularly puzzling, given that Shapiro has done substantial work in science communication, publishing the nonfiction book *How to Clone a Mammoth* (2015) and engaging in numerous interviews to discuss de-extinction science.[754] Evidently, there are rhetorical tensions around the concept of "de-extinction," which can lead to confusion about the discrepancies in how de-extinction science is communicated by scientists and scientific organizations.

These rhetorical tensions are important to acknowledge as more than just "semantics." Instead, these tensions demonstrate the different goals in the communication of de-extinction. Indeed, it is worth noting that encouraging public engagement in scientific developments is certainly an important aspect of science communication. As Intemann notes, "[g]enerating enthusiasm and provoking interest in science helps engage laypersons to be scientifically informed."[755] Similarly, E.G. Grebenshchikova notes that hype can potentially result in greater engagement in science across audiences, since it "can initiate an exchange of views between different parties involved in innovation processes."[756] For Colossal, then, hype could potentially result in benefits like greater public engagement in de-extinction science, and potentially even additional funding.

However, the risks of hype are important to recognize, since the way that de-extinction is communicated can shape the way that public audiences understand and engage not only with de-

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[754] Interestingly, in an interview just a few years earlier on *The MeatEater*, Shapiro *did* comment on how the sensationalization of de-extinction can create problems, saying that "what I worry about is that the kind of spectacular nature of thinking about bringing extinct species back might make people less likely to think about some of the real benefits that this technology could have to species that are still alive."[754] Rinella, "Cloning Mammoths," 1:20:30-1:21:33.

[755] Intemann, "The Problem of Hype," 282.

[756] E. G. Grebenshchikova, "Hype in the Communication of Science and Society," *Herald of the Russian Academy of Sciences* 94, no. 2 (April 1, 2024): 79–85, https://doi.org/10.1134/S1019331625600143. 81.

extinction, but with conservation more broadly. In Campagna et al.'s discussion of the rhetoric of de-extinction, they argue that it is critical not to relegate language to nothing more than "mere semantics,"[757] since "[l]anguage shapes value systems" and "establishes the limits of all our efforts to promote conservation."[758] If language does indeed set the expectations and boundaries for conservation and de-extinction work, it is important to consider what impact hype has on shaping what the public views as the limitations and possibilities of these projects. As Intemann notes, hype can have widespread implications, since it "can undermine or erode warranted epistemic trust in scientists (or even scientific institutions) even if no one is actually taken in by hype."[759] In Colossal's de-extinction work, as audiences take note of the disconnect between dramatic headlines about resurrecting lost species and the more nuanced comments from scientists and conservationists about the reality of what genetic modification can achieve, the result could be a decrease in public trust in the scientists and scientific organizations working on de-extinction. The result of this loss of trust could then be lower support for future de-extinction and conservation work. Ultimately, whether audiences are led to believe that it is in fact possible to resurrect species using genetic engineering alone, or if they recognize the discrepancies in how these developments are communicated and lose trust, a shared potential outcome emerges: there could be decreased support for more effective and ecologically focused conservation and de-extinction efforts. In the following sections, I investigate how the solarpunk short story "Birdsong Fossil" provides a counternarrative to the hype of current de-extinction discourse. Rather than a version of species identity based on genetics, "Birdsong Fossil" focuses on the behaviour and ecological significance of de-extinction candidates, and considers how vital, but underappreciated, species can be framed as valid conservation and de-extinction candidates.

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[757] Campagna et al., "De-Scenting Extinction," 48.
[758] Campagna et al., "De-Scenting Extinction," 48.
[759] Intemann, "The Problem of Hype," 289.

4.3 De-Extinction in "The Birdsong Fossil": Solarpunk and Hopeful Technological Futures

D.K. Mok's short story, "The Birdsong Fossil," was published in the collection *Multispecies Cities: Solarpunk Urban Futures* (2021). The story centres on the "Enthographic Bio-Roboticist"[760] Yuzuki Alvarez, who was inspired by childhood memories of bird fossils to spend her career working on conservation and de-extinction. However, unlike her friend and competitor, Min Madaki, Yuzuki does not take a genetics-based approach to de-extinction. Instead, she advocates for the need to preserve the "culture"[761] of endangered and extinct species, which she does by programming robots to develop the unique personalities and behaviours of endangered species. When Yuzuki eventually loses research funding, she continues to work on what she sees as more authentic de-extinction projects: as friends and former colleagues bring Yuzuki species that they would like to see preserved, she populates an abandoned warehouse with a wide range of robotic animals, including underappreciated species like magpies and stick insects. When a war breaks out and her warehouse is certain to be destroyed, Yuzuki releases the robotic animals. Eight years later, when she and her robot companion, Evan, set out to find Min, they unexpectedly cross paths with a group of three elephants—one robotic and two biotic—that seem to be created from similar technologies to the ones Yuzuki had developed (though she had never worked on elephants during her warehouse experiments). However, Yuzuki has little time to reflect on this discovery: in an encounter with a bear, Evan is seriously injured. Yuzuki manages to get Evan to Min, and together they save Evan by transferring his consciousness into a new body. Min then reveals to Yuzuki that she had been

[760] D.K. Mok, "The Birdsong Fossil," in *Multispecies Cities: Solarpunk Urban Futures*, ed. Christoph Rupprecht et al. (World Weaver Press, 2021). 300.
[761] Mok, "Birdsong Fossil," 297.

combining her genetic research with Yuzuki's approach to de-extinction by using robotic animals to train genetically engineered biotic animals, which have been rewilded. The story ends with the sun rising over a pair of robotic stick insects.

"Birdsong Fossil" both critiques the hype around charismatic species *and* envisions a post-anthropocentric future where technology can be used to mitigate damage to ecosystems, rather than to generate profits and fulfill capitalist interests. This hopeful embrace of technology as a means of ethically reshaping the world and responding to issues like climate change is a core principle of the solarpunk genre. As Juan David Reina-Rozo explains, solarpunk is associated with "an uprising of hope against the daily despair that these times bring,"[762] and it can provide a means to "re-imagine the relationship between technology - society - nature."[763] Olga Thierbach-McLean echoes this sentiment, arguing that "solarpunk is a decidedly technophilic genre."[764] However, while the solarpunk genre promotes technological solutions to environmental crises and envisions humans altering animal bodies, ecosystems, and the environment, it also promotes a radical shift from current techno-solutionist discourse that positions technological developments within anthropocentric and capitalist systems as a necessary step towards more resilient futures. William Joseph Gillam argues that "[a] solarpunk society is post-capitalist and post-scarcity," since it "deconstructs power" and promotes a "community-oriented" approach to environmental activism.[765] Thus, while solarpunk may initially appear to align with an anthropocentric approach where humans use technology to intervene and "fix"

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[762] Juan David Reina-Rozo, "Art, Energy and Technology: The Solarpunk Movement," *International Journal of Engineering, Social Justice, and Peace* 8, no. 1 (March 5, 2021): 55–68, https://doi.org/10.24908/ijesjp.v8i1.14292. 50.
[763] Reina-Rozo, "The Solarpunk Movement," 50.
[764] Olga Thierbach-McLean, "Uncanceling the Future: Cyberpunk, Solarpunk, and the Rebellion of Eco-Optimism," in *Eco-Consciousness in American Culture: Imperatives in the Age of the Anthropocene*, ed. Adina Ciugureanu and Eduard Vlad (Peter Lang, 2023). 256.
[765] William Joseph Gillam, "A Solarpunk Manifesto: Turning Imaginary into Reality." *Philosophies* 8, no. 4 (August 1, 2023): https://doi.org/10.3390/philosophies8040073. 3.

environmental crises, it actually promotes a significant reimagining of political, economic, and social systems to better allow for human/nonhuman co-existence.

Human and nonhuman co-existence is a core theme in the solarpunk collection in which "Birdsong Fossil" was published, which promotes multispecies kinship and environmental care. In their introduction to *Multispecies Cities*, the editors Christoph Rupperecht et al. discuss the decision to focus on "multispecies" as a core concept to highlight the formation of new types of "alliances" between humans and nonhumans, and particularly "the more-than-human ties, relationships and kinship on which such alliances might be built."[766] In their separate analyses of short stories from the collection, both Elizabeth Tavella and Heather Alberro affirm the collection's emphasis on interspecies relationships. Tavella notes that the "interconnectedness" of human and nonhuman in the stories "lays the foundations for more radical re-imaginings of systems as well as visions of multispecies kinship based on notions of justice that transcend logics of commodification, instrumentalisation, exploitation, and extraction, rather than rely on unquestioned systems of violence and domination."[767] Alberro, meanwhile, analyzes multispecies kinship across a range of stories in the collection, including "Birdsong Fossil," arguing that *Multispecies Cities* "presents a mosaic of visions of more inclusive and diverse urban spaces populated by all manner of purposive entities who speak – if only humans make the effort to listen well and deeply."[768] Evidently, then, multispecies kinship is a critical aspect of the collection.

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[766] Christoph Rupprecht et al., "Introduction," in *Multispecies Cities: Solarpunk Urban Futures*, ed. Christoph Rupprecht et al. (World Weaver Press, 2021). 2.
[767] Elizabeth Tavella, "Speculating on Ecological Futures: Narratives of Hope and Multispecies Justice in Contemporary Ecofiction," in *Storying the Ecocatastrophe* (Routledge, 2024). 175.
[768] Heather Alberro, *Terrestrial Ecotopias: Multispecies Flourishing in and Beyond the Capitalocene* (Peter Lang Verlag, 2024). 132.

The stories' depiction of multispecies kinship and rejection of exploitative systems provide a useful means through which to imagine alternative environmental futures where technology can address issues like extinction and biodiversity loss without defaulting to the commodification of living beings and natural resources. Building on the work of scholars like Tavella and Alberro, I argue that "Birdsong Fossil" provides an important intervention into conversations about de-extinction science by serving as an example of the solarpunk genre's rejection of commodification. While other recent de-extinction narratives tend to take a critical tone towards attempts to resurrect lost species and focus on the potential exploitation of bodies and genes within de-extinction science,[769] "Birdsong Fossil" envisions a future for de-extinction *beyond* commodification, where candidate species selection is reframed in the context of species' unique behaviours and ecological networks. Importantly, rather than rejecting de-extinction science, the short story considers how de-extinction technology could be used ethically, and how a multispecies approach to de-extinction is particularly promising due to the way it can bring non-charismatic species into conversations around de-extinction and conservation.

4.4 Adorable Puppies vs. Unlovable Vermin: The Role of Charisma in De-Extinction Candidate Species Selection

A core aspect of sensationalism or hype in de-extinction discourse that "Birdsong Fossil" contests is the focus on charismatic animals as candidate species. This dynamic can be seen across both real-world and fictional de-extinction projects: for example, along with the dire wolf, other de-extinction candidate species selected by the companies Colossal and Revive & Restore include

[769] In Chapter 1, I discuss three examples of recent fictional depictions of de-extinction that explore "biovalue" and the commodification of bodies in de-extinction science.

mammoths, thylacines, dodos, and passenger pigeons,[770] while Neanderthals and dinosaurs tend to dominate fictional depictions of de-extinction.[771] Shapiro explains why she believes mammoths have generated so much interest: "I think people think of mammoths as soon as they realize that they can't bring back dinosaurs. I just think it's like the second most spectacular thing."[772] Shapiro's belief that the "spectacular" nature of mammoths—second only to dinosaurs—has been instrumental in driving de-extinction efforts is supported by a recent study on the factors influencing de-extinction candidate species selection. Tessa Molhuizen et al. investigated the motivations behind de-extinction projects by interviewing several of the scientists involved. While Molhuizen et al. identify seven factors influencing candidate species selection, they found that the primary motivating factor across every project was the appeal of the species selected: "animal charisma seems to be an essential condition for any species to be selected as a de-extinction candidate."[773] In Molhuizen et al.'s study, species charisma was further broken down into aesthetic value, uniqueness, and iconic status.[774] In other words, species that are viewed as being particularly interesting, awe-inspiring, or cute, as well as species that have cultural significance, are often seen as more charismatic than other species.

"Birdsong Fossil" satirizes the hype around charismatic species by depicting the consequences that occur when scientific funding agencies prioritize sensationalism. Early in the story, charisma *is* depicted as playing a major role in determining which de-extinction candidate species are considered worthwhile and which scientific research projects receive funding. For example, Yuzuki

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[770] Colossal Laboratories & Biosciences, "Species." Revive & Restore, "About the Passenger Pigeon," 2025, https://reviverestore.org/projects/about-the-passenger-pigeon/.
[771] In chapter 1, I analyze two examples of Neanderthal de-extinction narratives: *Ghost Species* (2020) and *The Neanderthal's Aunt* (2014), alongside dinosaur de-extinction in the *Jurassic World* film trilogy (2015-2022).
[772] Rinella, "Cloning Mammoths," 1:08:38-1:09:03.
[773]Tessa Molhuizen, Koen Beumer, and Ine Dorresteijn, "Who to Revive? Explaining Charismatic Species Bias in the Selection of De-Extinction Candidate Species," *Environment and Planning E: Nature and Space*, January 19, 2025, https://doi.org/10.1177/25148486241310698. 11.
[774] Molhuizen et al., "Who to Revive?," 9.

explains that she works at CURIUS—"the Centre for Useful Research and Investable Understandable Science"[775]—conducting ethnographic and robotics research. While Yuzuki and her colleague, Min Madaki, both work on extinct species, their approaches differ: Yuzuki's approach to de-extinction prioritizes animal behaviour and "culture,"[776] which she believes is more central to species identity than appearance or genetics. As Yuzuki explains, "I wasn't trying to create a robot that looked like a bird. I was trying to create a bird that had the body of a robot. That was crucial if we hoped to understand and preserve the infinitely complex ecosystems of this unstable world."[777] Min, on the other hand, takes a genetics-based approach and focuses her attention on well-loved mammalian species. The two approaches to de-extinction result in drastically different levels of public and institutional interest as well as research funding, and Yuzuki notices a clear discrepancy in the attention and support that their projects receive. While Yuzuki's work is "scoffed at"[778] and dismissed, Min's work on more charismatic animals is widely celebrated and catapults her into the limelight as "one of CURIUS's darlings: not only a rising star in the field of de-extinction biology, but also a brilliant science communicator who frequently did the media rounds and turned up in viral videos involving baby pandas."[779] While Yuzuki carefully labours over what she views as a more authentic approach to de-extinction, Min's work gains higher acclaim due to the appeal of her work with beloved charismatic species.

When Yuzuki is invited to a party to celebrate Min's latest achievements in thylacine de-extinction, she is again confronted with the popularity of charismatic species, since "[t]he 'small

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[775] Mok, "Birdsong Fossil," 299.
[776] Mok, "Birdsong Fossil," 297.
[777] Mok, "Birdsong Fossil," 296-297.
[778] Mok, "Birdsong Fossil," 302.
[779] Mok, "Birdsong Fossil," 297.

celebration' turned out to be a packed ballroom event, complete with voracious press."[780] The "voracious" media attention is, once again, due to the charisma of the species under discussion, as "[a] perilously large banner boasted: CURIUS BREAKTHROUGH! THYLACINE RESURRECTION! accompanied by an adorable photo of a mewling pup, distinctive black stripes already visible across its back."[781] The "adorable" and "distinctive" thylacine pup, like the baby pandas, attracts attention and hype, resulting in Min's work being seen as more significant than Yuzuki's. This depiction of the celebration of charismatic species like thylacines in "Birdsong Fossil" mirrors real-world preferences for de-extinction candidate species: the story's description of "an adorable photo of a mewling pup" has recently been realized, albeit through Colossal's genetically modified wolves rather than through thylacines.

The attention received by Min's pandas and thylacines represents an example of what Kenneth Boyd refers to as "cutewashing."[782] Boyd discusses Colossal's creation of "woolly mice"—that have been genetically modified to have bright orange fur—as part of their mammoth de-extinction research. As Boyd explains, the woolly mouse "has been met with near-universal proclamations of adoration in the news and heart-eye emojis online."[783] Boyd argues that this focus on the "cuteness" of a genetically modified species can create issues, since

> The degree to which a genetically engineered animal is cute should presumably not be a relevant factor when weighing moral considerations around its existence or the actions that led to its creation. But the cuteness of the woolly mouse reminds us that our moral judgments are often intertwined with our affective judgments; in other words, whether we think something is morally wrong or acceptable is often tied up with how we feel about it.[784]

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[780] Mok, "Birdsong Fossil," 298.
[781] Mok, "Birdsong Fossil," 298.
[782] Kenneth Boyd, "Woolly Mice and the Ethics of Cutewashing," The Prindle Institute for Ethics, March 24, 2025, https://www.prindleinstitute.org/2025/03/woolly-mice-and-the-ethics-of-cutewashing/.
[783] Boyd, "Woolly Mice."
[784] Boyd, "Woolly Mice."

The "cutewashing" of projects like Colossal's genetically modified wolves and Min's thylacine puppies functions as a specific form of hype. However, as Boyd points out, cutewashing can be highly problematic by distracting from key ethical considerations. In the case of "Birdsong Fossil," the funding and promotion of "adorable" candidate species provides a key example of how hype can influence the future directions of de-extinction.

A potential impact of the focus on charismatic species in de-extinction science is that it shapes what species are seen as worth protecting or restoring, which—as depicted in "Birdsong Fossil"—can have tangible impacts on researchers. As Molhuizen et al. describe, charisma can be a powerful motivation to focus on specific species over others, since "[i]f a species is valued as being charismatic, it is easier for the researcher to get attention and funding for their work."[785] Capitalizing on the "cuteness" of charismatic species can lead to a cycle where the public engages more enthusiastically with these projects, which reinforces which types of research receive funding. Andrew Moore notes that the urge to sensationalize scientific developments can be driven by scientists' and institutions' desire to attract funding or attention, since "[s]cience is increasingly 'sold' in a competitive market, which is why many high-profile scientific journals want to attract 'sexy' research to ensure that their scoop will be covered by the media within hours of publication."[786] Hyping scientific developments, then, is often driven by the desire to capitalize on what the public (and by extensions, funding agencies) find exciting and interesting. This cycle can lead to more emphasis being placed on charismatic species over time. Given that charismatic (and "cute") species

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[785] Molhuizen et al., "Who to Revive?," 13.
[786] Andrew Moore, "Bad Science in the Headlines: Who Takes Responsibility When Science Is Distorted in the Mass Media?," *EMBO Reports* 7, no. 12 (December 2006): 1193–96, https://doi.org/10.1038/sj.embor.7400862. 1194.

are likely to be seen as more valuable, it is unsurprising that scientists would focus their efforts on these species, as is depicted in Min's thylacine de-extinction in "Birdsong Fossil."

However, when researchers capitalize on species charisma as a source of hype, the consequence is that it also reinforces which species are *excluded* from de-extinction and conservation work. For example, Derek Turner notes that "[w]oolly mammoths are charismatic megafauna, and they loom large in popular culture. But what if we were talking about reversing the extinction of an ecologically significant plant species that few non-specialists had ever heard of? The argument from coolness would get very little traction."[787] As "Birdsong Fossil" satirically demonstrates, the outcome of a system that prioritizes "coolness" or "cuteness" is that species that are less charismatic (but still ecologically significant) do not receive funding. For example, in contrast to Min's thylacines, Yuzuki's preferred candidate species—including a range of birds and insects—appear to lack the same degree of charm, and therefore seen as less valuable, regardless of their ecological significance. Yuzuki reflects on reactions to her work, thinking about how "[j]ust last week, someone from True Today Gazette had called up, asking if I was squandering taxpayer money on robotic vermin."[788] While Min's genetic work on pandas and thylacines is widely celebrated, Yuzuki's ethnographic work on birds and insects is reduced to wasteful attempts to protect "vermin." In "Birdsong Fossil," then, the hyping of charismatic species goes hand-in-hand with the denigration of species that are viewed as less charismatic. As this demonstrates, the sensationalization of charismatic species in de-extinction discourse can be actively harmful by shaping which species are viewed as valuable, and which species are not. "Birdsong Fossil" calls attention to the problems that can arise from this

[787] Derek Turner, "The Restorationist Argument for Extinction Reversal," in *The Ethics of Animal Re-Creation and Modification: Reviving, Rewilding, Restoring*, ed. Markku Oksanen and Helena Siipi, 2014. 49.
[788] Mok, "Birdsong Fossil," 304.

dynamic by depicting the way that research that is seen as having the potential to gain public attention and elicit excitement is valued above less "exciting" projects.

4.5 Species "adrift in a world that no longer knew them": Extinction, Ecological Networks, and Systems Thinking

Along with the exclusion of less charismatic species from de-extinction projects, there is another way that sensationalism occurs in de-extinction science: there is often a focus on *genetic* and *morphological* approaches to species identity. As Markku Oksanen and Helena Siipi note in their introduction to *The Ethics of Animal Re-Creation and Modification*, most de-extinction projects employ "a species concept that is genome-centred, morphology-centred or both."[789] While the idea of creating an animal that closely resembles an extinct species might excite public audiences—contributing to the cycle of hype—this approach leads to a critical oversight, since the result is that "[a]n animal's lack of ecological interactions with its (native) biophysical environment, social relations and the way it came into existence is seen as insignificant to its species identity."[790]As Oksanen and Siipi point out, the focus on creating animals that genetically and morphologically resemble extinct species promotes a limited perspective on ecology and species identity. Curt Meine describes this as a "reductionist" view of species identity, which, Meine notes, is "the old-fashioned way" of viewing species as "a biological part—in this case, a now more easily malleable genome—as isolated in time and space, detached from its ecological milieu and its ethological expression, with

[789] Markku Oksanen and Helena Siipi, "Introduction: Towards a Philosophy of Resurrection Science," in *The Ethics of Animal Re-Creation and Modification: Reviving, Rewilding, Restoring*, ed. Markku Oksanen and Helena Siipi (Palgrave Macmillan, 2014). 11.
[790] Oksanen and Siipi, "Introduction," 11.

little consideration given to its evolutionary or human social context."[791] In other words, current de-extinction science fails to recognize that species shape and are shaped by their ecological networks.

In "Birdsong Fossil," Yuzuki calls attention to the issues created by a reductionist approach to species identity when she points out the flaws in Min's genetics-based de-extinction projects: "I don't disagree with your research. I disagree with how you're presenting it. Or rather, what you're leaving out."[792] Yuzuki elaborates on what she thinks Min is "leaving out," explaining that "[o]nce we lose a species—it's gone. You might bring back the body, but you're not bringing back the mind, the culture, the ecological systems."[793] While Min's genetically engineered animals might share both their appearance and genetic code with their extinct predecessors, this does not guarantee that the animals will have the same behaviour or interact with their ecosystems in the same way. A similar critique has been raised by conservationists and ecologists. For example, Douglas J. McCauley et al. note that from an ecological perspective, "a resurrected mammoth counts as mammoth only if it looks like a mammoth and consumes, defecates, tramples and migrates like a mammoth."[794] From this perspective, a de-extinct species can only be considered as a valid replacement for its extinct counterpart if it exhibits the same behaviours. Otherwise, the de-extinct species simply *resembles* the extinct species without having more meaningful connections with its ecosystem.

The reductionist approach can be countered by viewing species in the context of interconnected systems. Indeed, several scholars have argued for the benefits of taking a systems thinking approach to conservation. For example, Frederico Davila et al. argue that "[a] complex systems perspective has prompted increased recognition of the mutual interactions between humans

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[791] Curt Meine, "De-Extinction and the Community of Being," *Hastings Center Report* 47, no. 4 (2017): S9–17, https://doi.org/10.1002/hast.746. 12.
[792] Mok, "Birdsong Fossil," 297.
[793] Mok, "Birdsong Fossil," 297-298.
[794] Douglas J. McCauley et al., "A Mammoth Undertaking: Harnessing Insight from Functional Ecology to Shape de-Extinction Priority Setting," *Functional Ecology* 31, no. 5 (2017): 1003–11. 1009.

and biodiversity,"[795] and they consider ways that it can lead to more "sustainable and just futures."[796] Similarly, in an article about de-extinction and conservation, Patrice Kohl discusses studies on the role of systems thinking in inspiring care for the environment, and notes that "[p]eople who engage in 'systems thinking' by appreciating longer chains of causality and embracing complexity tend to value nature more, and exposing people to metaphors that highlight complex relational structures gives systems thinking a boost, resulting in more relational and holistic thinking."[797] By shifting the perspective from individual genes, animals, or species to thinking about "chains of causality" and interactions within ecosystems, a systems thinking approach can help to address some of the hype around morphology and genetics-based approaches to de-extinction.

Rather than using charismatic species as the starting point for de-extinction projects and then trying to identify an environment in which to rewild them, some scholars have suggested starting with a specific ecosystem instead. For example, Turner notes that an "ecological restorationist" approach would require that we "[s]tart by identifying ecosystems that are most in need of restoration, and then determine whether reintroduction of lost species would be helpful in those particular cases. Focus on *places*, rather than species."[798] In this approach, de-extinction should serve specific ecosystems that have been impacted by the loss of ecologically important species. McCauley et al. similarly argue that de-extinction science should prioritize the "ecological function" of candidate species and outline three criteria that they recommend for de-extinction science, which include focusing on candidate species that provide a unique ecological function, that have been extinct for shorter periods of time, and that

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[795] Federico Davila et al., "Biodiversity Revisited through Systems Thinking," *Environmental Conservation* 48, no. 1 (2021): 16–24, https://doi.org/10.1017/S0376892920000508. 16.
[796] Davila et al., "Biodiversity Revisited," 17.
[797] Patrice Kohl, "Reclaiming Hope in Extinction Storytelling," *Hastings Center Report* 47, no. 4 (2017): S24–29, https://doi.org/10.1002/hast.748. 27.
[798] Turner, "The Restorationist Argument," 49. Emphasis added.

can be restored in higher abundance.[799] The purpose of these criteria, they argue, is to ensure that de-extinction is "ecologically meaningful."[800] The goal from an ecological perspective, then, is to create species that will successfully integrate into ecosystems and provide necessary ecological functions. In "Birdsong Fossil," Yuzuki's approach to de-extinction appears to align with this ecosystem-based approach. For example, in contrast to the public hype over Min's thylacines, Yuzuki reflects on the city's delicate ecological network that could be disrupted by the reintroduction of the animals: "[w]ho knew where, or if, the thylacine would fit into this complicated ecological puzzle."[801] And while Min's thylacines appeal to both public audiences and funding bodies and are consequently celebrated as a scientific breakthrough, Yuzuki does not view this as effective de-extinction since it fails to consider the ecological reality of the animals being created and the implications for the environments where they will eventually live.

Countering the hype of genetics and morphology in de-extinction discourse requires not only recognizing how species interact within their ecosystems at a particular moment, but also how species and their ecosystems develop across time. Systems thinking can provide important insights into these questions, since, as Lauren M. Hallett and Richard J. Hobbs explain, "[k]ey dynamics explored by systems models include the consequences of non-linear relationships, delays and feedbacks."[802] In de-extinction projects, questions of temporality, linearity, and delayed impact are critical. For example, extinction studies scholars have called attention to the way that extinction interrupts and ends generations of evolution: as Deborah Bird Rose et al. explain, by breaking connections across generations, extinction represents "the ending of an ongoing lineage cultivated over hundreds of

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[799] McCauley et al., "A Mammoth Undertaking," 1009-1010.
[800] McCauley et al., "A Mammoth Undertaking," 1009-1010.
[801] Mok, "Birdsong Fossil," 298.
[802] Lauren M. Hallett and Richard J. Hobbs, "Thinking Systemically about Ecological Interventions: What Do System Archetypes Teach Us?," *Restoration Ecology* 28, no. 5 (2020): 1017–25, https://doi.org/10.1111/rec.13220. 1018.

thousands, perhaps even millions, of years of evolutionary time; the abrupt termination of a whole way of life, a mode of being that will never again be born or hatched into our world."[803] While de-extinction may superficially appear to address this "abrupt termination" of a species' existence, the disruptions created—first by a species' extinction and then by the introduction of a proxy species into an ecosystem—can be difficult to predict and trace across time.

"Birdsong Fossil" engages with precisely this notion of interrupted species lineages. For example, Yuzuki describes how part of her motivation for taking an ethnographic approach to de-extinction was when she learned about the fate of the last existing cranes. While she explains that efforts had been made to protect the endangered species in captivity, the birds were unable or unwilling to reproduce: "No one knew why these captive-bred cranes wouldn't incubate their eggs. The invisible thread that connected every generation to the next had somehow been broken, and no one knew how to fix it."[804] Since the captive cranes had no connection to their predecessors, they had lost their learned behaviours, which were an essential aspect of their species identity and ability to survive. The loss of temporal connections had disrupted the species' ability to exist by preventing them from learning their essential behaviours from previous generations of cranes. This depiction aligns with Shapiro's stance on the impossibility of bringing back extinct species. As Shapiro explains, in a hypothetical mammoth de-extinction, "this thing that is born might have mammoth DNA, but it's not going to be 100% identical to a mammoth that used to be alive and that's because mammoths aren't here anymore."[805] The only way to overcome that, she explains, is "[y]ou would need a family of mammoths and a mammoth habitat and mammoth gut microbes, et cetera, if you

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[803] Deborah Bird Rose et al., "Introduction: Telling Extinction Stories," in *Extinction Studies: Stories of Time, Death, and Generations*, ed. Deborah Bird Rose et al. (Columbia University Press, 2017). 9.
[804] Mok, "Birdsong Fossil," 302.
[805] Rinella, "Cloning Mammoths," 1:07:14-1:07:39.

were going to make something that is 100% identical to a mammoth. Which is why it can't happen."[806] In other words, the extinction of a species also means that the species' learned behaviours and ecological ties are also lost. Even if the species is genetically re-created, these factors will not necessarily be re-created as well.

In "Birdsong Fossil," the result of the temporal disruption is that the cranes are unable to form meaningful connections with each other and with their broader ecosystem. As Yuzuki explains, "[t]hese cranes were supposed to know *how* to be cranes. But they were just bird-shaped creatures adrift in a world that no longer knew them."[807] Through the depiction of cranes being reduced to "bird-shaped creatures" with no connection with the surrounding world, "Birdsong Fossil" demonstrates that shifting de-extinction efforts away from genetics- and morphology-based approaches requires that we better understand and acknowledge the role that species play within their larger ecosystems, as well as the importance of temporal connections in shaping animal behaviour. By depicting how consequences for altering a system's components can be dispersed over time and in unexpected ways, "Birdsong Fossil" encourages readers to take a systems-based approach to de-extinction.

By considering how species are shaped by their interactions with their ecosystems, "Birdsong Fossil" explores the drawbacks of viewing technology as a "fix" for environmental problems. Henry Skaug Sætra and Evan Selinger differentiate between the related concepts of techno-fixes and techno-solutionism, and explain that "[a] *techno-fix* is a technological remedy for a social problem,"[808] noting that "while 'fixes' tend to be paired with fast and basic remedies, a 'solution' better reflects attempts

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[806] Rinella, "Cloning Mammoths," 1:07:14-1:07:39.
[807] Mok, "Birdsong Fossil," 302.
[808] Henrik Skaug Sætra and Evan Selinger, "Technological Remedies for Social Problems: Defining and Demarcating Techno-Fixes and Techno-Solutionism," *Science and Engineering Ethics* 30, no. 6 (2024): 60, https://doi.org/10.1007/s11948-024-00524-x. 7.

to address complex problems, and not necessarily quickly and easily."[809] Hallett and Hobbs argue that systems thinking can provide a means to think through this type of problem. They argue that avoiding "fixes that fail" in conservation projects involves "acknowledging when actions are merely fixing the symptom and pursuing other interventions that target the relevant features of the system."[810] In "Birdsong Fossil," while the creation of hybrid thylacines and the captivity of the cranes are framed as "fixes" for the extinction of the species, these actions do not address what caused these species to become endangered or extinct. As Yuzuki explains, "[m]ost conservation now is just palliative care for a planet most of us aren't even trying to save."[811] The critical problem that needs to be addressed, according to Yuzuki, is widespread human-caused environmental damage, since "the world was facing a firestorm. A firestorm of spreading pandemics, collapsing ecosystems, mass extinctions and catastrophic climate change."[812] And while Yuzuki notes that "[s]cientists were the metaphorical firefighters in this approaching calamity,"[813] designing "cute" thylacines is not an adequate solution to the problem of climate change, ecosystem collapse, and biodiversity loss. Additionally, by trying to "solve" extinction by genetically engineering a species that *looks like* its extinct predecessor without factoring in the behavior of that species, de-extinction will not address the underlying ecological problems caused by the loss of the species. Ultimately, then, "Birdsong Fossil" encourages readers to view de-extinction candidates in the context of complex interconnected ecological systems, rather than just in terms of their genetics or appearance, in order to better identify how de-extinction can function as more than a superficial "fix" for human-caused environmental problems.

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[809] Sætra and Selinger, "Technological Remedies," 8.
[810] Hallett and Hobbs, "Thinking Systemically," 1019.
[811] Mok, "Birdsong Fossil," 307.
[812] Mok, "Birdsong Fossil," 305.
[813] Mok, "Birdsong Fossil," 305.

4.6 "A couple husks and a story": Embracing Curious and Charismatic Possibilities in Arthropod De-Extinction

For de-extinction researchers and conservationists, as well as members of the public, paying attention to other species can serve as a way of countering the hype around charismatic species and can bring underappreciated species into the conversation about de-extinction. Rose and Thom van Dooren consider the lack of efforts made to protect non-charismatic species, and consider how even beloved charismatic species are going extinct. They note that "what hope could there possibly be for the countless other creatures who are *less visible, less beautiful, less a part of our cultural lives*?"[814] In order to better account for species that are not considered charismatic, Molhuizen et al. argue that the different "actors" involved in de-extinction science, such as researchers, funding organizations, and members of the public, "must create new circumstances in which it becomes possible for researchers to make different choices."[815] While the ecological and systems thinking approach is one way to remind audiences that ecosystems rely on a range of species with diverse ecological functions, another possibility is that fiction like "Birdsong Fossil" can call attention to the unique behaviours of poorly understood or underappreciated species, thereby allowing them to *become* more charismatic.

To counteract the hype around charismatic species and genetic engineering, "Birdsong Fossil" brings attention to the unique behaviours of underappreciated species. This focus on observing species behaviour and culture engages with a key concept in multispecies studies: the idea of "passionate immersion." In a special issue on multispecies studies and "unloved others,"[816] Anna Tsing argues for the "passionate immersion in the lives of the nonhumans being studied,"[817] which

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[814] Deborah Bird Rose and Thom van Dooren, "Guest Editors' Introduction," *Australian Humanities Review*, no. 50 (2011). 1. Emphasis added.
[815] Molhuizen et al., "Who to Revive?," 15.
[816] Rose and van Dooren, "Guest Editors' Introduction," 1.
[817] Anna Tsing, "Arts of Inclusion, or, How to Love a Mushroom," *Australian Humanities Review*, no. 50 (2011). 9.

she applies to the study of matsutake mushrooms. This kind of immersion and attentiveness has shaped the field of multispecies studies: for example, van Dooren et al. return to the concept of immersion, arguing that "[a]t its core it involves *attentive interactions* with diverse lifeways."[818] Other related terms, "arts of inclusion"[819] and "arts of attentiveness,"[820] have been used to call attention to *paying attention*. From a multispecies studies perspective, by paying attention and becoming immersed in the lives of animals, plants, or fungi, both researchers and members of the public can better observe and understand the unique existence of these species, leading to greater appreciation for them.[821] Paying attention to nonhuman beings is interlinked with both curiosity and care. As van Dooren et al. argue, "passionate immersion means *becoming curious* and so entangled, 'learning to be affected' and so perhaps to understand and care a little differently."[822] Other scholars have previously discussed *Multispecies Cities* and "Birdsong Fossil" in the context of multispecies kinship; for example, in Alberro's analysis of ecotopias, she draws on the concept of multispecies "attentiveness"[823] and concludes that "[b]y learning to listen more carefully and keenly, paying closer attention and becoming alive to the narrative agencies around us, we can ensure that ecotopian strivings for the 'good life' remain inclusive of our other-than-human kin."[824] Given that the story's relevance to discussions of multispecies kinship has been established, I focus here specifically on how

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[818] Thom van Dooren, Eben Kirksey, and Ursula Münster, "Multispecies Studies: Cultivating Arts of Attentiveness," *Environmental Humanities* 8, no. 1 (May 1, 2016): 1–23, https://doi.org/10.1215/22011919-3527695. 6. Emphasis added.
[819] Tsing, "Arts of Inclusion," 2.
[820] van Dooren et al., "Multispecies Studies," 17.
[821] Since *passion* is framed as a core component of immersion, this raises concerns about how (and whether) this approach might conflict with existing scientific approaches to studying animal behaviour. However, Tsing notes that passionate immersion can allow for interdisciplinary perspectives by bringing together methods from the arts and sciences, since "[o]nce such immersion was allowed only to natural scientists, and mainly on the condition that the love didn't show. The critical intervention of this new science studies is that it allows learnedness in natural science and all the tools of the arts to convey passionate connection." Tsing, "Arts of Inclusion," 9.
[822] van Dooren et al., "Multispecies Studies," 6. Emphasis added.
[823] Alberro, *Terrestrial Ecotopias*, 132.
[824] Alberro, *Terrestrial Ecotopias*, 141.

the depiction of *passionate immersion* and *curiosity* in "Birdsong Fossil" can lead to underappreciated species being recognized as important de-extinction candidates.

One significant barrier that can make certain species appear to be less appealing as conservation and de-extinction candidates is the process of "massification" that occurs while reporting their extinctions. Massification, as animal studies scholar Jodey Castricano explains, is the process by which "one by one, millions of animals disappear into data."[825] Castricano elaborates, explaining that "[i]f we are called to bear witness to the annihilation of millions of our fellow animals and are told that species losses amount to extinction every 30 minutes and that 70% of wildlife species have already been lost, we are handed a conceptual overload. How do we hold such overwhelming numbers of beings in our minds?"[826] Arthropods, and especially insects, are often subject to a higher degree of massification, since not only are there more species of insects,[827] but they are also disappearing at a higher rate than other animals.[828] And even as scientists attempt to quantify the number of insect species at risk, this can be a difficult task given that many of these species have not yet been identified in the first place.[829] Evidently, insects risk "disappearing into data" as they continue to go extinct faster than other animals and faster than they can be identified.

Castricano calls on storytelling as a way of counteracting massification, which she argues can better allow us "to develop a transformational ethics towards this understanding of animal loss in the

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[825] Jodey Castricano, "Learning by Heart: Storytelling and Animal Loss in the Anthropocene," in *Lost Kingdom: Animal Death in the Anthropocene*, ed. Wendy A. Wiseman (Vernon Press, 2024). 127.
[826] Castricano, "Learning by Heart," 129.
[827] Smithsonian Institution, "Numbers of Insects (Species and Individuals)," accessed March 31, 2025, https://www.si.edu/spotlight/buginfo/bugnos.
[828] Damian Carrington, "Plummeting Insect Numbers 'Threaten Collapse of Nature,'" *The Guardian*, February 10, 2019, sec. US news, https://www.theguardian.com/environment/2019/feb/10/plummeting-insect-numbers-threaten-collapse-of-nature.
[829] Pedro Cardoso et al., "Scientists' Warning to Humanity on Insect Extinctions," *Biological Conservation* 242 (February 1, 2020): 108426, https://doi.org/10.1016/j.biocon.2020.108426. 2.

Anthropocene" than simply presenting the numbers of lost species alone.[830] Throughout "Birdsong Fossil," we can see an example of how massification is counteracted by storytelling in the way that Yuzuki focuses her attention on arthropods including insects and arachnids. Early in the story, Evan recognizes that public opinions about what types of de-extinction projects are worthwhile will impact Yuzuki's ability to carry out her research, and he encourages her to consider the benefits of temporarily changing her research approach to focus on more "commercially appealing research to secure your funding."[831] Yuzuki rejects Evan's pragmatic advice, however, and responds by lamenting the hundreds of species that go extinct every day, to which Evan responds that it is "[m]ostly beetles"[832] that are being lost. Evidently, extinct and endangered beetles—despite disappearing in high numbers—do not present the same possibilities for "commercially appealing research" as pandas and thylacines.

Despite the lack of commercial possibilities, Yuzuki refuses to view insects and arachnids as insignificant datapoints, and instead demonstrates what it could look like to *meaningfully notice* these species. For example, when Yuzuki describes diving bell spiders to Evan, her love for the species' unique behaviour is apparent. Yuzuki asks, "[e]ver watched a diving bell spider build a cubby house out of bubbles? I'm not making a robot that *does* that. I'm making a robot that knows *why* it's doing that. And feels disappointed when its neighbour has a fancier bubble house."[833] While diving bell spiders are less "commercially appealing" and more prone to massification than thylacines, Yuzuki insists that their behaviours are still important and worth recognizing. Yuzuki's curiosity about species that are frequently overlooked aligns with Amelia DeFalco's concept of "curious kin," where

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[830] Castricano, "Learning by Heart," 145.
[831] Mok, "Birdsong Fossil," 303.
[832] Mok, "Birdsong Fossil," 303.
[833] Mok, "Birdsong Fossil," 303.

she discusses the role of curiosity in inspiring care for nonhuman beings. DeFalco notes that "[i]n its confluence of care, cleverness, art, enquiry, transgression, oddity, and queerness, 'curious' articulates a guiding principle for my exploration of unruly, artful relations of care that disregard, even flout, boundaries of species, being, and matter."[834] As an "unruly" form of care that "flouts" the expectations for which species that are prioritized in conservation and de-extinction, Yuzuki's interest in the diving bell spiders serves as an example of how curiosity in the behaviours of underappreciated species can prevent them from disappearing through massification.

The attentiveness and curiosity that Yuzuki demonstrates for diving bells spiders is also extended to stick insects, which become an important symbol of the meaningful application of de-extinction science throughout the story. When Yuzuki's former colleague Rhys first approaches Yuzuki to ask her to work on the Lord Howe Island Stick Insects, he explains that while the insects are currently being kept alive in captive environments, he fears that they will not be considered important or valuable enough to invest in keeping alive long term.[835] Yuzuki, however, immediately thinks of reasons why people should care about the species:

> Lord Howe Island Stick Insects were the only insects know to pair-bond for life. During the night, the females foraged and explored, and the males happily accompanied them, engaging in whatever activities she chose. And during the day, they slept side by side, the male wrapping his limbs around his partner in an exceptionally leggy cuddle.[836]

The romanticized imagery of pair-bonded stick insects foraging, embracing, and dreaming together elicits an emotional response for Yuzuki. When Rhys tells her he doesn't want the insects to be reduced to "a couple husks and a story,"[837] Yuzuki reassures him that she too sees the importance of

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[834] Amelia DeFalco, *Curious Kin in Fictions of Posthuman Care* (Oxford University Press, 2023), https://doi.org/10.1093/oso/9780192886125.001.0001. 7.
[835] Mok, "Birdsong Fossil," 310.
[836] Mok, "Birdsong Fossil," 310.
[837] Mok, "Birdsong Fossil," 310.

protecting the species and ensuring their continuity. The depiction of stick insects in "Birdsong Fossil" highlights the unique behaviours that could be lost by losing this species. As Pedro Cardoso et al. argue in their discussion of insect extinction, "[e]ach species contributes a unique piece to a complex living tapestry that changes in space and time. Each species represents an unrepeatable part of the history of life."[838] By considering the unique characteristics of pair-bonded stick insects, "Birdsong Fossil" depicts the insects as "an unrepeatable part of the history of life" that could be lost by not including the species in de-extinction and conservation projects.

In the exchange between Rhys and Yuzuki, it is notable that rather than focusing on the ecological significance of the species, Yuzuki instead focuses on what she sees as their unique behaviour. And while "Birdsong Fossil" ends with the reintegration of stick insects into the wild, the story takes a more sentimental, rather than ecological, approach to depicting the insects: "beneath the murmuring leaves of a melaleuca tree, two silvery stick insects held each other gently as dawn brushed the fading stars."[839] Like the diving bell spiders and their desire for a "fancy" bubble house, the stick insects cuddling beneath the sunrise are depicted in a romanticized and anthropomorphized way. Despite that, the story's depiction of arthropods could be an effective way of promoting what Tsing describes as "multispecies love,"[840] or what Stacy Alaimo describes as "intimate relationality."[841] In a discussion of extinction, biodiversity, and environmentalism, Alaimo considers possibilities for a multispecies future and argues that

> The pleasures of intimate relationality with other species, whether they be immediate or mediated, literal or speculative, practical or aesthetic, could provoke the passionate desire for the continued existence of multitude of other species and multispecies communities, as well as sparking political activism and inspiring creative projects and everyday practices that

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[838] Cardoso et al., "Scientists' Warning," 5.
[839] Mok, "Birdsong Fossil," 324.
[840] Tsing, "Arts of Inclusion," 9.
[841] Stacy Alaimo, "Wanting All the Species to Be: Extinction, Environmental Visions, and Intimate Aesthetics," *Australian Feminist Studies* 34, no. 102 (2019): 398–412, https://doi.org/10.1080/08164649.2019.1698284. 409.

> sustain imperilled creatures. Even insects, vanishing at astonishing rates worldwide, need hospitality, rather than abjection.[842]

In other words, "intimate relationality" is a way to engage audiences in conversations about species that typically receive less attention in conservation and de-extinction projects. By highlighting the unique characteristics of diving bell spiders and stick insects that would be lost by their extinction, the short story encourages audiences to briefly become immersed in the existence of these species, and through that experience, to begin to value them.

A more sentimental approach like the depiction of stick insects and diving bell spiders in "Birdsong Fossil" can inspire audiences to care about protecting underappreciated species, which can complement an ecosystems-based approach to de-extinction. While the ecological function of species remains an essential component in selecting candidate species that will contribute to ecosystem restoration in a meaningful way, in a world where charisma is valued above ecological function, perhaps beginning with curiosity and immersion in the lives of unappreciated species is another approach to shifting perspectives on candidate species selection. As DeFalco argues, curiosity is an ongoing way of relating to the nonhuman world, since it "is expansive, seeking, open-ended, never finished. It is also odd, strange, eccentric, unexpected."[843] As a simultaneously "expansive" and "unexpected" experience, curiosity for underappreciated species can result in a shift in worldview, which can have long-term implications for conservation. This can be seen through Yuzuki's compassion towards—and genuine curiosity and interest in—the arthropods depicted in "The Birdsong Fossil," through which Yuzuki demonstrates a level of immersion that is rarely given to insects and arachnids. As Cardoso et al. argue, "[a]ll species, including insects, are valuable as unique combinations of evolutionary events, have innate value, and so require care and conservation."[844] By

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[842] Alaimo, "Wanting All the Species to Be," 409.
[843] DeFalco, *Curious Kin*, 6.
[844] Cardoso et al., "Scientists' Warning," 5.

exploring the uniqueness of arthropods, stories like "Birdsong Fossil" can encourage readers envision ways to view underappreciated species differently, potentially resulting in greater support for conservation and de-extinction work on these underappreciated species.

4.7 "Something I didn't dare call happiness": Co-Becoming with Techno-Ecosystems

Even if de-extinction efforts focus on ecologically significant candidate species and prioritize ecosystem restoration, the concept of de-extinction is still based on human mediation. Anthropocentrism, along with techno-solutionism, is certainly present across de-extinction discourse. For example, in Sarah Bezan's posthumanist analysis of de-extinction, she notes that "it is the human (and human interests) that typically remain front and centre in these interventionist regimes," since they tend to rely on "human exceptionalist values" regarding the role of technology and candidate species selection.[845] As Bezan argues, "[d]isengaging from these kinds of deeply entrenched anthropocentric ideals requires a posthumanist approach that will reach far beyond the realm of human interests and in turn think more expansively about the meaning of extinction itself."[846] Is it possible to move beyond human exceptionalism and anthropocentrism in de-extinction? If de-extinction always involves a degree of techno-solutionism, is there a way to ensure that technology is being applied in a way that benefits the environment, rather than solely serving human interests? Or will using technology to intentionally shape the environment always reinforce and reinscribe anthropocentrism?

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[845] Sarah Bezan, "A Posthumanist Critique of De-Extinction Science," in *Bioethics and the Posthumanities* (Routledge, 2022). 89.
[846] Bezan, "Posthumanist Critique," 92.

In "Birdsong Fossil," the depiction of humans actively and intentionally shaping the environment aligns with several environmental philosophies about the role of human intervention and technology in preserving ecosystems. For example, Gregory E. Kaebnick considers de-extinction from the perspective of the "gardening ethic" of nature, which is an approach to conservation that "celebrates the land and declares that it must now be managed."[847] As Kaebnick explains, de-extinction, like gardening, involves the intentional curation and cultivation of which species are present in a given ecosystem. Like gardeners selecting which plants to grow in their gardens, scientists select species to resurrect and rewild, although it is a "relocation [that] occurs across time rather than across space."[848] And while this is certainly an anthropocentric approach,[849] as Kaebnick notes, a gardening ethic approach to de-extinction can be interpreted in multiple ways and can align with different values.[850] Kaebnick leans toward a "ranger's or steward's gardening ethic,"[851] which, he argues, "doesn't separate humans from nature, and it allows that we can take an active role in safeguarding it."[852] Similarly, another approach to de-extinction is an "eco-communitarian" approach, which, Bruce Jennings explains, "doesn't erase power and technology from the relationship between humans and nature, but it does take pride of place away from human fabrication and control in favor of judicious membership and attention to mutuality or symbiosis within biotic communities and geophysical systems."[853] These approaches both allow for human intervention and the application of technology, but challenge unmediated human exceptionalism by promoting "symbiosis" with the

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[847] Gregory E. Kaebnick, "The Spectacular Garden: Where Might De-Extinction Lead?," *Hastings Center Report* 47, no. S2 (2017): S60–64, https://doi.org/10.1002/hast.754. 61.
[848] Kaebnick, "The Spectacular Garden," 62.
[849] For an analysis of how recent approaches to de-extinction, such as Kaebnick's gardening ethic, represent "a rapacious yearning for macroevolutionary authority," see Bezan, "Posthumanist Critique," 94.
[850] Kaebnick, "The Spectacular Garden," 62.
[851] Kaebnick, "The Spectacular Garden," 64.
[852] Kaebnick, "The Spectacular Garden," 64.
[853] Bruce Jennings, "The Moral Imagination of De-Extinction," *Hastings Center Report* 47, no. S2 (2017): S54–59, https://doi.org/10.1002/hast.753. 55.

environment. The approach to de-extinction in "Birdsong Fossil" appears to embrace a similar environmental philosophy to the "gardening ethic" and "eco-communitarian" approaches: the story suggests that humans are responsible for *ethically* using technology to shape the future existence of nonhuman animals, plants, and ecosystems.

And while these approaches imply that humans *should* use technological intervention to shape ecosystems and restore biodiversity, "Birdsong Fossil" does not end with ongoing human control. From the perspective of ecologists, for de-extinction to be considered effective, it should lead to rewilding and ecological restoration. As McCauley et al. note, "[t]here is little to be gained for ecologists by having de-extinction simply manufacture biological curiosities for display in laboratories and zoolike spaces."[854] In "Birdsong Fossil," the goal of Yuzuki's de-extinction is not to populate zoos: instead, rewilding—through the release of the species she works on into their ecosystems—does indeed take place. When Yuzuki's research is interrupted by war, she releases the robotic animals. As time passes, Yuzuki marvels at the way that they have integrated into the environment: "Insects had reclaimed the planet, much to the delight of the birds, and every now and then, I'd catch a glimpse of silvery plumage and feel a guilty shiver of something I didn't dare call happiness."[855] Later, Yuzuki discovers that an even larger-scale rewilding has taken place when she and Evan come across a group of both robotic and biotic elephants. They learn that Min had gone to Yuzuki's damaged warehouse and recovered her research, which Min and her team used to create robotic elephants who could act as a missing cultural link for the de-extinct elephants, along with other species.[856] By the end of "Birdsong Fossil," then, genetic and robotic de-extinction have

[854] McCauley et al., 2017, 1010.
[855] Mok, "Birdsong Fossil," 316.
[856] Mok, "Birdsong Fossil," 321.

together led to ecological rewilding, where the species have been integrated back into their ecosystems and formed relationships across technological and biological boundaries.

The story's depiction of thriving ecosystems comprising both biological animals and the "silvery plumage" of the robotic animals presents a future of de-extinction and rewilding where technology and nature are intertwined. Matthew Calarco notes that one of the criticisms of "rewilding discourse" is that it "is plagued by a sharp and *untenable division between nature and culture*, with wildlife and wilderness entirely on the nature side of the binary and all human activity on the culture side."[857] "Birdsong Fossil," however, presents an alternative to this "untenable division." Here, the idea that wildlife aligns with nature while humans align with culture and technology is disrupted by the depiction of a new type of techno-ecosystem where technology and biology intermingle, resulting in altered species and new forms of co-existence where the boundaries between "nature" and "culture," "robot" and "animal," and "technology" and "environment" are blurred. This blurring results in the creation of new forms of kinship that engage with what Donna Haraway refers to as "oddkin," where kinship across species boundaries arises from "unexpected collaborations and combinations, in hot compost piles."[858] In "Birdsong Fossil," the intermingling of technology and biology, and the formation of thriving ecosystems that bring together robotic and biotic animals, is an example of the kind of "oddkin" that emerge from the "hot compost pile" that Haraway describes. Rather than promoting technology as an easy solution to environmental crises that will allow humans to intervene and control the environment, "Birdsong Fossil" considers a future where technology and biology intermingle in unexpected ways, forming new entanglements.

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[857] Matthew R. Calarco, *Animal Studies: The Key Concepts* (Routledge, 2021). 118. Emphasis added.
[858] Donna Haraway, *Staying With the Trouble: Making Kin in the Chthulucene* (Duke University Press, 2016). 4.

With the blurring of boundaries and formation of new kinds of existence and kinship, what future does "Birdsong Fossil" suggest for *human* identity and society? Notably, in the story, technology alone is not sufficient to prevent environmental and societal collapse. Climate change is an ongoing concern throughout the story, as is the threat (and eventually, the reality) of a global war. The short story ends with Yuzuki acknowledging that, regardless of technological intervention, the world's future is uncertain.[859] In an analysis of "Birdsong Fossil" and the solarpunk genre, Katarzyna Więckowska argues that the story ending with this reminder of the changing nature of the world and humanity is significant, since "[r]ather than romanticizing the possibility of resurrection and the human power of creation, the ending points to the need to accept contingency and vulnerability, and to come to terms with the fact that humans are also a species that can come and go."[860] The "contingency and vulnerability" that Więckowska describes is a critical component of the short story's perspective on what a future of de-extinction could look like: while humans can use technology to support ecosystems and restore biodiversity, "Birdsong Fossil" also promotes the idea that technology does not grant humans complete control over the natural world, nor, as Więckowska notes, does it ensure the continuation of humanity. "Birdsong Fossil" therefore challenges anthropocentrism and human exceptionalism, even while embracing a technological approach to addressing climate change and biodiversity loss.

By highlighting the instability of technological/biological boundaries *and* of human existence, "Birdsong Fossil" also indicates that through technological interventions, humans can be

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[859] Mok, "Birdsong Fossil," 323-324.
[860] Katarzyna Więckowska, "Appositions: The Future in Solarpunk and Post-Apocalyptic Fiction," *Text Matters: A Journal of Literature, Theory and Culture*, no. 12 (November 24, 2022): 345–59, https://doi.org/10.18778/2083-2931.12.21. 10.

altered as well. Tsing calls attention to the concept of "precarity,"[861] which can be seen through the way that "[w]e are *contaminated* by our encounters; they change who we are as we make way for others."[862] In their introduction to multispecies studies, van Dooren et al. similarly argue that human identity is shaped by "diverse and consequential entanglements" with the surrounding world, and that "[t]here is no human in isolation, no form of human life that has not arisen in dialogue with a wider world."[863] While "Birdsong Fossil" does not envision direct changes to the human body, it *does* envision the possibility for both contamination and entanglement. The story ends with Evan—Yuzuki's anthropomorphic robot companion—experiencing physical change. After being attacked, Evan agrees to allow his consciousness to be transferred to the hardware used for creating robotic animals. When the transfer is complete, Evan's new form takes shape as he grows wings.[864] This transformation—which Evan happily considers "an upgrade"[865]—hints at the possibilities for new embodied existences and entanglements that could emerge, bringing technology, animals, and humans together into new configurations. Importantly, the story's depiction of consciousness transfer is not an attempt to escape embodiment. As Thierbach-McLean describes, solarpunk diverges from cyberpunk in that "[a]lthough one will also encounter fantastical high-tech in solarpunk narratives, its primary purpose is no longer to facilitate disembodiment in cyberspace but rather to help humans harmoniously coexist with their environment."[866] Rather than leading to a transhuman disembodiment, the transfer of Evan's consciousness results in a new form of physical, embodied existence that connects him more closely with the techno-ecosystem around him.

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[861] Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton University Press, 2015), https://doi.org/10.2307/j.ctvc77bcc. 27.
[862] Tsing, *The Mushroom*, 27. Emphasis added.
[863] van Dooren et al., "Multispecies Studies," 14.
[864] Mok, "Birdsong Fossil," 323.
[865] Mok, "Birdsong Fossil," 323.
[866] Thierbach-McLean, "Uncanceling the Future," 256.

While solarpunk embraces the possibilities of technology, it also promotes ethical interactions with the natural world and challenges anthropocentrism. By envisioning an alternative approach to de-extinction that challenges the hype and anthropocentrism of current de-extinction discourse, "Birdsong Fossil" suggests that a more ethical future might indeed be possible. Instead of promoting a techno-solutionist approach to extinction, both Evan's new embodiment and the hints of silver appearing throughout the environment show the way that technological interventions will have far-reaching, unanticipated consequences, not only for animals and their ecosystems, but also for humans. These technological-biological entanglements can lead to new forms of existence and kinship: as Tsing argues, "changing with circumstances is the stuff of survival."[867] Or, in Haraway's words, "[w]e become-with each other or not at all."[868] Ultimately, then, the story suggests that the goal of de-extinction is not to use technology to gain greater control over the natural world, but rather to find new ways of co-becoming in technological-biological entanglements.

4.8 Envisioning Solarpunk Futures: Technology as a Tool in Conversation Biology

Solarpunk stories like "Birdsong Fossil" can help to shape the way that we approach conservation and de-extinction, and can provide an important counternarrative to hype- and charisma-driven de-extinction discourse. By exploring candidate species selection, fiction can interrogate and challenge assumptions about which species are worth conserving, which methods should be used, and what forms of human intervention should be accepted. Kohl, for example, discusses the problems arising from anthropocentric and techno-solutionist approaches to extinction, and argues that "[t]he stories we tell about nature, extinction, and solving environmental problems matter. They shape what

[867] Tsing, *The Mushroom*, 27.
[868] Haraway, *Staying With the Trouble*, 4.

we value and how we think it should be protected. They can help us reevaluate our place on the planet and acknowledge the sacrifices that are required of us, as well as the rewards."[869] Or, as Haraway succinctly puts it, "it matters what stories tell stories."[870] Certainly, storytelling matters when it comes to the future of de-extinction science and conservation. Stories like "Birdsong Fossil" do important work to shift the discourse around de-extinction away from charismatic megafauna like mammoths, and towards underappreciated animals like insects and spiders.

While the solarpunk genre does envision technological innovations playing a key role in conservationist activities, it also promotes the idea that environmental protection and restoration can be achieved by acting more sustainably and by viewing the world through a more ecologically conscious lens. As Gillam explains, the solarpunk genre is "also meant to be a societal goal; not just a tool for fiction, but as commentary on a new possible future."[871] One example of a recent, real-world project that uses technology to work towards ecological protection by focusing on underappreciated species is the Antenna project. This project, based in Montreal, uses artificial intelligence (AI) to identify and track previously unknown insects. As researcher David Rolnick explains, "[w]e're hoping not just to understand how populations are changing, we're also hoping to use AI to discover new species and understand how to protect those species before they disappear forever."[872] An article reporting on the Antenna project more dramatically describes how the project's goal is to use insect data collected by AI to "help reverse species collapse and avert catastrophe for the planet."[873] The project's interest in insect behaviour and goal of environmental protection echoes "Birdsong Fossil,"

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[869] Kohl, "Reclaiming Hope," 28.
[870] Haraway, *Staying with the Trouble*, 39.
[871] Gillam, "A Solarpunk Manifesto," 2.
[872] Mila, "Antenna," 2025, https://mila.quebec/en/ai4humanity/applied-projects/antenna. 1:51-2:29.
[873] "Canada AI Project Hopes to Help Reverse Mass Insect Extinction," *Phys.Org*, November 21, 2024, https://phys.org/news/2024-11-canada-ai-reverse-mass-insect.html.

and hints toward potential future applications of the data in conservation. Another way that the project mirrors the story is through the focus on using innovative technology to create opportunities to protect endangered species. As Rolnick explains, "[w]ith AI and with automated tools, we hope that we can see more and understand more, and thereby have more meaningful action."[874] While the Antenna project does not directly involve bringing back lost insect species, it does represent one tangible possibility for how technology can be used as a tool to better understand species that rarely get attention in conservation discussions.

While the Antenna project is a large-scale, international initiative using advanced technology, there are more local and easily accessible ways to engage in the protection of underappreciated species. Biologists David L. Wagner et al. call on scientists to "find ways to integrate insects and other arthropods into the fabric of daily human life,"[875] and describe citizen science efforts as a way of engaging the public in insect conservation, noting that "[s]uch actions could play important roles in changing public attitudes toward insects and motivate efforts to protect them."[876] Across Canada and globally, there are numerous citizen science projects that call on members of the public to observe and record wildlife data. For example, eButterfly is a citizen science project that runs in partnership with Espace Pour la Vie Montreal, Vermont Center for Ecostudies, Mila, and the University of Ottawa, and allows members of the public to share butterfly photos as a way of contributing to conservation.[877] Similarly, iNaturalist, an independent nonprofit organization, supports a variety of citizen science projects that focus on different plant and animal species, including a range of

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[874] Mila, "Antenna," 1:51-2:29.
[875] David L. Wagner et al., "Insect Decline in the Anthropocene: Death by a Thousand Cuts," *Proceedings of the National Academy of Sciences* 118, no. 2 (January 12, 2021): e2023989118, https://doi.org/10.1073/pnas.2023989118. 9.
[876] Wagner et al., "Insect Decline," 6.
[877] eButterfly, "About eButterfly," 2022, https://www.e-butterfly.org/en/content/about.

arthropods. Through this work, they strive to create "a world where everyone can understand and sustain biodiversity through the practice of observing wild organisms and sharing information about them."[878] As these examples show, citizen science projects can be one important step towards conservation, and technology plays a key role in enabling participation in this type of work.

While some arthropod-focused citizen science projects, like Budworm Tracker,[879] are intended to help identify the spread of harmful invasive species, others promote using technology to create closer relationships with arthropods. For example, one of iNaturalist's citizen science projects, "Arthropod Faces," calls on the public to share close-up photographs of arthropods, and their website displays recently shared photos depicting a variety of bees, ants, flies, beetles, spiders, centipedes, and woodlice. Along with documenting species, the project aims to "increase appreciation and respect for arthropods,"[880] since "[a]rthropods are often maligned by the general public, but being able to look them in the eyes can serve as a reminder that they are living creatures just like we are."[881] The goal of the "Arthropod Faces" project, then, aligns with the depiction of curiosity and immersion in arthropod lives in "Birdsong Fossil" by embracing the idea that the more opportunities that exist to meaningfully engage with these species, the more likely for there to be support for including them in conservation efforts.

While storytelling and citizen science projects offer distinct approaches to engaging the public in conversations about extinction, they both can provide ways of immersing audiences in the lives of underappreciated species, thereby potentially making these species more interesting and

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[878] iNaturalist, "About," 2024, https://www.inaturalist.org/pages/about.
[879] Healthy Forest Partnership, "About the Program," 2019, https://healthyforestpartnership.ca/budworm-tracker/about-the-program/.
[880] iNaturalist, "Arthropod Faces," accessed April 13, 2025, https://www.inaturalist.org/projects/arthropod-faces.
[881] iNaturalist, "Arthropod Faces."

appealing. In contrast to the drama and hype of mammoth, dire wolf, or thylacine de-extinction, in both citizen science and in solarpunk, interactions with the nonhuman world are highlighted as commonplace experiences. For example, in the introduction to *Multispecies Cities*, Rupperecht et al. describe how, across the stories, the multispecies relationships depicted call attention to "how familiar and everyday so many of these encounters are."[882] By making underappreciated species more familiar, both solarpunk and citizen science can inspire greater interest and care in the experiences of these species. And it is certainly possible that storytelling and science can work together: stories that feature underappreciated species can inspire greater interest in their conservation, and greater public engagement in protecting those species can lead to them receiving greater attention in fiction and in the media. Since encounters with animals and plants are everyday occurrences, both citizen science projects and solarpunk fiction strive to encourage the public to reflect on and engage more meaningfully in these encounters.

Importantly, along with inspiring greater interest in and curiosity about underappreciated species, stories like "Birdsong Fossil" can envision more ethical approaches to the design of future de-extinction and conservation technologies. The incorporation of specific values into technological design has been discussed as a form of *stewardship*: as Kari Zacharias et al. argue, "technological stewardship" is connected with the idea of "engineering for good,"[883] and the role of "tech stewards" is to "consider the values that are important to them, in connection with the values that are embedded in technologies, as an integral part of the design process."[884] Beyond incorporating *human* values into technology, there has also been interest in how *posthuman* values can be incorporated into the design

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[882] Rupprecht et al., "Introduction," 5.
[883] Kari Zacharias et al., "Technological Stewardship: Assessing a Value-Sensitive Approach to 'Engineering For Good,'" 2022 *IEEE Frontiers in Education Conference* (FIE), October 2022, 1–4, https://doi.org/10.1109/FIE56618.2022.9962745. 3.
[884] Zacharias et al., "Technological Stewardship," 2.

process. Steven Umbrello brings posthumanist ethics into an analysis of the concept of Design for Values (DfV), arguing that "[f]or DfV approaches to be genuinely salient to what has been termed the sixth mass extinction event—mostly due to anthropocentric, technological modernisation—they must account for nonhumans as essential stakeholders in their design considerations."[885] In solarpunk stories like "Birdsong Fossil" (along with citizen science projects like Arthropod Faces), by using technology to highlight the kinship and entanglements between humans and arthropods, posthumanist ethics becomes a critical component of the design process.

For de-extinction and conservation projects to engage with multispecies and posthumanist ethics—resulting in what Umbrello refers to as "a much needed *ecological turn in design*"[886]—they need to prioritize kinship across species boundaries. As "Birdsong Fossil" shows, learning more about underappreciated species, and incorporating these species directly into the design of de-extinction technologies, can better allow these species and their ecosystems to benefit from conservation efforts. To return to Haraway's discussion of "oddkin," she argues that "staying with the trouble requires learning to be truly present […] as mortal critters entwined in myriad unfinished configurations of places, times, matters, meanings."[887] By finding means of "passionate immersion" into the existence of species that we coexist with—whether through technology or through fiction—we can remain "truly present" and thereby participate in the "unfinished configurations" that Haraway describes.

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[885] Steven Umbrello, "The Ecological Turn in Design: Adopting a Posthumanist Ethics to Inform Value Sensitive Design," *Philosophies* 6, no. 2 (2021): 2, https://doi.org/10.3390/philosophies6020029. 2.
[886] Umbrello, "The Ecological Turn," 17.
[887] Haraway, *Staying with the Trouble*, 1. By using the phrase "staying with the trouble," Haraway is referring to the need to find new ways to co-exist in the context of the environmental challenges of the 21st century.

4.9 Conclusion

In current de-extinction discourse, the sensationalism of recreating charismatic extinct species using genetic engineering is being capitalized on in projects like Colossal's "dire wolves." And yet, this approach to de-extinction—and the way it is described in much of its media coverage—overlooks critical considerations. As de-extinction science develops and public audiences continue to be confronted with headlines about the latest species "brought back" from extinction, it is essential to have conversations about what these projects can realistically achieve, the candidate species being selected, and the ecological impacts of rewilding these species. Since a hype-driven approach could divide audiences and lead to a loss of trust, and potentially limit, in problematic ways, the types of candidate species that are prioritized, fictional depictions of de-extinction can provide important interventions into these conversations and can shape the way that audiences respond to developments not only in de-extinction science, but also in conservation more broadly.

One of the critical ways that stories like D.K. Mok's "The Birdsong Fossil" can encourage a shift in perspective is by showing how de-extinction technologies can provide environmental benefits, without reinforcing anthropocentrism or techno-solutionism. As Umbrello notes, bringing a posthumanist perspective into technological design can lead to more ethical relationships between humans and animals, and consequently, "[h]ow we design technologies, what design approaches we choose, technical limitations, and how they can interplay and constrain our choices about the future all become valuable questions in the twenty-first century."[888] By envisioning an approach to de-extinction that prioritizes ecological interaction, along with depicting multispecies curiosity and immersion, "Birdsong Fossil" encourages audiences to question the anthropocentric assumptions that underlie current de-extinction discourse, and to reconsider how technological interventions can be

[888] Umbrello, "The Ecological Turn," 2.

used not to solve environmental problems, but to encourage a shift in perspective on the relationships between humans, animals, and technology. Additionally, the story's focus on animal culture and exploration of the unique existence of underappreciated species provides a much-needed alternative to the charismatic megafauna that dominate real-world de-extinction and conservation. Ultimately, "Birdsong Fossil" encourages a more ethical perspective on the development of de-extinction technologies, and provides an important counternarrative to the discourse of de-extinction.

Chapter 5: Reimagining Kinship in Xenotransplantation: From "Spare Parts" To Interspecies Entanglements in *Pighearted* (2021)

5.1 Introduction

In the developing field of xenotransplantation, genetically modified pigs have recently been embraced as a potential source of transplantable organs. In a 2022 *Discover Magazine* article following David Bennett Sr.'s transplant surgery, where he received the heart of a genetically modified Revivicor pig, science writer Kenneth R. Miller notes how "advances in gene editing have opened a new possibility: modifying animals to provide *user-friendly spare parts*."[889] He writes that "experts regard Bennett's case as a major step toward a future in which *replacement organs are available on demand*."[890] The use of terms like "replacement organs" and "user-friendly spare parts" gestures to a future where nonhuman animal organs can be harvested "on demand" for human patients. Indeed, the spare parts metaphor is part of the larger rhetorical positioning of nonhuman animals like pigs as an *abundant* source of transplantable organs.[891] As replaceable pieces of machinery, these organs become enmeshed in the bioeconomy as useful sources of value. With the frame of abundance and the concept of spare parts being as dominant as they are in media coverage of xenotransplantation, is it possible to imagine what a future *beyond* commodification and exploitation would look like for the animals being created in xenotransplantation research?

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[889] Kenneth R. Miller, "Pig Heart Transplant Offers Uncertain Hope," *Discover Magazine*, December 11, 2022, https://www.discovermagazine.com/health/pig-heart-transplant-offers-uncertain-hope. Emphasis added.
[890] Miller, "Uncertain Hope." Emphasis added.
[891] I discuss the rhetoric of abundance in xenotransplantation discourse in more depth in Chapter 3.

In this chapter, I argue that while the spare parts metaphor is used to rhetorically obscure the exploitation of animals in xenotransplantation, speculative fiction (SF) can provide a lens through which to consider the ethics of capitalizing on animals as a source of biovalue and to envision futures outside of this exploitative framework. An exemplary text is Alex Perry's young adult (YA) novel *Pighearted* (2021), which directly responds to emerging questions about the ethics of using animals in xenotransplantation through its speculative depiction of the relationship between a xenograft recipient and an anthropomorphized, chimeric pig. As I will discuss, the novel complicates the spare parts metaphor by exploring interspecies care, kinship, and entanglement. Importantly, the novel does not engage with cultural anxieties about chimeras and the potential for pig organs to negatively impact the identity of human recipients; instead, the novel explores how both humans and pigs become entangled through biomedical science and are altered by their *relationship* rather than by their biology. Additionally, the novel draws on conventions of the SF and YA genres to demonstrate how readers can reimagine their relationships with nonhuman animals as well as the future of biomedicine and bioethics. By envisioning how interspecies kinship can influence biomedicine and the future of transplant medicine, *Pighearted* provides an important posthumanist challenge to the spare parts metaphor that currently dominates xenotransplantation discourse.

5.2 Mechanization and "Spare Parts": Objectification, Dehumanization, and Exploitation

Metaphors shape the way that we understand medical advancements, including those in the field of organ transplantation. In *Transplant Fictions*, Emily Russell highlights the value of analyzing narratives and discourse of organ transplantation, arguing that "[a] method of close reading drawn from cultural study is particularly valuable in this case because the founding ideologies of organ

exchange are so often expressed through metaphor."[892] Russell identifies common metaphors used to make sense of organ transplantation, including the "gift of life" and "spare parts."[893] While the "gift of life" metaphor involves organs being compared to gifts selflessly passed from one person to another, the "spare parts" metaphor depicts the body as *mechanized*, or compared to a machine. As Omar Sultan Haque and Adam Waytz discuss in their analysis of dehumanization in medical contexts, metaphorical mechanization is prevalent across medical fields, and medical practitioners participate in this process by "thinking of patients as mechanical systems made up of interacting parts."[894] This way of viewing the body in medicine is particularly relevant in the fields of anatomy and internal surgery, where, as Catherine Waldby explains, "the interior of the living body is therapeutically addressed as an assemblage of (in this case) malfunctioning technologies—organs to be fixed or replaced by other working parts."[895] The spare parts metaphor thus encourages us to see bodies as operable and repairable, and organs as individual pieces of machinery that are transferable and replaceable—if an organ ceases to function, it can be replaced with a new, functioning organ that will "fix" the malfunctioning body.

As Paul Craddock describes in *Spare Parts: The Story of Medicine Through the History of Transplant Surgery*, the spare parts metaphor has shaped transplant medicine for hundreds of years. Craddock describes attempted tooth transplants throughout the 18th century, where teeth (usually sourced from corpses or bought from impoverished children) became a commodity, noting how "[t]he idea that the body was constructed of 'parts' suggested that all kinds of compatibilities might exist,

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[892] Emily Russell, *Transplant Fictions: A Cultural Study of Organ Exchange* (Palgrave Macmillan, 2019). 11.
[893] Russell, *Transplant Fictions*, 11.
[894] Omar Sultan Haque and Adam Waytz, "Dehumanization in Medicine: Causes, Solutions, and Functions," *Perspectives on Psychological Science* 7, no. 2 (2012): 176–86. 178.
[895] Catherine Waldby, *The Visible Human Project: Informatic Bodies and Posthuman Medicine* (Routledge, 2000). 69.

and in the eighteenth century this sparked the first market in body parts for transplantation."[896] The connection between the spare parts metaphor and the "first market in body parts" is especially notable, since this indicates that the spare parts metaphor contributes to the commodification of body parts as a form of what Waldby refers to as "biovalue."[897] As Waldby explains, the production of biovalue is closely connected with medicine, and the field of anatomy more specifically, since it "involves finding a use-value for the corpse, calling it to account in order to produce a surplus of vivification for the living."[898] While corpses are certainly central in transplant medicine, the idea that the body is "an assemblage of tools, whose value lies in its capacity as useful machine"[899] has implications for *living* patients and donors as well.

While Craddock focuses on the historical dimensions of the spare parts metaphor, even in the 21st century the process of mechanization can have important implications for patients' sense of self. Haque and Waytz describe how viewing the body as a machine can result in dehumanization, with patients being treated like collections of parts rather than people: "Medical problem solving often necessarily entails focusing on less than the whole human organism, disregarding a person's inner mental life."[900] This process can be psychologically and emotionally detrimental for patients, since, "[w]ith all the measuring, palpating, listening for abnormal body sounds, percussing, injecting, and imaging of innards, doctors may treat patients like objects rather than a complete person with rich, subjective experiences."[901] As this statement indicates, in being treated as collections of parts—even

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[896] Paul Craddock, *Spare Parts: The Story of Medicine Through the History of Transplant Surgery* (New York: St. Martin's Press, 2021). 7.
[897] Waldby, *Visible Human Project*, 51.
[898] Waldby, *Visible Human Project*, 51.
[899] Waldby, *Visible Human Project*, 55.
[900] Haque and Waytz, "Dehumanization in Medicine," 178.
[901] Haque and Waytz, "Dehumanization in Medicine," 178.

when this process facilitates effective diagnosis and treatment—patients can experience objectification and dehumanization.

While the metaphors of mechanization and of the spare part are frequently used interchangeably, a notable distinction is that mechanization can occur in any medical context, while the spare parts metaphor is frequently evoked in exploitative contexts. In Sherryl Vint's analysis of "biopolitical figurations" in 21st-century SF, she argues that the "spare part" is one such figuration, in which "[o]ne's own bodily tissues, parts, and fluids can *become alienated from the self*, turned into market commodities that circulate independent of the individual who was the origin: body parts become transferable assets."[902] While Vint focuses on examples of organ harvesting in SF where *human* bodies are exploited, she notes that this can extend to xenotransplantation as well.[903] In xenotransplantation, the spare part metaphor positions body parts as separable from the nonhuman animal bodies from which they originate, thereby framing those body parts as a *transferable and reusable* source of biovalue in different contexts and different bodies, and positioning the source of the body part as *disposable*.

This process of framing bodies and body parts as transferable, reusable, and disposable has a problematic history. Craddock outlines how transplant medicine has developed from blood transfusions and teeth transplants to whole-organ donations, and notes that "very rarely today will you hear a transplant professional referring to 'spare parts.'"[904] Part of this, he explains, is due to the *absence* of any "spare" organs given the organ shortage crisis, but so too is it because "no professional would refer to another person's body in terms of their 'parts,' which would be

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[902] Sherryl Vint, *Biopolitical Futures in Twenty-First-Century Speculative Fiction* (Cambridge University Press, 2021). 93. Emphasis added.
[903] Vint, *Biopolitical Futures*, 91.
[904] Craddock, *Spare Parts*, 243.

particularly disrespectful to donors," and that "historically, donors have simply been *erased from the story*, present only through the phantom of their body parts."[905] As Craddock outlines, the spare parts metaphor has historically been used as a way of rendering the sources of organs invisible, which can obscure the exploitative practices that have shaped the history of transplant medicine and continue to shape transplant medicine today.

As transplant medicine has evolved, the "disposable" sources of organs have shifted as well. While it is viewed as unethical to treat or refer to *humans* as sources of spare parts, the same cannot be said of nonhuman animals. Indeed, the discourse around xenotransplantation—where animals become incubators for transplantable organs—relies heavily on the spare parts metaphor. For example, while Craddock argues that one of the reasons that the spare parts metaphor is no longer used is because of the lack of available organs, proponents of xenotransplantation have used the rhetoric of abundance to frame animal organs as a way to address the shortage of human organs. With proponents advocating for a future in which pig organs can be readily produced and distributed, it is unsurprising that the spare parts metaphor would become a key rhetorical strategy in envisioning that future. Xenotransplantation might also seem to overcome the other concerns that Craddock raises about the ethical issues raised by treating human beings like a source of replacement parts for other people. By using animals instead—and especially a species like pigs that are already treated as commodities—the problematic nature of treating bodies as incubators for organs may appear to be minimized. As Kathleen N. Fenton notes in a special issue of *Artificial Organs* about xenotransplantation, while the use of nonhuman primates (NHPs) elicits ethical concerns,

> the recent turn to the use of pigs has led many to conclude that there are now no ethical questions in this space. After all, even if xenotransplantation were to become commonplace,

[905] Craddock, *Spare Parts*, 243. Emphasis added.

> the small numbers would seem insignificant as compared to those bred and slaughtered for food, a practice that is commonly accepted almost throughout the world.[906]

In the same issue of *Artificial Organs*, John W. Entwistle et al. call attention to the way that speciesism—or "the belief that some animal species are more valuable than others despite similar interests"[907]—has shaped the way that pigs have been deemed acceptable sources of organs, since "[s]peciesism might lead one to believe that four-legged animals are better suited for xenotransplantation than non-human primates because they lack characteristics that humans value."[908] While important steps have been taken to prevent the exploitation of humans and NHPs in transplant medicine, species like pigs are not viewed as being in need of the same protections. Therefore, cultural beliefs about which animals are worthy of ethical rights and which are not have been influential in shaping public opinions about the use of pigs in xenotransplantation.

Considering that the reduction of an animal to relevant body parts is an integral component in making xenotransplantation ethically acceptable to public audiences, it is worth interrogating the spare parts metaphor and considering alternative perspectives on the use of pig organs in xenotransplantation. As I will argue in this chapter, the novel *Pighearted* provides one such alternative. In *Pighearted*, a chimeric[909] pig, J6, provides readers with a means through which to empathize with the pigs developed for use as biomedical products. While the adult characters in *Pighearted* treat J6 as a source of spare parts, the novel counters this tendency through the chapters

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[906] Kathleen N. Fenton, "Xenotransplantation: A Microcosm of Bioethics," *Artificial Organs* 46, no. 6 (2022): 995–96, https://doi.org/10.1111/aor.14260. 996.
[907] John W. Entwistle, Robert M. Sade, and Daniel H. Drake, "Clinical Xenotransplantation Seems Close: Ethical Issues Persist," *Artificial Organs* 46, no. 6 (2022): 987–94, https://doi.org/10.1111/aor.14255. 992.
[908] Entwistle et al., "Clinical Xenotransplantation," 992.
[909] Calum MacKellar and David Albert Jones provide a useful overview of the historical, cultural, ethical, and scientific dimensions of chimeras. They explain that "[c]himeras, unlike genetic hybrids, consist of combinations of cells, tissue and organs from two different biological entities whether or not they are of the same species." Calum MacKellar and David Albert Jones, eds., *Chimera's Children: Ethical, Philosophical and Religious Perspectives on Human-Nonhuman Experimentation* (Continuum, 2012). 105.

that highlight both J6's and Jeremiah's perspectives and their developing relationship. J6 is depicted as a being with agency who experiences hopes and fears and develops bonds with his human family. Furthermore, as a chimera with both pig and human cells, J6 troubles the spare parts metaphor, since the acts of creating a chimera and transplanting a chimeric organ entangles humans and pigs, which challenges anthropocentric and speciesist concepts of identity and value.

5.3 "You don't get it from a dead guy?": The Spare Parts Metaphor in *Pighearted*

In chapters that alternate between "Boy" and "Pig," Perry's YA novel follows the perspectives of Jeremiah, an 11-year-old boy with heart disease, and J6 (short for Jeremiah Six), a chimeric pig with a "perfect" heart designed by the company Gen-e-heart. The novel opens with Jeremiah receiving a left ventricular assist device (LVAD) after collapsing during a soccer game. The LVAD is only a temporary measure, and Jeremiah is restricted to his house for three months while waiting to undergo a heart transplant. Although Jeremiah believes he will be receiving a laboratory-grown heart, unbeknownst to him, his family has agreed to him receiving a pig heart from Gen-e-heart, which was created using Jeremiah's cells. Because Gen-e-heart's xenotransplantation program is being phased out to make way for research into artificial hearts, Dr. Willis recommends that J6—whose heart is not yet ready for transplant—temporarily live with Jeremiah's family under the guise of being a "therapy pig" to support Jeremiah's recovery. Jeremiah initially resents J6's presence, finding the pig an irritating and inconvenient addition to the family. J6, meanwhile, believes that acting as Jeremiah's therapy pig is an opportunity for him to finally gain a family of his own. Despite a series of conflicts between Jeremiah and J6 resulting from J6's misguided attempts to integrate himself into the family, the bond between the pair grows. As the waiting period to harvest J6's heart draws to a close, Jeremiah realizes that he had been lied to and attempts to sneak J6 to safety at a

local rescue farm. However, a storm rolls in and Jeremiah's LVAD sustains water damage. J6 realizes that Jeremiah will quickly die without his "perfect" heart and makes the decision to allow his heart to be transplanted into Jeremiah. Following the procedure, Jeremiah struggles with grief and guilt. As he regains health and strength, he decides to visit the animal rescue farm. When Jeremiah arrives, he is greeted by a pig resembling J6 with a surgical scar that is identical to his own. Jeremiah learns that Dr. Willis had stolen an artificial heart from Gen-e-heart and used it to keep J6 alive. The novel ends with Jeremiah and J6 happily reuniting, and Jeremiah thanking J6 for his sacrifice.

Throughout *Pighearted*, the narrative engages with the metaphors of mechanization and spare parts. The idea that pigs are a source of replacement organs for humans is constantly reinforced by the adult characters, especially Jeremiah's medical team. One of the ways that this happens is through the use of medical terminology to refer to J6's heart. For example, in the "Pig" chapters, it becomes clear that J6, who was raised in a medical laboratory by Dr. Willis, has absorbed the clinical language that was used to refer to his genetically modified heart. At multiple points throughout the novel, J6 references his "perfect" heart:

> "My heart—which Dr. Willis told me has a '*superior vena cava*'—making it better than anyone else's—thumped."[910]
>
> "My well-formed heart with *strong ventricle walls* thumped and pumped and kept shaking."[911]
>
> "*I have an excellent heart with strong ventricle walls*…."[912]

Long before J6 understands that he was created solely for the purpose of growing a replacement heart for Jeremiah, he learns to think of his "excellent" heart as a "superior," "strong" medical object. Through the repetition of the medical terminology describing perfect anatomy and functionality, the

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[910] Alex Perry, *Pighearted* (Little, Brown and Company, 2021). 63. Emphasis added.
[911] Perry, *Pighearted*, 98. Emphasis added.
[912] Perry, *Pighearted*, 171. Emphasis in original.

idea that J6's heart is merely a piece of machinery within his body is reinforced. While J6 is simply repeating the terminology used by other characters and does not understand the implications of it, it becomes clear that J6 is seen—at least within the laboratory—as a source of spare parts. To return to Haque and Waytz's discussion of dehumanization in medicine, they argue that "[m]echanization is apparent in any surgical or interventional setting: Puncturing the body's envelope requires a focused and transient reduction of a person to their less-than-well-functioning parts."[913] In *Pighearted*, however, rather than reducing the human patient, Jeremiah, to his "less-than-well-functioning" heart, the mechanistic language used by medical professionals reduces the "donor" animal, J6, to his medically "perfect" heart—the spare part that will be used to replace Jeremiah's heart and thereby save his life.

In the "Boy" chapters, Jeremiah is also encouraged to see organs in mechanistic terms by his parents and medical team through the scientific terminology that they use to refer to his upcoming transplant. When Jeremiah receives his LVAD, Dr. Willis explains that it will be a temporary measure: her lab has "been growing a heart for three months, but it needs to grow for three more months before we can harvest it and give it to you."[914] Rather than explaining that the heart is being sourced from a pig, Dr. Willis describes how it will "grow" in a lab before being "harvested," using technical language to make it sound like the heart is being created independently of a body. This obfuscation intentionally creates distance between human xenograft recipients like Jeremiah and pig "donors" like J6. For example, Jeremiah curiously questions his doctor and his parents about the creation of the heart, asking

> 'How do you grow a heart? You grow it in the lab? In a jar or something? You don't get it from a dead guy?'

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[913] Haque and Waytz, "Dehumanization in Medicine," 178.
[914] Perry, *Pighearted*, 33.

> ‘Not really,’ Mom said. ‘Dr. Willis grew this perfect heart in her lab. It just needs to finish growing.’
> ‘Like a clone heart?’
> ‘Yes.’
> ‘So, I’m a cyborg and I’m getting a clone heart?’[915]

In this exchange, Jeremiah wonders how a heart can be “grown” without there being a “dead guy” to provide it.[916] While the truth is that the heart *will* come from another living being—resulting in death—Jeremiah’s mother tries to shift the conversation away from this reality, allowing Jeremiah to believe that his heart will be more like a piece of specially designed, perhaps even abiotic, equipment, making him into a “cyborg.” In the chapters told from both Jeremiah’s and J6’s perspectives, then, language is used to create an association between organs and machinery in order to distance the xenograft recipient from the “donor” animal and obscure the fact that the animal will be killed as part of the process of harvesting the organ.

The purpose of using mechanistic language to make the heart appear to be a piece of machinery that is scientifically designed is an attempt to avoid the emotional reaction that Jeremiah might experience should he discover the truth about his “therapy pig.” As Dr. Willis advises Jeremiah’s parents before she brings J6 to their home, “you might not want to tell Jeremiah the truth,” since “[h]e has a tender heart.”[917] Two different metaphors are at work as J6’s medically perfect heart is contrasted with Jeremiah’s “tender” heart: J6’s heart is a high-performing, durable, mechanized medical object within a disposable vessel, while Jeremiah’s physically fragile heart is tied to his compassionate emotional reactions and his overall identity as a human. In the novel, then, metaphors play an important role in shaping perceptions of the significance of a pig heart transplant.

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[915] Perry, *Pighearted*, 33.
[916] In the same chapter, Jeremiah thinks about how his LVAD scar is “straight out of *Frankenstein*.” Perry, *Pighearted*, 28. Evidently, Mary Shelley’s novel (and its cultural impact) provides context for how Jeremiah understands spare parts in transplant medicine, believing that biological materials like organs are only taken from corpses.
[917] Perry, *Pighearted*, 26.

Framing J6's heart as a piece of machinery—a "spare part"—allows his parents and Dr. Willis to circumvent the potential moral conundrums that Jeremiah might experience if he knew that the heart was in fact coming from a living being who would be sacrificed to save his life. And as it turns out, Dr. Willis was right to acknowledge the potential emotional fallout that the discovery of J6's true purpose would have for Jeremiah. When Jeremiah first learns about Gen-e-heart's xenotransplantation program after finding a biology textbook with a section on Gen-e-heart in his older sister Jazmine's room, he tries to process what this means. Jeremiah grapples with the textbook's description of Gen-e-heart's research: "I read it again. And again. I was trying to piece something together. Dr. Willis had other pigs? That she killed? I guess J6 was lucky that he got to live with me instead of getting his organs stolen. Maybe that's why we adopted him, to keep him safe."[918] Despite his parents' and doctor's attempts to frame J6's heart as a piece of machinery, Jeremiah views the xenotransplantation program through a very different lens, using words like "killed" and "stolen" (rather than Dr. Willis' use of "grow" and "harvest") to describe the process. When Jeremiah eventually discovers that this was indeed the same fate intended for J6 and confronts Dr. Willis, she continues to use technical scientific language to describe the procedure, explaining that "[w]e made him special for you. We cut out some of his genes before he was born. Then we gave him some of the stem cells we harvested from your skin cells. He's specially designed to help you."[919] Again, Dr. Willis uses words like "harvest," "genes," "stem cells," and "specially designed" to frame J6's heart as a piece of medical equipment. However, this does not alleviate Jeremiah's concerns, and he grows increasingly horrified. Later, when Jeremiah tries to take J6 to the animal rescue farm, he explains to the woman who runs the farm, Emily, that "[h]e's from Gen-e-heart. They messed with his DNA. He

[918] Perry, *Pighearted*, 107.
[919] Perry, *Pighearted*, 128.

was born just so they could kill him."[920] Through Jeremiah's reaction to the revelation that the "cyborg" heart he is supposed to receive is actually J6's heart, it is apparent that the spare parts metaphor is an ineffective way for Jeremiah to understand the source of his replacement heart, since he does not view J6 as an incubator.

While Jeremiah does not see J6 as a source of spare parts, he understands that within this framework, bodies and body parts become disposable, which can extend to *human* bodies as well. While Jeremiah is primarily concerned with J6's fate, the novel indicates that troubling consequences for human identity can also arise from objectifying and exploiting pig bodies as sources of spare parts. Jeremiah later begins to see his body as a machine with components that are just as disposable as the nonhuman animals used in xenotransplantation. For example, when he awakens after his heart transplant procedure, he immediately thinks about the fate of his *own* heart: "I woke up without my heart. Dr. Willis ripped it out and threw it in the trash,"[921] and "[t]hey cut out my heart, got rid of it, and hooked up the new one."[922] Within the spare parts framework for understanding organ transplantation, Jeremiah's own body has become mechanized, and his body parts have become disposable. As Craddock explains, human heart transplants bring particularly troubling implications for patients, since "[i]t was one thing to understand on an intellectual level that the heart is a mechanism, and another thing entirely to confront our humanity and identities by treating it as a spare part."[923] Jeremiah experiences this "confrontation" of identity after undergoing the transplant procedure. And while Jeremiah had previously viewed his body through a mechanistic (and perhaps even transhumanist) lens in his curiosity and excitement about whether he would become a "cyborg"

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[920] Perry, *Pighearted*, 248. It is interesting that in this scene, Jeremiah does not recognize that most domestic pigs *are* raised to be killed for human benefit. Perhaps because he was introduced to J6 as a therapy pig, he understood J6 within a different framework for human-animal interaction than animal agriculture.
[921] Perry, *Pighearted*, 271.
[922] Perry, *Pighearted*, 273.
[923] Craddock, *Spare Parts*, 222.

by receiving a lab-grown heart, his perspective on his body being altered by transplant medicine has now shifted from excitement to a more somber reflection on how bodies and body parts become disposable. Later, when Dr. Willis tries to hint to Jeremiah that she had saved J6 by telling him that J6 was in a "good place," Jeremiah again thinks of disposability, thinking, "[w]hat good place? Wasn't he in the trash somewhere?"[924] While Jeremiah does not ruminate in depth about the significance of his heart and J6's body both potentially being discarded as "trash," the novel demonstrates that the exploitation and disposability of animal bodies can impact human patients as well, changing the way that they view their own bodies.

5.4 "He's my brother": Interspecies Care, Kinship, and Chosen Family in *Pighearted*

While the adult characters in *Pighearted* use the spare parts metaphor as a framework for understanding xenotransplantation, the novel encourages readers to consider an alternative perspective, which actively resists the reduction of J6 to a replacement heart for Jeremiah. Instead, the novel envisions the possibility of meaningful relationships to emerge, even from within exploitative xenotransplantation research settings. In doing so, *Pighearted* responds to key bioethical and animal rights concerns raised by xenotransplantation. For example, in an article about the ethics of xenotransplantation, Sheila Jasanoff asks, "[i]n making human and nonhuman bodies more compatible with one another, is transplant medicine risking our capacity to respect the moral status of both partners? A wider public discussion of these issues seems *urgently called for*."[925] Indeed, the novel responds to the need for discussion about the concerns raised by using nonhuman animals in xenotransplantation by providing an alternative perspective to the spare parts metaphor. Even though

[924] Perry, *Pighearted*, 275.
[925] Sheila Jasanoff, "Bodies in Transition: Ethics in Xenotransplantation Research," *Hastings Center Report* 48, no. S4 (2018): S67–69, https://doi.org/10.1002/hast.960. 3. Emphasis added.

some of the characters in the novel engage with the spare parts metaphor, the novel encourages readers to look beyond it by depicting chimeric pigs as being capable of forming meaningful relationships with humans that transcend species boundaries, thereby highlighting the way that biomedical research could result in unanticipated entanglements and new forms of kinship. As Lesley A. Sharp argues, analyzing interspecies entanglements requires new ways of thinking, since "an interspecies approach necessitates, at the very least, tinkering with established modes of representation, thought, and action."[926] To explore the entanglements between pigs and humans that could develop because of xenotransplantation, *Pighearted* engages with the YA literature genre's focus on subverting family structures in order to envision the relationship between a human boy and a chimeric pig as a form of kinship.

Kinship between animals and humans has been explored by scholars across fields including animal studies, multispecies studies, and critical posthumanism. Terms like "companion species,"[927] "oddkin,"[928] "multispecies assemblages,"[929] "curious kin,"[930] "relatedness,"[931] "interspecies friendship,"[932] and "interspecies kinship"[933] have been used to articulate the complexities of the relationships between humans and other beings. Donna Haraway's influential term companion

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[926] Lesley A. Sharp, "Interspecies Engagement in Medical Anthropology," *Medical Anthropology Quarterly* 33, no. 1 (2019): 163–67, https://doi.org/10.1111/maq.12493. 164.
[927] Donna Haraway, *When Species Meet* (University of Minnesota Press, 2007). 16.
[928] Donna Haraway, *Staying With the Trouble: Making Kin in the Chthulucene* (Duke University Press, 2016). 4.
[929] Thom van Dooren, Eben Kirksey, and Ursula Münster, "Multispecies Studies: Cultivating Arts of Attentiveness," Environmental Humanities 8, no. 1 (May 1, 2016): 1–23, https://doi.org/10.1215/22011919-3527695. 14.
[930] Amelia DeFalco, "Introduction: From Human to Posthuman Care," in *Curious Kin in Fictions of Posthuman Care* (Oxford University Press, 2023). 10.
[931] Radhika Govindrajan, *Animal Intimacies: Interspecies Relatedness in India's Central Himalayas* (Chicago: University of Chicago Press, 2018). 3.
[932] Mary Trachsel, "Befriending Your Food: Pigs and People Coming of Age in the Anthropocene," *Social Sciences* 8, no. 4 (April 2019): 106, https://doi.org/10.3390/socsci8040106. 15.
[933] Megan Tucker, "Kinship with Piglets: Inter-Species Intra-Actions and Corporeal Yearnings," *Phenomenology & Practice* 18, no. 1 (November 26, 2023), https://doi.org/10.29173/pandpr29534. 54.

species refers to the ways that humans and nonhuman animals are constantly "becoming-with"[934] one another. As Haraway explains,

> we are in a knot of species coshaping one another in *layers of reciprocating complexity* all the way down. Response and respect are possible only in those knots, with actual animals and people looking back at each other, sticky with all their muddled histories. […] It is a question of cosmopolitics, of learning to be "polite" in responsible relation to always asymmetrical living and dying, and nurturing and killing.[935]

A key element of companion species, then, is that the impact is *reciprocal* (if not symmetrical), with consequences for both humans and animals. The idea that companion species shape one another is particularly important, since, as Erica Fudge argues, "[a] discussion of pet ownership begins with a glance at a dog, you might say, and ends with contemplation of the nature of the human."[936] While Fudge is describing human-pet relationships specifically (in contrast to Haraway, who differentiates companion *species* from companion *animals*[937]), this "contemplation of the nature of the human" is elicited by a wide range of relationships between humans and nonhuman animals. Therefore, analyzing the depiction of interspecies kinship in novels like *Pighearted* can provide insights into how the modification of animals for use in biomedicine can impact both animals *and* humans. Drawing on the work of these scholars, I will use the terms "interspecies care" to describe the impact that humans and nonhuman animals have on one another's wellbeing, "interspecies kinship" to describe the bonds that forms across species, and "interspecies entanglement" to refer to the broader ways that humans and pigs shape each other's existence in the future of xenotransplantation and biomedicine envisioned by *Pighearted*.

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[934] Haraway, *When Species Meet*, 301.
[935] Haraway, *When Species Meet*, 42. Emphasis added.
[936] Erica Fudge, *Pets* (Stocksfield: Acumen Pub, 2008). 10.
[937] Haraway, *When Species Meet*, 16.

Like many stories written for children and young adult audiences, *Pighearted* focuses closely on the meaning of family, and how bonds between family members develop and are subverted and reformed under various circumstances. Victoria Flanagan notes that "[u]nderpinning much literature for children, especially narratives that engage with the heroic or quest paradigm, is a construction of agency based on the principles of individualism, action and autonomy," which, she writes, "is even more pronounced within the genre of YA fiction, where an individualistic construction of agency prevails in narratives that frequently revolve around the adolescent character's acquisition of independence and concomitant separation from the family unit."[938] In *Pighearted*, the meaning of family—and the possibility of forming kin relationships outside of traditional human family structures—is considered from both Jeremiah's and J6's perspectives. Jeremiah is the middle child and only son in a family of five, and his heart condition has come to define the family's life: his parents move the family from Florida to Texas in order to be closer to Jeremiah's specialized medical team, and his older sister, Jazmine, gains an interest in future careers in medicine and starts researching Gen-e-heart. Jeremiah feels guilt for causing his family to relocate, and after coming across a draft of an essay Jazmine was writing where she discusses how Jeremiah's heart condition inspired her interest in medicine, he misguidedly believes that she resents him for his heart condition. Jeremiah thinks, "I was never good enough for Jazmine […] I didn't know how she actually felt. The day I was born was her worst memory."[939] The novel therefore begins with Jeremiah feeling isolated within his family unit, and the chapters told from his perspective often focus on his complicated feelings towards his family and the guilt he feels for how his health impacts them.

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[938] Victoria Flanagan, *Technology and Identity in Young Adult Fiction: The Posthuman Subject* (Palgrave Macmillan, 2014). 13-14.
[939] Perry, *Pighearted*, 78.

In J6's chapters, it becomes apparent that like Jeremiah, J6 feels isolated. Unlike Jeremiah, though, J6 had lost his biological family. During his time living in the Gen-e-heart laboratory, J6 had watched as his five brothers—J1 through to J5—all either died or developed health and behavioural issues that made them ineligible for the xenotransplantation program and consequently were taken away from the laboratory. As the sole remaining member of the cohort, J6 experiences loneliness and remorse over being unable to save his brothers. However, he retains a sense of optimism about the role that family can play in his life. J6 contemplates the possibility that he may be able to form new family bonds based on the depictions of human families that he sees while watching television in the laboratory:

> If you're a part of a family, then you have it made. You get a whole giant room with a bed and no one puts you in a sandwich. No one wraps you in blankets and takes you away. The TV showed me that if I found 'parents,' they would give me replacement brothers.[940]

Evidently, J6's understanding of family is closely connected with liberation from captivity in the laboratory *and* from the constraints that shape the existence of pigs as either medical or agricultural products. In this view, then, finding family means a future where J6 is no longer considered a product for human consumption and is instead valued as an autonomous living being. Beyond this, though, J6's understanding of family is shaped by his desire for a brother whom—unlike the pigs in the Gen-e-heart laboratory—he can protect. When Dr. Willis takes J6 to live with Jeremiah's family, J6 believes that Jeremiah is meant to be his new brother, and his subsequent behaviour throughout the novel is characterized by attempts to "get officially promoted from pig to brother"[941] and be recognized as a "real" member of the family. While J6's initial attempts to become part of the family are humorously misguided, he finally achieves his goal by rescuing Jeremiah from being attacked after witnessing a burglary at a nearby store. When J6 drives off Jeremiah's attackers, Jeremiah

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[940] Perry, *Pighearted*, 22.
[941] Perry, *Pighearted*, 51.

finally starts to see him as a being with agency. For J6, this means that he has achieved his ultimate goal of finding a brother to protect and care for, making his life "complete."[942]

While J6 had always viewed humans as being potential family members, Jeremiah needs more time to shift his perspective on family, which he initially views through an anthropocentric lens. Jeremiah and his family are initially annoyed by J6, and because of J6's (accidentally) destructive attempts to endear himself to the family—such as trying to "free" Jeremiah by biting through his LVAD wire, or trying to "save" the family from fire by knocking a cake with candles onto the floor—Jeremiah's parents keep J6 locked in a crate. Despite being annoyed at J6's antics, Jeremiah disagrees with the way his parents treat him, thinking, "I couldn't even look at him when his little eyes were so sad. He didn't deserve to be trapped."[943] Jeremiah becomes increasingly irritated by his parents refusing to name the pig and referring to him as "it": "The *it* echoed in my head. Why didn't he get a name?"[944] As Haque and Waytz discuss in their analysis of dehumanization in medicine, "[t]he essence of dehumanization is the denial of a distinctively human mind to another person,"[945] and this process "involves viewing others as incapable of fully experiencing joy, pain, and desire," which "makes it easier to hurt them without causing feelings of personal distress."[946] While Haque and Waytz are discussing human patients, and the term "dehumanization" typically refers to the treatment of humans, this "denial" of subjectivity and agency can be seen in the way that animals are reduced to

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[942] Perry, *Pighearted*, 122. Interestingly, a similar dynamic can be seen in other SF depicting "nonhuman" characters who search for meaning through discovering or gaining a family. For example, in the film *Blade Runner: 2049*, the replicant K (whose full name, like J6's, is a series of letters and numbers, indicating his status as a *product*) searches for the truth about his identity. When K learns that a replicant had given birth, he believes that he might be the replicant child. Because of the potential that he might have a biological mother, K begins to see himself as more "human." *Pighearted* instead shows the possibility for characters like J6 to find purpose through chosen (rather than biological) family, exploring the way that both humans and nonhumans can find meaning through interspecies kinship.
[943] Perry, *Pighearted*, 71.
[944] Perry, *Pighearted*, 71.
[945] Haque and Waytz, "Dehumanization in Medicine," 177.
[946] Haque and Waytz, "Dehumanization in Medicine," 178.

a source of spare parts. As Matthew R. Calarco notes, the concept of dehumanization is relevant for animal studies, since "it […] has important implications for understanding human violence and discrimination directed at animals. These implications can be seen more clearly if dehumanization is understood as being something fundamentally different from simply denying persons biological species membership."[947] Indeed, a similar process occurs for J6 in the novel: the adult characters refuse to risk "humanizing" J6 by giving him a name or establishing a bond with him, since it would complicate his identity as a medical object and make his eventual death more difficult for them to emotionally reconcile with. Therefore, keeping firm boundaries separating the pig from the family is both a coping strategy that reinforces J6's identity as a medical object, and evidence of the anthropocentric belief that animals do not require the same ethical considerations as humans.

Jeremiah refuses to engage in the same dehumanizing behaviour and slowly shifts his perspective on J6. As their relationship develops, Jeremiah has to navigate the perceived boundaries that separate them. For example, when J6 attempts to "help" Jeremiah with his homework, Jeremiah compares J6 to "a pesky little brother," and is surprised when he sees that "[h]is tail started wagging as soon as he heard the word *brother*."[948] Because of the species divide between them, Jeremiah struggles to find the right language to articulate his growing bond with J6, telling him, "[i]f you were a person, I'd think we were related. But you're just a pig. I shouldn't even be talking to you."[949] Jeremiah is shocked when J6 seems distressed to hear Jeremiah's words. He reflects, "I thought the words didn't matter with animals, just the tone of voice, but his tail stopped moving […] But was I actually being mean?"[950] Jeremiah's surprise at J6's response may be rooted in the same logic as the

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[947] Matthew R. Calarco, *Animal Studies: The Key Concepts* (Routledge, 2021). 54.
[948] Perry, *Pighearted*, 102.
[949] Perry, *Pighearted*, 102.
[950] Perry, *Pighearted*, 102-103.

spare parts metaphor. For example, Craddock discusses the connection between René Descartes' belief that animals cannot experience pain or emotional responses and the development of the spare parts metaphor. As Craddock outlines, "Descartes, who, after hearing about circulation, was quick to compare animals to clocks and pulley systems, thought animals couldn't feel pain. […] As mere machines, they were simply incapable of any kind of emotional response."[951] Even while Jeremiah does not view J6 as a source of spare parts, his initial surprise at J6 exhibiting an emotional response demonstrates the far-reaching influence of Descartes' mechanistic view of animals. This interaction has an important impact on Jeremiah's perspective by forcing him to reconsider the assumptions he held about both nonhuman animals and family.

Importantly, the novel does not depict J6 as a *pet*; instead, Jeremiah comes to view J6 as a chosen member of his family. In Zoe Jaques' analysis of animals in children's literature, she explores "the ways animal stories offer a child-centered address to posthumanist discourse, where it is not just the humanist models of dominion or stewardship that might be imagined as possibilities for human-animal encounters."[952] In *Pighearted*, this posthumanist approach to human-animal kinship is demonstrated through the way that Jeremiah does not see J6 within "humanist models of dominion or stewardship." Rather than seeing J6 through the lens of being a commodity for human use or entertainment, Jeremiah sees J6 as an individual being with agency and personality, and actively *chooses* to view him as part of his family. Their relationship evidently aligns with Haraway's concept of companion species, since, as Calarco explains,

> In using the term companion, Haraway does not simply have in mind what are typically called 'companion animals,' that is, pets who are seen as accessories for human enjoyment or as sources of entertainment. Rather, she wants to articulate a sense of companionship that is

[951] Craddock, *Spare Parts*, 74.
[952] Zoe Jaques, *Children's Literature and the Posthuman: Animal, Environment, Cyborg, Children's Literature and Culture* (Routledge, 2015). 13.

> more profound and more challenging. For Haraway, companionship is a fundamental ontological category.[953]

While the depiction of J6 in *Pighearted* is significantly anthropomorphized, the depiction of his relationship with Jeremiah encourages readers to recognize the need for alternative lenses through which to view the type of interspecies kinship that could result from the entanglement of humans and pigs in xenotransplantation.

In *Pighearted*, the possibility for interspecies kinship emerges from the often-unrecognized ways that humans and nonhuman animals can express care for one another. In Amelia DeFalco's discussion of "curious kin" and posthumanist forms of care, she describes posthuman care as "care that operates outside of formalized systems, care that is unpaid, ubiquitous, vital, formative, taken for granted, transformative, and ordinary," and notes that "[a]nthropocentric assumptions about what qualifies as care can have grave consequences since perceived incapacities to care can disqualify one from human status with all the privileges that that status entails."[954] *Pighearted* explores the "anthropocentric assumptions" that can limit the recognition of interspecies care. Even though Jeremiah comes to view J6 as an integral part of his family, he is the only character in the novel to do so (aside from, perhaps, his younger sister Justus). When Jeremiah's condition deteriorates, his parents, Jazmine, and his doctors pressure him to undergo the transplant procedure and fail to understand why Jeremiah is horrified at the prospect of receiving J6's heart. When Jazmine tries to downplay the transplant by telling Jeremiah that "I know he's special, but he's just a pig," Jeremiah rejects this as a reason to use J6's heart, and retorts that "[h]e's my brother."[955] In this critical moment, Jeremiah articulates the bond he shares with J6 and compares his feelings of horror to how he would feel if it were his sisters in J6's place, thinking, "[k]illing J6 to save myself was the same as

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[953] Calarco, *Animal Studies*, 49.
[954] DeFalco, "Introduction," 5.
[955] Perry, *Pighearted*, 256.

killing Justus or Jazmine. He needed me."[956] When Jeremiah's condition worsens and J6 chooses to sacrifice himself to save Jeremiah, the pair have a final moment of understanding: "He oinked and I knew what he was trying to say. I wanted to tell him I loved him, too."[957] The novel therefore emphasizes the potential for interspecies care to go unrecognized and unappreciated due to the anthropocentric lens through which care, kinship, and family are often framed.

The novel's depiction of the capacity for interspecies kinship and care between humans and chimeric pigs challenges the objectification of J6 as a source of spare parts. While J6 had initially felt powerless at the realization that he had been created as a medical object to be used by humans and had wanted to escape before being killed, he later chooses to sacrifice himself after he realizes that Jeremiah does not see him as an object for human use. Instead, when Jeremiah desperately tries to save J6, J6 is shocked to realize that Jeremiah truly cares for him, thinking, "Jeremiah cared what I wanted because I mattered to him. Jeremiah would save me. No one ever saved a pig before."[958] When J6 is confronted with the decision to either save Jeremiah or himself, he reflects on Jeremiah's attempts to prevent him being killed, thinking,

> I was born to give him my heart, but that didn't matter. I *chose* to become his brother. Dr. Willis didn't own me. Not even Jeremiah owned me. No one got to choose what I did but me. And no one was going to steal my heart.
> I was going to give it away. Every beat in my pigheartedness led me to Jeremiah. And no one, not even my brother, could stop me.[959]

When J6 recognizes that Jeremiah cares for him, he realizes that there is another option for him beyond being commodified as a source of spare parts. Instead of the "spare parts" metaphor, he

[956] Perry, *Pighearted*, 234.
[957] Perry, *Pighearted*, 252.
[958] Perry, *Pighearted*, 152.
[959] Perry, *Pighearted*, 250. Emphasis added.

chooses to embrace another possibility by viewing his heart as a *gift* he can willingly bestow on Jeremiah as an act of love.

Importantly, Jeremiah's relationship with J6 has lasting impacts on his other family relationships. After his transplant procedure, Jeremiah begins to see his sisters differently, recognizing that they care for him in the same way that he had cared about J6. Through this realization, Jeremiah is able to reform and strengthen his bonds with his sisters, especially Jazmine, who he comes to realize *had not* resented him for his heart disease—instead, she had been grieving the potential loss of her brother the same way that he was grieving for J6. When Jazmine visits Jeremiah after his procedure, Jeremiah reflects on how he can better express care for his sister, thinking how "I'd do better by my sister. […] I'd be as good a brother to her as J6 was to me."[960] Later, when he starts to heal from his operation, his sisters take him to the animal rescue farm, the place he had hoped would be a safe haven for J6. While seeing the pigs at the farm brings up feelings of grief, Jeremiah reflects on how meaningful the support of Justus and Jazmine has been, and how important these relationships are in helping him cope with the loss of J6: "I didn't really have sisters until I got my brother, but I knew I could get through this with them by my side."[961] This depiction of Jeremiah's post-surgery experience envisions the potential for the interspecies entanglements to inspire greater compassion and empathy, resulting in changes to his *human* relationships as well.

Pighearted's depiction of kinship and care between Jeremiah and J6 aligns with other recent literary and philosophical analyses of the potential ethical implications that can arise from the recognition of the kinship between pigs and humans. For example, Megan Tucker describes her own experience caring for piglets and developing interspecies kinship. Tucker draws on Haraway's work

[960] Perry, *Pighearted*, 278-279.
[961] Perry, *Pighearted*, 287.

to discuss how the experience of caring for and writing about the piglets promoted a more ethical perspective on the role of pigs in society, since,

> The narrative of the piglets draws attention to the effects of the human/animal dualism, and influence of exceptionalism in how humans know, and interact with pig in Western contexts. And it encourages that perhaps if we were to know and get a feel for pig that there might be an inclination to rethink their characteristically instrumental value as instead companions, and our fellow kin.[962]

While Tucker is describing her real-world relationship with pigs, fictional relationships can also play an important role in promoting kinship. Mary Trachsel shares a similar perspective in her investigation into the depiction of pigs in coming-of-age novels. Trachsel argues that the fictional depiction of interspecies kinship between humans and pigs can have important ethical implications, since, "[i]n imagining pigs as friends instead of food, coming-of-age novels function beyond mere entertainment, as moral instruction that advances a biocentric ethic by challenging the human-centered morality of pig domestication and pork consumption."[963] My analysis of *Pighearted*, then, is situated within these discussions about the possibility for narratives about interspecies kinship to inspire ethical thinking about pigs as companion species.

Interestingly, the novel's use of the concept of *family* in its depiction of interspecies kinship between Jeremiah and J6 aligns with recent depictions of human-to-human organ transplantation in fiction. As Russell argues, sentimental fiction is a key genre that shapes public understanding of transplant medicine, since "the seeds of sentimental appeal […] persist as the dominant mode in discussions from the local to the national level."[964] Russell traces the way that one of the new forms of family connection emerging from sentimental discourse around transplant medicine is that of "savior siblings," or, "children who are able to provide stem cells, blood, bone marrow, or organs for

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[962] Tucker, "Kinship with Piglets," 62.
[963] Trachsel, "Befriending Your Food," 3.
[964] Russell, *Transplant Fictions*, 141.

their seriously ill siblings."[965] According to Russell, savior siblings, along with other ways of reimagining family connections in the context of transplant medicine, can "represent new forms of subjectivity and affiliation."[966] In *Pighearted*, this certainly appears to be the case: J6 functions as a sort of "savior sibling," purposefully designed to provide a heart for Jeremiah. More importantly, though, J6 and Jeremiah form a close family bond and express interspecies care for one another even *before* learning the truth about J6. This sentimental depiction of family bonds between a human boy and a chimeric pig is particularly important given the justification for the use of pigs in xenotransplantation. In an article about current directions in xenoscience, Sharp discusses how pigs are favoured over other animals like NHPs for xenotransplantation, noting that one of the reasons for this is because of pigs' lack of "sentimental" cultural status. Sharp notes:

> Swine have yet another advantage in that the *sentimental* qualities we assign to them are muted compared to what we assign to NHPs. In scientific discourse and beyond, we widely regard apes and monkeys as being very much like us. Whereas NHPs may inspire empathetic responses, pigs are far less likely to do so. Swine—who figure prominently in industrialized American food production—quickly become nondescript *generic* creatures, their value rooted in the market.[967]

Pighearted works against this cultural image of pigs as "generic" and unsentimental commodities through its highly sentimental depiction of J6 becoming part of Jeremiah's family. While the sentimental depiction of J6 as a "savior sibling" for Jeremiah still relies on the harvesting of J6's heart, it provides an alternative to the spare part metaphor, and reimagines the chimeric pigs created for xenotransplantation through the lens of family connection and interspecies care and kinship.

Pighearted's depiction of interspecies kinship and care can have important ethical implications for how readers perceive the role of nonhuman animals as family. In Flanagan's analysis

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[965] Russell, *Transplant Fictions*, 167.
[966] Russell, *Transplant Fictions*, 174.
[967] Lesley A. Sharp, "The Other Animal of Transplant's Future," *Hastings Center Report* 48, no. S4 (2018): S63–66, https://doi.org/10.1002/hast.959. 2. Emphasis in original.

of posthumanism in YA literature, Flanagan argues that "[p]osthuman YA narratives offer young readers and viewers a site from which to explore and question the various ways in which technology and science can affect human beings and the societies they live in."[968] One of the ways that YA literature does this, she argues, is by "interven[ing] in young adults' perceptions of themselves and the world by legitimising particular forms of identity and social relations."[969] *Pighearted* participates in this process by "legitimising" kinship between a pig and a human as a valid form of family bond. While J6's initial intended purpose is as a medical object, Jeremiah rejects this and instead actively participates in creating a different kind of relationship with J6, where the two share a reciprocal bond. Through this depiction of interspecies kinship, *Pighearted* encourages readers to consider their perspectives on nonhuman animals, which can have important ethical implications for the future of xenotransplantation. By engaging with YA literature's focus on how family bonds are subverted, altered, formed, and reformed, *Pighearted* encourages readers to recognize the potential for xenotransplantation to result in new forms of kinship, where the relationships between humans and pigs are altered in unanticipated ways.

5.5 "The pigs aren't pigs": Chimeras, Species Boundaries, and Entangled Identity in *Pighearted*

Chimeras hold an especially fraught position in the 21st-century biomedical imaginary. Interspecific chimeras are organisms with cells from two different species, which could include human and nonhuman animal cells.[970] In xenotransplantation, chimeric pigs with human cells could

[968] Flanagan, *Technology and Identity*, 38.
[969] Flanagan, *Technology and Identity*, 38.
[970] Katrien Devolder, Lauren J. Yip, and Thomas Douglas, "The Ethics of Creating and Using Human-Animal Chimeras," *ILAR Journal* 60, no. 3 (December 31, 2019): 434–38, https://doi.org/10.1093/ilar/ilaa002. 434.

be used to create better organ matches for xenograft recipients. However, there are inconsistencies in the regulations around this type of research, and the use of chimeras in research has been divisive among bioethicists. For example, the most recent guidelines about the use of chimeras in research created by the International Society for Stem Cell Research (ISSCR) have been met with backlash. Some bioethicists have criticized these guidelines for failing to address how human cells could alter the cognition of chimeras: for example, Julian J. Koplin outlines concerns about the ISSCR's most recent guidelines, and explains that "neurological chimeras could develop enhanced cognitive capacities; this, in turn, could arguably affect the animal's moral status (and thereby whether it is appropriate to use them in research.)"[971] On the other hand, some bioethicists have argued that it is more important to focus on animal welfare. Insoo Hyun, for example, argues that "[a]lthough various concerns have been raised about the ethical propriety of mixing human cells in animal hosts, regulatory oversight should remain squarely focused on animal welfare,"[972] since "animal suffering and acute biological dysfunction are the far more present and likely effects of human-animal chimerism."[973] These two bioethical stances are at odds over how future chimera research should proceed—should the use of chimeras be limited or avoided to prevent causing harm to creatures that might have an enhanced moral status, or are these merely abstract philosophical considerations that overlook more material animal welfare concerns and hinder scientific progress?

As bioethical concerns about the use of chimeras continue to be debated, fiction can play an important role in contributing to these discussions by envisioning potential implications of biomedical research. As Koplin argues, one reason to consider the moral status of chimeras is that "even if

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[971] Julian J. Koplin, "Response to the ISSCR Guidelines on Human–Animal Chimera Research," *Bioethics* 37, no. 2 (2023): 192–98, https://doi.org/10.1111/bioe.13104. 192.
[972] Insoo Hyun, "The Ethics of Chimera Creation in Stem Cell Research," *Current Stem Cell Reports* 4, no. 3 (September 1, 2018): 235–39, https://doi.org/10.1007/s40778-018-0136-6. 239.
[973] Hyun, "The Ethics of Chimera Creation," 239.

substantial cognitive enhancement is a future concern, there is value in identifying moral limits for such research *now*."[974] Novels like *Pighearted* can therefore encourage public audiences to consider the potential future ethical implications of using chimeras in xenotransplantation. *Pighearted* directly engages with the controversy around chimeras in xenotransplantation: in an author's note at the end of the novel, Perry explains that her inspiration for the story came from hearing about the creation of chimeric pigs with human cells in 2017. Perry takes a clear stance on the chimera debate, writing,

> there's a problem. The pigs aren't pigs. They're part human, and even scientists doing the experiments are afraid that the stem cells they inject could make their way into the brain. That would mean that these creatures might be able to have human thoughts and feelings like J6. That makes this research extremely controversial.[975]

While Perry assumes that the enhanced cognitive capacities that bioethicists consider to be a possible *future* risk already exist in chimeric pigs, her stance on xenotransplantation research clearly engages with the same concerns about the uncertainty around the moral status of chimeras that bioethicists like Koplin have outlined.

Species identity is a central concern throughout *Pighearted* and is frequently explored in the "Pig" chapters. While J6 was genetically modified to create a heart that was biologically tailored to Jeremiah, it quickly becomes clear to readers that J6 does not see his heart (or himself) as "human." Instead, J6 sees his "pigheartedness" as an essential characteristic that *distinguishes* him from humans. For example, when J6 introduces himself in the first "Pig" chapter, he explains, "I'm Jeremiah Six and I'm a pig. Kind of. Actually, Dr. Willis says I'm a chimera, which in my case means I'm a pig, but I have a human heart. Don't hold that against me. I consider myself pighearted."[976] While J6 feels some embarrassment at his biological identity as a chimera with both

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[974] Koplin, "Response to the ISSCR," 195. Emphasis in original.
[975] Perry, *Pighearted*, 292.
[976] Perry, *Pighearted*, 7.

pig and human cells, he also believes that this can be overridden by his "pigheartedness," which he describes as a driving force behind the decisions he makes. As J6 faces increasingly challenging scenarios in which he must decide whether to risk his own safety for Jeremiah, he turns to his instincts, believing them to be intrinsically connected to his biological identity as a pig:

> "I didn't know what to do. I closed my eyes, concentrated, and my pigheartedness whispered the most important word in the world: *brother*."[977]
>
> "I listened to my pigheartedness and I could hear it: *family*."[978]
>
> "I finally got the chance to decide what to do with myself, and I couldn't. I closed my eyes and listened to my pigheartedness. I could hear it again even though the fear was a little louder. It said: *brother*."[979]
>
> "But my heart kept beating the same rhythm. My pigheartedness shouted at me, louder than ever before: *brother*."[980]

While the novel aligns J6's "pigheartedness" with care for his human family member, he retains a strong sense of himself as a pig, rather than beginning to see himself as more "human." Indeed, J6 distinctly views the human components of his body as a negative influence. For example, when trying to rescue Jeremiah during the storm, J6 overestimates his ability to navigate the water, and as he gets swept away, he thinks, "I realized I was stupider than I thought. I guess I really did have a human brain."[981] Even when Jeremiah attempts to save J6 from having his heart sacrificed, J6 does not immediately acknowledge the possibility that a *human* could care as much as Jeremiah does, and instead attributes this to Jeremiah having his own pig-like qualities: "How did I miss it? Jeremiah is pighearted, too."[982] Throughout the novel, then, human superiority is challenged in the way that J6

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[977] Perry, *Pighearted*, 11. Emphasis in original.
[978] Perry, *Pighearted*, 23. Emphasis in original.
[979] Perry, *Pighearted*, 171. Emphasis in original.
[980] Perry, *Pighearted*, 250. Emphasis in original.
[981] Perry, *Pighearted*, 194.
[982] Perry, *Pighearted*, 152.

resists seeing himself as part human, instead viewing his pig qualities as what lead him to protect Jeremiah.

While J6's amusing commentary on the superiority of pig qualities throughout the novel provides a challenge to human superiority, the novel ultimately suggests that the path towards true interspecies kinship is through recognizing how entanglements between humans and nonhuman animals can result in beneficial impacts on both. It is not until later in the novel that J6 comes to believe that humans can also express care without necessarily being "pighearted": as J6 reflects on Jeremiah's attempt to save him, he realizes, "I was thinking about this the wrong way. […] Jeremiah messed up constantly, but he was brave and hopeful despite the fact that he's only a human."[983] Despite being "only human," J6 recognizes that Jeremiah expresses characteristics like bravery and selflessness, which J6 had previously associated with being a pig. Even more significantly, by the end of the novel, J6 decides that his combined biological identity as both pig *and* human will in fact make him stronger and more resilient than if he only had pig qualities, since, "I have the best that humanity and pigdom have to offer."[984] Through this realization, J6 becomes strong enough to face his fears, and he reunites with the family in time to save Jeremiah's life.

As J6 begins to embrace his chimeric identity and view himself as a combination of "the best that humanity and pigdom have to offer," Jeremiah also begins to see the potential for himself to undergo positive change because of J6. When Jeremiah is recovering in the hospital following his transplant procedure, he and Jazmine notice the "beeping" of his new heartbeat: "*Beep, beep, beep*, sang the EKG beside me. […] 'It's like I can hear him,' she said. / And then I heard him, too. I felt him. I always would."[985] The sensation of J6's heart beating in Jeremiah's body provides what feels

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[983] Perry, *Pighearted*, 210-211.
[984] Perry, *Pighearted*, 210-211.
[985] Perry, *Pighearted*, 279.

like a tangible connection between Jeremiah and J6, and Jeremiah's actions following his transplant are influenced by this physical reminder of J6. For example, despite Jeremiah's anger at his family for lying to him about J6, Jeremiah finds that he is able to forgive his family *because* he has J6's heart. When speaking to Jazmine after the procedure, Jeremiah thinks about how "[m]y brother's heart couldn't hate any of them, and I had his heart. […] J6's heart came with forgiveness."[986] While before the procedure Jeremiah had felt angry and betrayed that his parents and Jazmine had hidden the truth about J6 from him, following the procedure, he understands the difficulty of the situation for them as well, and how they had acted out of love for him. And while Jeremiah still grieves for J6, the physical reminder of him results in this newfound empathy. Through depicting two characters that transgress biological species boundaries—a chimeric pig with human DNA and a human boy with a pig heart—*Pighearted* challenges the idea that human and animal can be easily distinguished based on biology.

The novel's depiction of the changes that Jeremiah undergoes due to his heart transplant—regardless of whether the impetus for these changes is physical/biological or not—challenges the idea that pig organs can provide an easy source of replacement parts. The creation and acquisition of "spare parts" from a seemingly sterile laboratory environment is part of what makes their usage culturally acceptable by reducing the associations between the replacement organ and its source. However, as *Pighearted* indicates, receiving a transplanted organ is often *not* an emotionally sterile process for patients. As Craddock explains, "[w]hether it's a new nose, new tooth, new heart, or in the seventeenth century even a new set of humours, transplants have never been a simple matter of moving body parts around. They've always had consequences for people and their senses of self."[987] And while *Pighearted*'s depiction of Jeremiah and J6 living together and forming a bond before the

[986] Perry, *Pighearted*, 278-279.
[987] Craddock, *Spare Parts*, 250.

transplant procedure certainly complicates the impact that receiving J6's heart has on Jeremiah, the "consequences for people and their senses of self" that Craddock describes have been documented for real transplant recipients. For example, one study of 47 transplant recipients found that 89% of participants reported personality changes following their transplant surgeries.[988] For some patients, then, rather than viewing themselves as having simply acquired a replacement part to improve the functioning of their bodies, they associate the organ with unique traits and behaviours, and believe that the transplant can result in fundamental changes to their personalities. *Pighearted* indicates that this complex emotional experience could be even more nuanced in xenotransplantation, where the boundaries between human and animal identity come into question. As Flanagan argues, YA literature can have important implications for how readers understand the impact of scientific developments on human identity, since "[r]ather than reinstating or abandoning the humanist subject, a small but ever-increasing group of narratives are choosing to use technology as the means for both expanding and critiquing the category of 'human' in the modern digital age."[989] In *Pighearted*, the categories of both human and animal are indeed expanded, and while the novel explores the way that biology can shape identity, it suggests that species identity can change through interactions.

Another of the important implications of the novels' depiction of J6 and Jeremiah is the way that it challenges the belief that *biological* identity is what makes a being worthy of moral considerations. Despite Perry's claims that we need to be wary of creating chimeras for use in xenotransplantation because the pigs might be "part human," the moral status of chimeras in the novel is more nuanced than simply being determined by the presence of human cells or DNA. When Jeremiah tries to articulate why J6 is worthy of being spared, he struggles to explain it, thinking,

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[988] Brian Carter et al., "Personality Changes Associated with Organ Transplants," *Transplantology* 5, no. 1 (March 2024): 12–26, https://doi.org/10.3390/transplantology5010002.
[989] Flanagan, *Technology and Identity*, 38.

> *J6 has a human brain. He looks like a pig, but he's a kid, just six months old. The doctors made him out of me, and J6 taught me how to be a better brother and person. He saved me, and he loves me. He has my heart, but he has his own soul. You can give me that heart, but it won't do any good.*[990]

While Jeremiah had started this train of thought by reflecting on how J6 "has a human brain" and is "a kid" rather than a pig due to being created using Jeremiah's cells, this is not what Jeremiah ultimately believes makes J6 worthy of being saved. Instead, he thinks about how J6 "has his own soul" that is not connected with his biological origins, believing that J6's soul exists independently of his modified brain or heart. It therefore isn't human cells or DNA that Jeremiah believes makes J6 more than a spare part. Instead, it is J6's unique personality that has the potential to make Jeremiah "a better brother and person" *not* through undergoing the transplant, but by learning from J6 and following his example. Thus, while concerns about chimeric pigs being humanized are expressed in the novel, *Pighearted* does not depict this as the only reason to care about the moral status of pigs; it instead highlights the possibility for kinship and entanglement that transcends biological identity.

In *Pighearted*'s depiction of how both J6 and Jeremiah navigate the ways that their identities are altered and mediated by their biology and experiences, the novel highlights the kinds of entanglements that might emerge from xenotransplantation and how these interspecies relationships complicate the spare parts metaphor. Russell argues that "[i]n the spare parts analogy, a mechanistic view of the body assimilates many of the most radical elements of the surgery, reimagining it as *a simple and straightforward procedure* without troubling violations of boundary categories."[991] On the one hand, chimeras might appear to be the ultimate source of spare parts, since in xenotransplantation research, these animals are created to supply organs that are tailored to human recipients. On the other hand, chimeras can prove disruptive to spare parts rhetoric, since the intermixing of human and

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[990] Perry, *Pighearted*, 265. Emphasis in original.
[991] Russell, *Transplant Fictions*, 15. Emphasis added.

nonhuman cells, and the crossing of species and bodily boundaries make it more difficult to see a chimeric organ as a "spare part" that can be transferred from one body to another without complications. *Pighearted* challenges the attempt to frame the movement of organs between bodies as a "straightforward procedure," since the creation of J6 as a source of a replacement heart for Jeremiah results in changes for both J6 and Jeremiah, with ongoing consequences for both characters. In highlighting the entanglements between human and animal in biomedicine, *Pighearted* rejects the notion that animal organs can serve as unproblematic replacement parts for humans.

5.6 "He's changed a lot since I've known him": Sacrifice, Consent, and Care in *Pighearted*

While *Pighearted* depicts interspecies care, kinship, and entanglement, it is debatable whether the novel's depiction of J6 can truly be considered posthumanist—meaning that, in the words of Pramod K. Nayar, it "rejects the view of the human as exceptional,"[992] and takes "an ethical position against hierarchization of life forms."[993] Indeed, even in cases when the goal is to encourage a more ethical approach to the treatment of nonhuman animals, authors, scholars, and animal rights advocates might still rely on hierarchical, anthropocentric frameworks. As Sharp notes, one of the challenges to bringing interspecies entanglements into the field of medical anthropology is that "[i]nterspecies work is […] plagued by what might be an insurmountable challenge, namely, that humans writing within a multispecies framework will always struggle, no matter how self-conscious they might be, to overcome species hierarchies."[994] Cary Wolfe highlights a similar concern in

[992] Pramod K. Nayar, *Posthumanism*, Themes in Twentieth- and Twenty-First-Century Literature and Culture (Polity, 2014). 4.
[993] Nayar, *Posthumanism*, 31.
[994] Sharp, "Interspecies Engagement," 165.

animal rights philosophy, where, he argues, posthumanist and humanist approaches are in tension: on the one hand, the field embraces "opposition to anthropocentrism," but on the other, "animals are accorded standing because they embody, in diminished form, some normative concept of the 'human.'"[995]

This struggle to overcome species hierarchies in works that promote considerations of animal rights and interspecies entanglements is apparent in *Pighearted*, particularly in J6's decision to sacrifice himself to save Jeremiah. While J6 could have exercised his agency and chosen to live the rest of his life on the animal rescue farm, he instead chooses to go to the hospital with Dr. Willis and allows his heart to be harvested. And while readers learn at the end of the novel that J6 had been saved using an artificial heart that is not yet approved for human use, his life is still depicted as secondary (to the other characters *and* to the plot) compared to Jeremiah's. Further, Dr. Willis only chooses to save J6 because she recognizes that J6 has what she perceives as humanlike levels of cognition, which is what allows her to finally see J6 as a being worthy of moral considerations. Had J6 not displayed this level of intelligence, his heart would have been harvested *without* an artificial replacement and presumably, like all of Gen-e-heart's other chimeras, J6's life would have ended and his story would be over. Through the depiction of a human-like pig who sacrifices his life to save a human boy (and is thus rewarded through being saved himself), the novel reinforces anthropocentric hierarchies by valuing Jeremiah over J6.

J6's sacrifice aligns with a larger trend of animal sacrifice in YA literature featuring companion pigs. As Trachsel discusses in her analysis of coming-of-age novels, stories about pigs frequently depict these animals' deaths, reinforcing their status as agricultural animals rather than

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[995] Cary Wolfe, "Posthumanism," in *Posthuman Glossary*, ed. Rosi Braidotti and Maria Hlavajova (Bloomsbury Academic, 2018). 357.

companions. As Trachsel puts it, "[m]ost stories of relationships between people and pigs […] unfold as tragedies of sacrifice and betrayal, a storyline that tests an interspecies morality framing domestication as 'animal consent.'"[996] While most of these pig narratives focus on animal consent in agricultural contexts, Emma Trott calls attention to a similar instance of animal consent in another xenotransplantation narrative: Malorie Blackman's novel *Pig-Heart Boy*.[997] Trott describes how Cameron, another boy who undergoes a pig heart transplant, imagines the pig whose heart he receives giving consent for the procedure. Trott argues that "[w]ithin an anthropocentric moral code, the pig is afforded an unrealistic self-sacrificing benevolence that marks her as ripe to be used."[998] These examples show that animal sacrifice—and specifically *pig* sacrifice—is a recurring theme in YA literature. We see a similar instance of animal consent in *Pighearted*: by consenting to having his heart harvested out of love for Jeremiah, J6 fulfills his originally intended purpose as a medical product created solely to save a human life. In a sense, then, *Pighearted* aligns with the trend that Trachsel describes, where "the traditional pig–human friendship narrative equates adulthood with accepting the *inevitability of pig slaughter*."[999]

More recently, another instance of pig sacrifice was depicted in a xenotransplantation narrative not specifically intended for a young adult audience. In Sequoia Nagamatsu's speculative fiction novel *How High We Go in the Dark* (2022), a global pandemic has resulted in widespread disease, which causes organ failure, especially among children. The chapter "Pig Son" depicts a medical laboratory developing modified pigs to provide organs for xenotransplantation.[1000] One of the

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[996] Trachsel, "Befriending Your Food," 5.
[997] For an analysis of the bioethical issues raised in *Pig-Heart Boy*, see Chapter 2.
[998] Emma Trott, "A Change of Heart: Animality, Power, and Black Posthuman Enhancement in Malorie Blackman's Pig-Heart Boy," in *Animals and Science Fiction*, ed. Nora Castle and Giulia Champion (Cham: Springer International Publishing, 2024), 217–38, https://doi.org/10.1007/978-3-031-41695-8_13. 226.
[999] Trachsel, "Befriending Your Food," 6. Emphasis added.
[1000] Sequoia Nagamatsu, "Pig Son," in *How High We Go in the Dark*, 2022.

pigs, like J6, exhibits signs of cognitive enhancement and begins to communicate with the scientists in the lab. The scientists form a close relationship with the pig, and begin to treat him like a young child, viewing him as their "pig son." When it becomes apparent that the pig's rapidly growing brain will soon result in his death, the scientists give him the option to spend his remaining time as comfortably as possible outside the lab. However, he instead asks to be sacrificed so that his organs can save a human child. Interestingly, even though *How High We Go in the Dark* is not a YA novel, "Pig Son," like *Pighearted*, depicts a child-like pig sacrificing itself to save *human* children. Additionally, both stories depict the human companions of the pigs attempting to save them, but ultimately accepting their sacrifice as a gift. The depictions of pig sacrifice in these two narratives both provide highly sentimental and anthropomorphized visions of the pigs developed for xenotransplantation, and reinforce the idea that, if these pigs could choose for themselves, they would indeed sacrifice themselves for humans.[1001]

If *Pighearted*'s depiction of J6 sacrificing himself to save Jeremiah conforms to anthropocentric and speciesist hierarchies, does the novel still contribute to the posthumanist goal of decentering the human and recognizing other forms of life? I would argue that the novel *does* contribute to this goal by imagining the potential for interspecies entanglement in biomedicine to result in kinship and care that have an ongoing impact on Jeremiah's perspective on nonhuman animals. In DeFalco's discussion of posthuman care, she argues that it is not relegated to the technological futures envisioned by SF; instead, "it is always already happening to, with, and around us, most often in quiet, unremarkable ways that are easy to overlook."[1002] Throughout the novel, the

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[1001] Interestingly, Sharp has recently noted a similar dynamic in public communication about xenotransplantation, where "the pig has been reconfigured as a voluntary participant imbued with willing self-sacrifice in the spirit of medical desire and human need." Lesley A. Sharp, "Disrupting the 'Near Human' in Contemporary Xenotransplantation," *BioSocieties*, 2025, https://doi.org/10.1057/s41292-025-00354-5. 14.
[1002] DeFalco, "Introduction," 21.

seemingly "quiet, unremarkable ways" that Jeremiah's care for J6 has altered his perspective on nonhuman animals become apparent. For example, Jeremiah eventually decides to stop eating meat after witnessing J6's distress at seeing a barbeque truck at a local park with "a big sign with a pig in a chef's hat and apron holding a knife in one hand and a sandwich in the other."[1003] This behavioural change provides a stark contrast to Jeremiah's stance earlier in the novel, when he had wondered about why his parents referring to J6 as "it" bothered him, since "I ate bacon, and I didn't particularly love farm animals."[1004] J6 marvels at the changes Jeremiah exhibits, thinking about how "[n]ow Jeremiah doesn't eat any meat at all: no cows or chickens or even squirrels. He's changed a lot since I've known him."[1005] Perhaps unsurprisingly, this depiction corresponds with similar explorations of vegetarianism that Trachsel observes in recent children's and YA narratives about pigs, where, as she notes, characters are "acutely aware" of the identity of pigs as agricultural animals and respond by questioning or rejecting meat consumption.[1006] Even though Jeremiah is forced to undergo the heart transplant against his will, by becoming a vegetarian, he chooses to reject the commodification and consumption of animal bodies across biomedical *and* agricultural industries, which is reflective of the way that entanglements between humans and the altered animals of biomedicine can result in opportunities for expressions of interspecies (and posthuman) care that have impact beyond the immediate relationship.

Jeremiah's shift in perspective on nonhuman animals appears to continue even after J6's apparent death. In addition to becoming a vegetarian, Jeremiah chooses to volunteer at the animal

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[1003] Perry, *Pighearted*, 120.
[1004] Perry, *Pighearted*, 62.
[1005] Perry, *Pighearted*, 172.
[1006] Trachsel, "Befriending Your Food," 13. Interestingly, a similar shift to vegetarianism is also explored in Malorie Blackman's YA novel *Pig-Heart Boy*. See Trott's analysis of Cameron's decision to stop eating meat after receiving a pig heart transplant. Trott, "A Change of Heart," 224.

rescue farm after his transplant procedure. While Jeremiah was initially reluctant to go where he would be reminded of J6, his sisters encourage him, and when he arrives at Emily's house on the rescue farm he realizes how important the step is for addressing his grief: "It was so hopeful outside, and for the first time I could see my way to getting better."[1007] Jeremiah's perspective, and the responsibility he feels towards animals, has evidently been altered by his relationship with J6, and he consciously chooses to act in a more ethical way that respects nonhuman lives. The depiction of Jeremiah's shifting mindset in *Pighearted* once again aligns with Trachsel's observations for recent coming-of-age stories that feature pigs. Trachsel notes that in three novels that she analyzes (all published in 2017, only a few years before *Pighearted*), "the young protagonists disrupt anthropocentric norms and incline to a biocentric worldview anchored in relational understandings of the other-than-human world."[1008] Consequently, "[i]n honoring improbable interspecies friendships despite social and economic pressures to abandon them, [the protagonists] come of age by refusing to regard a non-human life as disposable."[1009] *Pighearted* certainly appears to follow this trend: the novel ends with Jeremiah using his second chance at life to honour the sacrifice made by J6, and he changes his behaviour in tangible ways in order to live more ethically alongside nonhuman animals.

5.7 Envisioning Posthumanist Futures for Biomedicine

Beyond reimagining the exploitation of pigs in agriculture, the novel also offers readers alternative frameworks through which to consider the future of biomedical research and transplant medicine. One of the implications of the novel's focus on entanglements in biomedicine is that

[1007] Perry, *Pighearted*, 289.
[1008] Trachsel, "Befriending Your Food," 16.
[1009] Trachsel, "Befriending Your Food," 16.

readers are encouraged to view bioethical concerns differently. For example, while other xenotransplantation narratives depict characters struggling to reconcile with the perceived changes that xenograft recipients undergo after receiving an animal organ and explore the discrimination that they face following their surgery,[1010] in *Pighearted*, Jeremiah is not concerned about how a pig heart transplant might change him. Instead, he is significantly more preoccupied with the impact of xenotransplantation on the animal being used as a source of organs. In other words, rather than focusing on the bioethical concerns arising from the threat to Jeremiah's status as a *self-contained human*, the novel instead promotes an approach to the bioethics of xenotransplantation that accounts for the *entangled experiences* of the human recipient and the animal "donor." *Pighearted*'s depiction of xenotransplantation thus aligns with sentimental fiction's exploration of new forms of kinship envisioned between recipient and donor, since, as Russell argues, "[r]ather than seeking a way to resist threats to the individual characterized by narratives celebrating autonomy, sentimentalism offers a pathway for relation and reinvention in the face of death."[1011] As Russell explains, this approach can have important bioethical implications.

Since humanist approaches to bioethics often prioritize autonomy and individuality in medicine, shifting the focus to networks of connection is a key element of *posthumanist* bioethics. As Tana Jean Welch describes in her analysis of posthumanism and medicine, "[a] posthuman perspective provides an avenue for relieving the tension between autonomy and heteronomy through concepts of kinship, mutual accountability, *becoming with*, shared vulnerability, and posthuman

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[1010] See Chapter 2 for an analysis of fears of infectious disease, as well as discrimination against xenograft recipients, in the novel *Pig-Heart Boy* and the short film *We Ate the Children Last*.
[1011] Russell, *Transplant Fictions*, 145.

subjectivity."[1012] In xenotransplantation, since patients are entangled with the animals that provide organs, this requires a new bioethical approach where autonomy and individuality is replaced by the "heteronomy" that Welch describes. Therefore, by depicting the impact of xenotransplantation on both Jeremiah and J6, readers are encouraged to take a posthumanist perspective on bioethics that accounts for the new forms of interspecies entanglements that emerge from biomedicine.

The entanglement of patients and research animals is demonstrated in one of the final scenes before Jeremiah undergoes his transplant procedure. Jazmine takes Jeremiah to say goodbye to J6, who is preparing for surgery in Gen-e-heart's laboratory. As Jazmine and Jeremiah search for J6, they enter a sterile room containing several unconscious pigs hooked up to medical machinery. Because of his own experience recovering from various surgical procedures, Jeremiah immediately recognizes the room as a recovery room, but realizes that in this case it is used for pigs to recover from animal testing procedures, rather than for humans to recover from life-saving surgeries. Jeremiah briefly pauses to interact with one of the pigs: "I wheeled myself closer and reached out to touch his side. It was warm and fuzzy, like J6's. His breathing was ragged and I wasn't sure if he could even feel me, but I gave him a few scratches."[1013] Reflecting on the pig's role as a research animal, Jeremiah apologizes and thanks the pig, and acknowledges "how wrong all of this felt."[1014] While the encounter between Jeremiah and Gen-e-heart's research pig is brief, it is a critical moment of understanding, where Jeremiah is confronted with the exploitation of animals in biomedicine who, unlike J6, will never leave the laboratory. Because these research animals are kept contained, they do not have the same opportunity to form bonds with humans and experience interspecies kinship, and the

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[1012] Tana Jean Welch, *Advancing Medical Posthumanism Through Twenty-First Century American Poetry*, Palgrave Studies in Literature, Science and Medicine (Palgrave Macmillan Cham, 2024), https://doi.org/10.1007/978-3-031-49888-6. 15.
[1013] Perry, *Pighearted*, 264.
[1014] Perry, *Pighearted*, 264.

entanglement between them and human patients goes unrecognized. However, as Jeremiah scratches the unnamed pig, he is able to recognize the role played by countless research animals. As Haraway argues, touch plays a critical role in human/nonhuman entanglements, since it "ramifies and shapes accountability […] Touch, regard, looking back, becoming with—all these make us responsible in unpredictable ways for which worlds take shape. In touch and regard, partners willy nilly are in the miscegenous mud that infuses our bodies with all that brought that contact into being."[1015] The contact between Jeremiah and the unnamed pig has significant bioethical implications for Jeremiah: it results in him recognizing both the similarities that they share as patient and test subject, *and* the differences created by anthropocentric hierarchies prioritizing human life over animal life. Importantly, then, the novel combines the depiction of Jeremiah and J6's relationship with a poignant—if fleeting—consideration of the existence of unnamed research animals.

The depiction of xenotransplantation in *Pighearted* is clearly nuanced and can be read in multiple ways. While the novel still engages in some forms of anthropocentrism, it simultaneously encourages readers to rethink their perspectives on the animals used in biomedicine. The depiction of the bond between Jeremiah and J6, and Jeremiah's shift in perspective on the role of animals not only in xenotransplantation, but in biomedical research more broadly, provide important challenges to the spare parts metaphor. To return to Haraway's discussion, "[c]ompanion species take shape in interaction. They more than change each other; they co-constitute each other, at least partly."[1016] This "co-constitution" through "interaction" is evident in *Pighearted* in the ways that Jeremiah and J6 shape each other's perspectives on the world. In contrast to the notion that pigs are disposable sources of spare parts that can be easily transferred and reused across species boundaries, *Pighearted* instead

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[1015] Haraway, *When Species Meet*, 36.
[1016] Donna Haraway, "Cyborgs to Companion Species: Reconfiguring Kinship in Technoscience," in *The Haraway Reader* (Routledge, 2004). 307.

shows a more complex entanglement between the human patient and the donor pig, where the two do indeed co-constitute one another as companion species. Beyond this, Jeremiah's reflection on research animals demonstrates that his relationship with J6 has had widespread implications for how he views nonhuman animals and medical research.

While *Pighearted* does not promote xenotransplantation as the "solution" to the shortage of human organs, it also does not encourage readers to reject or fear biomedical experimentation. Instead, it suggests alternative paths forward for transplant medicine. For example, Dr. Willis explains early in the novel that Gen-e-heart's xenotransplantation program is coming to an end, and their efforts will be redirected by "pouring millions into new lab-grown hearts that don't require pigs."[1017] While these artificial hearts are still considered "too experimental"[1018] for use in human patients, Dr. Willis later uses one to save J6's life. The novel indicates, then, that perhaps these artificial hearts can eventually become a successful treatment option for human patients as well—a sentiment that Perry echoes in her author's note.[1019] And just as the novel does not condemn science and medicine in general, nor does it depict the medical practitioners as simplistic "mad" scientists.[1020] While both Dr. Willis and Jazmine—two characters representing the medical perspective throughout the novel—had initially been unable to see J6 as worthy of moral status, both characters are shown changing their opinion on the use of pigs in xenotransplantation by the end of the novel. And interestingly, while Dr. Willis and Jazmine are J6's primary antagonists throughout the novel, he does not view medicine or science in a negative light. For example, even after discovering the truth about

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[1017] Perry, *Pighearted*, 24.
[1018] Perry, *Pighearted*, 130.
[1019] Perry, *Pighearted*, 292.
[1020] Jeremiah does think that Dr. Willis might be a "mad scientist" after she reveals the truth about J6. Perry, *Pighearted*, 131. However, she is portrayed as a more complex and sympathetic character throughout the novel. She expresses compassion for both Jeremiah and J6: to give Jeremiah the best chance at survival, she gives his family the option to go ahead with the pig heart transplant even though Gen-e-heart had chosen to end the program; later, she risks her job by stealing one of Gen-e-heart's experimental artificial hearts to save J6.

his intended purpose as a medical object, J6 still seems to view medical practitioners working in the field of transplant medicine positively: while daydreaming about a future where Jeremiah recovers from his heart transplant, J6 considers the professions that Jeremiah could pursue, including the possibility that perhaps "[h]e'll have studied so hard that he'll become a doctor who can help kids with heart problems."[1021] Importantly, then, the novel does not encourage readers to fear medical professionals or scientific development. Instead, by critiquing the ethics of using pigs in xenotransplantation *without* drawing on cultural fears about the dangers of science and medicine, *Pighearted* encourages readers to consider the role that pigs play in the field of transplant medicine and to envision biomedical futures beyond the exploitation of nonhuman animals.

This depiction can have important implications for how readers understand xenotransplantation. In Jaques' analysis of children's literature and posthumanism, she argues that "[b]oth children's fiction and posthumanism […] might be said to have the unique potential to offer a forward-focused agenda that unites the possibilities of fantasy with demonstrable real-world change."[1022] In other words, by imagining different possible ways of being and interacting, children's and YA literature can encourage readers to shift their perspectives on the world and to identify how they can choose to act in more ethical ways. By depicting the ongoing impacts that J6 has on Jeremiah, *Pighearted* aligns with what Francesca Ferrando refers to as existential posthumanism, which she argues "changes ways of existing, allowing us to ask not only ontological macro-questions, but also *practical micro-questions* related to our daily routines."[1023] While *Pighearted* certainly poses "ontological macro-questions" about how the entanglements between pigs and humans in

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[1021] Perry, *Pighearted*, 267.
[1022] Jaques, *Children's Literature*, 6.
[1023] Francesca Ferrando, "Existential Posthumanism: A Manifesto," in *More Posthuman Glossary*, ed. Rosi Braidotti et al. (Bloomsbury Academic, 2023). 48. Emphasis added.

biomedicine could change the we view ourselves and our relationships with the nonhuman world, it also poses important micro-questions about the day-to-day interactions between humans and animals for readers to consider as well. Ultimately, the novel suggests that pigs like J6 are not simply a source of spare parts for human use: instead, they are beings worthy of care and moral status, and actions like reducing meat consumption, volunteering with animal rescue initiatives, and reconsidering the role of animals in biomedical research are presented as viable ways to reimagine our relationships with the nonhuman world.

5.8 Conclusion

Is it possible to reimagine a future beyond commodification and exploitation for xenotransplantation? In a field where genetically modified animals are created exclusively for the purpose of being sacrificed to provide organs for human patients, it is easy for the spare parts metaphor to dominate biomedical discourse around xenotransplantation. And yet, there are ways to encourage public audiences to examine how this metaphor shapes our recognition of the use of nonhuman animals in biomedical research and transplant medicine. By reimagining the relationships between humans and chimeric pigs, novels like *Pighearted* can play a vital role in imaging alternative futures outside of this exploitative framework. By shifting the perspective on pigs from seeing them as organ incubators to instead imagining the possibility of interspecies kinship and care, *Pighearted* asks readers to reconsider their own perspectives on the ways that we use animals in experimental medicine, and how we can make decisions to live more ethically alongside the nonhuman world. As xenotransplantation continues to develop, SF can envision important alternatives to the spare parts metaphor that dominates biomedical discourse, thereby helping us to navigate bioethical and animal rights concerns and to consider the new forms of interspecies entanglements that might emerge.

Conclusion: The Speculative Futures of De-Extinction and Xenotransplantation

As I've immersed myself in the study of de-extinction and xenotransplantation over the past few years, one of the most striking aspects has been the rapid acceleration of developments in both fields. At the time that I started my research, Colossal Laboratories & Biosciences had just launched their woolly mammoth project, and within a few months, the University of Maryland School of Medicine conducted the first pig heart transplant into a living patient. Since then, Colossal has announced four additional candidate species *and* the supposed "de-extinction" of the dire wolf. Meanwhile, at least five more patients have undergone pig organ transplants, and both eGenesis and United Therapeutics have begun clinical trials of xenotransplantation. In the past month alone, there have been two significant developments that mark the rising stakes of de-extinction and xenotransplantation. First, in August 2025, Colossal's genetically modified "dire wolf" pack grew, with the youngest of their genetically modified wolves, Khaleesi, being introduced to the two older wolves, Romulus and Remus.[1024] Meanwhile, September 2025 marked the six-month anniversary of Tim Andrews' pig kidney transplant, making this case the longest lasting pig organ transplant.[1025] Developments are moving quickly as these formerly speculative fields are becoming increasingly real, making research on the ethics of de-extinction and xenotransplantation not just timely, but also more urgent than ever.

[1024] Mike Snider, "Dire Wolf Meet-up: Watch Colossal's Female Wolf Frolic with Older Brothers," *USA TODAY*, August 12, 2025, https://www.usatoday.com/story/pets-animals/wildlife/2025/08/12/colossal-dire-wolves-first-meeting/85619341007/.

[1025] Rachel Fieldhouse, "'Amazing Feat': US Man Still Alive Six Months after Pig Kidney Transplant," *Nature*, ahead of print, September 8, 2025, https://doi.org/10.1038/d41586-025-02851-w.

As a core contribution of my research, I hope to have highlighted the range of pressing ethical concerns about de-extinction and xenotransplantation, while also demonstrating how a posthumanist approach to bioethics and environmental ethics can help us to navigate the future of biotechnology, and to shape that future as it forms. As Susan Squier argues in her discussion of liminal lives, these figures who are created in biomedical experimentation "raise profound and complex ethical questions that the field of contemporary bioethics has yet to adequately address, largely because of its *indifference to the epistemological power of fiction*."[1026] As Squier notes, fiction has significant potential to contribute to bioethics (and, I would add, environmental ethics). Jay Clayton, similarly, argues that fiction should be taken seriously in discussions about science policy, and that literary analysis can provide an important tool in policy conversations. Drawing on narratives that explore genetics, Clayton outlines ways for literary scholars to engage in discussions around science policy, since fiction can "present questions that urgently need answering in all the complexity and ambiguity that policy makers need to grasp. By exploring the dense cultural networks that shape science and technology, these novels help us see multiple dimensions of policy issues that might be opaque to other forms of analysis."[1027] While my own analysis in this dissertation has focused primarily on ethical considerations, future work could certainly be done to extend the analysis of de-extinction and xenotransplantation narratives to consider what literary studies can contribute to conversations about the policy landscape around these fields.

While it is not always easy to identify the impact of fiction, one of the ways that it can shape how audiences respond to new scientific developments is by encouraging new perspectives beyond

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[1026] Susan Merrill Squier, *Liminal Lives: Imagining the Human at the Frontiers of Biomedicine* (Duke University Press, 2004). 4-5. Emphasis added.
[1027] Jay Clayton, *Literature, Science, and Public Policy: From Darwin to Genomics* (Cambridge University Press, 2023), https://doi.org/10.1017/9781009263504. xviii.

anthropocentrism and technosolutionism. Sherryl Vint argues that speculative fiction (SF) can be particularly important for posthumanist analysis by "offer[ing] a deep archive of ways of thinking about different embodiment, nonhuman agency, and diverse futures, often at scales far beyond a human lifetime, at times beyond the lifetime of our species."[1028] Through this, she argues, it becomes "a valuable methodology for rethinking our species to make a more livable world."[1029] The novels, short stories, and films that I investigated provide an important perspective from which to consider the potential posthumanist futures of de-extinction and xenotransplantation, and what a "more livable world" might look like in these cases. Each of these texts provide an opportunity to bring posthumanism into the conversation about de-extinction and xenotransplantation, and to reimagine what our relationships with these new biotechnologies might encompass.

Across my analyses of de-extinction and xenotransplantation narratives, I have been particularly interested in tracing the types of scientific futures that these stories envision, and how these depictions engage with different views on biotechnology. As Elaine L. Graham argues, while technophobia and technophilia are often viewed as oppositional, they are based on the same understanding of technology: "Technophobia, ostensibly, seems to be driven by a denial of progress, fear of change, loss of control; but the evidence suggests that so-called technophilic attitudes are subtended by similar projections, valorizing technologies as protections against fears of vulnerability, contingency, impurity and morality."[1030] Perhaps it is not surprising, then, that the real-world rhetoric around de-extinction and xenotransplantation is highly techno-optimistic and technosolutionistic, while fiction frequently tends to focus more on the potential risks posed by new biotechnologies.

[1028] Sherryl Vint, "Speculative Fiction," in *After the Human: Culture, Theory, and Criticism in the 21st Century*, ed. Sherryl Vint (Cambridge University Press, 2020). 232.
[1029] Vint, "Speculative Fiction," 232.
[1030] Elaine L. Graham, *Representations of the Post/Human: Monsters, Aliens and Others in Popular Culture* (Manchester University Press, 2002). 230.

The techno-optimism and technosolutionism of de-extinction and xenotransplantation quickly becomes evident from an analysis of the language used by companies and researchers working in these fields. Proponents of both fields, as I have shown, frequently frame de-extinction and xenotransplantation in the context of revolutionary human health and environmental outcomes. In xenotransplantation, companies like Makana Therapeutics, eGenesis, Qihan Biotech, and Revivicor have made claims about how their work is "[p]ushing the bounds of what's possible in transplantation,"[1031] with the goal of "eliminating the organ shortage crisis and *delivering hope*."[1032] Since "[x]enotransplantation is *a key solution*,"[1033] these companies promise to "[c]onstantly strive forward, race against time, and *battle against illness*."[1034] Meanwhile, in de-extinction, companies like Revive & Restore and Colossal claim to be "developing the science *that will save us*, our planet and the species that inhabit it,"[1035] since they "*see opportunities where others see risk* and act boldly to affect change."[1036]

On the other hand, there are clear anxieties in fiction about the potential risks posed by scientific developments, especially when it comes to the use of genetic engineering tools. These anxieties are visible in the way that, across de-extinction and xenotransplantation narratives, there are recurring references to the idea of unethical experimentation—and in several cases, direct references to *Frankenstein* and other stories about scientific creation. This pattern becomes clear across the following examples:

[1031] eGenesis, "Engineering Hope," accessed September 11, 2025, https://egenesisbio.com/.
[1032] Makana Therapeutics, "Makana Therapeutics," accessed June 23, 2023, https://makanatherapeutics.com/xenotransplantation/. 2:30-2:50. Emphasis added.
[1033] Revivicor, "Home," accessed September 11, 2025, https://www.revivicor.com/. Emphasis added.
[1034] Qihan Biotech, "Our Culture," accessed September 11, 2025, https://www.qihanbio.com/careers#culture. Emphasis added.
[1035] Colossal Laboratories & Biosciences, "Colossal," August 16, 2021, https://colossal.com/. Emphasis added.
[1036] Revive & Restore, "What We Do," accessed September 11, 2025, https://reviverestore.org/what-we-do/. Emphasis added.

***Pig-Heart Boy*:** "I just feel that it's *a Pandora's box* you're trying to open here. I wonder if you've really thought about the implications of what you want to do."[1037]

***We Ate the Children Last*:** "It's wrong! It's dead wrong when we *befoul the sanctity of the human body* with that of an animal."[1038]

***Chromosome 6*:** "'I'm a molecular biologist,' Kevin explained with a sigh of regret. 'Someone who overstepped his bounds and committed *a Promethean blunder*.'"[1039]

***Oryx and Crake*:** "What you're doing—this pig brain thing. You're interfering with the building blocks of life. It's immoral. It's… *sacrilegious*."[1040]

***Pighearted*:** "I caught Mom looking down at a big piece of gauze taped to my chest. It hid a scar straight out of *Frankenstein*. I tried to touch it, but my arms were tied up in tubes and wires."[1041]

***Jurassic World*:** "You are acting like we are engaged in some kind of *mad science*. But we are doing what we have done from the beginning. Nothing in Jurassic World is natural."[1042]

***The Neanderthal's Aunt*:** "Theo Barlas told me that his company, Barlas Labs, had developed a technology that could be used to re-create extinct species based on their DNA sequence. *Yes, I know what you're thinking—Jurassic Park, right*? No, I'm not going to put a dinosaur on the shared roof deck!"[1043]

***Ghost Species*:** "After that she seeks out other movies, not just about cavemen but about robots and monsters and patchwork people, all the uncanny golems of the Gothic imagination. Across that winter and into the summer she watches everything she can find, looking for guidance in films: *Frankenstein*, *Splice*, *Blade Runner*."[1044]

"The Birdsong Fossil": "Evan's eyes were wide with awe and apprehension. '*Are we supervillains yet*?'"[1045]

Some of these examples draw on well-known stories like *Frankenstein*, *Jurassic Park*, *Blade Runner*, and the myths of Prometheus and Pandora. Others incorporate broader references to mad science,

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[1037] Malorie Blackman, *Pig-Heart Boy* (Corgi Books, 1997). 36. Emphasis added.
[1038] *We Ate the Children Last*, directed by Andrew Cividino (Film Forge, 2011), 12:04, https://vimeo.com/27633865. 6:10-6:17. Emphasis added.
[1039] Robin Cook, *Chromosome 6* (Penguin Random House, 1997). 429. Emphasis added.
[1040] Margaret Atwood, *Oryx and Crake* (Vintage Canada, 2003). 57. Emphasis added.
[1041] Alex Perry, *Pighearted* (Little, Brown and Company, 2021). 28.
[1042] *Jurassic World*, directed by Colin Trevorrow (Universal Pictures, 2015). 52:05-52:14. Emphasis added.
[1043] Gina DeMarco, *The Neanderthal's Aunt* (Science Thrillers Media, 2014). 4. Emphasis added.
[1044] James Bradley, *Ghost Species* (Hodder Studio, 2020). 178-179.
[1045] D.K. Mok, "The Birdsong Fossil," in *Multispecies Cities: Solarpunk Urban Futures* (World Weaver Press, 2021). 312. Emphasis added.

sacrilege, and supervillains. In both cases, these references show that stories about de-extinction and xenotransplantation are frequently positioned within broader cultural anxieties about the ethical risks posed by scientific experimentation, particularly the implications for the human body and identity.

Are these narratives, then, simply a response to the techno-optimism of de-extinction and xenotransplantation discourse? In Daniel Dinello's analysis of "technophobic" attitudes towards science in SF, he explains that the term "is meant to suggest an aversion to, dislike of, or suspicion of technology rather than an irrational, illogical, or neurotic fear."[1046] Dinello argues that technophobia is widespread throughout the genre of SF, since "[m]ost science fiction […] projects a pessimistic vision of posthuman technology as an autonomous force that strengthens an anti-human, destructive, and repressive social milieu."[1047] An example of technophobia in SF can be seen in what R.L. Rutsky refers to as the "Frankenstein scenario," which "involves any case where a technology created by human beings ceases to be a tool or servant and rebels against its creators, usurping the place supposedly reserved for humans and becoming the master rather than the servant."[1048] It is perhaps unsurprising that "Frankenstein scenarios" are found in de-extinction and xenotransplantation narratives, especially those that overlap with the horror genre. For example, throughout the *Jurassic World* movies, the cloned and genetically modified dinosaurs repeatedly escape human control on larger and larger scales, eventually being freed by a cloned and genetically modified human girl. Meanwhile, in *We Ate the Children Last*, Porsicure patients become increasingly threatening not just because some of these patients have become violently hungry as a side effect of their procedure, but also because they blur the boundaries between human and nonhuman. While the *Jurassic World* films

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[1046] Daniel Dinello, *Technophobia! Science Fiction Visions of Posthuman Technology* (University of Texas Press, 2005). 8.
[1047] Dinello, *Technophobia!*, 17.
[1048] R.L. Rutsky, "Technologies," in *The Cambridge Companion to Literature and the Posthuman*, ed. Bruce Clarke and Manuela Rossini (Cambridge University Press, 2017). 183.

and *We Ate the Children Last* might be the most obvious examples of the "Frankenstein scenario," concerns about the ability to control technology, and the risks posed to human identity and society should that control be lost, are evident across most of the narratives that I have analyzed.

While each of the fictional depictions of xenotransplantation and de-extinction do reference the potential for unethical scientific experimentation, and several envision drastic "Frankenstein scenarios," I would argue that most of these examples are far more nuanced than simply being "pro-" or "anti-" de-extinction or xenotransplantation. Across xenotransplantation narratives, there is a deep concern about the risks of exploitation, both of patients and of nonhuman animals. Narratives frequently invoke various bioethical considerations, including the risks of discrimination against xenograft recipients, concerns about transplant tourism, and questions about animal welfare and rights. However, there is also a distinct thread throughout these narratives focusing on more hopeful futures, including futures where xenotransplantation is widely accessible by transplant patients—potentially resulting in the alleviation of the organ shortage and the restoration of patients' bodily autonomy—and where xenotransplantation is replaced by artificial organs—potentially driven by or resulting in interspecies kinship with nonhuman animals. In de-extinction narratives, meanwhile, there certainly are fears about the escape of genetically modified animals and the subsequent ecological impact of their release. Additionally, there are anxieties about what de-extinction will mean for humans, such as the potential alteration of humans through genetic engineering, and the commodification of human bodies and genetic material by biomedical corporations. On the other hand, there are also hopes about ecological restoration, multispecies kinship, and co-existence.

Ghost Species and *Pig-Heart Boy* are two particularly compelling examples, given that they both follow the perspective of characters who have been altered by technology. *Pig-Heart Boy* shows Cameron navigating life after undergoing a pig heart transplant, while *Ghost Species* shows Eve

learning about her identity as a Neanderthal. Neither Cameron's experience as a xenograft recipient (which has adverse physical and social implications for him) nor Eve's experience as a de-extinct Neanderthal (as she struggles with isolation and feels shame over her physical differences) align with the high hopes expressed for these biotechnologies to solve medical and environmental problems. However, neither of these stories necessarily condemns biotechnological intervention into the body. Unlike in *We Ate the Children Last*, where Porsicure patients are discriminated against and eventually executed, *Pig-Heart Boy* instead ends with Cameron coming to terms with the drawbacks of xenotransplantation and choosing to undergo a second procedure. Meanwhile, unlike the *Jurassic World* films, which end with Maisie choosing to see herself as human, *Ghost Species* instead ends with Eve leaving human society and meeting other de-extinct Neanderthals. *Pig-Heart Boy* and *Ghost Species* therefore offer more nuanced approaches to biotechnology: they emphasize the ethical risks by depicting the challenges that their protagonists face due to their biotechnological creation or modification, while also envisioning these characters' desires to experience the futures that xenotransplantation and de-extinction hold for them. Just as Graham points out "the inadequacy of the polarization of technophobia and technophilia,"[1049] then, it appears that this distinction is equally inadequate when it comes to de-extinction and xenotransplantation narratives.

The futures for conservation and transplant medicine envisioned in "The Birdsong Fossil" and *Pighearted* are even further removed from the technophobic/technophilic divide. Both stories depict distinctly *hopeful* futures of biotechnological intervention, but without reinforcing the technosolutionism found in de-extinction and xenotransplantation discourse. "Birdsong Fossil" critiques a hype-fueled approach to de-extinction and positions multispecies curiosity and posthumanist technological design as core aspects in making de-extinction a viable conservation

[1049] Graham, *Representations of the Post/Human*, 230.

strategy. *Pighearted* provides a slightly more complicated depiction of technology as it envisions the future of transplant medicine. While the novel critiques the use of chimeric pigs as a source of organs, it does not depict either the pigs developed for xenotransplantation, nor the patients who receive xenografts, as monstrous or threatening. Instead, J6 and Jeremiah form a close bond based on interspecies care, kinship, and entanglement, both before and after the transplant takes place. And while the novel is critical of the reliance on nonhuman animals in xenotransplantation, it encourages readers to consider other ways that biotechnology can be used to address the organ shortage, such as artificial organs. These stories therefore align with a newer trend in SF: while Rutsky points out the prevalence of Frankenstein scenarios, he notes that SF has increasingly moved towards more nuanced depictions of technology and technological beings, since

> there have been a growing number of cases in recent years where the representation of living or autonomous technologies has broken from the opposition that casts good technologies as *controllable and subservient*, on the one hand, and technologies that are out of human control as *dangerous threats*, on the other hand.[1050]

Neither "Birdsong Fossil" nor *Pighearted* envisions the biotechnological beings created in de-extinction and xenotransplantation as "dangerous threats," but nor do they depict them as "controllable and subservient." Instead, the robotic/biotic animals in "Birdsong Fossil," along with the chimeric pig in *Pighearted*, are shown developing relationships with human characters, while also finding new ways to exist *beyond* merely being "solutions" to human problems.

This brings me back to the idea of the biotechnological stray. These figures who are created using biotechnology blur the boundaries between technology and biology, while also subverting the idea that biotechnology must either be viewed in terms of its ability to improve human existence, or in terms of the challenge it poses to human identity. As Barbara Creed argues, "[a] stray ethics offers

[1050] Rutsky, "Technologies," 184. Emphasis added.

a new aesthetic that unsettles established positions. It is the stray thought and outside point of view that shifts the ground from under us, which can offer the most radical and transformative insights."[1051] The perspectives of characters who are cloned, genetically modified, or undergo experimental medical procedures in the *Jurassic World* films, *Ghost Species*, *We Ate the Children Last*, and *Pig-Heart Boy* can be one useful way to consider the blurring of these boundaries. However, these characters are often depicted as being uncomfortable with biotechnological alterations to their bodies and the role of technology in shaping their identity. In contrast, *Pighearted* and "Birdsong Fossil" do not depict biotechnological intervention into the body as a source of anxiety. Perhaps, then, the "most radical and transformative insights" are those offered by the depictions of the robotic/biotic animals in "Birdsong Fossil," and the chimeric pig in *Pighearted*.

In Heather Alberro's analysis of ecotopian fiction including "Birdsong Fossil," she too draws on Creed's stray ethics. Alberro argues that strays can be found in "interstitial spaces," which "are also home to radical utopian possibility, to the potential for new ways of living and being to be born that challenge and transgress established norms."[1052] While Alberro is specifically discussing the formation of ecotopian societies where humans and nonhumans live alongside one another, I would extend this further to argue that "Birdsong Fossil" and *Pighearted* specifically envision the radical and transformative possibilities of living in increasingly entangled relationships with biotechnology. Both "Birdsong Fossil" and *Pighearted* envision a future where technology and biology unexpectedly intermingle. For example, "Birdsong Fossil" ends with the merging of technology and biology as the "de-extinct" animals—a combination of robotic and genetically engineered beings—are rewilded. These animals become closely entangled, creating new ecosystems as the robotic animals teach the

[1051] Barbara Creed, *Stray: Human-Animal Ethics in the Anthropocene* (Power Publications, 2017). 101.
[1052] Heather Alberro, *Terrestrial Ecotopias: Multispecies Flourishing in and Beyond the Capitalocene* (Peter Lang Verlag, 2024). 140.

biotic animals the behaviours of their extinct predecessors. Meanwhile, *Pighearted* ends with J6, the chimeric pig, and Jeremiah, the human boy with a pig heart, being reunited. Biotechnology has altered both of their bodies: J6 was created using genetic engineering before later undergoing an artificial heart transplant, while Jeremiah's cells were used to create the chimeric pig whose heart now beats in his body, entangling them both with each other and with biotechnology in ever closer ways. In Rutsky's analysis of the changing depictions of technology in SF, he argues that "this shift in representation suggests that a similar shift has taken place—or is in the process of taking place—in how we see, understand, and relate to technology."[1053] From this perspective, both "Birdsong Fossil" and *Pighearted* seem to suggest biotechnological futures where the urge to control biotechnology becomes superseded by possibilities both for new forms of multispecies kinship as well as for conceptions of identity that extend far beyond the biology/technology divide.

Francesca Ferrando argues for the need to adopt posthumanist thought as a practical way of living, an approach that I have argued is explored in both *Pighearted* and in "Birdsong Fossil." These depictions, then, could be the most meaningful for inspiring ethical futures for de-extinction and xenotransplantation, rather than the more dramatic examples of societal collapse and biotechnological catastrophes depicted in other texts. As Ferrando argues, the goal of critical posthumanism is not to encourage human extinction as a way of ending the damage caused by anthropocentrism, since "[t]his celebratory self-extinction scenario still relies on a dichotomous approach of 'good' versus 'evil,' which does not bring ultimate change. The solution is to be found not in self-inflicted, although joyful, extinctions but *in becoming self-aware*."[1054] "Birdsong Fossil" and *Pighearted* can certainly model this awareness: while one envisions a future where humans express curiosity about (and

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[1053] Rutsky, "Technologies," 184.
[1054] Francesca Ferrando, *The Art of Being Posthuman: Who Are We in the 21st Century?* (Polity Press, 2024). 53. Emphasis added.

therefore awareness for) the underappreciated species that are often forgotten in conservation, the other promotes an awareness of the often-unseen animals that are created and then sacrificed in medical laboratories. By straying from their usual realm in these narratives, these beings—and the ethical considerations arising from their creation—become harder to ignore.

This awareness becomes especially critical as biotechnology and biomedical corporations continue to optimistically offer solutions to environmental and medical crises and promise futures where disease and ecological destruction can be overcome using biotechnology. While it may be doubtful that either of these fields is the "solution" to the problems they claim to address, this does not mean that we need to reject technology, either: as both "Birdsong Fossil" and *Pighearted* show, it is possible to envision biotechnological futures beyond anthropocentrism, techno-solutionism, and commodification. Taking a critical posthumanist and multispecies perspective to these fields is, I believe, an essential step in establishing ethical futures for de-extinction, for xenotransplantation, and for the many other biotechnological developments that the future holds.

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